A CONCEPTUAL WATER RESOURCE ACCOUNTS FRAMEWORK IN THE PHILIPPINES

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ABSTRACT

Sustainable development aims to find patterns of production and consumption that can be continued indefinitely without degrading the natural stock -- including 'natural capital' stocks. By so doing care is taken that future generations will have similar options open to them as the current generation.

Achievement of sustainable development might bring about conflicts since sustainability implies the setting of limits on resource use. This will imply costs and the need to make decisions about trade-offs. Especially in developing countries, such decisions will be difficult to make and will require good data and information.

To know if development is progressing sustainably, full account needs to be taken of improvements in or deterioration of the stock of natural capital. This aspect of resource monitoring is called natural resource accounting (NRA). The tool of NRA addresses some of the shortcomings in the current system of national accounts (SNA), such as the treatment of defensive expenditures, environmental degradation, and the physical depletion of natural assets. Neglect of accounting for the use, degradation and depletion of natural resources may lead to serious implication for a country.

Economists in different countries have attempted to adopt, or modify the current SNA through accounting activities using two approaches: physical and monetary accounting of changes in the resource stock over time. Natural resource accounting extensively used the physical approach as it achieves a relatively complete and consistent set of physical accounts for both stocks and flows of the natural and environmental capital.

The initial attempt by some has inspired the other to follow. Steps taken with regard to natural resource accounting, in different countries, vary the importance of natural resources in the countries overall development, and the priorities and needs of

that country. In the Philippines, priority has been given to resource accounting for fresh water with the aim to improve the management and conservation of this resource as it has become an ecological flashpoint in this country.

In most developing countries, one of the major impediments to adjusting the SNA by using NRA, is the incompleteness, inaccuracy, and fragmentation of data and information and, the skepticism held by many regarding the availability of skills within those countries to undertake the work. Further, much controversy has arisen among practitioners regarding a common numeraire for the NRA methodology and possible valuation of resource stock changes.

This study basically builds a conceptual water resource accounts framework that should be viewed as an 'ideal'. Specifically, in developing this framework the study aims at demonstrating the need for such accounts and points to research and data gathering that needs to take place to make NRA a reality in the Philippines. The study builds on overseas work that has taken place in this area.

The overall conclusion of the study is that the conceptualised framework cannot, as yet, be implemented in the Philippines. The reasons are explained and concern in the main data availability and skills. However, in the building of this framework and the matching of the available data, clear guidelines have been discovered with regard to data gathering, needed accuracy, agency involvement, manpower requirement, and integration with other NRA efforts in the Philippines.

The construction of the framework is that be seen as a practical start to think clearly about water, its use and conservation. The framework can now be used as a 'template' to guide further research work and data collection, and in due time become resource accounts for freshwater to aid in decision making process to achieve a sustainable future.

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INTRODUCTION

1.1 Sustainable Development and the Need for Natural Resource Accounting

The basic theme of the 1992 "Earth Summit", the United Nations Commission on Environment and Development (UNCED) Conference and also of the World Bank's 1992 World Development Report on Environment and Development, was sustainable development. It has become the principle behind much decision making on economic development, environmental protection and the founding of professional organizations such as the International Society for Ecological Economics (Toman, 1994). Debates on its context and policy implications have driven interdisciplinary reactions. Though its meaning has yet to be discussed and defined in detail (Radermacher, 1994), it has triggered tremendous responses from all over the world. Different policy tools and economic instruments have been formulated and tried by different countries as they move towards its achievement.

Sustainable development is basically not a new concept. However, its significance in policy decisions has increased over the last decade to a global clamor for the improvement of and sustenance for the quality of life. The aim today is to find sustainable patterns in production and consumption that will not impair the natural and environmental resources of planet earth for present and future generations. Stress is on the importance of permanent growth and development (Pearce and Warford, 1993), capturing the idea of constant capital stock - both physical and environmental. This is tantamount to the Brundtland definition of sustainable development:

> ...development that meets the needs of the present without compromising the ability of future generations to meet their own needs. (Pearce, Markandya & Barbier, 1989; Carson,1994).

The concept is indeed encompassing, and includes both ecological conditions and social values. Only by considering science together with socio-economic values, can sustainability evolve to the point of offering better guidance for social policy (Toman, 1994). For a social policy to be effective, economic and ecological concepts should meet. This calls for the analysis of the natural environment according to economic, ecological and social functions. In a broader context, this embodies the interdependence of human beings with their environment. The concept is wrapped up with human values and institutions, not just economic and ecological functions: for without ecological underpinnings economic analysis can be misleading. Indeed,

> Maintaining our life-support system remains primarily the ecological standpoint. Whereas, the task of ecological economics is to seek ways to keep human society within sustainable bounds. The boundaries refer to the capacity of the environment to support human activities at various scales. (Radermacher, 1994).

A management regime that allows sustainability requires a knowledge of the economic and ecological bounds of natural and environmental resources both renewable and non-renewable. In particular, to achieve these sustainable bounds, knowledge is necessary of the sustainable rate at which these resources should be used to maintain stocks at a level that allows a renewable resource to renew itself while a sustainable yield is taken. Sustainable depletion of non-renewable resources happens in special circumstances, when its depletion is justified by the alternative investment of its depletion value to other substitute sources of income that would generate and or maintain equal benefits in the future. Investment preferences generally may differ from country to country. Though investment in human capital is needed before investment in natural capital, both, however, require profound institutional changes in industrialized and developing countries. The greatest challenge to economics and ecology, therefore, is that sustainable development will demand a reshaping not only of our relationships with nature but also of our relationship with each other.

A particular concern of this thesis is the achievement of sustainable resource uses. However, sustainable resource uses are bound by several economic arguments. From a microeconomic perspective, private property rights or well-defined property rights are the key to sustainability. Again, it requires maintenance of the resource stock; and only in special circumstances is the depletion of stock is justified. This concept is linked to the precautionary principle which embodies the sources of lack of sustainability and market failures. The latter happens due to the presence of externalities and the inappropriate use of shared resources due to defects in property rights systems, for example when resource characteristics are open-access or pure public good. Even where private property rights are well-defined, there are still doubts about the ability of the actual market system to ensure the desired levels of economic sustainability.

Apart from the knowledge of sustainable stocks or level of environmental and natural resources, environmental risks and hazards are also important issues.

Obviously, in the process of achieving sustainability, ecological and economic issues need to be reshaped and addressed. This might have complications for some countries, especially resource-based countries. One of the implications is that conditions in resource-user countries, usually less developed, might make reaching this mode difficult. Because sustainability sets limits to resource use, and creates costs in its implementation, resource-user countries are likely to suffer from the tradeoffs of sustainable development. And these resource-user countries are mostly developing countries. The Brundtland reports (WCED, 1987) suggest that such a transition will be impossible in LDC, unless poverty can be eliminated. Furthermore, Smith and Warr (1991) cited:

> The earth is one but the world is not...there will be no sustainable development in the world if this takes place only in the North. There can be no sustainable development, as long as poverty is a scourge from which more than one million people suffer. (Smith & Warr, 1991: p. 282).

Nevertheless, countries from different economic regions (developed, developing and less developed) have shown awareness of and have responded to the need for achieving sustainable development.

To achieve sustainability, we need to incorporate ecosystem goods and services into economic accounting. In all small countries, rich or poor, economic development must take full account in its measurement of growth of the improvement or deterioration in natural resources (Repetto, 1990).

The concept of sustainable development carries in it the idea that activities can be sustained. To sustain the activities requires that the stock of capital on which these activities depend for inputs remains constant. A declining total stock would imply that, barring technological change, less could be done in the future.

Indicators of sustainable development will, on the one hand, show increases in output and incomes but should, on the other hand, also indicate what is happening to the stock of natural and man-made resources - i.e. countries (especially small ones), rich or poor, must take full account of the improvement or deterioration in the stock of natural capital (Repetto, 1990). This latter aspect of resource monitoring is called natural resource accounting.

The idea of natural resource accounting has basically grown from the shortcomings of the current system of national accounts (SNA).

For over fifty years, the SNA provided an information framework suitable for analysing the performance of the economic system (Repetto *et al.*, 1989) by providing indicators of economic growth, the Gross National Product (GNP) or Gross Domestic Product (GDP), and the Net National Product (NNP). These indicators were calculated based on market values. Mansfield (1977) defines GNP as the value of final goods and services produced by a country i.e. a reflection of a country's production capacity. The NNP is tagged as being more accurate because it takes into account the depreciation of man-made assets, the capital or equipment used in producing the year's output. These figures have been very useful for economic policy and planning, they are used to classify countries into developed, developing, least developed, rich or poor categories.

However, in the face of a changing environment as is happening today, the way the SNA is calculated is less useful for gauging long-term sustainable growth and welfare, for which measures, broader than the monetary measure of income of goods and services produced; are needed:

> The gross national product (GNP) does not allow for the health of our children, the quality of their education, or the joy of their play. It does not include the beauty of our poetry or the strength of our marriages; the intelligence of our public debate or the integrity of our officials. It measures neither our wit nor our courage neither our wisdom nor our learning; neither our compassion and devotion to our country; it measures everything, in short, except that which makes life worthwhile. (President John F. Kennedy, *Finance & Development*, 1993: p. 20).

It is seen to discourage the implementation of policies that result in sustained development (Lutz & Munasinghe, 1991).

The deficiencies of the SNA with regard to natural resources and the environment have been noted by many. Several economists have attempted to adapt, modify or correct the accounts. An example of such is the work by William Nordhaus and James Tobin (Mansfield, 1977). They corrected the GNP figures by accounting for among other things the value of leisure, housewives' services, and the environmental effects of production (Mansfield, 1977; Cabe & Johnson, 1990). The measure of economic welfare (MEW) which resulted sought to extend and remove anomalies from the officially reported national income and product aggregates in several areas. However, environmental and natural resource issues, specifically treatment of environmental protection costs and the degradation and depletion of natural resources, are still not properly dealt with (Cabe & Johnson, 1990; El Serafy & Lutz, 1989). Apparently, while the depreciation of reproducible wealth is subtracted from the GDP to obtain NDP, there is no parallel calculation for any depreciation in the stock of natural resources (ENRAP Main Report, 1994). The conventional accounts further overlook important inputs and outputs that characterize a nation's "production function" - inputs and outputs that have economic significance but are neglected because they lack market-determined values and prices (ENRAP Main Report, 1994). And as Wright (1989) cites from Hueting's report (1989):

> Tomorrow's scarcity is not reflected in today's price.

Prices no longer tell the truth and this in one way or another has a bearing on information or data resources. Hence the implementation of theoretical economic models has not been successful. This means that "the information problem is no longer a marginal issue but of a central nature and must influence the way theoretical models are set up". (Radermacher, 1994). Thus, these indicators are criticized for providing wrong signals to policy makers and decision makers. Programs and policies based on them have caused serious resource depletion and environmental degradation, particularly in resource-based countries, which are in most cases, developing countries. The OECD's issue on the *Declaration on environment: Resources for the future*, endorses steps to ensure long-term environmental and economic sustainability and commits OECD nations to developing more accurate resource accounts.

Multilateral institutions seek to address the need for better understanding and improvement of the SNA with emphasis on the treatment of environmental and natural resources, because the way our natural assets are being consumed and treated in economic activities poses a threat to sustainability.

The idea of constant resource stock, as an indicator for sustainability, derived from a basic idea established by John R. Hicks (Pearce & Warford, 1993; Repetto *et al.*, 1989; El Serafy & Lutz, 1989), which states that sustainable income is " the maximum amount that can be consumed in a given period without reducing the amount of possible consumption in a future period." (El Serafy & Lutz, 1989: p.2).

There is a critical need to analyze the conditions under which optimal growth is also sustainable growth. Greater priority should be given to the environment if economic policies are to be sustainable. This can be done by systematically considering the environmental effects of growth and by valuing environmental functions (Pearce & Warford, 1993).

There is also a need for a set of accounts that provides better data for taking "full account" of natural and physical resources sustainability - New Zealand Environmental Act, 1986 (Wright, 1989). Because,

> A national accounting system that drew attention to the deteriorating asset position might have alerted policymakers to the need for policy changes and international lenders to the growing risks of further exposure. (Repetto *et al.*, 1989: p.4).

In this context, natural resource accounting is seen as a starting point to make the interaction between nature or environment and the economy more vivid. Natural resource accounting (NRA) is just one of the approaches that attempts to rectify the concept of income given by the current SNA.

The development of NRA has in the main concentrated on the collection and organization of information on the stocks and flows of natural resources (OECD, 1993). The accounts, usually in physical measures, describe the flow of resources within the economy. They display the physical base of a society, tell what is physically possible, describe the ultimate constraints (albeit soft constraints), and point to impending scarcities (Wright, 1989). They provide policy makers with an information base on natural resources, and generate awareness of environmental issues at various levels of decision making as well as among the general public (OECD, 1993). The accounts once established, will make us evaluate more comprehensively and objectively the process and results of economic development. Because of this rigorous and systematic treatment of data, NRA could possibly provide sustainable indicators for optimal natural resource consumption (allocation) and production.

Exploring the feasibility of a natural resource accounting framework does not necessarily involve the use of standardized models. Statistical capability, data needs and requirements that affect methodology, vary across countries. However, international recommendations have been provided in the UN *Handbook of Integrated Environmental and Economical Accounting* (Meyer, 1993). The Organization for Economic Co-operation and Development (OECD) and the European Community are also taking part in a global effort to establish a standard methodology. Whether countries will establish resource accounts is not yet sure, but a start has already been made by several. Norgaard (1989), as cited by Wright (1989), says,

> Less effort should be spent on debating and more on experimenting, learning through doing and sharing experiences. (p. 185).

Indeed, as one economist notes: "the task of establishing a resource accounting framework will not happen overnight; the task is formidable on a national scale and remains in the realms of research today." Because, "only when the basic measures of economic performance, codified in an official framework, conform to valid definition of income will economic policies be influenced towards sustainability" (Repetto, 1989: p.11). An overriding research issue is to find the most sensible ways of assigning value to natural resources and capital (Felke *et al.*, 1994).

1.2 Water and Sustainable Development

> Water is life! To sustain life, we must save our endangered water. We must save our environment for "we did not inherit it from our parents, we borrowed it from our children". (*Ecowebs,* Vol. IV, No. 2, 1994)

Water is the universal liquid, a traditionally common property resource. It serves as input (capital) to the economy, acts as a waste sink and, more importantly, is a part of the earth's life-support system. It is usually categorized among the renewable resources, although certain groundwater resources are non-renewable (Meister & Alexander, 1994). The non-renewability of some groundwater makes it expensive to extract and renders it vulnerable to overextraction. It is one of the major resources for which the potential of more discoveries appears slimmer and more expensive (Peskin, 1989a). The nature of surface waters, particularly as a renewable flow resource, makes it vulnerable to wastage, pollution and deterioration. Irrational use of water resources poses a menace to men and the universe.

> Man and his technology are causing the earth's water supply to deteriorate in quality at a rate that is truly a cause for concern. (Jeremy Randall, 1990: p.83)

Renewable as it may be, the supply of water must be considered in proportion to the number of its users. Of the world's total water resources, only 2.53 % is freshwater. The rest (97%) is contained in saline oceans. Of that 2.53 %, 68.7 % is in the form of glaciers and snow covers, 0.34 % is deposited in lakes, swamps, and others, 30.1 % is found underground, and 0.86 % is found in permafrost (Cubelo, 1994; Tebutt, 1973). This shows that the freshwater we domestically use constitutes only 0.008 % of the earth's water. The world population that utilizes the 0.008 % freshwater is 5.5 billion (Cubelo, 1994) which is expected to reach 6 billion by year 2020. Three quarters of the earth's surface is water. Unfortunately, one-quarter of the earth's population does not have enough.

Clearly, it is alarming to experience water-supply shortages, water-borne diseases, droughts, low-yield harvests, etc..

The greatest environmental threat to developing countries is the disappearance of the resource base, on which the survival of million of people depends (Ahmad, El Serafy & Lutz, 1989). The depletion of the quantity and quality of water features highly in this disappearance. Groundwater is being depleted rapidly and irreversibly. Existing withdrawals limit further expansion of irrigation and in-stream uses (e.g., river, transport, sediment, fishing) (Ince, 1991). The deterioration in the quality of this service has already affected certain areas and caused hazards to some extent.

The consequences of water problems are strongly felt in the developing world. Poor and developing countries die sapless while the rich drown in pools, as in the case of Egypt and Canada (Cubelo, 1994). Literature shows that nearly 1 billion people in the developing world are still without access to clean water for drinking and bathing, and 1.7 billion must contend with inadequate facilities. As a result in these areas, there is a prevalence of water-borne diseases which continue to wreck havoc with human welfare (Steer, 1992). Around 25 million children under five die each year from water associated diseases, one third of those deaths being from diarrhea alone (Ince, 1991). In some locations, there is growing scarcity of water which makes it difficult and expensive to meet the increasing demand for drinking water, for irrigation and for industrial use.

In Asia, the economic boom has made water the single most important environmental issue because of its deteriorating quantity and quality (Asian Business Review, 1995). In Taiwan, groundwater is affected by piggeries. Water pollution and water shortages are beginning to affect economic development in North China, and factories with high water consumption are being shutdown for up to three days a week. South Korea experienced water crises two years ago. Now, the country has embarked on a major environmental clean up and a conservation program is accompanied by strengthened regulatory enforcement. Overuse of groundwater has become a pressing problem in Jakarta and there is a need for increased sanitation.

The World Watch Institute reports that by the end of the century, there will be 11 waterscarce countries and four others will follow soon, forming one-third of the continent's total population.

The high pressure placed on water by rapid population growth and industrialization has seriously altered water quantity and quality. If this is not remedied productivity could be affected. Human behaviour and attitude toward this resource have significant influence on biological and ecological aspects. This implies that economic, political and legal aspects form important components of a water management strategy.

Water is considered as an open-access environmental resource. When its traditional governance of common property with limited access was replaced by open access and intensive competitiveness, demand started to exceed sustainable withdrawal levels.

The management of water in terms of its allocation and quality (and quantity) levels can be achieved by a variety of policy instruments, including economic instruments (Meister & Alexander, 1994) that comprehensively fit the present water resource problems. The choice of management instruments should be based on the particular problems at hand, because:

> When you are concerned about water, experience must take precedence over theory. (Leonardo da Vinci)

Access rights to the use of water and approaches to its management need to be imaginatively brought together in a way that will enhance ecological sustainability and at the same time ensure fair access (Grima, 1989).

Because it was once a free gift of nature, although used in economic activities, the value of water as an input to the economy and as a part of the life support system, does not feature in most countries' System of National Accounts (SNA). It is treated as a non-market activity which is ignored in the national data system, and such a system cannot, therefore, support accurate analysis of economic behaviour. "Therefore, as long as maintaining the stock of these resources (water is one) is considered essential to sustained economic growth in developing nations, the neglect of their deterioration in the national accounts is especially serious."(Peskin, 1989a: p.60). Water resource management and plans for its sustainable management and strategies are not possible without the use of quantitative and qualitative resource indicators.

Because of the negative consequences of its mismanagement and improper allocation, water is one of the natural resources prioritized for global conservation and management.

The problems associated with the world's freshwater supply received international attention at the United Nations' Conference on Environment and Development (UNCED) in 1992. The conference called on all States to design and implement national action programs to ensure that water resources are sustainably managed, with a target date of 2025. (Ministry of Foreign Affairs and Trade, 1995).

One of the major steps taken in response to this call is accounting for natural and environmental resources. Development of a water resource accounts framework is seen as one practical response to the need for sustainable water resource management. Conservation and management, and economic policy formulation in general, require information based on a resource accounting framework. This framework must show a consistent, systematic and rigorous environment-economy relationship for effective and efficient resource allocation to meet present demand without depriving future use. Such a water accounts framework will promote the measurement of physical scarcity by providing a resource balance sheet, and also show up environmental degradation (OECD, 1994).

1.3 Statement of Objectives, Methodology, Scope and Limitation of the Study

The purpose of this research is basically to come up with a conceptual framework for inland water accounts in the Philippines. The framework is built with reference to the experience of other countries like France, Norway, Botswana; also to the United Nations (UN) recommended *Integrated Economic and Environmental Accounting (IEEA) Handbook.*

The specific objectives of this research are:

1. to review the literature, and practical experiences, on natural resource accounting in general and on water accounting in particular;
2. to demonstrate the need for a water accounting framework for the Philippines;
3. to build a conceptual framework for inland water accounts in the Philippines;
4. to discuss which part of this conceptual framework could and should be implemented in the Philippines.

This study will proceed as follows:

1. Review the literature for information on theoretical aspects of resource accounting with emphasis on water accounts (Chapter II).
2. Discussion of the experiences of other countries in resource accounting.
3. The development of a conceptual framework (Chapter III). This will be mainly in qualitative terms.
4. Discussion of the water resources in Philippines, data sources and their suitability for the framework (Chapter IV). Issues related to valuation and water quality will also be discussed.
5. Conclusion and Recommendation. The recommendations will in particular focus on data types and sources and feasibility of implementation of the framework.

The development of the theoretical framework will proceed in close co-ordination with Statistics New Zealand and the Philippine's Environmental and Natural Resource Accounting Project as they provided related literature.

CHAPTER II

REVIEW OF RELATED LITERATURE

NATURAL RESOURCE ACCOUNTING STATE OF THE ART

There is a growing realisation that one of the primary factors that contributes to the increasing environmental problems is the neglect of environmental considerations within economic planning (WCED, 1987; WB, 1987, Cited by Arntzen and Gilbert, 1991). Economic planning uses the accounts output of national economic accounting or the System of National Accounts (SNA) as a basis because these accounts serve economic policy of the nation in three ways (Peskin, 1989b). They provide a framework within which economic statistics can be assembled in a consistent and coherent way; they provide a tool of analysis for better understanding of how the economy functions; and they provide indices that gauge the performance of the economy and therefore the success and failure of economic policy decision. Because of the rigidity of these accounts, their integrity is preserved and the index they provide, known as the GNP, has been used for over fifty years as basis for economic policy decisions.

Yet, it was reported that official and public support for the SNA has diminished greatly because of the shortcoming of its data to reflect the total welfare of the country. Welfare which, in a broader sense, encompasses the sustainability in social, economic and ecological aspects of the nation, is mostly not reflected in the SNA. There are goods and services that are non-marketed, but contribute to the enhancement of well-being. An example is the services and activities rendered by housewives. These services which if done by other people and paid for as the form of wages would have been reflected the country's income, but now are not. Also, the flows of goods and services from the natural environment are often not accounted for properly.

A more specific relevant-deficiency of SNA is the failure to account for the deterioration and depletion of natural resources and other environmental wealth. It follows then that the GNP, as an indicator, excludes the extraction and depletion of natural and environmental capital. Hence, this implies an overstatement of a country's income that might have serious policy implications and could pose a threat to achieving sustainable development if remained uncorrected.

The consequences of this deficiency can be serious in the developing countries which are resource-dependent countries, where the trends in the quantity and quality of natural resource stocks should be vital to economic planners and decision-makers (Arntzen & Gilbert, 1991). Programs that have used GNP as a basis for policy formulation may have not foreseen certain implications. As for example the Philippine's structural adjustment programs the implications of which on the use of these assets were not foreseen. According to Cruz and Repetto(1992):

> Structural adjustment policies have been designed without adequate consideration of ecological effects and implemented without safeguards and corrective policies needed to control and reduce adverse environmental impacts.

Consequently, natural and environmental resources are now depleting and deteriorating.

Because of these deficiencies in the SNA, proposed modifications have been suggested by various enthusiasts, expert groups and individuals. This chapter discusses the state of activities geared towards modifying the traditional SNA.

2.1 Natural resource accounting

It has been acknowledged that the SNA is indeed an essential element in macroeconomic planning. Yet, it is considered limited because of its emphasis on market-oriented flows of commodities and services expressed in monetary values, and the subsequent neglect of stocks and flows which cannot be measured (Arntzen & Gilbert, 1991). Particularly, non-market flows are poorly documented and understood in developing countries with a large subsistence sector. According to Repetto *et al.* (1989; Also cited by Arntzen and Gilbert, 1991), these non-market activities are only included when they are directly comparable to production in the market and when their value can be reliably estimated.

There are three functions of the natural environment that come as non-market flows and are not always reflected in the SNA, they are: as an assimilator of residuals (water bodies as waste sink); as a supplier of final goods; and as a source of resources (Wright, 1989). These three functions gave rise to three concerns: pollution and its control; conservation of the natural state of the environment, and the depletion of natural resources, Wright (1989) further notes.

In NRA, an accounting approach is applied and being experimented with for further refinement, to account for the goods and services that the natural environment provides. The result could come in the format an adjusted measure of income, possibly a more sustainable income measure. Wright (1989) considers the first two of the three concerns within the context of environmental accounting which quantifies in a systematic manner the aspects of these first two.

A particular concern of this thesis is the third concern. Again, according to Wright (1989), resource accounting systematically quantifies the aspect of natural resource depletion, the third of the three concerns mentioned. More specifically, natural resource accounting, quantifies and values the assets that are consumed in the economic activities but are not valued or adequately accounted for in most instances.

Nonetheless, natural resource and environmental accounting is becoming a significant activity as concern about environmental degradation, natural resource depletion and the sustainability of economic activity increases (Hamilton, Pearce, Atkinson, Gomez-Lobo and Young, 1994). Natural resource and environmental accounting attempts to correct these shortcomings in the SNA.

Arntzen and Gilbert (1991) tell that in practice, natural resources are not treated as economic production factors and the depletion of their stocks does not lead to changes in net product and income. Instead their extraction is treated as income only. Hence, a country that exhaust its natural resources in the name of economic profit as reflected by the GNP, overstates its wealth, and is unsustainable in terms of development.

The so-called "defensive expenditures", such as pollution control and other types of rehabilitation, often result in increases in national product and are taken as increase in welfare. However, it is not the defensive expenditure itself which is related to an increase in welfare, but the effectiveness of the measures financed. Consequently, the SNA does not generate appropriate insights into environmental damage and its mitigation. Repetto *et al.*(1989; Also cited in Arntzen and Gilbert, 1991) considers treatment of pollution control by source as another anomaly of the accounts, because it is considered as an intermediate input and as such does not lead to an increase in national product, while control of the same pollution by another activity does.

Environmental functions are non-marketed (Arntzen & Gilbert, 1991) and are often neglected by the accounts (Pearce, Markandya, & Barbier, 1989) because monetary bias and valuation methodology makes its measurement and hence inclusion to SNA, difficult.

There are proposals to revise through natural resource and environmental activities, the System of National Accounts (SNA). Several authors have suggested that income and product should include the effects of resource depletion to give better measure of "true" or sustainable income. Because,

> A notion of 'sustainable income' could be defined and quantified, only if so-called 'defensive expenditure', environmental stock depreciation, and the value of remaining environmental degradation could be assessed. (Opschoor & Reijnders, 1991: p.25).

Although a lot of activities are underway, there was concern expressed at the Luxembourg SNA Meeting in 1989 (cited by Arntzen & Gilbert,1991) that the present hard core of the SNA is not altered. Rather, revisions will aim at simplification and clarification. Hence, the revised SNA handbook contains the two follow-up activities: the establishment of satellite accounts for the environment, making use of a mixture of physical and monetary accounts; and a section with a review of the shortcomings in dealing with the environment.

Satellite accounts are one of the accounting activities classified by the OECD as undertaken internationally (Hamilton, 1994; Hamilton, Pearce, Atkinson, Gomez-Lobo, & Young, 1994). These accounts are linked to the SNA but not fully integrated with them. They are constructed in response to the desire expressed in 1992 by the United Nations (UN) for "the need to expand the analytical capacity of the national accounting system for selected areas of social concern in a flexible manner without overburdening or disrupting the central system.".

Other OECD accounting activities classified based on empirical and conceptual works of different countries are environmental and natural resource accounts and the altered national accounting aggregates.

A report by Hamilton *et al.* (1994) defines natural resource accounts (NRAs) as sets of accounts that represent an attempt to achieve complete and consistent physical accounts for both the stocks and flows of a nation's endowment of commercial resources: the usual account categories include opening stocks/extraction/harvest, revisions, growth, discoveries and closing stocks.

Environmental accounts are more diverse than natural resource accounts as they include measurements of quantities and qualities of resources lying outside the market system.

The altered accounting aggregates are the new aggregates in which monetary value is assigned to environmental variables and new measure of income, product and wealth are produced. The nature of these aggregates suggests that a resource or environmental functions considered should be accounted for in physical terms after which possible valuation of the resource is facilitated and so its integration with national accounts to produce new aggregates. The aggregates are often termed as "green" aggregates, i.e a more sustainable income measure.

These accounting activities are continually gaining popularity as the endeavour to a more sustainable income measure goes on despite the controversy regarding procedural aspects. The generation of the accounts mentioned previously uses two broad approaches: the physical and monetary approaches.

The physical approach expresses the resource in physical units. According to Pearce *et al.* (1989) the accounts so constructed are useful in answering ecological questions of interest, and are basically the starting point for the economic valuation of the resource use level changes (depreciation and appreciation). Hence, they try to describe the relationship between environment and the economy by giving a picture of the level (sustainable or unsustainable) of resource use in the economy. Furthermore, the accounts would make possible the construction and calculation of an input/output matrix that would reflect the overall consequences of a change in the composition and level of final demand on several aspects of the environment.

Natural resource accounting extensively uses this approach as it achieves a relatively complete and consistent set of physical accounts for both the stocks and flows of the natural and environmental capital. In the same way, measuring quantities and qualities of resources outside the market system has to be expressed in physical terms to come up with environmental accounts.

Despite of the usefulness of this approach, physical accounts alone are being criticised for their lack of a common unit of measurement which makes it difficult to aggregate and integrate the result into economic decisions. The accounts do not enable policy makers and planners to understand the impact of economic policies on the nation's natural resources. Hence, the accounts may not give the complete picture of the environment and the natural resources needed for integration into the national measures of income and wealth.

The monetary approach basically values environmental and natural resources used in the economy. This approach, as described by Pearce *et al.* (1989), attempts to link the use of environmental resources to the national income accounts. While the national income accounts measure goods and services produced within the economy in a given period of time, the monetary approach attempts to adjust the national income to reflect more closely a sustainable resource measure. The approach also tries to monetarise the negative impacts of economic activities on the environment and its resources, which indirectly affect the welfare of the state. Hence, it has a central place in the evaluation of economic performance and economic policy decisions both at micro- and macro-level.

The monetary approach facilitates construction of altered national accounting aggregates by assigning values to the adjustments to be made from the physical accounts of the natural and environmental goods and services. Only then that the monetised physical accounts are integrated into the SNA thereby producing new aggregates. Monetary approaches make the physical accounts of environmental and natural resources more useful in economic policy decision-making because of a common unit is easily understandable to users.

A mixture of physical and monetary units are used in the construction of satellite accounts making the accounts more capable of covering the most important relationship between environment/natural resources and economic activities (Ahmad *et al.*, 1989; Also cited in Arntzen and Gilbert, 1991).

The OECD (1994) considers both the natural and environmental accounts concerned with physical stocks and flows of natural resources as well as the physical and monetary flows associated with exploitation of natural resources, in a framework that is independent of the SNA. The balance sheet flavour of natural resources accounts either in physical or monetary, or combination of both, shows potential for principal policy and analytical uses. The uses include as: being a physical scarcity measurement, resource management, balance sheet of the resource sectors, productivity measurement, portfolio analysis and management, and valuation of depletion, and environmental degradation.

There are a number of works that have established good examples in physical resource accounting and further works continue. Moreover, monetarisation or valuation proposals for these accounts that lead to adjustment in SNA, have been and are being explored and experimented with. There is no fix concept as yet and there is still much controversy. However, the suggestions and the results obtained from them give different views about how these shortcomings mentioned earlier are to be treated in the national economic accounting system.

The treatment of the *defensive expenditures*, i.e the costs expended to prevent or correct environmental damage due to economic activities by enterprises, governments or households, varies among sectors. According to Hamilton *et al.* (1994), governments and households treat defensive expenditures as final consumption in the national accounts, while enterprises consider them as intermediate consumption. Two approaches have been suggested to deal with them. First, defensive expenditures by governments and households could be treated as intermediate costs to prevent or correct deterioration of the environment- i.e. in the same way enterprises do. This would reduce GDP by the cost of degradation which remains uncorrected. Second, whether by enterprise, governments or households, defensive expenditures could be subtracted the same way as the depreciation of fixed capital asset which is subtracted from GDP to arrive at NDP. The argument of Pearce *et al.* (1989) emphasizes that expenditures by households are regarded as the costs of producing the goods and services that people enjoy and should therefore not be included as final expenditure giving rise to utility. Because as these expenditures increase, national income increases and is thus taken as increase in welfare. However, as Arntzen and Gilbert (1991) noted earlier that it is not the defensive expenditure themselves which are related to an increase in welfare, but the effectiveness of the measures financed. Thus, the SNA does not generate appropriate insights into environmental damage and its mitigation.

Environmental degradation is represented either by the cost of preventing deterioration or by the cost of restoring the quality of the environment back to the level prevailing at the beginning of an accounting period or to a level specified by official standard indices. Some costs are measureable (e.g. crop losses, the reduced life of a dam reservoir); others are difficult to measure, such as the deterioration of air and water quality. There are two proposed approaches that attempt to place this element in the aggregate income measure. The first approach treats the cost of environmental degradation as a decline in stocks and subtracts it from total output to obtain GDP. The second approach treats degradation as depreciation of fixed capital and subtracts it from GDP to arrive at NDP. Pearce *et al.* (1989) emphasized that to measure current welfare requires estimates of the actual pollution that is generated but not mitigated. When this impact is accounted for in the traditional account, current welfare measure would then be measured as:

> Current Welfare = measured consumption - household expenditure - monetary value of residual pollution

The physical resource *depletion of stocks* is using the identity:

Opening stocks - Net change = Closing stock
Net change = Additions (or subtraction)

The physical accounts are then converted into monetary value. Depletion or appreciation correspond to net changes in resource stocks which are then expressed in monetary value via net price method (NPM), asset value approach (APA) or the user cost approach. Pearce *et al.* (1989) commented that the concern of natural capital depletion is not current welfare but the measure of an economy's potential welfare or expected welfare over a long (perhaps indefinite) period of time. Therefore,

GNP = Consumption (current welfare) + investment (present value of future consumption, both in the absence of market failure where prices equal marginal social costs of production)

To determine whether the economy is accumulating or decumulating as far as environmental capital is concerned, it is necessary to distinguish between exhaustible and renewable resources and ecosystems essential for economic activity (Pearce et al., 1989).

Devarajan and Weiner (1988), as cited by Pearce *et al.* (1989), stressed that if exhaustible resources are depleted too fast then current GNP is an overestimate of discounted long-run welfare and should be adjusted downward. On the other hand, if depleted too slowly, the reverse is the case.

The same principles apply to renewable resources (Pearce *et al.*, 1989). Non-optimal rates of extraction imply over or undervaluation of currrent GNP.

Moreover, the ultimate productive capacity of the economy is affected by the use and abuse of land ecosystems. Even though the impact of ecosystem degradation on GNP has not been fully worked out, there is a strong presumption that:

> if being fundamentally degraded, then current GNP is an overestimate of future GNP." (Pearce et al., 1989).

An example of altered accounting aggregates that reflect these monetarised deficiencies, is the theoretical framework summarised in the report of Hamilton *et al.* (1994). The theoretical framework for resource accounting is presented below as well as some of the arguments regarding particular inclusions.

1) $g\ GDP = GDP + ES\ (+, -)\ ED - DE - IR$
2) $g\ NDP = NDP + RD - DEP - ED_2$
3) $NW = NFA + TA_H + TA_N$

where:

g = “adjusted” or “green”
ES = Environmental Services
ED = Environmental Damages (can be added or subtracted)
ED_2 = refers to ED in equation two; subtracted from ordinary NDP to arrive new NDP
DE = Defensive Expenditures
IR = Invested resource rents
RD = Resource Discoveries
DEP = Depletion of resources
NFA = Net Financial Assets
TA = Tangible Assets (Human-made ($_H$), Natural ($_N$))
NW = Net Welfare

Peskin (1989) recognized environmental services or waste disposal services provided by the environment. The value placed on these services would augment the GDP. However, these free services to producers (or users) are already reflected in profits and income, hence their inclusion is still controversial.

The framework suggests that environmental damages (ED) can be added or subtracted. On one hand, as in equation one, the ED is added when the expenditure for the activities to repair the damage is reflected as income and thus increases the GNP. On the other hand, the ED is subtracted from GDP because these externalities are a reduction in welfare. Hence, the value attributed to them would reduce GDP, although some economist argue that GDP is not a measure of welfare. Harrison (1989) infers that GDP is understated because it does not reflect the consumption of environmental assets. This requires the estimation of dollar value for total environmental deterioration, including that which has been prevented as a result of current abatement expenditures. Peskin (1989) thus suggests that subtracting ED from GDP is a much better indicator. The subtraction of ED in equation 1 is significant in calculating the altered (g) GDP. While its (ED_2) subtraction in equation 2 from the ordinary Net Domestic Product (NDP) helps calculating for the adjusted (g) NDP.

Hamilton *et al.* (1994) commented that when defensive expenditures are in response to environmental deterioration, they should be measures and deducted from the net product (or added to the gross product, as Harisson would have it) rather than household expenditures *per se*. More formal arguments by Maler (1991) as cited by Hamilton *et al.* (1994), regard the government environmental protection expenditures (e.g. on waste management) as essentially intermediate in character which should be deducted from domestic product. However, this contention is criticised since the GDP cannot vary simply by sectoring. For example, when government waste management activities were privatised and these activities were privatised and these services sold to producers, after adjustments to taxes and prices nominal GDP should be unchanged.

As cited by Hamilton *et al.* (1994), El Serafy (1989) argues that the true income from non-renewable natural resource is a constant stream of income which can be obtained from investing a portion of the resource rents from the exploitation in a fund. He further argues that one should calculate the "true income" part of revenues, and that the residual part of the revenues (net of extraction costs) should be deducted for the GDP, so that, if part of the revenues were invested, the future returns of capital would allow for a higher sustainable consumption than if the country did not possess the natural resource. Basically, the principle hinges on the Hicksian concept of income. This is equivalent to valuing the charge in the present value of the resource stock as a result, it is a "true user cost" according to Hartwick and Hageman (1993), as cited by Hamilton *et al.* (1994).

Regarding resource discoveries (RD), Repetto (1989) proposed that the resource discoveries should be added to net product in the period in which they are made. In effect, this would lead to the adjustment of net product by treating resource discoveries like investments. The discovery is viewed as an increase in the stream of income in the future- therefore an increment of wealth. Similarly, Hartwick's model treats discovery as an addition to net product, but this results from his specification of exploration costs as a function of resource stocks.

The depletion of natural resources (DEP) is valued as the total resource rents taken in the accounting period, and is measured using the net price method (NPM) or the present value of foregone production (as in the case of soil erosion). This should be adjusted to net product, as suggested by Repetto (1989). The UN (1993) suggests valuing the depletion using either user cost or net approaches.

The non-financial assets (NFA) are also shown in the framework as an important component of total wealth. These are significant in a country where domestic investment opportunities are limited. Other forms of assets reflected in the framework are human-made tangible assets (TA_H) and natural tangible assets (TA_N).

Human-made tangible assets are reproducible capital. Hartwick's rule states that in order to permit a non-declining stream of consumption into an indefinite future, resource rents should be invested in reproducible capital. This fits the criterion of weak sustainability described by Pearce *et al.* (1989). It is said that this criterion is met by building up human-made capital to match the drawing down of natural resources.

Natural tangible assets (TA_N) are measured by the dollar value of commercial resources (minerals, energy, forests and fish) and environmental resources (natural environments providing non-market services including waste disposal and amenity value). Expanding the national balance sheet account to include commercial resources has been suggested by Scott (1956) but is problematic to implement. The problems include defining the appropriate measure of quantity and, in the absence of markets for publicly held resource deposits, deriving values for these deposits. Valuation of non-market resources is indeed subject to many difficulties.

The above framework indeed provides a summary of the proposed methodology in the treatment of SNA deficiencies in developing a new accounting framework for adjusted aggregates. It is noteworthy that only when a relatively systematic, coherent and consistent physical account of the natural resources stocks and flows, and the environmental services is constructed that the proposed treatment SNA deficiencies can be dealt with. However, in the process of developing sustainability measures, difficulties are encountered along the way, such as methodology, the definition of resource extent, and problems in the valuation of stocks.

There are several schools of thought about the best approach to the accounting problem (Norgaard, Ch. 8, ctd. by El Serafy & Lutz, 1989). Environmental accounting in physical terms is advocated by some economists and environmentalists who have little interest in establishing linkage with the SNA. These advocates of environmental accounting aim to use indicators of physical change to influence public opinion and environmental policies. Others feel that environmental accounting can have an effect only when the accounts are monetarised and integrated into the SNA to produce an adjusted (sustainable) national income.

El Serafy and Lutz (1989) believe that natural resource and environmental accounting in physical terms is essential, particularly as this would cover collecting data that indicate the direction and rate of change in the quantity and quality of a resource. At the same time, they recognise that "magnetisation" to the extent possible, is important as well, and that a link with the SNA and an adjustment of the current income concepts and measurements are urgently needed.

Considering the problems and difficulties in developing sustainability measures such as natural resource and environmental accounting, El Serafy and Lutz (1989) recognise that more conceptual and empirical work is necessary before GDP and NDP in the core of SNA can be replaced by more sustainable GDP and NDP. They encourage the construction of the accounts mentioned earlier, specifically satellite accounts wherein physical account is the initial step. This is viewed as half way solution not as a threat to the perpetuity of the SNA and has a fair chance of adoption.

The adjustment to the SNA discussed above are those suggested in the relevant literature as suitable for correcting the shortcomings of the national income measure to derive a more accurate measure of sustainable income and wealth. In the next sections we will look at how international organisations and individual countries have used this framework to come up with practical and feasible approaches to NRA.

2.2 Trends in Natural Resource Accounting in the International Organizations

A number of international organizations has spearheaded natural resource and environmental accounting around the world. The United Nations (UN), the World Bank (WB), the Organization for Economic Cooperation and Development (OECD), and the Eurostat have led the pursuit for the establishment and continuation of resource and environmental accounting (Wright, 1989; Jinchang *et al.*, 1990; OECD, 1994; Hamilton *et al.*, 1994). These organizations have also led and guided the countries undertaking their own resource and environmental accounting activities.

Because the Systems of National Accounts (SNA) is based on the UN guidelines, the UN is particularly interested in the topic of NRA. The World Bank (WB) and the UN Statistical Office have financed most of the research activities, one of which is the application of new satellite accounting techniques conducted in Papua New Guinea (PNG) and Mexico. The European Community (EC) made related efforts with emphasis on the environment. In 1986, the Organisation for Economic Co-operation and Development's (OECD) group on the state of the environment has incorporated NRA into its work program. A research program on NRA was also started by UNEP in 1993.

The United Nations

In 1980, the United Nations Education, Scientific and Cultural Organisation (UNESCO) adopted a methodology for resource accounting, developed in Scotland under the leadership of Malcolm Slesser (Wright, 1989), in which they began exploring ways to bring the interaction between population, natural resources and the environment into long-term planning. This is one of three UN undertakings. Wright (1989) reported that the UN Statistical Commission (UNSC) had been involved in the revision of the UN System of National Accounts (UN SNA) and, together with the World Bank, they had developed a methodology for a Satellite System of Integrated Environmental-Economic Acounting (SEEA). This system focused on examinations of the concepts, definitions, classifications and tabulations of environmental and natural resource accounts and their possible link to SNA (ENRAP, 1994; OECD, 1994; Hamilton *et al.*,1994). Though the UN undertakes these efforts, there is no intention to bring environment and natural resources into the SNA accounts, leading to the alteration of national accounts aggregates. This is mainly because the UN Statistical Commission wants to maintain the continuity of the functions of traditional SNA. In addition, certain methodological problems, particularly regarding the valuation of non-market transactions, make it premature to alter the SNA. Thus, the United Nations Statistical Office (UNSO) prefers to elaborate the SNA via the development of the Satellite System of Integrated environmental and Economic Accounting (SEEA) (ENRAP, 1994).

The push towards further development of standards for SEEA was boosted by the inclusion of environmental and natural resource accounting in the *Agenda 21* of the UN Conference on Environment and Development (UNCED) (1992). According to Hamilton *et al.* (1994), the structure of the SEEA features the following characteristics: 1) economic assets are split between produced and non-produced (natural) assets; (ii) the environment appears explicitly as a source of non-produced (but non-economic) natural assets; (iii) specific account is taken of the use of non-produced assets to arrive at a revised net product measure; and (iv) the transfer of natural assets from environmental (non-economic) to economic non-produced assets is explicitly accounted for (Hamilton *et al.*, 1994; SEEA, 1993). One major proposition in the SEEA is the new net product measure, termed "environmentally adjusted net domestic product" (EDP). This is measured as follows:

$$\begin{aligned}
\text{EDP} \;&= \;\text{consumption}\\
&+ \;\text{gross capital formation (produced)}\\
&- \;\text{consumption of fixed capital (produced)}\\
&- \;\text{depletion of non-produced economic assets}\\
&- \;\text{degradation of environmental assets}\\
&+ \;\text{net exports}
\end{aligned}$$

The environmentally adjusted net Domestic Product (EDP) is obtained by subtracting from GDP the depreciation of conventional fixed capital (to arrive at NDP), and by deducting the value of depleted natural assets and the value of environmental protection activities.

To make these adjustments, various methods have been suggested. The El Serafy or the Repetto *et al.* (1989) approaches are suggested for measuring the depletion of commercial natural resources. Either the cost-based method (the cost of returning the environment to its original state at the beginning of the accounting period) or contingent valuation of changes in the environment are suggested as methods for valuing degradation of the environment.

The close link of the environment and the economy as featured in the SEEA is of value in several ways. The ENRAP (1994) has enumerated some of the SEEA merits. For example, SEEA is valuable for making it possible to trace inter-industry effects of environmental change. This is exhibited in the comprehensive and widely disaggregated table of accumulation of tangible assets which distinguishes between produced (biological and non-biological) and non-produced assets. Furthermore, the breakdown of environmental protection expenditures by consuming sector and "environmental costs" (i.e., essentially environmental degradation and resource depletion) by sector of origin, can be featured among the consolidated accounts "use" table.

The ENRAP (1994) report also highlights some of the shortcomings of the United Nations Statistical Office (UNSO) framework. One is that it fails, as does the Hueting approach, to distinguish between services provided to economic sectors by the environment and damages (or "costs") to environment, by these sectors. The fact that "environmental cost" is the only entry implies that both values are considered identical. The concept of sustainability underlying the valuation method of "environmental cost" is cost-oriented rather than welfare oriented. This choice is justified by the authors because of measurement problems and difficulties in establishing ties between particular pollutants and damage to health and welfare.

The pilot studies of Mexico, Papua New Guinea and Thailand have provided UNSO with practical experience in the development of the SEEA.

The UNSO views the SEEA as one element of an integrative data system which encompasses economic and environmental data as well as social and demographic statistics.

> "The UNSO argues that there are no generally accepted models of the dynamics of economic impacts on, nor repercussions from, the natural environment. The difficulties of identifying the unequivocally functional relationships between economic and environmental variables are the main reasons why the United Nations' Framework for the Development of Environmental Statistics (FDES) opted simply to list environmental and related economic variables under major information categories, without attempting to specify further connections among them." (ENRAP, 1994, pp. 192).

According to Wright (1989), while the UNSO shied away from environmental modifications of GNP, it supported modifications to the UNSNA, but in the balance sheet and reconciliation accounts rather than in the current flow accounts.

The provisional draft of Chapter XXI of the revised SNA succinctly stated that the SEEA

> "..is included to guide countries in responding effectively to the current emphases in policy making and analysis on environmentally sound and sustainable economic growth and development and to help national accountants in elaborating environmental satellite studies which take the national accounts as a point of departure". (Hamilton *et al.*, 1994).

The European Community(EC)

While long experience with environmental accounts and indicators does exist in some member states (France, Netherlands, Germany), environmental accounting does not have a very long tradition in the European Community (ENRAP, 1994). The EC has been compiling for some time a considerably large number of environmental statistics which they consider synonymously with environmental accounting. The following are the compiled environmental indicators: 1) environmental statistics closely linked to environmental legislation; 2) indicators (predominantly) on the state of the environment generated by the CORINE programme (Co-Ordination of Information on the environment); 3) physical indicators conceived within the pressure/state/response model and monetary data on expenditures on the environment with the SERIEE methodology (Systeme Europeen de Rassemblement de l'Information Economique sur l'Environment). More recently, work on the field of "green national accounting" has started at Eurostat.

The following are brief descriptions of the compilations of environmental accounts and indicators mentioned earlier, based on the ENRAP Phase II Report (1994).

The first generation of environmental statistics was part of the reporting requirement of the Community legislation. The Directorate General for the Commission of the EC created directives for the collection of environmental data (quality of water for certain uses, concentration of lead, etc.). In the meantime, the directives are being used to improve and enhance the monitoring and reporting system until the data quality will suit for statistical uses.

Since 1975, the CORINE has provided a framework for the systematic collection of local data on the environment and related issues. Basically, the CORINE handles a large data base with themes like biotopes, soil types, land quality and important resources, soil erosion risk, land cover, air emissions and water resources. The Task

Force for the European Environmental Agency that has taken on the task of CORINE, was created in 1990 but its work was delayed due to organizational problems. It was only in May 1993 that the agency formulated its annual work program. One aim of the agency is to relate environmental indicators to each topic and the priorities of the 5th Environmental Action Programme of the Community, and to specify the necessary data needed to construct indicators and to show in what way these indicators could be made available to users.

The European System for the Collection of Economic Information on the Environment (SERIEE) has been launched by the Statistical Office of the European Communities (OECD, 1994). Its work is geared more to the environment, and has been enhanced by a series of workshops on environmental accounting by the WB and UNEP. The main features of the SERIEE are the generation of data on environmental protection activities of the various sectors in the economy, and the integration of physical data with monetary data. The functions of SERIEE are on the one hand, to analyse the financial circuits of expenditures for environmental protection. It tries to answer the following questions : which agents, and how much money on what environmental protection measures; who finances the environmental protection expenditures; and in what form and through what channels are these operations financed? On the other hand, the SERIEE strives for an analysis of absolute cost of environmental protection. The calculation of absolute data for environmental protection would allow the comparison of such data on a micro and macro level with general economic indicators (e.g. turnover, investment of industrial branches) to gauge the relative environmental efforts of countries and sectors.

Along with establishing an EC-wide inventory of environmental protection expenditures and analysing the underlying financing streams, the SERIEE aims at providing information on the comparison between economic activity and the environment. Strong emphasis therefore has been laid on the link between economic data (environmental clean -up expenditures or investments) and physical data (state of environment, depletion of natural assets).

Currently, a number of pilot projects are being carried out to test the feasibility of an application of SERIEE methodology to collecting experimental data on environmental protection activities and expenditures of industry, public administrations and private households.

The Organization for Economic Co-operation and Development (OECD)

The OECD countries are also taking initiatives on NRA (Wright, 1989; OECD, 1994; Hamilton *et al.*, 1994) through its State of the Environment Division (SED) that is principally charged with the development of environmental indicators, information and reporting. In addition to its SED work, there is also the development of environmental accounting which is aimed at integrating environmental concerns into economic policies.

The OECD's work centered on natural resource and environmental accounts in physical units as well as satellite accounts of environmental expenditures.

Hamilton *et al.* (1994) stressed that the OECD recognizes natural resource and environmental accounting as an integral part of policy making. It has, however, rejected the idea of modifying the SNA to arrive at a "green" GNP figure for two major reasons: methodology and strategy. Pursuing the methods would jeopardize the consistency of the SNA, the cost of which would outweigh the benefits of revising it. Adjustment for a "green" GNP figure would miscalculate the welfare effects of environmental degradation and would therefore impede rather than intensify the impact of the exercise. This is possible because of the small share commercial natural resources play in the OECD economies and the inability of the SNA directly to incorporate non-commercial resources (Hamilton *et al.*, 1994). However, the usefulness of the physical resource and environmental accounts has been recognized: as they have increased awareness of environmental issues both on the part of the general public and within policymaking circles.

The OECD has identified two main NRA policy uses. One direct use is in the assessment of the impacts of sectoral economic activities and policies. Even more important is the use of resource and environmental accounts either as inputs in constructing other indicators or as input into environment-economy models (Hamilton *et al.*, 1994).

Few OECD countries, however, have come up with tried methodologies and approaches that could be applied across all OECD countries. Resources such as forests and inland water were the focus of some initial studies. Norway and France respectively took the lead on these. On forest studies, Norway is the pilot country and Canada, Italy, and Finland, France and Sweden have also taken part. Emphasis is on physical input-output in forest industries. The second pilot study is on inland water with France as the pilot country. Finland, Italy and Portugal are also taking part in this study. Five types of accounts are being considered: water cycle (quantity), water quality, aquatic ecosystem accounting, water utilisation accounting, and water economics. Hamilton *et al.*(1994) reports that though these pilot studies have not been successful so far, as indicated by the slow response rate of the countries covered, the data gathered has been sufficient to construct resource sustainability indicators. For forests, an indicator for the intensity of forest use was constructed by calculating the ratio of total annual harvest to annual growth of the forest resource. For water use, a similar indicator was constructed by taking the ratio of total water withdrawal to resource availability.

The SED's work on satellite accounts, composed of information surveyed from different member countries, has resulted in regular publication of statistics on pollution abatement and control expenditures. The information from the publications is used in making cross country comparisons, and serves as an input into research on the economic impacts of environmental regulations.

The United Nations Environment Program (UNEP)

In 1982, a special conference of UNEP mandated the Executive Director of UNEP to develop methodological guidelines for environmental accounting in the context of developing countries. Since then UNEP, along with the World Bank, has been active in the area of environmental statistics. The two organizations sponsored expert seminars on national accounting. In 1993, UNEP launched its own environmental economics programme, a significant component of which was detailed case work on environmental accounting. UNEP focused on modifying the GNP to a sustainable GNP by considering subtractions such as "user costs" of natural resources and "defensive environmental expenditures", and additions such as "discoveries" and other increases of natural resources and "net environmental benefits" (Wright, 1989; Hamilton *et al.*, 1994).

2.3 Current State of Natural Resource Accounting

It has not only been international agencies that have developed NRA methodologies. Several countries have developed their own and have experimented with them. Some of these developments will be discussed below.

One of the pioneers in the field of NRA has been Norway. Work on NRA started in the 1970s when concern was raised over physical resource scarcity and resource management (Hamilton *et al.*, 1994; Wright, 1989). In 1987, Norway published the 'Natural Resource Accounting of Norway' (Jinchang and Zhengang, 1990). The purpose of these accounts was to provide data and tools for policy analysis and decision making, while at the same time presenting a monitoring framework.

The Norwegian accounts are limited to physical accounts containing two categories: material and environment or stock and flow accounts. The former encompass mineral resources, biotic resources, 'inflowing resources' and energy; the latter include environmental assets which provide non-market environmental services. The material accounts are further divided into three parts: resource accounts (reflecting extraction and conversion), trade accounts and consumption accounts.

Although Norway's work is limited to physical accounts, it allows for a theoretical link to economic activity. The second and third part of the material resource accounts can be linked to economic activities. As a relatively complete system, it describes the transformation of resources (mineral, timber and fish), energy and selected contaminants for each economic activity. It shows the input/output relationships between resources and energy as inputs entering the production process, and products and wastes as the outputs from the transformation process (Meyer, 1993).

Today, NRA is part of an on-going effort to integrate resource and environmental issues into existing economic planning procedures as reported by Hamilton *et al.* (1994). Economic, resource and environmental variables, are now standard inputs in models such as the Multi-Sectoral Growth Model (MSG). This model covers the energy and emission accounts and is used to explore long term economic prospects. The use of these models in the analysis of natural resource issues has facilitated communication between Ministries of Finance, Environment, and Petroleum and Energy. One guiding principle of the Norwegian work is the firm insistence that resource and environmental information, which is expensive to collect and compile, must be policy relevant (Hamilton, 1994). A lesson learned is that institutional relationships are important. The close links between statisticians, modellers, and policy analysts in the ministries of Finance, Environment, and Petroleum and Energy are arguably one of the strengths of the Norwegian work.

Similar to the Norwegian accounts are the French "natural patrimony accounts". France started with resource accounting after a committee on natural resource accounting (NRA) was established in 1978 (Jinchang *et al.*, 1990). The committee, in co-operation with the Ministry of Environment and Statistical Bureau, published a report that introduced the principle and method of NRA.

The French accounts have three components (Hamilton *et al.*, 1994): **Element** accounts that are established for individual resources such as underground resources, continental waters, soil, the atmosphere, sea water, flora and fauna. **Ecosystem** accounts, established for monitoring the health or well-being of ecosystems as opposed to tracking the evolution of the stock of an individual resource. **Agent** accounts which record the interactions between man and the environment and have the same classification as national accounting categories. These last accounts are initially measured in physical and economic terms (Wright, 1989; Hamilton, 1994). Expenditure on pollution abatement technologies is expressed in monetary terms. It is in the agent accounts that the environmental satellite accounts, linked to SNA, exist (Hamilton *et al.*, 1994).

The accounts are termed "Patrimony accounts" because resources are inherited from our ancestors to be passed equitably onto future generations. Theys (1984) states their objective as: "to demonstrate not a set of profit or loss with respect to man's exploration of nature, but conflicts between economic, ecological, and social functions of natural resources" (Wright, 1989).

From a conceptual point of view the French work is probably the most ambitious accounting system in use (ENRAP, 1994). This is so for two reasons. One is its broad coverage of the environmental and resource assets and its large coverage of the functions of the natural environment. Natural assets exclude, however, those parts of the natural environment which cannot be transformed or appropriated by man and the so-called "artificial patrimony" (i.e., man-made materials, buildings, etc.), and which have no cultural significance or which are not closely related to natural systems. The second reason for being ambitious, cited in the ENRAP report (1994), is its intention to describe and analyse each element of the natural environment in terms of the basic functions mentioned above: economic, ecological, and social functions.

The system features an hierarchical structure of different levels. Level I comprises disaggregated basic data, Level II handles Sectoral statistics, Level III synthesised statistics, Level IV contains the accounts, Level V shows the Models, and Level VI contains the National Aggregates.

Sophisticated and ambitious as it may be, the complexity of its overlapping categories and fragmentation of its data are also a weakness. It is also said to lack explicit links to policy concerns and to contain levels of detail too high to be useful for national-level policy questions and too low for local or regional environmental problems.

Though the accounts are not yet incorporated within the SNA, potential for their integration exists. To date, resource accounts for forestry and water are the most complete.

Like Norway, France has exhibited a good example of natural resource accounts in physical terms but one that is not practically implemented as yet.

In Australia, work on resource accounting was initiated by the Australian Environmental Council and the Victorian Ministry for Planning and Environment. Wright (1989) reported that Dr. Robert Repetto from the World Resources Institute (WRI) was commissioned to prepare a discussion paper in 1986. A two-staged study followed. The first was on timber, petroleum and brown coal; the second on fisheries, water and soil. Unlike France and Norway, the development of these accounts is at an early stage (Hamilton *et al.*, 1994).

According to Young (1992), Australia has attempted to calculate a 'green' GDP by taking into account the use of renewable and non-renewable resources in production. Because of the major part played by non-renewable resources in Australian economic activity it was important to include these resources and their changes in the income adjustments to arrive at a 'green' GDP. However, because of data collection problems, many of the entries are based on "guesstimates" designed to be environmentally generous. Repetto's treatment of discoveries, allowing the adjusted GDP to be greater than the conventional GDP in all but two of the years during the period (1980- '89), was used. General results show that the adjustment to GDP is small. Pressure to establish a "green GDP" has arisen from the environmentalists and some parts of the government and the environmental protection industry. This has been resisted partly because of uncertainties in valuation procedures and partly because of concerns about whether a green GDP would give correct signals to policy makers. Hamilton (1994) cited that Mike Young himself notes that there is widespread confusion and disillusionment about the nature and purpose of the NRA; that these accounts are unlikely to affect resource management. However, it is argued that this need not lead to rejection of NRA, but to a greater recognition that there are methodological issues to be resolved such as the treatment of discoveries.

Aware of the usefulness of the adjusted accounts, Young (1992) made several suggestions which can be summarised as follows: stress should be given to GDP per capita; non-market values of the services of the environment which might be significant, should not be neglected; and the use of Geographic Information System (GIS) in regional or sectoral accounts must be recognised as an effective way of dealing with the annual costs and benefits of land use within the region. While aggregate accounting systems are strongly supported by local land administrations and resource managers, GIS-based systems are opposed, which would indicate the impact of particular projects. Young envisages that the GIS system would be able to answer an array of questions such as the likely effects of conservation programmes on land uses.

Though the Australian accounts are not as detailed as those France and Norway in physical terms, their work on adjusting the GDP shows a further advance in natural resource accounting. It is the economic valuation of the non-renewable resource depletion using Repetto's valuation method that explicitly illustrates the integration of natural resources into the economy, which in the end gives signals useful for policy decisions and resource and environmental management. In doing so, the result has provided a good example of the critical contribution of non-renewable resources in an economy's production activity and hence the importance of taking these resources into account.

In the U.S., work on environmental and natural resource accounts shows similar beginnings to the work of France and Norway. In the early stage of attempting resource accounting, the U.S. paid great attention to physical accounting which triggered further related endeavours towards sustainability. At the moment, concern for environmental valuation is conspicuous as the U.S. considers the environment as another production sector by calculating the expenses (input) of harnessing environment and pollution abatement and evaluating its beneficial result (output). Most of the country's undertakings are guided by the principle of sustainability. Hamilton *et al.* (1994) reports that construction of welfare adjusted measures has been the subject of several studies in the U.S. These studies used the rationale of Nordhaus and Tobin's Measure of Economic Welfare (MEW) vs. GNP or Daly and Cobb's Index of Sustainable Economic Welfare (SEW). In 1981-1990 depletion of oil was estimated, as was the value of air and water quality. Rents were calculated using the Hartwick and Hageman formula. However, the results are not related to "green" NDP.

A report by Hamilton (1994) mentions the Bureau of Economic Analysis' (BEA) publication of its first Integrated Economic and Environmental Satellite Account (IEESA) in 1994. These accounts were designed to, (i) examine the effect of changing patterns of demand on natural resource use; and (ii) support the analysis of the effect of changing resource costs and the availability of suppliers and users of natural resources.

The success of physical accounting and succeeding activities have motivated the publication of the first American SIEESA. This effort shows that the U.S. leads in integrating the environment and the economy following the UN's proposed guidelines, and in this case, shows a greater advance than Norway, France and Australia in the pursuit of environmental and economic integration towards the development of sustainable income measurement.

New Zealand (N.Z.) has also responded to the global debate. Shereen (1995) reports that since early 1990, the Department of Statistics, in conjunction with the Ministry for the Environment, has undertaken preliminary investigations into the development of environment statistics and state of the environment reporting systems. There are five main areas of environment accounting and related issues: feasibility and case studies on environmental accounts; environmental statistics and the state of the environment reporting; valuation of country's conservation estate; indicators of sustainability; and the development of the input-output tables.

New Zealand is currently proceeding with the development of frameworks for physical environmental accounts. Most of the work is still methodological and theoretical. Considering N.Z's brief experience with environmental accounts, this was seen as the most cost-effective and efficient use of existing resources. The framework describes the structure of the accounts without the actual numerical detail. Evaluation of information and resource requirements for two critical areas for sustainability, energy and planted production forests, are the key components of the first stage. The aim is to ensure consistency in concepts, definitions, and classifications. The development of the framework identifies the sort of questions the next stage, prototype accounts, could help answer. The results of this first stage have been reviewed by potential users. The government has agreed that further work on the development of prototype accounts for energy and production forests should proceed.

Unlike other countries, New Zealand uses ENRA in a more practical and cost-effective manner. The theoretical undertaking of New Zealand in the field of ENRA has shown that physical accounts are always the starting point of further ENRA work. Even at the theoretical stage, the outcome of this work has been useful to potential users. In order that the resources and environmental issues needed could be prioritised they were identified according to those specific issues the framework is trying to address. Although New Zealand has structured a framework for natural resource and environmental accounts, the present work does not show any attempt for incorporating these accounts into the SNA, thereby producing adjusted or 'green' GDP. Yet, as the developed framework and the methodologies are implemented for research or experimentation, potential for the framework's integration with economic accounts exist. The framework could then be a potential instrument for measuring the sustainable management of natural resources and the environment, especially if the country values its natural resources and environment because of their major contribution to the economy.

Like France, Canada came up with a dual physical and economic approach. Hamilton (1994) cited Smith's report on the work of Statistics Canada to develop natural resource accounts in quantity and value, physical resource use and pollution emission accounts, and environmental expenditures accounts concerning greenhouse gas emission accounts. One example is the pilot study on the physical and monetary accounts for Alberta's forests - a study by Anielski (1992) cited by Hamilton *et al.*, (1994). Another example is the study by Born (1992) on Alberta's oil and gas reserves expressed in both volume and value for the period 1951 to 1990.

A main feature of most of Canada's studies is the thorough discussion of theoretical methodological issues in the meaning of economic rent and the validity of the various assumptions underlying its measurements. The Hoteling assumption was used but found too restrictive for the Alberta data (Hamilton *et al.*, 1994), and the present value (PV) approach and the El Serafy method were used instead.

The Japanese proposals, like the American, are clearly based on the theory of welfare economics (Wright, 1989; Theys, 1989). The results of the first Japanese attempt were updated in 1975. Uno (1989) made a third attempt for the period 1980 and 1985. Hamilton *et al.* (1994) report that the main adjustments in the latest version include: government consumption, personal consumption, capital investment, leisure time, non-market activities, environmental damages and, losses due to urbanisation. Recently, Uno (1994) presented the developed social, economic, and environmental data set (SEEDS) framework. The framework is not really a rigid statistical system. It is a group of modular building blocks, each designed to be compatible with related ones and which can be assembled for particular analytical needs to respond to a particular policy issue. It attempts to provide statistical accounts from which social indicators can be derived (Uno, 1994).

While most of the countries mentioned focused their attention on accounting for natural and environmental resources, Japan has paid attention to the compilation of statistics that address those social policy issues which have something to do with welfare. The Japanese have a unique vision for their work. Japan envisions that the recent NRA-related work should be interlinked with other countries dealing with similar resource-bases, believing that an interaction and link among the international entities could make the effort more meaningful.

In the pursuit of efficiency in the use of physical accounts, close interaction between statisticians, analysts and policy makers are called for in Finnish work. According to Kottola (Hamilton, 1994), Finland launched a natural resource accounting project through its statistical office in 1985, as reported by Hamilton (1994). Published in 1992, the complete wood material accounts in physical quantities have been used in economic modelling, carbon balance accounting and experimental monetary valuation of forest resources. They form a basic component of the Finland Long Term Modelling System (FMS). The system also includes energy use and air emission components.

In Germany, as Hamilton (1994) reports, a system of Environmental Economic Accounting (IEEG) is being developed by the Federal Statistical Office. The system will have five subject areas: (1) material energy and emission flow accounts, tied to the I/O accounts; (2) a geographic information system (GIS) on the use of land and space; (3) a set of indicators of the state of the environment; (4) environmental protection activities accounts; and (5) accounts of the imputed costs of achieving standards set for the environment. Germany's accounts are better suited to measuring quantity rather than quality, although this is often not an insurmountable problem.

The Netherlands' research on physical accounting was carried out mainly on the basis of the Norwegian experience. Jinchang *et al.* (1990) report that the Central Bureau of Statistics (CBS) of The Netherlands carried out accounting of land, energy resources, forest, etc. Funds for the research were allocated and supported by the National Statistical Office, the Ministry of Agriculture, and the Ministry of Forestry. A report by Hamilton *et al.* (1994) shows that the CBS has compiled a report on environmental statistics published in *Environmental Statistics in The Netherlands 1993*. The physical accounts can be linked to the SNA and are based upon developments in the use of the social accounting matrix (SAM) of which elements are structured consistently with the SNA. The themes reportedly include the greenhouse effect, ozone depletion, acidification eutrophication, and waste production.

Among the developing nations, Indonesia pioneered work on natural resource accounting. The case study published in 1989 by Repetto *et al.* (1989) of the World Resources Institute (WRI) (Repetto, *et al.*, 1989; Jinchang *et al.*, 1990; Meyer, 1993; Hamilton *et al.*, 1994) covers timber, petroleum and soil.

The Indonesian work is not merely physical accounting. Although the resources covered are not as broad as those of France and Norway, the Indonesia case study illustrates different valuation techniques for the resources under consideration.

The physical stocks and flow of each assets were quantified for each year in the period of the study, using the depreciation approach. Assets were valued using the net price method: rents were determined by taking the international resource commodity price and deducting all factor costs incurred in extraction (Hamilton *et al.*, 1994). The variation between each represents (dis) investment in natural capital.

Soil depreciation is calculated from the loss of potential future farm income considered equivalent to the depreciation of an economic asset (Hamilton *et al.*, 1994). Incremental erosion due to human intervention is estimated in physical terms by the difference between per-hectare loss on forest land and on dryland farming. A yield erosion relationship was also estimated with farm income declining linearly as erosion increased. The economic measure of social depreciation was then obtained from the capitalised value of one-year costs of erosion, to obtain the total present value of the future stream of productivity losses due to erosion in each year.

The resulting loss in natural assets in both cases is significant. Repetto (1989), Meyer (1993), and Suparmoko (1994) report that while GDP increased at the average annual rate of 7.1 per cent in 1971 - 1984, domestic product net of depreciation increased by only 4.0 per cent per year. This result struck policy decision makers: it clearly showed the extent to which Indonesia had been living off its capital. According to Suparmoko (1994), NRA is a useful basis for economic development planning and for natural resource management and has gained appreciation. He recommended further studies to obtain better methods and increase understanding of how to cope with the problems of degradation of physical natural resources and their valuation.

Gilbert (1990) attempted natural resource accounting for Botswana. His study is composed of three major accounts: stock accounts, resource user accounts, and socio-economic accounts. Both the quantity and the quality of resource stocks and flows are addressed by a cause-and-effect approach. Water, apart from the ecosystem, land and air make up the stock accounts. The stock dynamics of the water and component subaccounts are documented using an equation identity composed of stock at the beginning of stock period (So), imports (I), natural gain (N), consumption (C), exports (E), natural loss (M), and stock at the end of time period (S_1); so that, $So + I + N = C + E + M + S_1$. Only freshwater stocks are considered, distinguishing between ground and surface waters. The quality aspect of air and water subaccounts takes into account natural and human-made emissions into water bodies (causes), and the resulting water quality (effects). The resource user accounts which consist of fisheries, livestock, crops, forestry, conservation, recreation (including tourism), water storage, urban and transport, and waste disposal subaccounts, describe the use of these stocks within the economic-environmental interface in a mixture of physical and monetary units. The socio-economic accounts describe, predominantly in monetary units, the movement of raw materials into the economy, and also other benefits from environmental use by human-oriented activities.

These accounts resemble the Norwegian accounts for minerals and forests, and they are to be used to help set both macroeconomic policy (with input-output models) and sectoral policy (Meyer, 1993).

As mentioned in 2.2 the UN conducted a case study in Mexico and Papua New Guinea. These case studies have gone beyond physical accounting and mere valuation, as both countries applied the concepts in the UN *Handbook* upon which any adjustment of the SNA is based.

Other developing countries at various stages in NRA development include Tanzania (Peskin, 1989b), India (Meyer, 1993; Parikh, 1994), Thailand (Manopimoke, 1994), Columbia and El Salvador (Meyer, 1993), Brazil (Seroa de Mota, 1993), Zimbabwe (Adger, 1993), and China (Jinchang *et al.*, 1990).

2.4 Environmental and Natural Resource Accounting in the Philippines

Cognisant of the need for a national accounting system that integrates environment economy relations, the Philippines has joined other countries in taking steps towards "greening" the national accounts through the environmental and natural resource accounting projects and pre-implementation activities. The Department of Environment and Natural Resources (DENR) and the United States Agency for International Development (USAID) established in 1991 the Environmental and Natural Resources Accounting Project (ENRAP). It was implemented by the International Resources Group (IRG) and the Mandala Agricultural Development Corporation (MADECOR) with technical support from the National Statistical Co-ordination Board (NSCB) and the DENR. The project is the first attempt in the Philippines to do the Natural Resource Accounting (NRA).

The first phase of the project, (NRAP), was sectoral in approach, and modified the Philippine Gross National Product (GNP) with depreciation estimates of the country's forest resources (Project Brief). The implementation under Phase I made it apparent that the project should continue, as the importance of NRA captured attention of the economist, policy makers, decision makers, statisticians at different levels of management.

The participation of the Philippines in the United Nations Conference for Environmental Development (UNCED) in June 1992 at Rio de Janiero, further recognised the usefulness of NRA through the establishment of the Philippine Council for Sustainable Development (PCSD). Created under Executive Order (EO) Number 15, dated September 1, 1992, the PCSD is the first body in Asia to respond to the UNCED, and ensure that the commitments made at Rio and the Implication of Earth Summit to the Philippines are implemented (PCSD Briefing Folder, 1993).

To insure a healthy environment and prosperous economy for the current and future generations is the fundamental goal of the Philippine Agenda 21. Priority actions for the agenda are clearly stated, one of which is the protection and conservation of natural resources such as water, atmosphere, forestry, land, biological diversity and agriculture. Natural Resource Accounting (NRA) is identified as an instrument both in direct planning activity and in long-term implementation. It is apparent that the project must continue to another phase, this time by broadening the scope.

From January 1993 to March 1994, ENRAP II developed a comprehensive accounting framework that examined the role of both the natural and environmental resources, and their impact on the country's economy. Specifically, Phase II accounts for the depreciation of small surface-dwelling fisheries, upland soil (erosion), and minerals (copper and gold). Economy-environment interactions were also estimated in terms of waste disposal services provided by air and water resources to households, industry and government. This system of environmental accounts is built to support economic, natural resources and environmental policy formulation.

The outcomes of Phases I and II signified the need to continue the project. The results of NRAP Phase I accounting for forest resources were used as inputs into the current debate on the proposed logging ban, both by the DENR and the congressional committee. Project findings revealed that some areas for improvement regarding procedures and data quality needed to be addressed. The ENRAP Phase II Report (1994) primarily focused on economic data constraints such as the incomplete cost of information on pollution control, natural resource extraction, and household adjustments to health effects of environmental changes. To fill these information gaps, enhanced environmental resource data and improvements in the national data gathering systems for economic variables are needed.

Now in its third phase, ENRAP is mandated with the task of institutionalising the various ENRA processes within government structures. The project is expected to refine further the environmental indicators so far developed and to address better a number of key environmental policies and management issues.

One of the four objectives of Phase III is to formulate viable data development approaches at the national level that may be replicated in resource-specific and site-specific areas. Investigation into frameworks and approaches to account for resources such as water are not, as yet, included. To achieve ENRAP III requires the enhancement of technical capability on the field of NRA; training; further research studies and experimentation; the examination of other countries' experiences; and more access to international literature.

2.5 International Experience in Water Resource Accounting

In this section international experience directly related to resource accounting efforts dealing with water will be discussed. Most of the OECD's studies on water generally considered five types of accounts: water quantity, water quality, aquatic ecosystem, and water economics. The studies were considered in the drafting of the UN *Handbook of Integrated Environmental and Economic Accounting* that features the possible attributes of water as:

Figure 1. Possible functions of water as a natural asset.

Quantitative (flow of goods, depletion of stocks)	Drinking Cooling Process Water Irrigation
Qualitative (flow of services, degradation of fixed assets)	Recreation Navigation Habitat for plants and animals Hydropower
Qualitative (disposal service, flow of residuals, degradation of environmental media)	Storing/ Absorbing Residuals

France, Botswana and China are the countries that have provided explicit work on water resource accounting. France was the first pilot country for a study dealing with inland water resources. Water accounts are presented in three types of accounts: central, peripheral and agent. Central accounts describe the state of the resource variations between the beginning and end of a period. Peripheral accounts show the relationship between one resource and another, and between human activities and the resource under consideration (Pearce *et al.*, 1989). These accounts show interdependence or exchanges of (between) the elements with respect to water, for example the amount of water withdrawn or returned by man. Agent accounts describe the flow between the resource and an economic activity in physical quantity. A water quality balance sheet is also established by river basin and present quality levels are matched with quality objectives set up at the beginning of the period.

Like the other resources in the patrimony accounts, the accounts for water attempt to establish the link between natural heritage and national accounts. It shows some linkages between the economy and the environment that are of general interest. However, although these linkages have been recognized, the use of these accounts in economic analysis with policy relevance is still unclear (Pearce *et al.*, 1989).

Norway has collected a large amount of data on the national water environment (Jinchang, L. & Zhengang, G., 1990). In the Norwegian resource accounting system, water appears within the two broad classification of material resources (such as hydro-power) and environmental resources (such as water quality for recreation, drinking etc.). As a material resource under the bio-physical classification, a breakdown by geographical location for water is recognized as important and is therefore undertaken. In this way, the Norwegian experience proves that material resource accounts, of which water is one, are easier to prepare than environmental resources accounts (e.g. water quality).

Although Norway has not given as clear an illustration of water resource and environmental accounts as France, the geographical dimension is an important part feature which facilitates the preparation of emissions and state of environment accounts by sector and by region. This characteristic is helpful when dealing with transboundary emissions account and state accounts for water resources.

Though some economists do not recommend the French and Norwegian experience for reasons to be stated lately, yet these two countries' experience present a good example for water resource accounting.

The Botswana's NRA model, developed by Gilbert (1989) exemplifies changes in environment conditions (Dixon, James and Sherman, 1990) and is composed of three major accounts: stock accounts, resource user accounts, and socio-economic accounts. Water is one of the resources that composes the stock account. Both quantity and quality of resource stocks and flows are addressed by a cause-and-effect approach.

The stock dynamics of the water and component subaccounts are documented using an identity composed of stock at the beginning of stock period (S_0), imports (I), natural gain (N), consumption (C), exports (E), natural loss (M), and stock at the end of time period (S_1); so that $S_0 + I + N = C + E + M + S_1$. Specifically, for the Botswana balance of water:

S_0 = stocks of surface water
I = net imports
N = net natural increase (rainfall, run-off, evaporation)
C = groundwater extraction by resource user

Only freshwater stocks are considered distinguishing between ground and surface waters. The resource user accounts describe the use of these stocks within the economic-environmental interface in a mixture of physical and monetary units.

The importance of also incorporating water quality was mentioned by Perrings *et al.* (1989) and this for two reasons: first, so that more information is given on the value or usefulness of the resource; and second, so that changes in resource quality over time can be monitored. It is said that this can be achieved by defining classes which group water by the basis of chemical or physical characteristics which relate to its potential use.

For example, water can be described according to a range of chemical and bacterial criteria to determine whether it is suitable for drinking, industrial or other purposes. Hence, balances can then be constructed for each class of resource.

China's NRA covers specifically groundwater resources. The report by Jinchang, Yaoqi, Zhengang, Guogang, and Weishing (1990) provides a more detailed presentation of the country's initial step in groundwater resource accounting. The effort was prompted by the increasing awareness of people of the country's depleting and deteriorating groundwater. As a result, the economic value of water has been given particular attention and has been imputed into water price charges.

As a first step, the physical quantity is accounted for in three parts: the quantity of natural resource, the exploited resource, and the exploited amount. Natural resource, is the resource stock which includes the amount of water recharged. Exploitable resource, which is the same as the stock of natural resource is the amount that guarantees exploitation of groundwater; also reflects worsening water quality and ecological imbalance. Exploited amount reflects the flow of the natural resource being extracted or exploited.

Groundwater resources include geothermal water the spatial distribution of which was identified. Related data includes heat supplied in standard coal equivalent per year; and depth of wells. It was found out that exploitation potential of this resource is quite great.

Mineral water is another groundwater resource considered. Though the distribution of it is not well known, there is evidence that lots of groundwater possess the characteristics of the mineral water. Distribution of exploited resources of groundwater resources was also presented by district.

In establishing physical accounting of the groundwater resource, China made use of several types of data. Data on precipitation and underground water recharge which includes underground run-off, leakage of water supply canals and reservoirs, and return of irrigation water. Depletion data include evaporation of soil and water, artificial exploitation, and loss from underground run-off to lower reaches outside the region.

Considering the characteristics of China, groundwater accounting should be divided into smaller regions so that valuation of the quantity exploited can be facilitated. Compared to mineral accounting, resource reserves are not too important because it is generally thought that these reserves should not be drained and therefore no extraction or use takes place. The natural recharge which become the exploitable yield is taken seriously. Hence, the flows, balances, reductions and use of this exploitable yield needed to be properly accounted for. Net reduction takes place only when the exploitation is greater than the exploitable yield and is recharged only with the drain of the reserve of groundwater resource.

An actual case study of groundwater accounting in the Central Plain Area in Beijing has provided a concrete example of the proposed structure. The result shows a negative variation in the groundwater resource, which implies a continual draining of the reserve.

The economic valuation of groundwater resource has raised arguments between the World Resources Institute (WRI) and the United Nations (UN). On one hand, the WRI considers groundwater loss to be a form of resource depletion since groundwater is a physical productive asset whose depletion can be measured quantitatively. On the other hand, UN's interpretation reflects a differing valuation principles applied. For groundwater loss, the cost was assumed to equal what it would cost to re-inject water into underground reservoirs. Water-and-air pollution costs were valued according to what it would cost to reduce pollution to acceptable levels. Since these valuation techniques rely on actual cost information instead of "speculative values", they are typically chosen (Meyer, 1993). Although a "net rent" or net price method theoretically could be used to measure depletion of groundwater, in practice estimating true rent may be difficult.

Started in 1991 through the Central Bureau of Statistics, the Netherlands' NRA activity covers water as well, however, no valuation of water resources was undertaken. Rather, the aim was to establish data for the environment management and link these economic data so as to come up with satellite performance indicators. Its framework describes the state and change in stocks and flows based on three ecological functions-source, sink, and life-support system expressed in physical terms. Such aspects resemble the French ecological accounts.

In New Zealand (Sheerin, 1995) an accounting framework which also accounts for water is being examined. The water account framework has a potential to present a detailed account of stocks and balances of water. Similar to Norway, water accounts and associated data are presented in a geographical or regional breakdown to facilitate regional analysis and national aggregation. The accounts framework also shows sectoral breakdown of different uses (extractive and non-extractive) by economic sectors. Other elements shown in the framework address environmental issues like emission accounts by sectors. The opening stocks and balances (for quantity and quality) can also be presented in the framework. The present work does not elaborate on the economic valuation aspect. Different value attributes for water are recognized and this is reflected in Figure 2.

Figure 2. Freshwater resources framework (SNZ, 1994).

		BIOTIC (1)	ABIOTIC (2)	
Significant Values (3)		Conditionally Renewable (4)	Conditionally Renewable (5)	Non-Renewable (6)
Resource Values	Energy Resources	Not Available (N/A)	Hydro-electricity; potential reserves for energy production; actual product. Geothermal energy	N/A
	Material Resources	N/A	Water stocks and flows; balance sheet; input/output accounts; utilization by sector. Impact of climate change.	
Service Values	Amenity services	Freshwater fish stock	Recreational use; tourism potential (boating, fishing, swimming); water quality.	
	Absorption Services	Health status of flora and fauna	Waste flows into freshwater systems by type of waste (industry, agriculture); water quality measures.	
	Ecological Services	Status of flora and fauna dependent on freshwater systems	Habit function for fauna (fish, bird, other); land/flora interface; land soil quality.	
Intrinsic Values	Sanctions	Protection of freshwater fauna and flora	Protection of freshwater systems	

Statistics New Zealand's (SNZ) project is structured in such a way as to complement environmental management and information gathering and in particular the state of environment indicators program under the auspices of the Ministry for the Environment (Sheerin, 1995).

Other countries have started developing water resource accounts but none as yet have reached the level of detail and sophistication as those of the countries mentioned above.

CHAPTER III

NATURAL RESOURCE ACCOUNTS: A FRAMEWORK FOR WATER

The framework to be built is based on a view that recognizes water as a natural resource, and as a social and economic good whose quantity and quality determine the nature of its own utilization. Also, water is recognized as a resource that is affected by economic activity. Finally water can be seen as environmental capital with the characteristic of being conditionally renewable. Although water clearly has value, it is often not bought and sold in the market place which means that the true value of these services cannot be readily observed (Herfindahl and Kneese, 1974).

The framework to be developed will serve as a tool for examining environment-economy interactions and will provide information for making policy decisions on the sustainable management and use of critical natural assets such as freshwater. As a flow resource, a critical feature is the rate at which it is replenished relative to the rate at which it is used. Water is critical because of its role as a life-sustaining good. Combining this critical role with the open-access nature of many water resources, which can easily lead to overexploitation of water, leads to an obvious need for management. Determining its most effective use is crucial in the sustainable management of water resource. Management however, requires information. The framework to be developed will provide this. Specifically, the aim is to build a framework that will:

a) provide an additional and more uniform measure or indicator of progress towards sustainable development;
b) provide a balance sheet of stocks and flows of water in the economy on a regular basis;
c) unify the types of data on water resources already in existence, but in a fragmented way and which are under-utilized.

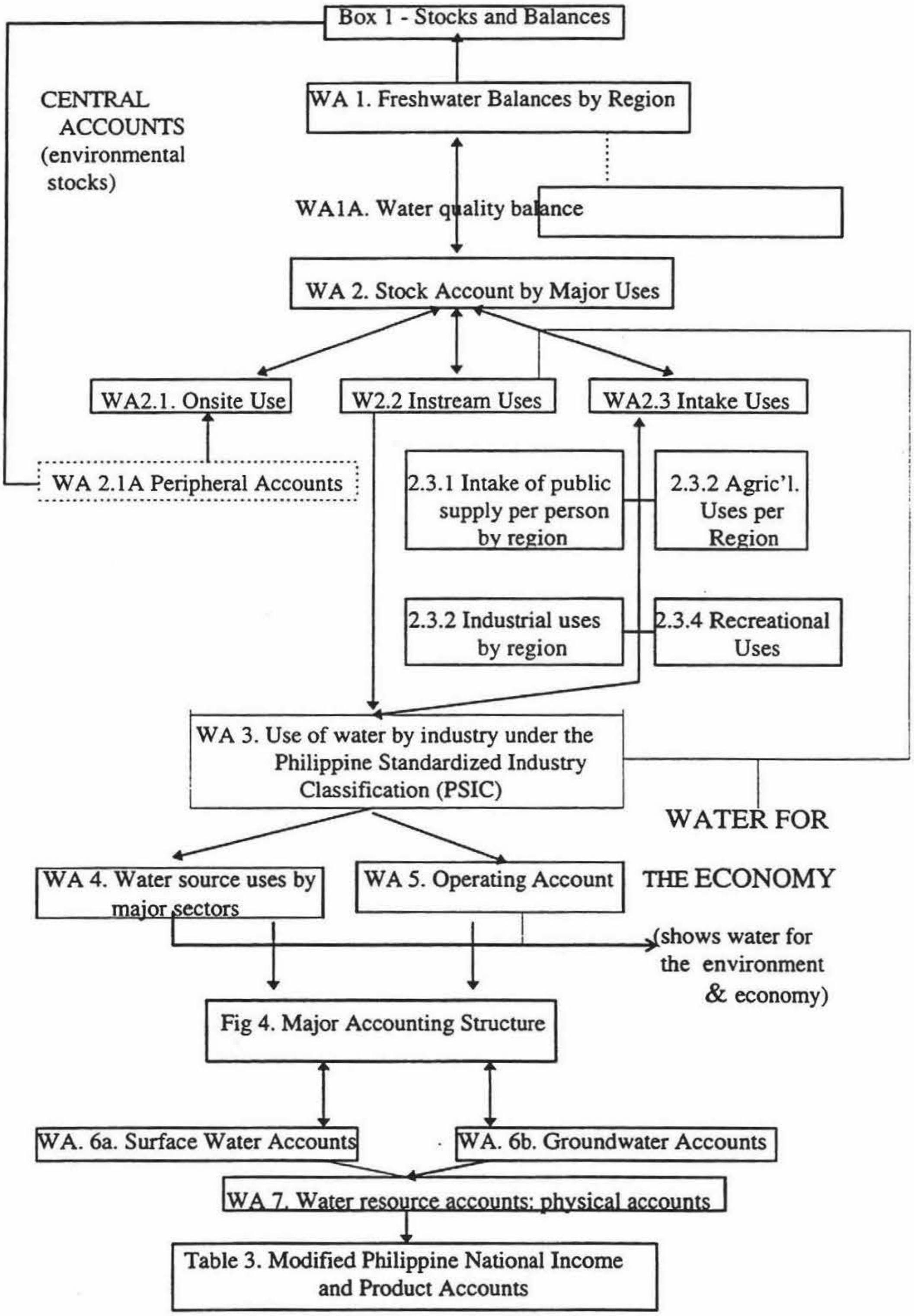
3.1 Physical Accounts Framework

As discussed in Chapter II the most straightforward way to show the impact of economic activity on water resource stocks is to develop physical resource accounts. These accounts assess resource availability, use, and overuse and are thus an important tool for managing natural resources. For these accounts, no resource value data on water is included and the starting point is hydrological data at the national level. They present only an intermediate step in the overall assessment of the natural resource base which is required to formulate and evaluate resource policies that are compatible with general development policies (Repetto, 1988).

The diagram (Figure 3) below presents the general structure of the framework. The broken lines suggest implicit integration, while the solid lines mean explicit integration. This structure is to be seen as the 'ideal' situation that we would like to develop. As will be seen, lack of data, will seldom allow this and something of a less ambitious nature will have to be settled for. It is however good to first describe the complete framework before looking at a more pragmatic approach.

Figure 3

Structure of proposed water accounts in the Philippines



The diagram above captures the entire sets of accounts formulated in this study. The figure illustrates the central stock account of water in the environment and its uses in the economy. It further shows how these uses interrelate with each other. Environmental stocks refer to water, available either by natural or artificial processes, for the use of the environment and the economy. Use by the environment which is now given emphasis and recognized not only for economic but also for ecological reasons, includes water that is utilized in the hydrological process affecting the earth's water budget and for the life-support of the earth's biota.

All these uses, economic and ecological, are in the framework and will be discussed in the sections following.

The first set of accounts are the stocks and balances accounts.

Box1. Stocks and Balances of water in the Philippines (in millions of cubic meters, 19___.

Beginning of the Period	**End of Period**
Sub-items	
<u>SURFACE WATERS</u>	<u>SURFACE WATERS</u>
1. Rivers	1. Rivers
2. Dams	2. Dams
3. Lakes	3. Lakes
4. Ponds	4. Ponds
<u>GROUND WATERS</u>	<u>GROUND WATERS</u>
1. confined aquifer (C)	1. confined aquifer (C)
2. unconfined aquifer (U)	2. unconfined aquifer (U)
<u>OTHER SOURCES</u>	<u>OTHER SOURCES</u>
1. Annual Rainfall	1. Annual Rainfall
2. Rainfall Captured by Household	2. Rainfall Captured by Household
3. other human activities	3. other human activities
Whole country TOTAL	

Box 1 resembles the French central environmental stock. It shows the stocks and balances of major freshwater resources in millions of cubic meters (mcm) at the beginning and end of the period. Rivers (including streams and waterfalls), dams, lakes and ponds are classified under surface water. Ground water is classified into confined and unconfined aquifers.

Surface and ground waters are the major water resources in the country. The account allows inclusion of other water resources and other water bodies except oceans and seas.

In the Philippines, streams and rivers vary in frequency and volume of discharge. Hence, accounting for this variability is necessary. One way to do this is by catchment or drainage basin. Wright (1990) states that for the structure of "water accounts to be useful, they should be disaggregated to catchment level".(pp. 34-36).

Lakes are also a major water resource of this country, and are in critical condition nowadays. The EMB (1990) reports that the country's 58 lakes, except Laguna de Bay, have not been monitored on a regular basis nor have schemes for their utilization and management been drawn up.

When resources are in critical condition, it is vital to account for the level and quality of stocks as these are a major consideration in deciding to which optimal use(s) such resource could be put. Permanence of and fluctuations in water levels, both seasonal and annual, are a consequence of variability in rainfall and other climatological factors. It is important to account for the permanence of water levels because it could easily offer an opportunity to decide on the best optimal use a lake could be put. Also, the unprecedented changes that are attributed to effects man has on the hydrological cycle with respect to changes in land use and construction of artificial controls in outflows, need to be incorporated.

Dams are also popular as devices for controlling water supplies on a large scale. A dam creates a lake whose discharge can be controlled according to the demands placed upon the resource (European Community, 1994) especially in the different seasons between which water supply varies and uses are differently affected. Taking into account the various uses of dams, is integral for determining their economic and ecological function, as well as anthropological uses.

Ground water is the most significant source of water used by industry, agriculture and domestic users. It has been recognized as a resource with high potential for profitability (World Bank 1981). This potential increases as demand by various economic sectors increases. However, being an open access resource it is vulnerable to exploitation and to conflict in use. There is a growing realization that there are now a number of areas where overexploitation is likely, or where it has already occurred as shown by either falling water tables or saline water intrusion into groundwater aquifers or both.

The potential of groundwater has not been fully developed in low income countries (World Bank, 1981). A report of the Institute of Development Studies cited by the World Bank (1981) further stresses that: "Groundwater resources may be the largest remaining untapped resource available for alleviating the pervasive and intractable problem of rural poverty in South Asia. Groundwater is at present being appropriated largely by those who are richer (or perhaps more accurately less poor) and more powerful. Opportunities to those who are poorer and weaker to benefit are passing. Who is to gain from this last frontier? The haves or the have-nots?".

Overexploitation can also lead to the drying out of soil and possible subsidence with consequent secondary effects on agricultural production. Water is conditionally renewable. It is replenished by infiltration and thus if water is abstracted at a rate greater than the rate of replenishment, the water table will fall and the source will be eventually exhausted (Tebutt, 1973; European Community 1994).

In order to maintain groundwater as an economically and ecologically important resource, it is essential that the rate of abstraction from aquifers does not exceed the rate of recharge. Hence, it is essential that the groundwater levels, their rates of abstraction and recharge should be periodically monitored and accounted for.

The Philippines is experiencing the negative externalities of groundwater exploitation. Domestic water supplies, public utilities, agriculture and industry have been affected by saline water intrusion. Since 1970s, groundwater levels have decreased by 30 % to 50 % all over the country (PEAN, 1994).

Water Account (WA) 1 summarizes the data on regional water resources which when aggregated provide entries for Box 1.

Water Account 1. Freshwater Balance- Philippines (MCM), 19 ___.

	Category							
Region	Rivers	Dams	Lakes/ Ponds	Groundwater (C)	(U)	Ann. Ave. Rainfall	Ave. HH Rainfall Catchments	TOTAL
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
I - Ilocos Region								
II - Cagayan Valley								
III- Central Luzon								
IV- Southern Tagalog								
V - Bicol								
VI - Western Visayas								
VII- Central Visayas								
VIII- Esatern Visaya								
IX - Southern Mindanao								
X- Northern Mindanao								
XI- South-eastern Mindanao								
XII- Southern Mindanao								
Whole Country TOTAL								

The country is divided into water resources regions. Such classification facilitates evaluation and development of water supply for different uses. While water account 1 contains the physical quantity of water resources by region, WA 1a summarizes the state of water quality for the same regions at the beginning of the accounting period.

Water Account 1A. Water quality balance sheet by region, 19__.

Region	Water Resources *	Quality Levels (Present Status)					Total	Quality Objectives					Total
		A	B	C	D	E		A	B	C	D	E	
	(1)	(2)						(3)					(4)
I- Ilocos Region													
II - Cagayan Valley													
III - Central Luzon													
IV - Southern Tagalog													
V - Bicol													
VI - Western Visayas													
VII - Central Visayas													
VIII- Eastern Visayas													
IX - Southern Mindanao													
X - Northern Mindanao													
XI - Southeastern Mindanao													
XII - Southern Mindanao													
Total													

*Needed to be specified if groundwater or surface water

Quality is a critical factor in deciding whether lakes, rivers and other water bodies can be used as a resource for livestock watering, irrigation, industrial and other uses or not.

Management of water quality relates essentially to the beneficial uses of water rather than the adequate treatment or disposition of waste water. Integrating water quality into resource management leads to the attainment of three objectives consistent to the attainment of sustainability (UNCED, 1993): (1) maintenance of ecosystem integrity, (2) public health protection, (3) human resource development. Generally the management principle is to preserve aquatic ecosystems including the living resources and to protect them from any form of degradation. Safe minimum standards designed by economists may be relevant to the protection of critical level of natural capital (Felke, C.; Hammer, M.J.; Costanza, R.; Jansen, A.M., 1994).

Different sectors and users require certain quality. For example, reasonable quality should be available for livestock taking into account their tolerance limits. Industries using water for processing require high quality water - mineral water in some cases as with pharmaceuticals, and chemical manufacturing, etc.

Quality is defined in terms of its chemistry, biological quality, and physical characteristics such as color, and in terms of acceptability for uses, including aesthetic acceptability. Standards or indicators can be defined to assist in quality management. These indicators tell about the suitability of the water for these various uses and the degree of treatment necessary for effluent discharge or for water abstracted from the source (Tebutt, 1973). Indeed, water can be made fit to drink, for domestic purposes and even for other industrial uses at a cost (Stephenson and Peterson, 1991). Hence, water quality monitoring needs to be reflected in the physical accounts to come up with a true picture of the nation's water supply.

In the Philippines, a very small number of rivers have been classified according to their best usage and many others are not regularly monitored according to water quality (EMB, 1990).

The numerous threats to the country's lakes which have surfaced with alarming frequency and intensity underscore the need for continuous monitoring of the state of the country's lakes. Some of the data already exist but are poorly managed and underutilised.

The Philippine National Water Resources Council (NWRC) (1976) classified water use as intake uses, onsite uses, and instream uses. **Intake uses** consist of water for domestic, agricultural, and industrial purposes or uses that actually remove water from its source. **Onsite uses** consist mainly of water consumed by swamps, wetlands, evaporation from surface bodies, natural vegetation, unirrigated crops and wild life. **Instream uses** include water for estuaries, navigation, hydro electric power, waste dilution and some fish and recreational uses.

When water is used in industries and power production, especially for cooling and condensing operation, a considerable amount of heat is transferred to the water resource which can lead to thermal pollution. Such pollution can have serious effect on the environment since most biochemical and chemical reactions are temperature dependent. Although the water volume remains basically unchanged, the rise in temperature and consequent reduction in dissolved oxygen can cause a serious problem affecting the economy and the environment.

A description of the uses of the natural environment in physical terms (quantity and quality) should start with the immediate consequences of human intervention on natural balances, even though in many cases such intervention has a variety of indirect effects. Domestic, industrial supply, recreation and effluent disposal use lowers the quality of water in the system.

The Philippines has accounted for the disposal services of water and air. Quantities of residuals emitted to the water are recorded.

Water account 2 summarizes the stock account according to major uses by region.

Water Account 2. Stock account and major uses by region (MCM), 19__.

Region	Water Use				
	Onsite (1)	Instream (2)	Intake (3)	TOTAL (4)	Percentage of which is Groundwater (5)
I - Ilocos Region					
II - CAgayan Valley					
III - Central Luzon					
IV - Southern Tagalog					
V - Bicol					
VI - Western Visayas					
VII - Central Visayas					
VIII -Eastern Visayas					
IX - Southern Mindanao					
X - Northern Mindanao					
XI - Southeastern Mindanao					
XII - Southern Mindanao					
TOTAL					

The succeeding boxes show the details of accounts for the three (3) major uses mentioned above.

Water account 2.1. **Onsite use** of water by region, 19 ___.

	Onsite Uses/Consumption						
Region	Swamps (1)	Wetlands (2)	Evaporation from the sea (3)	Natural Vegetation (4)	Unirrigated Crops (5)	Wildlife (6)	TOTAL (7)
I - Ilocos region							
II - Cagayan Valley							
III -Central Luzon							
IV - Southern Tagalog							
V - Bicol							
VI - Western Visayas							
VII - Central Visayas							
VIII - Eastern Visayas							
IX - Southewestern Mindanao							
X - Northern Mindanao							
XI - Southeastern Mindanao							
XII - Southern Mindanao							
TOTAL							

This water account (WA2.1) illustrates the onsite uses of water. This also illustrates the importance of this type of use in water accounting as it illustrates the ecological functions of water.

Legge (1994) emphasized that uses and requirements of the natural environment such as wetlands and wildlife must be kept in mind. Wetlands were once regarded as wasteland but are now recognized as being vital to surface water quality and wildlife (Stanger, 1994). They provide different services such as storm protection, recreation, fisheries, timber, or water purification (Bockstael; Constanza; Strand; Boynton; Bell and Wainger, 1994). Particularly, wetlands are the natural bio-physical water filters and flow regulators of natural ecosystem. They are indispensable for the sustenance of life on earth; and are important to all socio-economic sectors.

Swamps, on the other hand, are defined by Stanger (1994) as any saturated water and vegetative land, usually with an abundance of standing water. It is a marshland ecosystem which requires a certain amount of water level enough to sustain life in it. Any water utilization beyond the established water level requirement of wetlands, leads to the disturbance of the aquatic ecosystems and threatens the living freshwater species in it (OECD 1994).

Information on important onsite uses of water such as the ones mentioned above, is sparsely available. Furthermore, data on these uses cannot be measured by conventional types of data collection and analysis (NWRC,1976). Some data on these uses are still inadequate. An effort to present hypothetically the potential use of these data in an accounting framework is needed because of the growing awareness of the indispensable functions these uses play in our society.

Like the French accounts, an account such as 2.1.A. describes the exchanges between natural elements: soil, air, living organisms and seawater and highlights the interdependence of the elements with respect to water.

Water Account 2.1A. Peripheral accounts of water in the Philippines.

Origins	**Destinations**
Evaporation from the sea	Runoff
Evapo-transpiration	
of which : Plants	Percolation
Soil	Infiltration
Air	Interception
———	———
TOTAL	TOTAL

These elements are central to the natural distillation process, and the hydrological cycle, and are determinants of the earth's water budget. Hence, it is deemed important to have an account for these.

Evapotranspiration which is the combined water loss by evaporation from the ground and from transpiration by vegetation (Stanger, 1994), is important in the hydrological cycle but is however difficult to quantify (The Open University, 1984). The quantity of water evapotranspired shows the amount lost from surface waters and is regarded as consumption by the atmosphere.

Runoff is essential for groundwater recharge. When water reaches the ground without being intercepted, it may become a part of the surface runoff, or it may soak into the soil adding to the groundwater or it may evaporate. Generally, runoff occurs only after the requirements of evapotranspiration, soil and groundwater recharge have been satisfied (Speidel *et al.*, 1988). This contributes to the potential groundwater recharge therefore, a factor for natural increase.

Percolation describes the passage of water into, through, and out of the ground. The soil moisture can be considered as a savings account, however, is not a typical savings account because there is a limit to soil moisture capacity (Speidel *et al.*, 1988). The water in excess of the limit percolates deeper and recharges groundwater thus adding to the quantity of water.

Some of the water infiltrating the openings of the soil is returned to the atmosphere. However, some of it enters the openings of the soil or rock and when these become saturated it accumulates and slowly feeds springs and streams. Furthermore, the part taken up by plants is released to the atmosphere through transpiration. This is important as it contributes to the water supply as the process shows.

Interception can determine the amount of water that could add to water supply through the water falling upon vegetation but is re-evaporated to the atmosphere. This also plays an important part in the natural distillation process.

Because NWRB reports that these elements are difficult to measure, data on these are not promptly collected and are incomplete and inconsistent. From an ecological point of view, an important task for any environmental policy is to balance the needs of humans with those of other living organisms (plants or animals) (SIEEA, 1993). Balancing human and natural needs not only protects flora and fauna from human influences, but also maintain the natural environment and its assets such as water, in an intact state for future human generations. This leads to the concept of sustainability (Bartelmus, 1992; Pearce, Markandya and Barbier, 1989). Thus, taking these elements seriously into account is crucial to an accounting framework for it to be useful for sustainable management and allocation of natural water resources.

Hydro-electric power and energy production are major water users in the Philippines. They are principally **instream or non-consumptive uses** converting the energy of falling water into electricity; actually what is being considered here is the potential energy which is evidently of enormous value. The water used for hydro-electric power generation is a measurable quantity, because the water is passed through the plant and can be documented.

Large water withdrawals over a short time may adversely affect use for power generation impairing the power generation capacity. Water is also used for steam generation and cooling and to a lesser extent as an energy source. When used for cooling, water in most cases is not consumed. Rather, some amount is returned to its source affecting its original state. The quality change is indicative of its property particularly temperature. Hence, thermal pollution which increases dissolved oxygen is likely to occur.

Recycling of water used in the process of power and energy generation is essential in the protection of water resources from depletion, pollution and degradation. When water is returned, its quality is being altered by the change in its temperature which is a vital property of water. When temperature increases, dissolved oxygen also increases. This condition is generally detrimental to aquatic life.

In the Philippines, power outages occurred frequently from 1992 to early 1994 (personal experience). The frequency of brown-outs was higher during summer due to the depleted water supply available for the hydro-power generation. This situation has been caused by deforestation has affected water supplies.

If stocks and balances are being accounted for in certain period, authorities will be guided in water planning and management particularly with regard to water storage and allocation throughout the year especially during the critical period. Because of the high economic potential of hydro-electric power, the supply of running water must be periodically accounted for. However, a constraint to meaningful analysis of instream water uses such use for hydro-power generation is the lack of comparable data.

Water account 2.2 tries to put together the types of related data necessary for the accounting of water used for hydro-power generation, an instream water use.

Water Account 2.2. Water use in energy production in the Philippines
Total Throughput per annum, 19 __.

	Generation		**Generation**	**Production/Flow**	
Energy Type	**(Capacity)**	**(Actual)**	**Utilisation**	**Cooling**	**Total**
	Gwh	**Gwh**			
	(1)	(2)	(3)	(4)	(5)
INDIGENOUS					
1. Conventional					
Oil					*
Coal					*
Hydro					
Geothermal					*
II - Non- conventional					Production
Water Use					
Bagasse					*
Agriwaste					*
Others					*
TOTAL					

* in millions of barrels of oil equivalents

Major water using sectors are domestic, municipal, agriculture, industry and others (Water account 2.3).

Intake use of water is the most complicated and controversial among the three major types of uses mentioned earlier. Intake uses of water take or divert water from natural source. Hence, acquisition of rights over the use of waters, allowed by law, is required. Chapter III, article 10 of the Philippine Water Code states the following purposes by which water may be appropriated. The concept and definition of uses are strictly applied to this framework as well.

a) **Domestic Purposes** - utilisation of water for drinking, washing, bathing, cooking or other household needs, home gardens, and watering of lawns or domestic animals.

b) **Municipal Purposes** - use of water for supplying the water requirements of the community.

c) **Use of water for Irrigation** - mainly falls under agriculture; use of water for producing agricultural crops (i.e. irrigation).

d) **Use of water for power generation** - utilisation of water for producing
electrical or mechanical power.

e) **Use of water for fisheries** - use of water for the propagation and culture of fish as commercial enterprises.

f) **Use of water for livestock raising** - utilisation of water for the large herds or flocks of animals raised as commercial enterprise.

g) **Use of water for industrial purposes** - utilisation of water in factories,
industrial plants and mines, including use of water as an ingredient of finished product.

h) **Recreational Purposes** - the utilisation of water for swimming pools, bath houses, boating, water skiing, golf courses and other similar facilities in resorts and other places of recreation.

Water Account 2.3. Mean annual water intake use by sector and by region, 19 __.

Region	Intake Water Use							
	Domestic/ Municipal (1)	Industry (2)	Agri- culture (3)	Recreational & others (4)	Leakage (-) (5)	TOTAL (6)	NET TOTAL (7)	Percentage of which is Groundwater (8)
I - Ilocos Region								
II - Cagayan Valley								
III - Central Luzon								
IV - Southern Tagalog								
V - Bicol								
VI - Western Visayas								
VII- Central Visayas								
VIII- Eastern Visayas								
IX - Southern Minadanao								
X - Northern Mindanao								
X1- Southeastern Mindanao								
XII- Southern Mindanao								
TOTAL								

NB: Col.6 = (1) + (2) + (3) + (4) + (5) : Col 7 = Col. 6 - (5)

Data in column one are to be obtained from water account 2.3.1. Entries for columns two to four are to be taken from water account 2.3.2, 2.3.3, and 2.3.4 respectively, in which uses by sector are further disaggregated. When regional totals in column 6 are added, results must equal to national total in water account 3.

Various data for domestic and municipal water use are available, however, most are not consistent with each other and some are not reliable. Reconciliation of these data in this accounting framework will enhance the data handling and management. Once reconciled, these data are essential in planning for the optimal allocation of water resources.

Water account 2.3.1. Water intake of public water supply plants and water consumption per person per region , 19___.

Region	Domestic Use Urban (1)	 Rural (2)	Leakage (-) (3)	Total Water Intake (4)	Percentage of which is Groundwater (5)
I - Ilocos Region					
II - Cagayan Valley					
III - Central Luzon					
IV - Southern Tagalog					
V - Bicol					
VI - Western Visayas					
VII - Central Visayas					
VIII- Eastern Visayas					
IX - Southern Mindanao					
X - Northern Mindanao					
XI - Southeastern Mindanao					
XII - Southern Mindanao					
TOTAL					

NB: Col. 4 = (1) + (2) + (-3)

The succeeding boxes 2.3.2 , 2.3.3 and 2.3.4 show regional uses of water in agriculture, industry and recreation, respectively.

Water Account 2.3.2 Agricultural uses of water by region (MCM), 19__.

Agricultural Uses Region	Crop Production/ Irrigation (1)	Animal Production (2)	Fishery (3)	Forestry (4)	Agricultural Services (5)	TOTAL (6)	Percentage of which is Groundwater (7)
I - Ilocos Region							
II - Cagayan Valley							
III - Central Luzon							
IV - Southern Tagalog							
V - Bicol							
VI - Western Visayas							
VII - Central Visayas							
VIII- Eastern Visayas							
IX - Southern Mindanao							
X - Northern Mindanao							
XI - Southeastern Mindanao							
XII - Southern Mindanao							
TOTAL							

Agricultural water use includes water for irrigation, animal production, fishery, forestry and other agricultural services. In the Philippines, uses for irrigation and livestock covered 85 % and 74%, respectively of the total withdrawals for 1975. This Water Account 2.3.2 shows the data necessary to establish accounts on agricultural uses.

Water Account 2.3.3 Industrial uses of water by region (MCM), 9____.

	Quantity and Purpose of Use						
Region	Washing (1)	Cooling (2)	Boiler (3)	Process & Manufacturing (4)	Water & Power Plant Intake (5)	Percentage of which is Groundwater (6)	TOTAL (7)
I- Ilocos Region							
II - Cagayan Valley							
III - Central Luzon							
IV - Southern Tagalog							
V - Bicol							
VI - Western Visayas							
VII - Central Visayas							
VIII- Eastern Visayas							
IX - Southern Mindanao							
X - Northern Mindanao							
XI - Southeastern Mindanao							
XII - Southern Mindanao							
TOTAL							

Water Account 2.3.3 shows the quantity and purpose of use of water in industry. It is assumed that regional details on types of industry are classified based on a standardized classification to facilitate national aggregation as Water Account 3.

The next box shows the types of data for recreational purposes- another major intake user. This strictly applies to swimming pools, bath houses, boating, water skiing, golf courses and other similar facilities in resorts and other places.

Water Account 2.3.4 Recreational uses of water by region, 19 ___,
millions of cubic meters (MCM).

				Quantity & Uses			
Region	Swimming Pools	Bath Houses	Boating *	Golf Courses	Others	Percentage of which is Groundwater	TOTAL
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
II - Cagayan Valley							
III - Central Luzon							
IV - Southern Tagalog							
V - Bicol							
VI - Western Visayas							
VII - Central Visayas							
VIII- Eastern Visayas							
IX - Southern Mindanao							
X - Northern Mindanao							
XI - Southeastern Mindanao							
XII - Southern Mindanao							
TOTAL							

*Water used for boating refers to the quantity that is extracted or withdrawn from sources, and confined in a certain artificial reservoir as in resorts or recreation centers; just for certain purpose.

Account 2.3.4 shows the recreational uses of water; the water quantity for such purpose by region. Total recreational use is obtained by collating regional totals.

Water account 3, shows the aggregation of the water accounts by sector. This is obtained by accumulating regional accounts 2.3.1, 2.3.2, 2.3.3, and 2.3.4.

Water account 3 shows the estimates of water abstractions from surface and groundwater, by sectors and industries classified according to the Philippine Standardized Industry Classification (PSIC). When combined with GDP sectoral output measures, an index of water use per dollar of output can be developed.

Water account 3. Estimates of water abstractions from surface water and groundwater (MCM) by industry classified under the Philippine Standardized Industry Classification (PSIC), 19__.

Industry	Quantity & Purpose of Use								
	Washing	Cooling	Boiler	Process & manufacturing (GDP)	Water & Power	others	TOTAL (MCM)	Output Index	Gross Domestic Product
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Agriculture, Forestry And Fishery									
11 Agricultural crops production									
12 Livestock, poultry and other animals production									
13 Agricultural services									
14 Fishery									
15 Forestry									
Mining and Quarrying									
21 Metallic ore mining									
22 Non-metallic mining and quarrying									
Manufacturing									
31 Manufacture of food, beverages and tobacco									
32 Textile, wearing apparel and leather industries									
33 Manufacture of wood and wood products including furniture and fixtures									
34 Manufacture of paper and paper products; printing and publishing									
35 Manufacture of chemicals and chemical, petroleum, coal, rubber and plastic products									
36 Manufacture of non-metallic mineral products									
37 Basic Metal industries									
38 Manufacture of fabricated metal products, machinery and equipment									
39 Other manufacturing industries									
ELECTRICITY, GAS AND WATER									
41 Electricity, gas and water									
42 Gas and steam									
43 Waterworks and supply									
CONSTRUCTION									
50 Construction									
WHOLESALE AND RETAIL TRADE									
61 Wholesale trade									
62 Retail trade									
TRANSPORTATION, STORAGE AND COMMUNICATIONS									
71 Transportation services									
72 Storage and warehousing									
73 Communication									
FINANCING INSURANCE, REAL ESTATE AND BUSINESS SERVICE									
81 Banking institution									
82 Financial Intermediaries									
83 Insurance									
84 Real estate									
85 Business services									
COMMUNITY, SOCIAL AND PERSONAL SERVICES									
91 Public administration and defence (for water: urban and other run-off)									
92 Sanitary and similar services									
93 Education services									
94 Medical, dental, sanitary or health services									
95 Other social and community related services									
96 Recreational and cultural services									
97 Personal and household services									
98 Restaurants and hotels									
99 International organisations and other extra-territorial bodies									
HH HOUSEHOLD SECTOR**									
NATURE SECTOR ***									
TOTAL									

* Philippine Standardised Industry Classification (PSIC) (ENRAP, 1994). *** estimation is ignored.

**Consumption of household sector will be drawn from water account 1d.

The accounts previously constructed can be used in coming up with a summary of the major water-using sectors - the quantity of water used and its sources. This also tells which of these sectors reap most of the water resources. This is useful in formulating water-related policy.

Water Account 4. Water sources use by major sectors (MCM), 19___.

Sector	Water Use (MCM) by source (withdrawn)				
	Surface Water*		Ground water		TOTAL
	Supply	Demand	Supply	Demand	
Municipal					
Industry					
Domestic (or Household)					
Agriculture					
Energy Production					
Recreational & others					
TOTAL					

* Specify source of surface water (refer to Box 1).

Water account 4 shows the quantity of water withdrawn from sources by major sectors. Domestic refer to WA 2.3.1, agriculture to WA 2.3.2 industry to WA 2.3.3 and recreational uses to WA 2.3.4 Water used for energy production is derived from WA 2.2.

This account also shows which of the resources is being depleted; and which has potential for further development and conservation. The former can be determined by amount of water use (MCM) according to sources -surface or ground water by these sectors. The amount these sectors utilize and their contribution to GDP determines their overall economic significance and the value of water used. When either of the sources exhibits rapid or intensive uses which nearly deplete or exploit them, then this could indicate a need for conservation and more efficient management.

Account 5 resembles France's Operating account. It shows the total of the different uses of water discussed in the earlier part. Water used is measured in two ways, by the amount withdrawn and by the amount consumed. Withdrawn water is the water diverted from its natural course for use, and may be returned later for further use. Water consumed is water that goes out in the product or is lost to the atmosphere through evaporation and transpiration, and cannot be re-used. Hence, the volume returned is most likely less than that withdrawn, since part of the water has been transformed into stream or vapor or infiltrated directly into the ground (NWRC, 1976).

Water Account 5. Operating Account/ Water use (MCM).

Sector	**Quantity (MCM)**			**Quality**	
	Withdrawn*	Return	Evaporation/or Net Consumption	Withdrawn	Return
	(1)	(2)	(3)	(4)	(5)
Municipal					
Domestic (or Household)					
Industry					
Energy Production					
Agriculture					
On-site use (WA 2.1)					
Recreational & others					
TOTAL					

Evaporation or net consumption is measured by the difference between quantity withdrawn and quantity returned.

Like water account 2.1A, this account shows interdependence among the elements such as the quantity withdrawn, return (ed), for evaporation or net consumption, and the quality. Water withdrawal and discharges are complementary not only in themselves but also in their direct effects (Morgan & Memon, 1994). Thus, when water is extracted the source is depleted in level or flow or both and when water is discharged the receiving waters are augmented and its quality changed. These effects are significant in rivers, small lakes and reservoirs. Also, it could possibly show which sector has, in terms of water, the highest impact on the environment. This is determined by either the quantity these sectors extract or the quality of the water being returned (discharged) to the environment.

The use of natural assets can affect their temporary or permanent depletion (quantitative use) or leave them unchanged quantitatively while possibly affecting the quality of the environment (qualitative use). Use of environmental goods can thus lead to depletion and degradation (qualitative deterioration) of natural assets (IEEA, 1993).

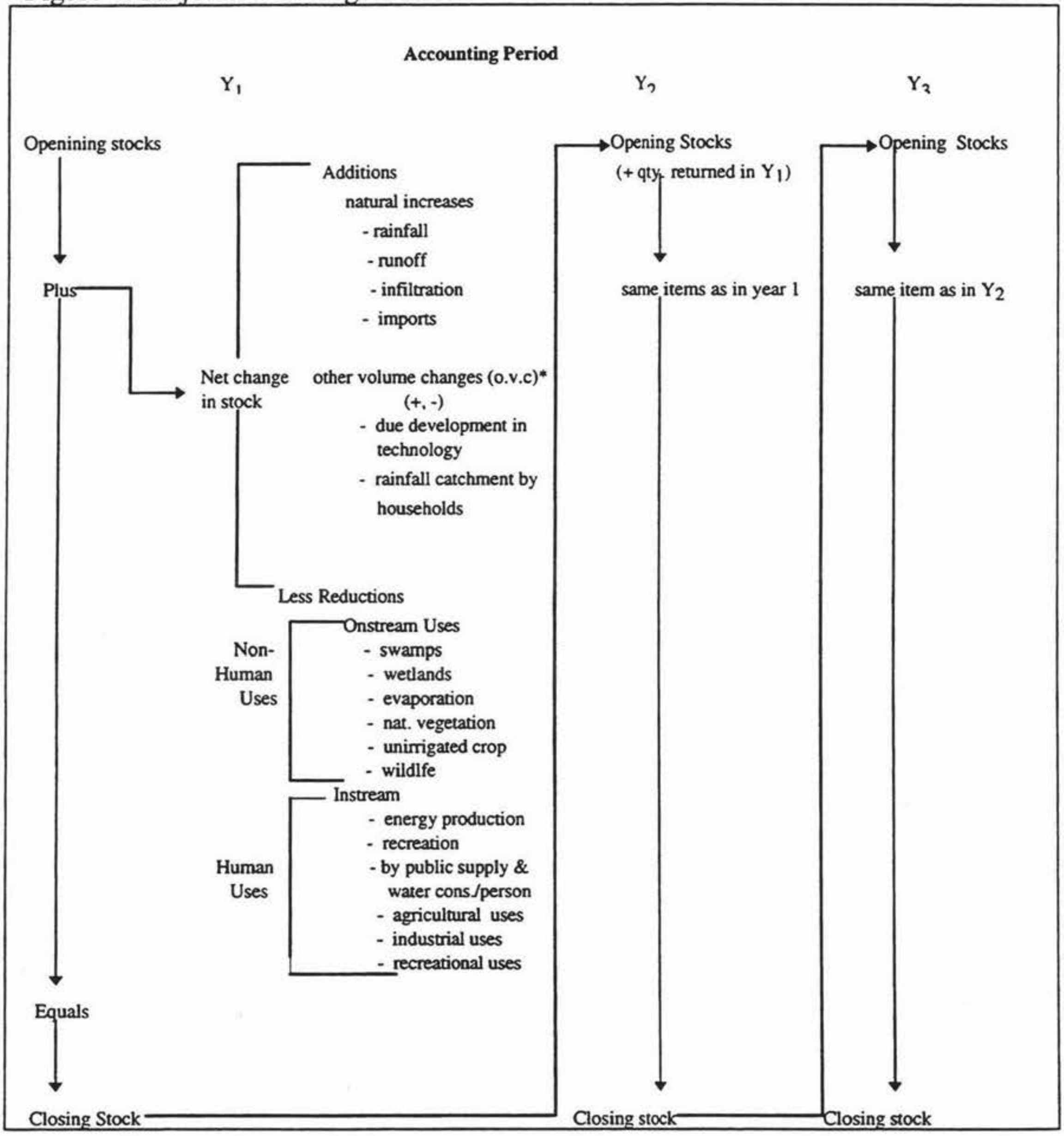
Water quality indicators could play an important role in the physical accounting of the environment. These indicators are complementary to data on quantitative stocks and flows. However, the IEEA (1993) mentions two problems regarding the measurement of quality: 1) the difficulty of choosing the most relevant constituents of environmental quality; and 2) the difficulty to aggregate measures of these constituents into overall indices of the quality of water.

3.2 A Water Accounting Structure

Putting all the previously collected data together, a general accounting structure is then constructed taking the form of:

Opening Stocks - Reductions + Additions + Quantity Returned = Closing Stock

Figure 4. Major Accounting Structure.



Alternatively, a stock balance for water can be also be drawn up as in Botswana's study by Perrings, Gilbert and Harrison (1989):

$$S_o + N + I = C + S_1$$

where:

S_o = stock at the beginning of time period (ground and surface water)
N = net natural increases
    rainfall
    run-off
    evaporation
I = net imports
C = extraction by resource-user

sectoral uses as discussed previously

S_1 = stock at end of time period

The items for reductions are further classified into human and non-human uses. The following table shows entries for reductions, and their sources from the framework.

Table 1. Reductions Table.

Items	Source/Location
Onsite Uses	Box 2.1
- swamps	
- wetlands	
- evaporation	
- natural vegetation	
- unirrigated crops	
- wildlife	
Instream Uses	Water Account (WA)2.2
- energy production	
Intake Uses	
- intake by water supply and water consumption per person per day	WA 2.3.1
- agricultural uses	WA 2.3.2
- industrial uses	WA 2.3.3
- recreational uses	WA 2.3.4
(Overall Extraction by economic sectors)	WA 2.3

Table 2. Additions Table.

Items	Sources / Location
Peripheral Accounts - run-off - percolation - infiltration - interception (determines groundwater surface recharge)	WA 2.1a
other sources - rainfall catchment by households - annual rainfall - other human activities (OVC)	Box 1
Quantity returned from other uses	WA 5, col.2

From this major accounting structure, a separate physical accounting framework for groundwater and surface water can be constructed such as the one below:

Water account 6a. Surface Physical Accounting

Region	Opening Stock* (Box 1) (1)	Additions or Increase (Table 2) (2)	Extraction (Table 1) (3)	Net** Changes Additions(-,+) Reductions (4)	End-of-year Balance* Col.. 1 +,- Col . 4 (5)
I Ilocos Region					
II Cagayan Valley					
III Central Luzon					
IV Southern Tagalog					
V Bicol					
VI Western Visayas					
VII Central Visayas					
VIII Eastern Visayas					
IX Southern Mindanao					
X Northern Mindanao					
XI Southeastern Mindanao					
XII Southern Mindanao					
Whole Country TOTAL					

* Refers total of all surface waters; consistent with the entry in Box 1 for this type.

** Includes other volume changes (o.v.c.). Entries are from Additions and Reductions table.

Water Account 6b. Ground water physical accounting .

Region	Opening * Stock (1)	Additions/ Increase (2)	Exploitation/ Extraction (3)	Net ** Changes (4)	End-of-the-year Balance* (5)
I Ilocos Region					
II Cagayan Valley					
III Central Luzon					
IV Southern Tagalog					
V Bicol					
VI Western Visayas					
VII Central Visayas					
VIII Eastern Visaya					
IX Southern Mindanao					
X Northern Mindanao					
XI South-eastern Mindanao					
XII Southern Mindanao					
Whole country T O T A L					

* Refers to all types of groundwater resources; consistent with entry in Box 1 for this type.

** This includes other volume changes (o.v.c.)

The same principle as water account 6a applies in each column of water account 6b.

3.3 The physical accounts in aggregates

From the physical accounts framework outlined above, the accounting structure (SEEA Version III) for natural resource accounts (physical accounts) is then constructed such as one below:

Water Account 7.**Water resource accounts: physical accounts**

			Quantities	**Qualities** (constituents)
1	**1**	**Opening stocks**	X	X
	+2	**Increase**		
2	2.1	Gross natural increase	X	
3	2.2	Discovery of resources	X	
4	2.3	Area increase by economic influence		
	-3	**Decrease**		
5	3.1	Decrease due to natural causes	X	
6	3.2	Depletion due to economic causes	X	
7	3.3	Area decrease by economic influence		
	+/-4	**Adjustments**		
8	4.1	Technical improvements	X	
9	4.2	Changes in prices, costs	X	
10	4.3	Improved estimation methods	X	
11	**=5**	**Closing stocks**	X	X

Water account 7 contains the balances of both surface and groundwater from the physical accounts WA 6a and 6b. This structure tries to show that the accounts framework constructed previously, can be aggregated into a water resource physical account, as in SEEA version III. The items with X marks are measurable in physical terms.

Increases in the water stock correspond to gross natural increases and discovery of resources. Gross natural increases have been described in the accounting structure. Discovery of a resource in this case may refer to a new find of a groundwater source and/or other potential water sources explored or developed. Decreases in water resources include decreases due to natural causes and depletion due to economic activity. Decreases due to natural causes refer to the effects of natural disasters, i.e.

drought, flash floods, etc. Depletion due to economic decisions refer to abstraction and extraction of water from its source for use in economic activities by different economic sectors discussed earlier. This can be treated as a situation in which the resource is withdrawn beyond the safe minimum yield considering the quantity and quality. Extraction beyond this becomes sub-optimal and hence incurs costs. Adjustments refer to revisions of estimates of resources due to changes in certain conditions of use (available techniques, price level, extraction costs). New estimates might be necessary because of improved estimation methods and so forth. Based on the IEEA *Handbook*, the physical accounts complement the material energy balances (MEB). However, the *Handbook* limits recording of physical flows back to the environment (residual flows). It does not attempt to present a comprehensive natural resource accounting picture. Opening stocks correspond to WA 1. Gross natural increase simply refers to rainfall, run-off, and evaporation as found in WA 1A, WA 2.1A and Box 2.1 or Box 1A, respectively. The decrease due to natural causes can be attributed to On-site uses in WA 2.1 and further due to other natural phenomena. Depletion due to economic causes correspond to the WA 2.4.

The Closing stock can be obtained by making the appropriate additions and subtractions. Data on water quality is supplemented by WA 4. Basically, once the elements of the framework fit with the IEEA's fundamental physical accounts, it is promising to note that such could be useful for further explorations in terms of linkage with the IEEA matrices. However, physical accounts need to be transformed into value terms to be consistent with economic accounts. Once these physical accounts have been valued, the framework could address the shortcomings of the national accounting specifically its failure to account for the depreciation or depletion of natural resources such as water in this case. The current undertaking of the Philippines is to apply the Peskin framework which makes modifications outside the traditional System of national accounts (SNA), such that conventional accounts are preserved. Thus, if water is to be integrated in the national income and product accounts, the resource will be placed under item 13 Natural Resource Depreciation (-,+) of the table below:

Table 3. Modified Philippine National Income and Product Accounts,19 ___.

GDP	EXPENDITURES ON GDP
1 Compensation of Employees	18 Personal Consumption
2 Indirect Taxes	19 Government Consumption
3 Depreciation (Produced Asset)	20 Capital Formation
4 Net Operating Surplus	21 Exports
	22 Imports (-)
	23 Statistical Discrepancy
5 GROSS DOMESTIC PRODUCT (GDP)	24 EXPENDITURE ON GDP
(sum of 1 to 4)	(sum 18 to 20 + [21 - 22] + 23)
6 Depreciation (Produced Asset) (-)	25 Depreciation (Produced Asset) (-)
7 NET DOMESTIC PRODUCT (NDP)	26 EXPENDITURE ON NDP
(5) - (6)	(24) - (25)
8 Income from Non-Marketed Nature Based Household (HH) Production (+)a/	27 Expenditure on Non-Marketed, Nature Based Household Production (+) a/
a. Upland agriculture	a. Upland agriculture
b. Fuelwood	b. Fuelwood
9 HH ADJUSTED GDP	28 EXPENDITURE ON ADJUSTED GDP
(5) + (8)	(24) + (27)
10 HH ADJUSTED NDP	29 EXPENDITURE ON ADJUSTED NDP
(7) + (8)	(26) + (27)
11 Environmental Waste Disposal Services (-)	30 Environmental Damages
a. Air	a. Air
b. Water	b. Water
12 Net Environmental Benefit (Disbenefit)	31 Direct Nature Services (+)
(11) + (31) - (30)	
13 **Natural Resource Depreciation (-)**	32 **Natural Resource Depreciation**
a. Forests a/	a. Forests a/
b. Fisheries	b. Fisheries
c. Minerals	c. Minerals
d. Soils	d. Soils
e. **Water**	e. **Water**
14 HH & ENR ADJUSTED GDP	33 EX ON HRH & EN ADJUSTED GAP
(9) - (11) + (12)	(28) - (30) + (31)
15 HH & ENR ADJUSTED NDP	34 EX ON HRH & EN ADJUSTED NAP
(10) - (11) + (12) - (13)	(29) - (30) + (31) - (32)
16 ENRA ADJUSTED GDP	35 EX ON EN ADJUSTED GAP
(14) - (8)	(33) - (27)
17 ENR ADJUSTED NDP	36 EX ON EN ADJUSTED NAP
(15) -(8)	

a/ NRA Phase-1 Estimate.

Water entry under item 13 and 32 is obtained from the monetarised quantity of the resource depleted as input (and other uses) to production activities in WA 3. Its value corresponds to the net change of the stock which could be positive which means appreciation or negative which implies depletion or depreciation.

3.4 Conclusion

Because of the increasing pressure placed on our water, it is now one of the vital natural assets in need of conservation and management. Conservation and management for sustainable use of this resource need to have a system that would provide a coherent picture of resource use and depletion or increase, which can be linked to, or integrated with the national accounts. This is essentially the resource accounting system.

The basic or initial step in designing such system, however, requires the formulation of a framework to conceptualize the idea and to help in data collection. The initial step consists of expressing the components of the framework in physical units which is a pre-requisite for any eventual monetary valuation.

The accounts framework constructed in this section essentially does the above, it establishes the framework and identifies the physical data requirements. This is taken as the 'ideal' situation to illustrate how the existing uses of our freshwater resources data can be unified into an accounting framework that would clearly show the interlinking relationship between the environment and the economy in terms of water uses.

The sources, stocks and balances, and uses both in the environment and economy are explained to some extent. Also, the aggregation of these elements in the SEEA Version III physical resource accounts and the Peskin's national income and product accounts framework is illustrated.

In the next chapter an overview of the water situation in the Philippines will be presented. A further point of discussion will be in how far the existing data types and sources in the Philippines could possibly satisfy the elements required in the framework. Gaps and difficulties in achieving this framework will be discussed.

CHAPTER IV

THE PHILIPPINES, ITS WATER RESOURCES AND DATA SOURCES

In this chapter an overview of the country's water resources is presented. Also, sources of data on water resources as required by the framework developed in Chapter III, are identified.

4.1 The Country and its Water Resources

The Philippines is an archipelago consisting of 7,100 islands and islets with an aggregate area of approximately 300,000 km^2. The country lies within latitude 4.5^0 to 21^0 and longitude 117^0 to 127^0 which is the tropical belt and is to the southeast of the Asian Mainland. The two largest islands - Luzon and Mindanao - occupy two-thirds of the total area. The remaining groups of bigger islands are composed mostly of the Visayas which are situated between Luzon and Mindanao (NWRB, 1980).

The country has a variety of topographical features from low marshes, a foot or so above high water at the head of Manila Bay, to high mountain masses, the highest peak being Mt. Apo in Mindanao with an elevation of approximately 2,954 meters above mean sea level.

Today's population is 68 million and still growing an average rate of 3 percent per year.

The country has been divided into twelve water resources region which correspond to the political regions (See figures 5 and 6 next pages).

PHILIPPINES
WATER RESOURCES REGIONS

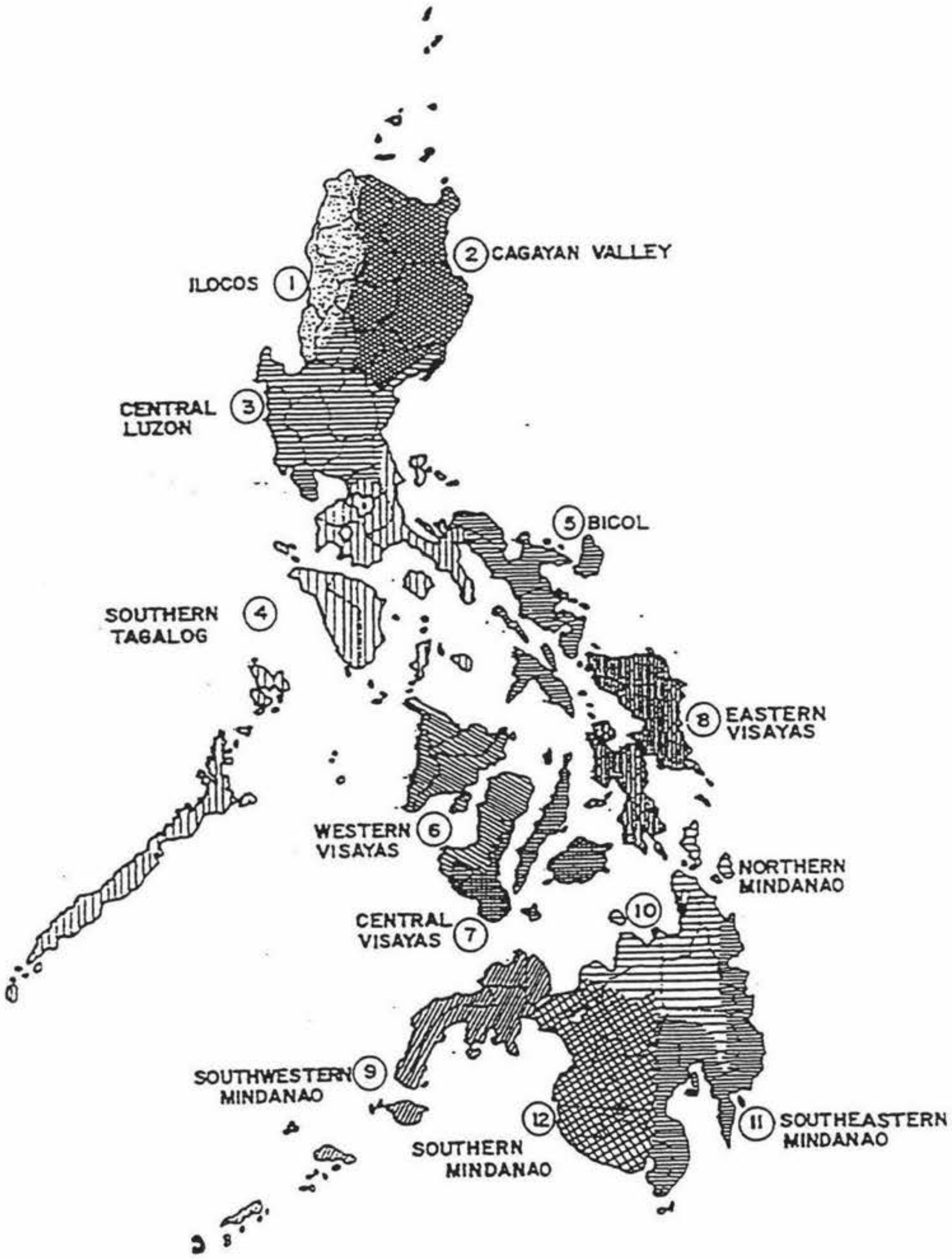


Fig. 5

PHILIPPINES
POLITICAL REGIONS

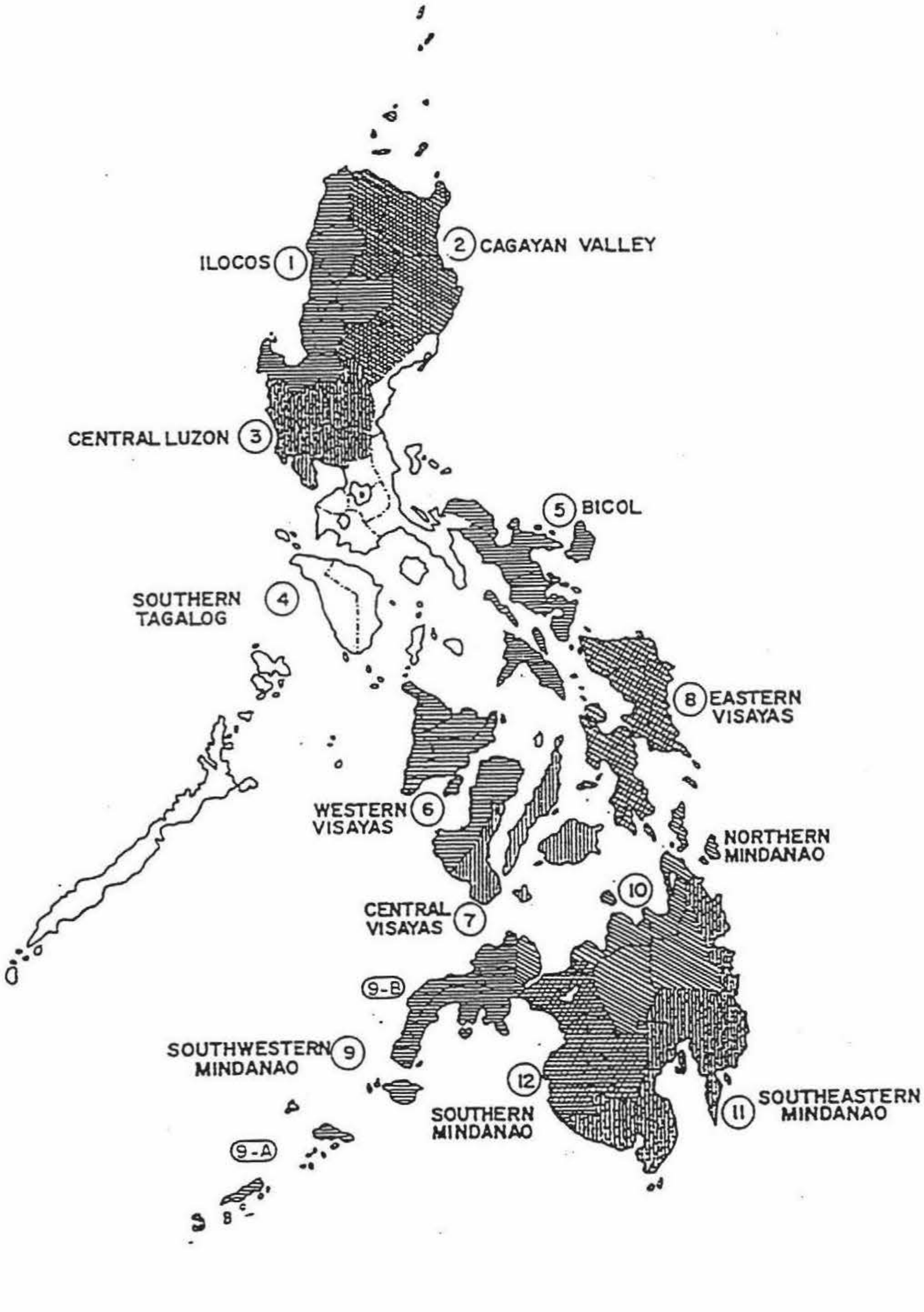


Fig. 6

The country is located along the earth's volcanic belt. The Commission on Volcanology reports a total of 44 registered volcanoes, 33 of which are active. The Philippines has considerable areas of volcanic formation of which the younger formation yields considerable amounts of groundwater.

Being situated in the tropical typhoon zones, on average, 19.7 tropical typhoons visit the country annually. While these weather disturbances bring destruction to people and property, they also bring rain which serves to act as a coolant to the country's tropical atmosphere. Average rainfall is, 2,256 mm/yr. and the average temperature is 26.22^0 C.

The rainfall component that seeps into the groundwater reservoir systems ranges from 5 to 30 per cent. Part of this discharges through numerous springs and finds its way to the river system as base flows. Another part, especially where the deep aquifers are present, goes directly to the sea. Being composed of many islands, the Philippines has a significant length of shoreline (sea), about 16,000 km.

The nation's seasons are a function of wind dynamics. They are divided into four, such as:

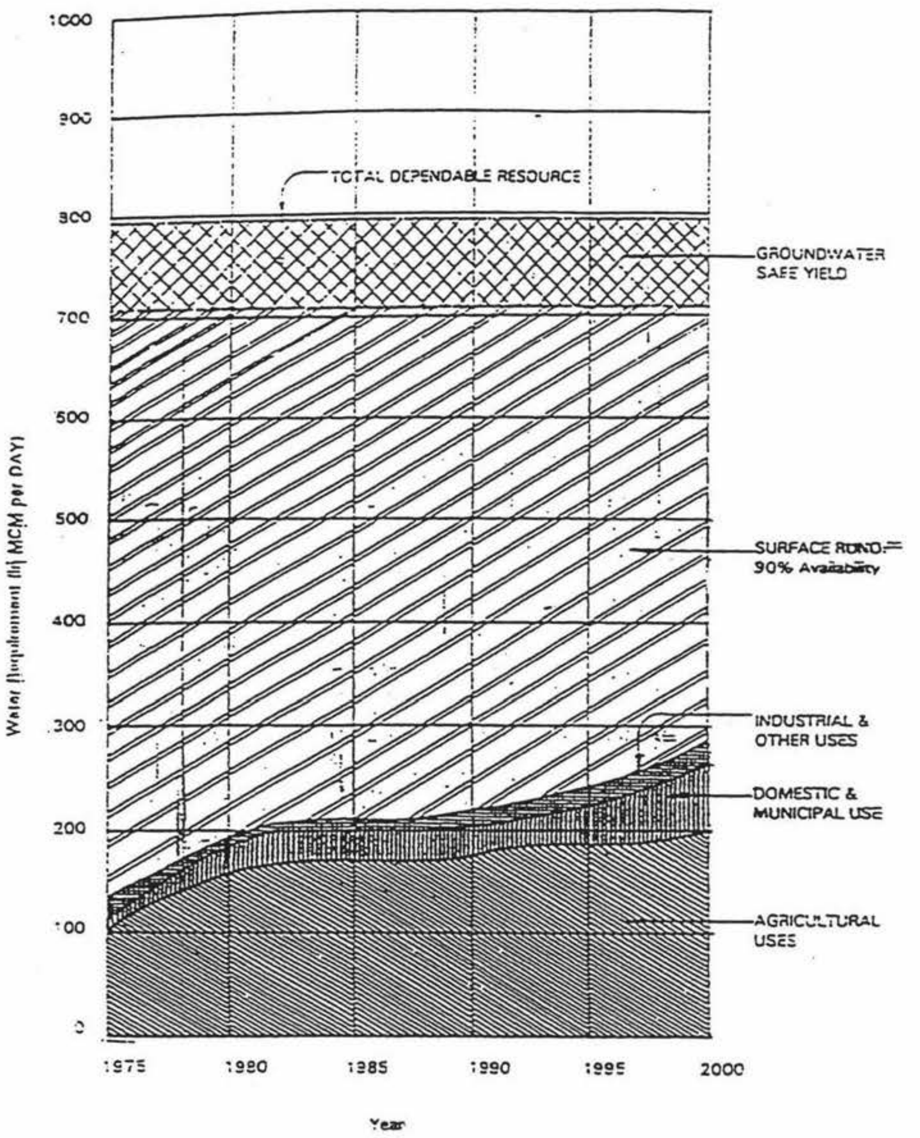
a. 1st type - Two pronounced seasons: dry from November to April and wet during the rest of the year;
b. 2nd type - No dry season with very pronounced maximum rainfall from November to January;
c. 3rd type - Seasons not very pronounced, relatively dry from November to April and wet during the rest of the year; and
d. 4th type - Rainfall more or less evenly distributed throughout the year.

Human settlements are established and agriculture is practiced in the country's vast plains. The nearby mountain ranges recharge the groundwater acquifers. The plains have high groundwater potential.

In terms of water resources, the country is indeed abundantly endowed by nature. It has 421 principal rivers with drainage areas ranging from 40 to 25,469 square kilometers and 59 natural lakes, aside from numerous individual streams. There are four major groundwater reservoirs with areas ranging from 6,000 to 10,200 square kilometers which when combined with other smaller reservoirs aggregate to an area of about 50,000 square kilometers. Groundwater is found in all types of rocks. However, significant amounts of water exist within unconsolidated rocks of both sedimentary and volcanic formations.

Figure 7 presents a picture of the availability of surface water in the Philippines (NWRC, 1976). The figure shows that the total amount of surface water, available 90 per cent of the time, will be sufficient to meet water requirements of the country even beyond the year 2000. The figure takes into account the shallow groundwater that discharges through springs and/or river systems.

Abundant as the water resources may be, there is a tendency for it to become scarce if not properly managed to optimize its development in meeting the changing patterns of consumption and the increasing demand by a rapidly expanding population.



NATIONAL WATER PICTURE
1975-2000

Fig. 7

4.2 Types of Data Available and Sources

According to NWRC (1980) basic data on water and water-related matters provide a basis for evaluation, planning and decision-making of water resource development. The need for data depends upon the analytical techniques, evaluation methods, planning objectives and water laws which are in effect in a certain country. These considerations are as dynamic in nature as the changing water situation in the country.

It is said that a good data system involves the collection, storage, retrieval, and dissemination of data and that it also provide a means of anticipating probable future needs such that it would insure potential users of the data available so that they can use it when needed (NWRC, 1980). Consequently, there is need for a more systematic and rigid water resource accounting framework which can serve as a tool for planning water resource development and management and for overall planning for sustainable economic development.

In 1908, the actual collection of data (streamflow) was started. Records extending back to that time were published. However during the World War II, many valuable data collected from 1923 to 1944 were destroyed by fire. Meteorological data has also been collected and kept in files. As early as 1865, one meteorological station was operated and many stations date back to the early 1900's. Groundwater data collection has been underway for decades but most of these data are unpublished and kept in the files of the government agencies which collected them.

The country has shown notable foresight with regard to the collection of water resources data. However, the data system has not been able to meet the ever-growing needs of the country. Inadequacies in the hydrologic data base has inhibited systematic planning and development. Other factors are insufficiency of the existing data collection network, and uncertainty in data accuracy because of lack of uniform standards for collection and processing. A factor related to these is the fragmentation of the overall collection system among several government agencies which are collecting and storing hydrologic data independently for their exclusive use.

In the past, water-data activity focused almost entirely upon water as an input. To provide hydrologic information for water planning and development in the traditional senses was the only purpose for collecting water data. Today, there is an obvious need to improve the data system because of the broadening range of needs and problems and an expanding water-related interest and related environmental matters. The NWRC has assumed this responsibility. Water now is not only regarded as a conventional input but as a key aspect of man's environment. There has been an increasing demand for water data, hence there is an urgent need to expand the scope of data collection and dissemination. More importantly, there is a need to unify these data in a systematic framework that shows the interaction of water supply and its uses by the environment and the economy as a whole.

The following tables present the existing data on water. These data are identified as to where they fit in the framework proposed in Chapter 3.

4.3 Data collection in the Philippines and their possible use in the framework

In this section, the relevance and usefulness of the existing data to the framework in the preceding Chapter is examined. The feasibility and gaps are also pointed out.

4.3.1 The framework and the available (unavailable) data.

Table 4a

WATER ACCOUNT (WA) NUMBER	DATA AVAILABLE	DATA NOT AVAILABLE
Box 1 Stocks and balances of water in the country	Rivers Ponds Lakes Groundwater (confined and unconfined) Annual Rainfall	Dams Rainfall captured by households other human activities

There is no accurate measure for water stored behind dams, rainfall captured by households and other human activities. Rainfall caught by household is suggested as a potential (other) source wherein water shortage is experienced. If undertaken, estimates of amount collected can be significant for water accounting purposes, and should be monitored if possible. Data on physical quantities of other bodies of water mentioned above are available in the existing system. However, regularity of monitoring and accuracy of the technique measures are needed to be enhanced in order to satisfy requirement of Box 1.

Table 4b

WATER ACCOUNT (WA) NUMBER	DATA AVAILABLE	DATA NOT AVAILABLE
WA 1 Stocks and balances of water in the Philippines	Regional breakdown of water bodies from Box 1, such as: Rivers (streamflow) Lakes Groundwater Annual Average Rainfall	Ponds Rainfall captured by household Other human activities

The resulting total regional water balance may not reflect the accurate water resource because of the deficiency of other data required in this table.

Table 4c

WATER ACCOUNT (WA) NUMBER	DATA AVAILABLE	DATA NOT AVAILABLE
WA 1A Water quality balance sheet	Selected water bodies Rivers Lakes Bays Water Quality Parameters Dissolved Oxygen Content (DOC) Biochemical Oxygen Demand (BOD) Concentration of heavy metals Mercury Copper Cadmium Zinc Lead Concentration of Pesticides Alpha BHC Lead Concentration of Pesticides Alpha BHC Gamma BHC Heptachlor Epoxide Aldrin Dieldren Annual Mean(s) of various water quality Temperature DOC BOD Total Coliform (MPN)/100 ml) Total Alkalinity Chlorides (mg/li) COD (mg/li) Total suspended solids (mg/li) (SS) Mercury levels in sediment samples Important parameters for selected bay's uses Water Use Parameter Fishing Dissolved oxygen, pH Irrigation Dissolved solids Industrial Water Supply pH. Dissolved oxygen Navigation pH Lakes (selected) (by station) Temperature pH Dissolved Oxygen (ppm) Total Phosphorous (ppm) Total Suspended Solids Groundwater Toxic substances pH Turbidity or transparency Total dissolved solids	Quality targets at a specified time- beginning and ending of accounting period.

Water quality parameters tell the extent of acceptability for intended use. These are useful in the classification of water such as Classes A, B, C, D, E. The existence of these data means that the creation of this specific water account is feasible. However, data on these are not systematic in such a way that they are fragmented and distributed among agencies. Hence, they do not fit water accounting purpose but the potential for its applicability obviously exists.

Table 4d

WATER ACCOUNT (WA) NUMBER	DATA AVAILABLE	DATA NOT AVAILABLE
WA 2 Stock account and major uses by region	Dependent on WA 2.1a, 2.2, 2.3, 2.3.1, 2.3.2, 2.3.3	

The prospect of this account is influenced by the water accounts mentioned in column two of this table.

Table 4e

WATER ACCOUNT (WA) NUMBER	DATA AVAILABLE	DATA NOT AVAILABLE
WA 2.1 Onsite use of water by region	Swamps Wetlands Evaporation	Natural vegetation Unirrigated crops Wildlife

Based on the available data, implementation of WA 2.1 is hampered by the absence of the three types of data shown in the table. The total for this account can be obtained however, but will not include water use by natural vegetation, unirrigated crops, and wildlife.

Table 4f

WATER ACCOUNT (WA) NUMBER	DATA AVAILABLE	DATA NOT AVAILABLE
WA 2.1A Peripheral accounts of water	Evaporation Run-off	Percolation Infiltration Interception

The existing data show that such framework may not be feasible due to lack of other important elements shown above.

Table 4g

WATER ACCOUNT (WA) NUMBER	DATA AVAILABLE	DATA NOT AVAILABLE
WA 2.2 Water use in energy production	Flow utilization (MCM)/power generation (kwh) x 10^6 by region Current and projected uses by hydro-electric power plant only	other energy production: oil coal geothermal bagasse agriwaste others other use(s): cooling

The energy produced from other indigenous sources of energy is available in the existing statistics. However, the quantity of water utilised in its production is not reported. Only water flow utilization by hydro-power generation plants is available. The absence of water use data for other sources of energy can impede full implementation of WA 2.2.

Table 4h

WATER ACCOUNT (WA) NUMBER	DATA AVAILABLE	DATA NOT AVAILABLE
WA 2.3 Mean annual water intake use by sector and by region	Domestic/municipal Industry Agriculture Leakage	Recreational and other uses Percentage of groundwater out of the total (net total) water used.

The WA 2.3 shows a high potential for implementation. Only two types of data are not available. The former is clearly defined and recognized by the government as a major water using industry however, no data for quantity of water being withdrawn for such purpose are existing. As mentioned in Chapter III, recreational use may only refer to boating activity that withdraws water from a source and confines the water in an artificial reservoir in a resort or recreation center. This use may fall under domestic use.

Percentage of groundwater used for these purposes is not shown in the current system. Such deficiency is significant and makes the completion of this account difficult.

Table 4i

WATER ACCOUNT (WA) NUMBER	DATA AVAILABLE	DATA NOT AVAILABLE
WA 2.3.1 Water intake of public water supply plants and water consumption per person per region.	Domestic Uses Urban Rural Leakage Net Total Total	Percentage of groundwater used out of the total

As shown in the table, there is a potential for a full implementation of this account. Percentage of groundwater used out of the total water used could be measured on a local district (or region) basis.

Table 4j

WATER ACCOUNT (WA) NUMBER	DATA AVAILABLE	DATA NOT AVAILABLE
WA 2.3.2 Agricultural uses of water by region.	Livestock population withdrawal Crops (selected) Rice Sugarcane Corn Vegetables Tobacco	Fishery Forestry Agricultural services

Fishery is basically considered in the agricultural sector. No precise data (as required by the framework) for this purpose currently exist. Examples of these are water bodies such as part of lakes, rivers devoted for fish culture which are common in the Philippines. Some related data can be obtained from Box 2.1 (onsite use) specifically on swamplands or ponds devoted for fish culture. From this some ideas can be obtained regarding the demand for water by fisheries.

Table 4k

WATER ACCOUNT (WA) NUMBER	DATA AVAILABLE	DATA NOT AVAILABLE
WA 2.3.3 Industrial uses of water by region	Process and manufacturing Water power plant intake Leakage	Washing Cooling Boiling Percentage of Groundwater

As shown above, some data needed for this account are still non-existent. Completion of this account might be hampered by these deficiencies.

Table 4 l

WATER ACCOUNT (WA) NUMBER	DATA AVAILABLE	DATA NOT AVAILABLE
WA 2.3.4 Recreational uses of water by region	-	All

These uses, measured in millions of cubic meters, include swimming pools, bath houses, boating (limited definition), golf courses and other measurable recreational uses. Despite the recognition of this use as one of the major water using industries and as industries with great environmental impacts, no accounting of the water uses for this purpose has been systematically done as yet. This makes the account impossible to implement.

Table 4 m

WATER ACCOUNT (WA)	DATA AVAILABLE	DATA NOT AVAILABLE
WA 3 Estimates of water abstraction from the surface water and groundwater	Process and manufacturing Water and power plant intake Leakage Output index for different sector Estimates of water abstractions	Washing Cooling Boiling

Again, data on water used specifically for washing, cooling, boiling are not present. This account aggregates the data from the preceeding accounts. Therefore, the deficiencies of data in those accounts are carried forward in the construction of water account 3 which is the aggregation of economic sectoral water uses. This account can be constructed only if those data available as mentioned above are satisfied. Moroever, the deficiency may hinder the construction of WA 3 for NRA purposes.

Table 4n

WATER ACCOUNT (WA) NUMBER	DATA AVAILABLE	DATA NOT AVAILABLE
WA 4 Water use by sector and by source	Municipal Industry Domestic (or household) Agriculture Energy production	Specification as to sources: Surface Groundwater Recreational uses

As a summary of the sectoral uses of water by source, WA 4 utilizes entries from WA 3 i.e total water withdrawn by industries. However, a breakdown as to source-surface or ground water is not possible based on the existing data.

Table 4o

WATER ACCOUNT (WA) NUMBER	DATA AVAILABLE	DATA NOT AVAILABLE
WA 5 Operating account/water use	Municipal Domestic (or household) Industry Energy production Agriculture On-site use	Recreational uses Some on-site uses such as those mentioned in Table 4e

The only deficiencies in WA 5 are recreational uses and some of the on-site uses mentioned in Table 4e. Quantity withdrawn is measurable. The quality of water upon withdrawal is workable because of the availability of the quality indicators and parameters as shown in Table 4c. Quantity and quality of water being returned are still doubtful and may influence computation for evaporation or net consumption. Most of the types of data needed in this specific account actually exist but have not yet been organised according to NRA purposes. A question of accuracy of quality of water returned to the environment or sources by the users, however, is what matters because of some skeptical reactions by the users of water, particularly industries, to environmental standards.

Considering the existing data system presented, the entries for tables 1 (reduction) and 2 (additions) , WA 6a to WA 7 and Table 3, modified Philippine national income and product accounts could not be wholly and accurately completed due to the data deficiencies discussed.

4.3.2 Data gaps and difficulties

This section tries to discuss some of the difficulties in the generation of data to close the gaps.

Water resources regions

Water resources regions are classified according to political regions based on institutional considerations. Other considerations for regionalization include: hydrological boundaries, physiographic features, and climatic homogeneity. This type of regional classification is also used in the framework to come up with regional water data. Regionalization facilitates data handling and management. However, the existing deficiency, inaccuracy and irregularity of existing data, reflects miscoordination and/or overlapping of functions among agencies involved.

Annual water surface flows

Annual water surface flow data are available for each region at 50, 75, 90 percent flow. However, the present system does not rigidly cover all the water mentioned in the surface water category. Only rivers and streams, and selected lakes are currently covered. Without improvements to the current system, WA 1 may not reflect the true picture of the country's water resources according to the NRA's sustainable natural asset measurement.

Corresponding water demands by major water-using sectors with projected economic growth

Data on the corresponding water demands by major water-using sectors with projected economic growth are estimated for each region. These can indicate which regions and sectors are likely to encounter long-run water problems. However, the existing system does not show data on sectoral water uses by specific sources. Hence, failure to account for especially groundwater use can result in mismanagement of the water resource and may lead to overexploitation of aquifers and may cause land subsidence and salinity intrusion, which are just a few examples of the negative consequences.

Rainfall Data (from stations)

The NWRC (1979) reported that the total number of stations listed do not include evaporation stations, synoptic stations, and agro-meteorological stations which have rain gauges in each station. The over-all density of the rainfall station network is below the reasonable minimum objective established by Langbein. Except for regions 3 and 5, the regions have densities below the reasonable minimum objective. Generally, data obtained are good. Some data from remote areas are fair. However, all these data need further checking either manually or by computer. Finance is a constraint to achieve a high degree of maintenance or to instal of more stations to bring the network to a level of adequate coverage. Another problem is the difficulty in recruiting observers for the remote and highland areas.

The framework exhibits the importance of rainfall data. However, given the comments about adequacy of the data, as mentioned above, there is a tendency that the supply of water from this source is measured inaccurately.

Stream Flow (by gauging stations)

The existing gauging system in the country is still inadequate. Adequacy is said to be based on the state of economic development, since it varies with the intensity of water problems and therefore influences the need for hydrologic information. The accuracy of records ranges from fair to good. The Bureau of Public Works (BPW) like the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAG-ASA), suffers from inadequate financial support to implement its programs and maintain its existing facilities. Compounding this problem is the difficulty of retaining engineers who have a tendency to transfer to other offices with better pay. Maintenance of about 20% of the stations has been reportedly abandoned.

Evaporation data (by stations)

The network is insufficient as far as the number of evaporation stations is concerned, both at the regional and national levels, with the exception of Region 3 (Central Luzon). Accuracy of evaporation data is from fair to good. Likewise, inadequate funding is the main constraint to maintenance and expansion of the evaporation stations network. Even though the accuracy of this type of data is impaired by insufficiency of the network, again, it is useful for Box 2.1. column, WA 2.1A, and as supporting data for WA 5, column 3.

Sediment and water quality Sampling Stations

Stations are distributed among the twelve water resources regions. However, data on the changing quality levels are not available and are not regularly updated due to lack of financial support for data collection activity. Except for Central Luzon, the station network is generally inadequate. Data are fairly accurate.

Water Quality

Data on water quality as shown in the Table 4c are useful in WA1a and WA 5. However, the existing system could not promptly provide the needs in water quality accounting because of some shortcomings that might have major implications for the types of data needed in water resource accounting. Most of these shortcomings are reported by the EMB (1990). In case of water quality of rivers, limited data had been gathered from monitoring activities. Water quality of the country's 58 lakes except Laguna de Bay, have not been monitored on a regular basis nor have schemes for water lakes utilization and management been drawn up. The water quality index (Sn) for Laguna de Bay is used to consolidate monthly observations in pH, DO, total coliforms, phosphate nitrate, turbidity, temperature and TDS (a high index value is indicative of high pollution). Other lakes had never been officially classified, thus, it is difficult to determine the level of parameters characterizing water quality levels. Monitoring activities were at lull after 1985, which accounts for the lack or absence of updated data on the country's inland water resources.

Despite of the inadequacy of information from the existing system, these water quality parameters had been used by ENRAP in the second phase of the project. These parameters were used to estimate the waste disposal services of water (ENRAP Phase-II, 1994). Discharges were estimated and adjusted for installed pollution control equipment. Target reductions of 90 % of uncontrolled emissions were valued using prospective abatement cost as a proxy for willingness-to-pay of polluters to discharge wastes into the environment. Environmental damages for air and water were estimated using the human capital approach for health impacts. Total health damage costs consist of cost of manpower lost and cost of medication from morbidity and cost of premature death, attributable to pollution. Specifically, damages to water bodies were estimated using the productivity loss approach for ecosystem and materials damages, including damage to coral reefs and marine fisheries, reservoirs, irrigation canals and agricultural production and inland fisheries.

The value for waste disposal services of water is illustrated using the Peskin Framework (refer to Appendix A). Appendix B also shows the environmental waste disposal services to water: sectoral shares to total abatement cost while Appendix C illustrates the types and usefulness of quality parameters in the recent ENRAP activity. The accounting for the environmental services provided by water is so far the established major data on water directly useful in environmental and natural resource accounting. They make physical accounting of water more meaningful.

Agro-meteorological stations

As far as number of stations are concerned, both national and regional coverage shows a very inadequate network. A major constraint in the implementation of programs is inadequate financial support. Also, lack of personnel with adequate background in meteorology has somewhat hampered the program.

Groundwater data

Some existing groundwater data are useful for the framework. However, there are problems that could impede the full implementation of the framework. Inadequacy of quantitative information and other hydrologic parameters generally characterizes the system. Oftentimes, information are inferred or deduced from indirect observations, hence subjectivity could not be avoided. There is an absence of standardized methodologies for the collection and processing of groundwater data. The programs for systematic collection of groundwater information on a national basis have been slow in development.

Intake uses

Based on the current system, problems that exist regarding data on water uses could make the full implementation of the framework impossible for the moment. The total consumptive use for the major intake uses are not readily available, because return flows are much more difficult to measure than withdrawals. However, although data may not be very accurate, they are used to predict future quantity and quality.

For domestic and municipal uses, entry for WA 2.3.1 is represented by the data on the average unit consumption and supply requirements, and the leakage which are both existing. The accounted leakage is the combined total from agriculture, domestic and industry. To complete WA 2.3, one difficulty is that the existing data do not show percentage breakdown of water by source. Moreover, though various data are available, most are not consistent with each other and some are not reliable.

The agricultural use account (WA 2.3.2) is constructed by using the following existing data: total withdrawal, use for irrigation (for crops mentioned above) and livestock. However, no data on the amount of water used by forestry exist. Furthermore, no definite percentage of water used by source is mentioned. Hence, entries in WA 2.3.2 are incomplete.

One way of expressing industrial use of water is through relating water use to manufacturing gross receipts. The estimation procedure utilizes the gross value added in manufacturing at constant year prices and water technical coefficient obtained from the specific year Input-Output table. Hence,

$$\text{water use in physical terms} = \frac{\text{water expenditure per million output}}{\text{industrial water charges (average)}}$$

The above formula shows the relationship of water use to manufacturing eceipts. The regional distribution of industries and the projected value added figures are based on NEDA-RDS estimates. The prevailing water rate charges used is a derived average from representative LWUA water districts.

Water use by the mineral industry are based on data on the growth of the mining industry and the corresponding water withdrawal per unit of output of same. The projections have been derived using constant water withdrawal per mineral output (in tons) at current condition.

Water requirements of thermal water plants, mostly for condenser cooling purposes, are based on per kilowatt hour generation and from data obtained on the projected expansion of thermal power generation in the country. This is useful for WA 2.2.

Since the water technical coefficient is in physical terms, it is computable and can be used alternatively for the elements in WA 3 column 8, which are the physical estimates of water abstraction. The water technical coefficient could also reflect meaningful relationship with the GDP in terms of gross value added in the manufacturing industry.

One difficulty in associating data on water use per industry output with WA 3 is that in the manufacturing sector, attempts to relate water use to physical output by weight of units of production are difficult because individual establishments data are not available. Indeed, water use per industry are either related to production size, employment working days, gross receipts or plant area. No studies or extensive surveys, however, have been made to uncover the range of relationships existing between water use and the production size, employment, working days, gross receipts and plant area. There may be reports from a few industries, but their number could not warrant a generalization.

Onsite and instream water uses

Uses here includes navigation, waste disposal, conservation of fish and wildlife, aesthetic purposes (inspiration, relaxation, scenic drives), recreation purposes (boating, swimming and fishing). Data on water for recreational purposes can be used to fill up column 4 of WA 2.3.

There are several difficulties that could hamper the accounting objectives. Only sparse data are available. These uses cannot be measured by the conventional types of data collection and analysis. Inadequacy also exists for data for on onsite uses.

Data on the current and projected instream uses of hydroelectric power plants and the flow utilization per unit of power generated can be used fill up WA 2.2 the total of which can be further used in WA 3, 4 and 5. However , difficulty may arise from few constraints. One is total water requirements for instream uses have not been compared with potential flows hence there is a tendency that instream uses might be impaired for this reason. Another is the lack of comparable data on instream uses which has prevented meaningful analysis and comparisons.

4.3.3 Other relevant data

The content of this section may not be directly related to physical accounting, however, it is deemed important for future directions in water resource accounting as a whole. This will be particularly so in the economic valuation of water resources

Water charges and other fees

Groundwater use for domestic water supply in the local districts outside Metropolitan Manila is said to have costs P0.50 per cubic meter. Consumer cost in Metro Manila is P1.00 per cubic meter. The average consumer cost in provincial areas is P0.85 per cubic meter. Domestic wells (drilled) cost is P3,000 to P30,000 depending upon geological location, materials used and method of construction. Bigger industrial and/or irrigation wells cost P100,000 to P300,000 excluding pump and its appurtenances.

Rule 1, Sec. 6 of *Philippine Water Code* (1991) states that a filing fee of P100.00 shall be imposed and collected a fee of P100.00 from every applicant, except government agencies, water district, and duly organized associations or cooperatives for irrigation or rural water supply.

Regarding water charges, Rule 1, Sec. 7 of the Code states that except when the appropriation is for family domestic purposes or when the quantity of water appropriated for agricultural use is not more than 5 liters per second, all appropriators shall pay the Council in the manner provided under the above article hereof, an annual water charge in accordance with the following schedule:

A. For the use of water extracted or diverted from the natural source:

Rate of withdrawal (liter/second)	**Charge per liter/sec.**
1) Not more than 30	P0.50
2) More than 30 but not exceeding 50	0.75
3) More than 50	1.00

B. For the use of surface water at its natural location for fish culture:

1) For surface area not to exceed 15 hectares - P20.00/ha.

2) For surface area of more than 15 hectares P300 plus P30/ha. of the excess over 15 has.

For this purpose a fraction of hectare shall be considered one hectare.

The Council may revise the above water charges or impose special water rates from time to time as the need arises taking into consideration, among others the following:

a) Intended use of water;

b) Quantity/rate of water withdrawal vis-a-vis other users taking into account the water bearing potential of the resource;

c) Environmental effects;

d) Extent to which water withdrawal will affect the source; and

e) Development cost of bringing water from the source.

These water charges and other fees are embodied in the Philippine Water Code (1991). The available data and other information on water charges are presented to show the prevailing basic consideration in pricing for water in different sectors. These are important in assigning economic values to the resource. Traditionally, water charges only reflected the necessary inputs extracting/withdrawing the resources. When these are the only costs considered in the computation for economic rent or resource rent, the result would be zero. No value for water at all. Currently little or no information is available on the true economic value of water. For that reason any move to translate the physical accounts into monetary values will be fraud with difficulties. Even though such a translation would provide useful information for policy makers, resource managers and planners, the current lack of data makes it infeasible.

4.4 Sources of Data

There are several government agencies involved with water resources development and management, water data collection and archiving. The National Water resources Board (NWRB), Bureau of Water Supply (Ministry of Public Works), Bureau of Mines (BM), National Irrigation Administration (NIA), Metropolitan Waterworks and Sewerage System (MWSS), Local Water Utilities Administration (LWUA), Army Corp of Engineers, National Power Corporation (NAPOCOR), the Philippine Atmospheric, Geophysical and Astronomic Services Administration (PAG-ASA) and the Rural Waterworks Development Corporation (RWDC).

"The National Water Resources Board (NWRB), formerly known as the National Water Resources Council (NWRC), is the government coordinating agency for all water resources development activities created to be responsible of achieving a scientific and orderly development of all water resources of the Philippines consistent with the principles of optimum utilization, conservation and protection to meet present and future needs" (NWRB *Information Brief*: p.1). The Board is composed of the heads of departments and line agencies most concerned with water resources. Currently, there are ten members representing the Department of Public Works and Highways (DPWH), Agriculture (DA), Economic Planning, Department of Health (DOH), Environment and Natural Resources (DENR), Department of Trade and Industry (DTI) and the heads of the MWSS, NIA, LWUA and NAPOCOR.

The Board is mainly responsible for coordinating water resources exploration and exploitation. It defines some standards for groundwater development and data collection.

The agencies mentioned above are particularly responsible for the handling of the data required by the framework. The PAG-ASA, NIA NAPOCOR and the MWSS are the agencies responsible for rainfall and other climatological data. The administration of stream flow is distributed among the three agencies with different percentage of load. The BPW, NAPOCOR and the NIA operates 74 %, 15 %, 10 % respectively. Together with PAG-ASA, these three agencies are also responsible for the evaporation data. The sediment and water quality sampling of surface water is undertaken by the BPW. In line with water quality concerns, other agencies that collaborate are the National Pollution Control Commission (NPCC), DENR- Environment Management Sectors (EMS). The Agro-Meteorological data are handled by the Agro-meteorological Division of PAG-ASA. The data on the comparison of available water (natural runoff) and demand (mcm) are actually generated by the BPW for the NWRB which also generates data on the available water supply of natural runoff at various percent levels of dependability. The data also include natural runoff and demand comparison.

The NWRB mainly administers assessment of groundwater in some areas. The data include estimated storage capacity and inflow of rainfall that recharges the aquifers. The other agencies involved are the BPW, NIA, BM, MWSS, LWUA through its Water districts and the RWDC which is created out of the NWRC Task Force on Rural Water

Supply. Other related data provided by these agencies are groundwater mining picture, statistics of groundwater level, and regional groundwater parameters.

There are four agencies that report data on water uses. The Philippine Environmental Quality Report for National Environmental Protection Council (NEPC) and the Environmental Management Bureau (EMB) provide data on domestic and municipal water uses, agricultural, and industrial and other uses. The Bureau of Fisheries for NWRB provides data on swamplands and wetlands available for development into fishponds, an important on-site use. Data on instream uses, particularly the current and projected instream uses of hydroelectric power plants, are obtained from the NAPOCOR which are then passed to the NWRB.

4.5 Conclusion

By nature, the Philippines was once assured of an abundant supply of natural water (NWRC, 1976). However, the changing pattern of water consumption due to the increase in population and economic activities has dramatically changed the freshwater supply picture in the last 19 years. As the turn of the century approaches, freshwater is becoming a critical resource. It will be the next ecological-political flashpoint in this country. This calls for a continuous effort in designing and formulating economic instruments that would possibly achieve optimal allocation of freshwater before the chaos over this resource becomes more serious.

The framework designed in Chapter III can be seen as one potential tool in planning and management of freshwater for sustainable development. However, the existing data gaps and difficulties would make implementation of the framework infeasible at the current time. The framework however does provide basis to look at water in more holistic and comprehensive way. The framework also helps to point out the gaps and lack of knowledge which will help to direct scientific research and data gathering in the future.

In the next Chapter, conclusions, and possible recommendation for the feasibility of the water resource accounting (in physical terms) in the country will be discussed.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

The creation of the Philippine Council for Sustainable Development (PCSD) manifests the Philippines' response to the 1992 "Earth Summit" to uphold the theme of global sustainable development. The Council's recognition of natural resource accounting as one of the tools in planning for sustainable management and conservation of the country's critical natural resources, of which water is one, has given impetus to the establishment of the Environmental and Natural Resource Accounting Project (ENRAP). The project has primarily concentrated on various ways to correct the traditional income measure, the GDP, through adjustments in resource and environmental depletion, degradation, and defensive expenditures. The project's output is gaining recognition from the private sector, policymakers, planners, environmentalists, statisticians and accountants, locals and internationals. Future action is directed towards accounting for other resources, such as water, economic optimal depletion of minerals, fisheries and soils. This is due to the broadening range of needs and problems and an expanding interest in water and related environmental matters.

In line with the present concern of ENRAP, and following the lead of France, Norway and Botswana, the present study primarily builds a conceptual framework for water resource accounting in physical terms. The framework aims at showing the physical changes in the stock of water over time. Because of data limitations, the framework had to remain conceptual although data needs have been discussed. The whole framework reiterates the relationship between environment and economy- how the stocks and flows of water from the environment are used up in the economy by different sectors in various uses. The framework also shows the geographical and sectoral distribution of water use.

The conceptual framework can be viewed as an 'ideal', one which can be used to point out the missing data necessary for the construction of water resource accounts; unify types of existing data however fragmented and under-utilised; point out the statistical capability, data needs and requirements for constructing the accounts and show the possibilities for further steps such as resource valuation. The physical accounts framework, once implemented, can be useful in decision making. In macro-planning, it can serve as a tool to test the sensitivity of economic forecasts to resource degradation and depletion. It can serve as a tool for testing the efficiency of current resource uses. Ultimately, the framework represents an intermediate step to resource valuation which makes the accounts capable of integration in the Systems of National Accounts (SNA).

The accounts basically consist of opening stocks of physical assets at the beginning of the accounting period; the amount of the stock depleted or extracted for onsite, instream, and offstream uses; the amount of increase due to discoveries of new water supply or natural increases and other volume changes; and the resulting closing stock. This is done at the national as well as sub-national level. When combined with GDP sectoral output measures, an index of water use (in physical terms) per dollar output can be developed such as the one presented in WA 3. Finally, water resource depletion can be integrated into a Philippine modified income and product account using the Peskin framework.

Currently, in the Philippines, existing data sets are not well developed and in many cases unsuitable for incorporation into the framework, due to technical, manpower and financial constraints. Although the country has shown notable foresight with regard to the collection of water resources data, yet the system has not been able to meet the ever-growing needs for them. Inadequacies in hydrology data has inhibited systematic planning and management. These inadequacies are reportedly due to several factors such as the insufficiency of the existing data collection network, uncertainty in data collection because of lack of uniform standards for collection and processing and because of lack of manpower capable of doing the required job. Another factor is said to be the fragmentation in the collection system among several government agencies which are collecting and storing hydrology data independently for their exclusive use.

It is with these limitations in mind that in the following section possible implementation strategies are discussed.

5.2 Conclusions and Recommendations

The construction of a conceptual physical accounts framework for inland water in the Philippines was motivated by the undertaking of the ENRAP responding to the need for sustainable wealth measures that account for natural and environmental assets. Freshwater resources especially groundwater are now threatened by a growing population and an increasing level of economic activity.

Given the changing water situation in the country, there is indeed an impending need to design a tool, such as this framework, that can identify and possibly rectify the irrational attitude towards this resource. One way of alerting society to the irrational use of the country's freshwater resources is through the construction of physical resource accounts such as the ones conceptualised.

The physical accounts framework developed in this thesis, provides a picture of the environmental stocks and balances of water and the potential of this resource in the economy for the sustenance of economic activities without depriving the need and requirement of the environment and its ecosystem. Hence, it should have the capacity to make us more aware of what can be called the "natural balance"- the balance between the demand and supply of water while sustaining the resource.

However, immediate implementation of the framework is hampered by the existing data system which is characterised by inadequacies, irregularities and uncertainties. It is recommended therefore that the framework is used as a "template" to guide data gathering and research, so that in due time the framework can be filled. This suggestion is made since there is an urgent need to make more transparent what is happening to stocks, balances and flow/uses in the environment and the economy. In particular, it is essential that this is done at the regional and catchment level.

Steps to achieve this are the orientation of agencies involved in water allocation towards NRA- purpose of data collection and processing, and the integration of the framework into the undertakings of the Environmental and Natural Resource Accounting in the Philippines (ENRAP) and the Philippine Council for Sustainable Development (PCSD). These steps are further discussed below.

Assembly of data needed to support water resources accounts and strengthening of network. There is a need for a more rigid water resources data system because of the existing weakness and the spotty information on uses (including recreational and environmental uses). This weakness is typical of developing countries. Without the information or data, it is extremely difficult to target water regulations towards economic sectors and geographical areas where it is most needed, and to devise and monitor regulations to see that this is achieved efficiently and effectively.

To proceed implementing the framework, it is best to start with the already existing data. Data collection, processing and management procedures practised in sectors with good data gathering systems should be followed or replicated in other sectors where this is not as yet present. The following steps are recommended that may aid this:

1) Update and enhance the existing data via closer and stronger coordination and networking between and among the agencies with NWRB spearheading the task. This also involves re-evaluation and further enhancement of the standards of measurement, and regularity of data collection. Particular attention needs to be given to the stocks and flows, sectoral uses and geographical distribution with emphasis being placed on those data which are missing but are identified as needed in the framework.

2) There should be a water statistics unit or a water statistician in the NWRB. The staff of this unit should work primarily on water data that serve accounting purposes and should serve as the link with the ENRAP's water resources unit.

Orientation towards natural resource accounting concepts and principles. This can be viewed as manpower capability building exercise.

1) Presently, data collection is geared towards multi-purposes, however, no hint of natural resource accounting concepts and principles is applied in the system. The agencies involved need to undergo training and orientation on the concepts and principles of NRA as a tool for measuring sustainability in terms of a country's income which involves natural assets such as water. The training should emphasize the following points:

a) Importance of accuracy in water data. This is especially so in the estimation of water stocks and balances, and flows to the environment and economy;

b) Sustainable water resource management;

c) More updated measurement techniques; collection, assembly and processing of data; and

d) The existence in the accounts of other renewable and non-renewable resources: its significance to the supply and quality of water for various uses.

2) The information should be inferred from direct observation to avoid subjectivity that can influence the integrity of NRA. This applies to data such as onsite uses that are either measured by conventional types of data collection or are difficult to measure. Examples are onsite uses such as water for conservation of fish and wildlife, natural vegetation, wetlands, unirrigated crops and other recreational uses, and some elements in the peripheral accounts.

3) Possible valuation should be introduced and integrated into the system to clearly understand and relate to its importance in data collection, processing, and retrieval of water accounts data.

Integration of the framework with the undertakings of the ENRAP and the PCSD.

If the framework is to be implemented, it should be integrated with the ENRAP to enhance the usefulness and credibility of the natural resource accounting process. Being at an early stage, ENRAP's procedures may not have achieved high accuracy as yet, but progress is being made. The same can be expected of the conceptual framework designed in this thesis once it has been tested for implementation. ENRAP has established a Steering Committee that provides guidance for the project's activities and this opens the possibility of further refinement of the framework once integrated with ENRAP. The Committee includes high level officials from Department of Environmental and Natural Resources (DENR), the National Statistics Coordinating Board (NSCB), the National Economic Development Authority (NEDA), the Department of Agriculture (DA), the Laguna Lake Development Authority (LLDA), and the United States Agency for International Development. A representative from the non-governmental community is also included.

Water resource accounting is indeed a difficult task. Hence, it is suggested that a water resources unit be added to the current staff of ENRAP to work on developing and integrating the water resource accounts into the overall NRA framework. Once this has been completed, the overall framework will present a much more complete means to guide policy for sustainable development.

The following are suggested for promoting the usefulness of the framework to institutions and agencies concerned:

1) Seek involvement of policymakers, as the ones who influence policy, in promoting the usefulness of such proposed framework, and

2) Always demonstrate policy relevance i.e. the contribution the accounts can make in helping to set priorities for the development of different economic sectors.

Generally, the framework needs further development. This can be done through further studies by and with ENRAP with the pooling of resources from the water-related agencies. Tapping the financial and manpower resources of ENRAP and of the other agencies can be seen as practical way to bring about experimentation, refinement and implementation of the conceptual framework in this study.

BIBLIOGRAPHY

Adger, W.N. 1993. 'Sustainable National Income and Natural Resource Degradation: Initial Results for Zimbabwe.' In Hamilton, K., Pearce, D., Atkinson, G., Gomez-Lobo, A. & Young, C.(1994*). The Policy Implications of Natural Resource Accounting*. CSERGE Working Paper GEC 94-18. University of East Anglia: Center for Social & Economic Research on the Global Environment.

Ahmad, Y. J., El Serafy, S.E., & Lutz, E. (eds). 1989. *Environmental Accounting for Sustainable Development*. Washington D.C.: The World Bank.

Anielski, M. 1992. 'Resource Accounting: Indicators of the Sustainability of Alberta's Forest Resources.' Hamilton, K. *et al.*(1994). *The Policy Implications of Natural Resource Accounting*. CSERGE Working paper GEC 94-18. University of East Anglia: Center for Social & Economic Research on the Global Environment.

Arntzen, G. & Gilbert, A. 1992. 'Natural Resource Accounting: State of Art and Perspectives for the Assessment of Trends in Sustainable Development.' *In Search of Indicators of Sustainable Development*, Vol. 1. Ed. by Kuik, O. & Verbruggen, H. Amsterdam, The Netherlands: Kluwer Academic Publishers.

Asian Business Review. 1995. *Struggling to Save the Environment*. Sydney; NSW, Australia: Asian Business Review, (July).

Bartelmus, P. 1992. *Environmental Accounting and Statistics*. Natural Resource Forum, February.

Born, A. 1992. 'Development of Natural Resource Accounts: Physical and Monetary Accounts for Crude Oil and Natural Gas Reserves in Alberta.' In Hamilton, K. *et al.* (1994). *The Policy Implications of Natural Resource Accounting* CSERGE Working paper GEC 94-18. University of East Anglia: Center for Social & Economic Research on the Global Environment.

Bockstael, N. *et al.*1994. 'Ecological Economic Modelling and Valuation of Ecosystems.' *Ecological Economics Journal*, 14 (1995) : 143-159.

Bojo, J. & Maler, K.G. & Unemo, L. 1990. *Environment and Development*. Dordreckt The Netherlands: Kluwer Academic Publishers.

Brundtland, G.H. 1987. *Our Common Future: Earth and Us*. Ed. by Tolba, M.K. & Biswas, A.K. Oxford: Butterworth, Heineman Ltd.

Burda, M. & Wyplosz, C. , 1993. *Macroeconomics: A European Text*. New York: Oxford University Press.

Cabe, R. & Johnson, S. , 1990. 'Natural Resource Accounting Systems and Environmental Policy Modelling.' *Journal of Soil and Water Conservation*, 45(5): 533-539.

Carson, C.S. 1994. 'Integrated Economic and Environmental Satellite Accounts.' *Survey of Current Business* (April). 135553.

Cruz, W. & Repetto, R. 1992. *The Environmental Effects of Stabilisation and Structural Adjustment Programs: The Philippine Case*. Washington D.C.: World Resources Institute and The World Bank.

Cubelo, D.G. 1994. 'A Breach Over Troubled Water.' *Ecowebs*, Vol. IV, No. 2. (July - Dec.). Quezon City, Philippines: Foundation for the Care of Creation, Inc.

Dixon, J.A., James, D.E. & Sherman, P.B. (eds) . 1990. *Dryland Management: Economic Studies*. London: Earthscan Publication Ltd.

Ecowebs 1994. 'Water.' *Ecowebs*, Vol IV, No.2. (July- December). Quezon City, Republic of the Philippines: Foundation for the Care of Creation Inc.

El Serafy, S.E & Lutz, E. 1989. 'Environmental and Resource Accounting in Developing Countries.' *Environmental Accounting for Sustainable Development*. Ed. Ahmad,Y.J., El Serafy, S.E. & Lutz, E. Washington D.C.: The World Bank. p.2.

Environmental and Natural Resource Accounting Project (ENRAP). 1994. *The Philippine ENRAP Phase II Main Report*. Philippines: International Resource Group Ltd. (p.192).

Environment and Management Bureau. 1990. *The Philippine Environment in the Eighties*. Philippines: Department of Environment and Natural Resources.

European Communities Environmental Policy Series. 1994. 'Potential Benefits of Integration of Environmental Economic Policies: An Incentive-based Approach to Policy Integration.' *A Report Prepared for the European Commission, Office for the Official Publications of the European Communities*. London: Graham & Trotman Ltd., 1994.

Fairbarire, T. I. & Tisdell, C.___. 'Applicability & Use of Natural Resource Accounting and Environmental Economics in Small Island Developing States.' *SPREP Studies Series* No. 83.

Felke, C. *et al.* 1994. 'Introduction Part.' *Investing Natural Capital: The ecological Economics Approach to Sustainability*. Ed. by Janssen, A.M. *et al.* Washington D.C.: Island Press.

Gilbert, A. 1990. 'Natural Resource Accounting: A case study of Botswana.' *Dryland Management: Economic Studies*. Ed. by Dixon, J.A., James, D.E. & Sherman, P. London: Earthscan Publication.

Grima, A. P. 1989. 'Natural Resources: Access, Rights-to-use and Management'. *Common-property Resources: Ecology and and Common-based Sustainable Development*. Ed.by Berkes, F. London: Belhaven Press.

Hamilton, K. *et al.* 1994. *The Policy Implications of Natural Resource Accounting*. CSERGE Working paper GEC 94-18. University of East Anglia: Center for Social & Economic Research on the Global Environment, 1994.

Hamilton, K. 1994. *Environmental Accounting for Decision-making*. Background paper ENV/EPOC/SE (94)4, OECD Group on the State of the Environment, Paris.

Herfindahl, O.C. & Kneese, A.V. 1974. *Economic Theory of Natural Resources*. Columbus, Ohio: Merill Pub. Ltd.

Ince, M. 1990. 'Water and Diseases.' *Developing World Water*. Ed. Pickford, J., WECD Center. London: Grosvenor Press International. p.19-25.

Ince, M. 1991. 'Instrumentation, Control, and Analysis'. *Developing World Water*. 5th ed. Ed. by Pickford, J., WECD Center. London: Grosvenor Press International.

Jinchang, L. & Zhengang, G. 1990. 'Natural Resource Accounting.' *Natural Resource Accounting for Sustainable Development.* Ed.by Jinchang, L. *et al.* Beijing: The China Environmental Science Press. p.22.

Jinchang, L. *et al.* (eds). 1990. *Natural Resource Accounting for Sustainable Development*. Beijing: The China Environmental Science Press.

Johnson, S.P. 1993. *The Earth Summit: The UNCED International Introduction and Commentary*. Environmental Law and Policy Series. London: Graham & Trotman Ltd.

Kennedy, J.F. 1968. 'Measuring Environmentally Sustainable Development.' In Steer, A. & Lutz, E. *Finance and Development* (1993). Washington D.C.: International Monetary Fund (IMF) and the World Resources Institute (WRI).

Kneese, A.V. 1977. *Economics and the Environment.* Harmondsworth, Middlesex England: Penguin Book Ltd.

Legge, M. 1994. 'Water Quality.' *New Zealand Environment- A Guide for Environmental Impact Assessment.* Ed. Morgan, R.K. & Memon, A. Environmental Policy and Management Research Center Pub. No. 6. University of Otago, Dunedin, New Zealand.

Lutz, E., & Munasinghe, M. 1991. 'Accounting for the Environment- An improved way of preparing national accounts could achieve more sustainable development.' *Finance and Development* (March).

Manopimoke, S. 1994. 'Country Paper: Thailand, Environmental and Natural Resource Accounting: Experience in Thailand.' *ENRAP Phase II Main Report.* Philippines: International Resource Group Ltd.

Mansfield, E. 1977. *Principles of Macroeconomics.* 2nd edition. University of Pennsylvannia: W.W. Norton and Company Inc.

Meister, A.D.& Alexander, R.R. 1994. 'Economic Instruments in Water Management: Effluent Charge and Transferable Water Rights.' *Water Conference, Implementing the Resource Management Act*, Proceedings of the Sixth National Water Conference. Hamilton, New Zealand.

Meyer, C.A. 1993. 'Environmental Accounting: Where to Begin?' *Issues in Development* (November). Washington: World Resources Institute's Center for International Development and Environment.

Miller, M.A.L. 1995. *The Third World in Global Environmental Politics.* Colorado: Lynne Rienner Publishers, Inc.

Milton, W. J. 1995. 'Environmental and Natural Resources in National Accounts.' *Integrating Economics and Ecological Indicators: Practical Methods for Environmental Policy Analysis.* Ed. Milton, J. & Shogren, J.F. London: Praeger Publishers.

Ministry of Foreign Affairs and Trade (MFAT). 1995. *International Environmental Issues: A New Zealand Perspective.* Information Bulletin No. 50, November. Wellington, New Zealand: MFAT.

Morgan, R.K. & Memon, A. 1994. *Environmental Policy and Management Research.* Center Pub. No. 6. University of Otago, Dunedin, New Zealand.

Nanda, V.P. 1977. 'Water Needs for the Future: Political, Economic, Legal and Technological Issues in a National and International Framework.' *Westview Special Studies in Natural Resource and Energy Management.* Boulder, Colo, U.S.A.: Westview Press Inc.

National Water Resources Board (NWRB).1991. *Philippine Water Code and the Implementing Rules and Guidelines.* Quezon City, Republic of the Philippines: NWRB.

National Water Resources Council (NWRC). 1980. *Report No. 9*, January.

National Water Resources Council (NWRC). 1976. *National Survey on Water Resources.* Quezon City, Republic of the Philippines: NWRC.

Natural Resource Accounting Project (NRAP). 1991. *Philippine NRAP. Executive Summary.* Philippines: Department of Environment and Natural Resources..

Opschoor, H. & Reijnders , L. 1991. 'Towards Sustainable Development Indicators.' *In Search of Indicators of Sustainable Development.* Ed. by Kuik, O. & Verbruggen ,H. Dordrecht: Kluwer Academic Publishers.

Organisation for Economic Co-operation and Development (OECD). 1994. *Natural Resource Accounts: Taking Stocks in OECD Countries.* Environment Monographs No. 84, Paris.

Organisation for Economic Co-operation and Development (OECD). 1993. *Nineteen Ninety Three Issues: OECD Response.* Paris.

Parikh, K. 1994. 'Country Paper: India, Sustainable Development and Natural Resource Accounting.' *ENRAP Phase II Main Report.* Philippines: International Resource Group Ltd.

Parikh, K. 1992. 'Natural Resource Accounting: A Framework for India.' In Hamilton, K., Pearce, D., Atkinson, G., Gomez- Lobo, A. & Young, C.(1994). *The Policy Implications of Natural Resource Accounting.* CSERGE Working paper GEC 94-18. University of East Anglia: Center for Social & Economic Research on the Global Environment.

Pearce, D.W. & Warford, J.J. 1993. *World Without End- Economics, Environment, and Sustainable Development.* The World Bank: Oxford University Press.

Pearce, D.W., Markandya, A. & Barbier, E.B. 1989. *Blueprint for a Green Economy.* UK Department of Environment, London: Earthscan Pub. Ltd.

Pelt, V. & Michael, J.F. 1993. *Ecological Sustainability and Project Appraisal.* New Castle: Athenaleum Press Ltd.

Perrings, C., Gilbert A., Harrison, A. 1989. 'Natural Resource Accounting for Botswana.'*Environmental Accounting for Natural Resource-based Economy.* LEEC Paper 89-11. London WCIHODD: London Environmental Economics Center.

Peskin, H.M. 1989a. 'Environmental and Nonmarket Accounting in Developing Countries.' *Environmental Accounting for Sustainable Development.* Ed. by Ahmad, J., El Serafy, S. and Lutz, E. Washington D.C.: The World Bank.

Peskin, H.M. 1989b. 'Accounting for Natural Resource Depletion and Degradation in Developing Countries.' *Environment Department Working Paper No. 13.* Environment Department: The World Bank Policy Planning And Research Staff.

Peskin, H.M. 1981. 'National income Accounting and the Environment.' *Natural Resources Journal,* Vol. 21.

Philippine Council for Sustainable Development (PCSD). 1993. *Briefing on the PCSD for H.E. President Fidel V. Ramos on the occasion of his working visit to the United States of America.*

Philippine Environmental Action Netwrok (PEAN). 1994. 'Responding to the Water Crisis Now'. *Ecowebs,* Vol. IV, No. 2. (July - Dec.). Quezon City, Philippines: Foundation for the Care of Creation, Inc.

Radermacher, W. 1994. 'Sustainable Income: Reflections on the Valuation of Nature in Environmental-Economic Accounting.' *Statistical Journal of the UN ECE 11,* 35-51, 10 S Press.

Randall, J. 1990. 'Groundwater Exploitation: Water Well Efficiency.' *Developing World Water.* Ed. WEDC. Hongkong: Grosvenor Press International. p. 83-95.

Repetto, R. 1990. 'The Case for Natural Resource Accounting.' *Economic Development and the Environment.* Reprinted with permission for *Technology Review.*

Repetto *et al.* 1989. *Wasting Assets: Natural Resources in the National Income Accounts.* Washington D.C.: World Resources Institute.

Repetto, R. 1988. 'Report on Natural Resource Accounting (NRA).' *Information Paper on the Use of NRA for Conutries with Natural Resource-based Economy and Potential: First Step in Australia.* Australian Economic Council.

Robinson, N.A. (ed.). 1994. 'Agenda 21: Earth's Action Plan (Annotated), Commission on Environmental Law IUCN- The World Conservation Union, *Environment Working Paper No. 27,* New York: Oceana Publication.

Scherp, J. 1994. 'What Does an Economist Need to Know About the Environment?- Approaches to Accounting for the Environment in the Statistical Information System.' *Background paper, ENRAP Phase II Main Report.* Philippines: International Resource Group Ltd.

Sheerin, J. 1995. 'Development in Environmental Accounts in New Zealand.' *New Zealand Paper 3.2. XII Conference of Commonwealth Statisticians.*

Smith, P. M. & Warr, K. (eds). 1991. *Global Environmental Issues for an Open University Course Term.* The Open University, UK: Hodder & Stoughton Ltd. p. 282.

Solarzano, R. *et al.* 1991. *Accounts Overdue: Natural Resource Depreciation in Costa Rica.* Tropical Science Center San Jose, Costa Rica. Washington D.C.: World Resources Institute.

Speidel, D.H. *et al.* 1988. 'Water Supply: The Hydrologic Cycle.' *Perspectives on Water Uses and Abuses.* New York: Oxford University Press Inc.

Stanger, G. 1994. *Dictionary of Hydrology and Water resources.* Flinders University in Association with Center for Groundwater Studies (November). Adelaide (S.A): Flinders Press

Steer, A. & Lutz, E. 1993. 'Measuring Environmentally Sustainable Development.' *Finance and Development.* Washington D.C. : International Monetary Fund (IMF) and World Resources Institute (WRI).

Steer, A. 1992. 'The Environment for Development.' *Finance and Development* (June). Washington D.C.: IMF and WB.

Stephenson, D. & Petersen, M.S. 1991. *Development in Water Science 41- Water Resources Development in Developing Countries.* New York: Elsevier Science Publishing Company Incorporated.

Suparmoko, M. 1994. 'Impacts of Natural Resource and Environmental Accounting on Policy Decision-Making in Indonesia Planing.' *Country Paper: Indonesia. ENRAP Phase II Main Report.* Philippines: International Resource Group Ltd.

Tebutt, T.H.Y. 1973. *Water Science and Technology.* London: J Murray William Clowesand Sons, Ltd.

The Open University. 1984. *Science: A Second Level Course: The Earth's Physical Resources.* Block 4 Water Resources. S238, Walton Hall: The Open University Press.

The Philippine natural Resource Accounting Project (NRAP) 1991. *The NRAP-Phase I Executive Summary.* Philippines: Department of Environment and Natural Resources (DENR).

Theys, J. 1989. 'Environmental Accounting in Development Policy: The French Experience.' *Environmental Accounting for Sustainable development.* Ed. by Ahmad, Y., El Serafy, S. & Lutz, E. Washington D.C.: The World Bank,.

Toman, M.A. 1994. 'Economics and Sustainability: Balancing Trade-offs and Imperatives.' *Land Economics Vol. No. 4* (November). Board of Regents of the University of Winconsin System: University of Winconsin Press.

Tongeren, V. J. *et al.* 1991. 'Integrated Environmental and Economic Accounting: A Case Study of Mexico.' In Hamilton, K. *et al.* (1994). *The Policy Implications of Natural Resource Accounting* CSERGE Working Paper GEC 94-18. University of East Anglia: Center for Social & Economic Research on the Global Environment.

United Nations Conference on Environment and Development (UNCED). 1993. *The Earth Summit: UNCED (Rio de Janiero, Brazil).* Commentary by Johnson, S.P. International Environmental Law and Policy Series. London: Graham and Trotman.

United Nations (UN). 1993. *Handbook of National Accounting: Integrated Environmental and Economic Accounting.* Series F, No. 61 New York: UN Department of Economic and Social Information Policy Analysis, Statistical Division.

Uno, K. 1994. 'Country Paper: Japan - Social, Economic and Environmental Data Set.' *ENRAP Phase II Main Report.* Philippines: International Resource Group Ltd.

Uno, K. 1989. 'Economic Growth and Environmental Change in Japan: Net National Welfare and Beyond.' In Hamilton, K. *et al.* (1994). *The Policy Implications of Natural Resource Accounting*, CSERGE Working Paper GEC 94-18. University of East Anglia: Center for Social & Economic Research on the Global Environment.

Walker, R. (1978). *Water Supply: Treatment and Distribution.* Englewood Cliffe, N.J.: Prentice-Hall Inc.

World Bank Staff Working Paper No. 496. 1981. *Economic Aspects and Policy Issues in Groundwater Development.* Prepared by Carruthers, I. & Stoner, R. (Consultants) Agricultural & Rural Development Department. Washington D.C.: The World Bank.

Water Science and Technology Board Symposium (10th 1992). 1993. *Proceedings on Sustaining our Water Resources 10th Anniversary Symposium.* Water Science and Technology Board, Commission on Engineering and Technical Systems, Commission on Geosciences, Environment and Resources, National Research Council. Washington D.C.: National Academy Press.

World Commission on Environment and Development (WCED). 1987. *Our Common Future.* Oxford; New York: Oxford University Press.

WCED 1987. 'Our Common Future: A Reader's guide.' *The Brundtland Report Explained.* Drafted by Hinrichsen, D. London: Earthscan Books.

Wright, J. C. 1990. *Natural Resource Accounting- An Overview from a New Zealand Perspective with Specific Reference to the Norwegian Experience.* Information Paper, No. 22. Lincoln University, Canterbury: Center for Resource Management.

Wright, J.C. 1989. *Natural Resource Accounting - a Technique for Improving Planning in New Zealand.* Information Paper No. 12. Lincoln College and University of Canterbury: Center for Resource Management.

Young, M.D. 1992. 'Natural Resource Accounting: Some Australian Experiences and Observations'. In Hamilton, K. *et al. The Policy Implications of Natural Resource Accounting*, CSERGE Working paper GEC 94-18. University of East Anglia: Center for Social & Economic Research on the Global Environment.

Appendix A

SUMMARY OF VALUE OF ENVIRONMENTAL SERVICES FOR WASTE DISPOSAL

Philippines, 1988
(in million pesos)

PSIC SECTOR	WATER
Agriculture, Forestry and Fishery	5,001.7
Mining and Quarrying	12.4
Manufacturing	513.8
Electricity, Gas, and Water	23.9
Construction	n.e
Wholesale and Retail Trade	4.4
Transportation, Storage and Communications	n.s.
Financing, Insurance, Real Estate and Business Service	n.e.
Community, Social and Personal Services	10,899.0
Household Sector	3,638.5
Nature Sector	n.e.
TOTAL	20,093.9

Source: ENRAP II, 1994

Appendix B

TOP USER OF WASTE DISPOSAL SERVICES PROVIDED BY WATER
Philippines, 1988

PSIC	SECTOR	% SHARE to Total Effluents
	BOD5	
HH	Household Sector	59.0
12	Livestock, Poultry and other Animal Products	31.8
31	Food, Beverages and Tobacco	7.0
32	Textile, Wearing Apparel and Leather Industries	0.9
	SS	
91	Public Administration and Defense (urban and other run-off)	46.7
12	Livestock, Poultry and Other Animal Products	27.1
21	Metallic Ore Mining	13.6
HH	Household Sector	10.2
31	Food, Beverages and Tobacco	1.1
41	Electricity, Gas and Water	0.9

Source: ENRAP II, 1994

SECTORS WITH HIGH WATER POLLUTION ABATEMENT COST
Philippines, 1988

PSIC	SECTOR	% SHARE to Total Abatement cost
91	Public Administration and Defense	54.1
11	Agricultural Crops Production	19.6
HH	Household	18.1
12	Livestock, Poultry and Other Animal Products	5.3
31	Food, Beverages and Tobacco	2.1

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Appendix C

WATER EFFLUENTS FROM DOMESTIC AND INDUSTRIAL SOURCES PHILIPPINES, 1988

(in metric tons)

(A Summary based on the ENRAP, 1994 estimates)

PSIC SECTOR	BOD5	SS	TDS	OIL	N	P
Agriculture, Forestry and Fishery	589,349	2,911,193	0	0	391,361	5,184
Mining and Quarrying	0	1,471,182	0	0	0	0
Manufacturing	161,783	149,798	743,854	26,243	14,990	0
Electricity, Gas and Water	7	94,236	346	0	0	0
Construction	ne	ne	ne	ne	ne	ne
Wholesale and Retail Trade	2,658	13,127	ne	ne	ne	ne
Transportation, Storage and Communications	ne	ne	ne	ne	ne	ne
Financing, Insurance, Real Estate and Business Services	5,904	5,026,023	0	248,768	845,528	32,995
Community, Social and Personal Services	1,092,646	1,092,646	ne	ne	174,823	29,137
Household Sector	ne	ne	ne	ne	ne	ne
Nature Sector						
TOTAL	1,852,347	10,758,206	744,201	275,191	1,426,702	67,317