No.429

An Environment-Economic Accounting System
- An Extension of Double Entry Bookkeeping System to the Man's Utilization of Environmental Resources -

by

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Abstract[1]:

One of the unpublished reports (Working Group2: Global Modelling) from the Tokyo International Symposium on the Human Response to Global Change, September 1988, observed that from a modelling and data perspective, the modelling dimension of physical human activities and the required information and an analysis of socio-political activities were as yet undefined within the HDGCP, where the Syposium was held as part of the Human Dimensions of Global Change Programme sponsored by the United Nations University, IFIAS, ISSC and UNESCO. Furthermore it recommends, among other things, that existing socio-economic data systems must be quicly adapted to meet current needs more closely. Reponding to this recommendation, the paper proposes an environment-economic accounting system, which is an extension of financial accounting system (double entry bookkeeping) to man's utilization of environmental resources. This accounting system may allow people in each region to evaluate what kinds of effects their environmental resource utilization activities are having not only in monetary evaluation way, but also in multidimensional way. It enables double effects, positive and negative effects, of our resource utilization processes, to be stored, separately, on the same account. Its framework is more general than those of existing modification systems of national accounting systems such as Peskin(1981). It aims at presenting a sample methodology by which "case studies can be conducted efficiently and quicly and in such a way that they yield comparative results." The needs for this kind of methodologies has been well pinpointed in Jacobson (1990).

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1) The main part of this manuscript was prepared for an International Workshop on Concepts, Models and Data for the Human Dimensions of Global Environmental Change Program (HDGECP) held in Moscow, 2-4 March, 1990.

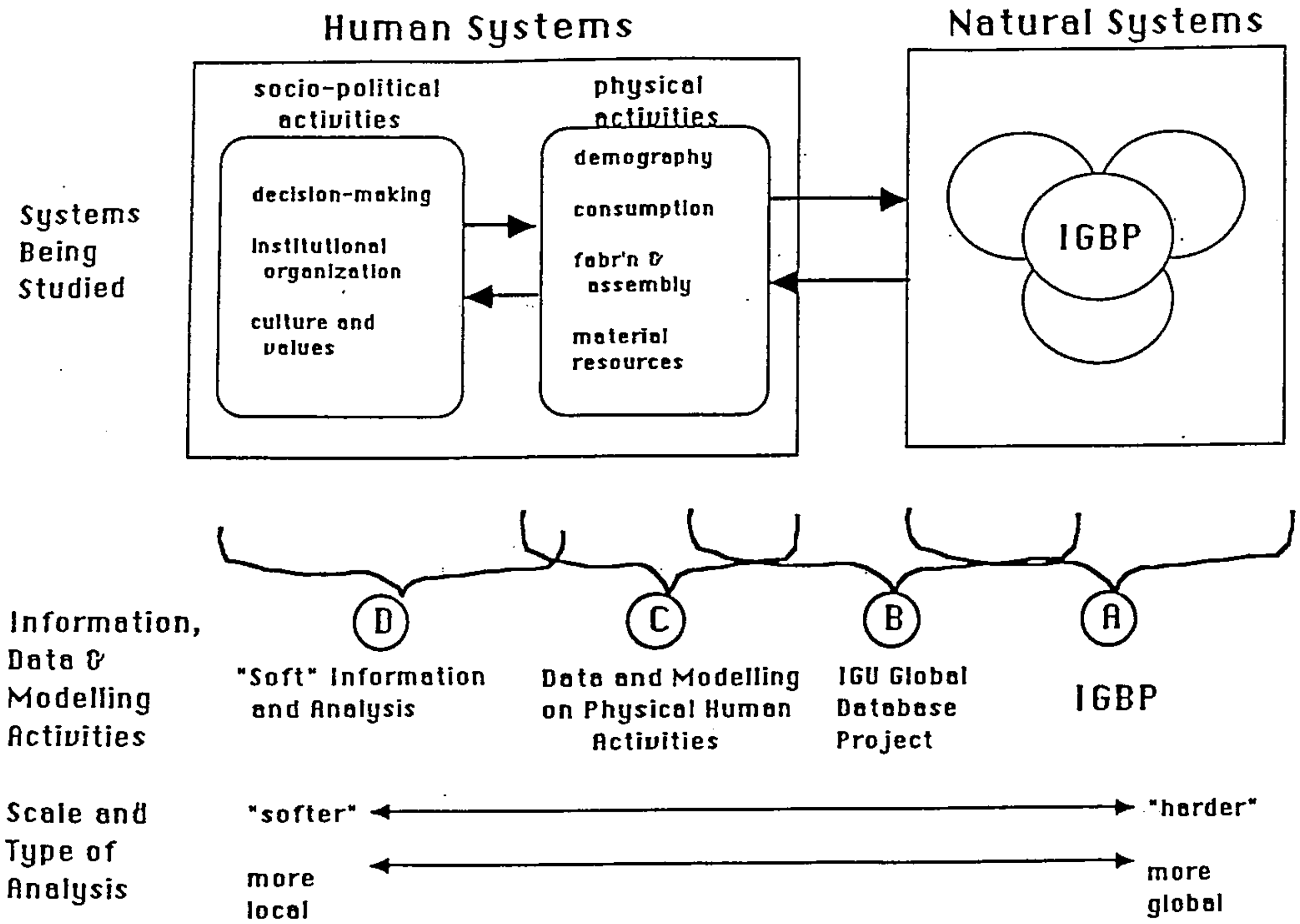
1. Introduction

In one of the group reports (Working Group 2: Global Modeling) from the Tokyo International Symposium on the Human Response to Global Change , a general kind of methodological structure or framework for HDGCP (Human Dimensions of Global Environmental Change) has been proposed, which is reproduced here in Figure 1. It expressed particular concern that "qualitative information and analysis not be neglected within HDGCP , since it is central to many of the socio-political and cultural issues that go to the heart of the human side of the programme." The central concern from the social sciences viewpoints lies in the left-hand component of the human systems box in Figure 1, which "represents those human processes by and through which human decisions are made and upon which behaviour is based," and which "describes human decision-making processes, institutional organizations, culture and values, and so on."

From a modelling and data perspective, the report rightly pinpoints that "the modelling dimension of physical human activities (C) and the required information and an analysis of socio-political activities (D) are as yet undefined within the HDGCP. Furthermore the report observes that "traditional national accounting systems do not include physical process data of the type required to address environmental and technical change and substitution issues properly. In general, existing socio-economic data systems contain an almost total lack of the physical process type data required for HDGCP analysis. Such systems must be quicly adapted to meet current needs more closely."

Responding to this recommendation, the author in this paper proposes an environment-economic accounting system, which is based on the author's historical study (see Appendix) on the man's utilization of environmental resources in Lake Kasumigaura in Japan. Figure 2 describes the structure of the proposed environment-economic accounting system, whichis an extension of financial accounting system (double entry bookkeeping) to man's utilization of environmental resources. To understand this structure, the next section briefly explains ordinalry business financial accounting (for details, see for example Nobes(1980)).

Figure 1 Proposed Conceptual Framework for Modelling Group



Source: Working Group 2: Global Modelling p32.

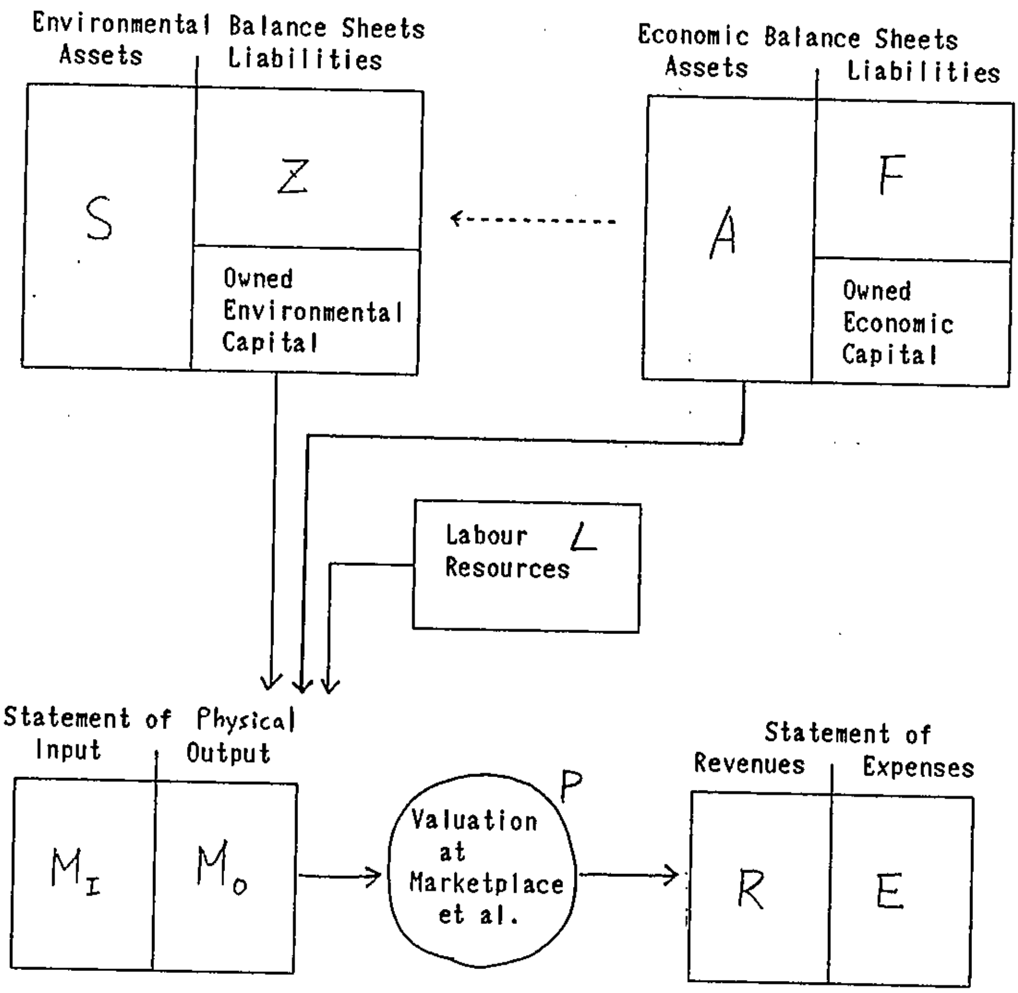


Figure 2 Structure of An Environment-Economic Accounting System

2. Two basic data sets in financial accounting

Main objectives in financial accounting are the preparation of a balance sheet to show the financial position of a business entity at one moment in time (stock accounting), and that of a statement of revenues and expenses that summarizes the receipts and the various costs incurred during a specified lengths of time (flow accounting).

As an illustrative example, let us suppose a business entity (manufacturer) owns, at one point in time (usually at the end of accounting period), 10 monetary units (10M) of cash, fixed property of land valued at 20M and buildings with machines valued at 30M, and intangible property of water abstraction right valued at its acquisition cost of 5M (cost sharing in water resource development project).

These managerial means owned by the business entity and which have expected future economic benefits are called economic "assets" (A) and grouped on the left-hand side of the economic balance sheet.

The right handside of the balance sheet describes how the total amount of assets are financed. Specifically, "liabilities"(F) are obligations to outside entities such as financial institutuions and government, that exist at the date of valuation. The total amount owned by the business (i.e. A), less the liabilities (F) is defined to be owned economic "capital". As an example, suppose the manufacturer self-finances the total amount of assets. Then the balance sheet of the manufacturer as at the end of the year (say 1988) may be written as in Table 1.

Now suppose this manufacture company, in the course of economic activities in the year 1989, received 20M in cash of sales revenue, paid 5M in cash for raw materials and 5M in cash for wages. It also pays 4M in cash for depreciation provision of buildings with machines and 1M in cash for depreciation provision of water abstraction right. "Profit" is defined to be the difference between revenues (R) and expenses (E). Thus the manufacturer earns 5M of profits in the year of 1989. Statement of revenues and expenses is written as in Table 2.

Table 1 Economic balance sheet of a manufacturer as at the end of 1988

Assets (A)		Liabilities (F) and capital	
Liquid assets: cash	10M	Liabilities (F):	none
Fixed assets: land	20M		
buildings with machines	30M		
Intangible assets:			
water abstraction right	5M	Capital:	65M

Table 2 Statement of Revenues and Expenses for the Manufacturer for 1989

Revenues		Expenses	
Sales of finished goods	20M	Purchase of materials	5M
		Wages	5M
		Depreciation provision	5M
		Profit	5M

Essencial point in double entry accounting system is to recognize that any transaction has at least two effects. Remember the case of manufacturer. The act of receiving sales revenue of 20M in cash means the increase of cash asset in the balance sheet by the same amount, while that of paying 10M in cash for trading expenses means the decrease in the cash asset. Depreciation provision of 4M for buildings with machines is considered to reflect the situation that fixed assets (excluding land) are used up in making the profit. It is customary to consider that this holds too for intangible asset such as water abstraction right. Thus in the balance sheet economic value of fixed assets will be reduced at the end of year 1989, while that of liquid assets will be increased by the same amount. The following Table 3 shows the balance sheet at the end of 1989:

Table 3 Economic Balance Sheet of a manufacturer as at the end of 1989

Assets		Liabilities and capital	
Liquid assets: cash	20M	Liabilities:	none
Fixed assets: land	20M		
buildings with machines	30M		
less depreciation	4M		
Intangible assets:			
water abstraction right	5M		
less depreciation	1M	capital	70M

3. Introduction to Environmental Accounting System

Due to solvent properties of water, water borne residuals cannot be generated without water supply. In this respect the act of water right appropriation to a manufacturing company automatically means an increase, without relevant public intervention, in the effluent loads to public waterbody.

In order to make our arguments concrete, suppose a regional government owns the environment, where this government is democratically chosen by people in the region (that is, the government pays due regard to people's preferences). At the end of 1987 the government is supposed to own 100F (physical units) of forest land, which is valued at 100M, and a lake which has water abstraction capacity of 100,000 m^3 with a representative water quality of 1 ppm. Suppose, during the year 1988, the government sold to the manufacturer 20F units of land in exchange for 20M of cash and changed the land-use category of sold land from forestry use to urban land use. The environmental liabilities for the regional government include the acceptance of 2 tonnes of residuals into the lake and the specified land use category of forestry use imposed on the owned 80F units of land. Environmental liabilities of the manufacturer are the specified land use category of urban land use imposed on the owned 20F units of land.

The concept of environmental capital is similar to "resource base" concepts in the field of natural resources. Landfeld and Hines(1985) says "resource base estimates include not only reserves capable of being extracted under today's economic conditions and technology, but also reserves capable of being extracted under future conditions." Environmentalcapital may be defined to be the economic entity in question's capability of utilizing environmental assets under today's as well as forseeable future's economic conditions and technology. As a continuation of the previous example, suppose the government can supply zero(carcinogenic)-risk drinking water without any water treatment, provided that the representative water quality of the lake is 1ppm. We further suppose that it cannot supply zero-risk drinking water without a conventional water treatment, if the lake water quality deteriorated into 10ppm. Then environmental capital for the government as at the end of 1988 consists of 100,000m^3 of zero-risk water supply capability without any water treatment. At the end of 1989, this environmental capital changed to 80,000m^3 of zero-risk water without any water treatment and 20,000m^3 of zero-risk water with a conventional water treatment.

Table 5 and 6 summarize environmental balance sheets of the manufacturer and of the government as at the end of 1989. Statement of physical input and output in Figure 2 describes in physical terms the input and output sides of man's utilization of the environment.This physical statement is converted, after valuation at market place or through some other institutional valuation process, to the statement of revenue and expenses. This completes the explanation of Figure 2.

In the next section we briefly explain how various key concepts in our environment-economic accounting system are related to the man's utilizationof environmental resources such as water resources.

Table 5 Environmental Balance Sheets of the Manufacturer (end of 1989)

Environmental Assets	Environmental Liabilities and Capital
Land Resources: land 20F	Land use category: urban
Water Resources:	
water abstraction right :	
α m³ per second	Environmental capital:
	land area compatible to
	urban land use 20F
	any form of water use compatible
	to the specified abstraction right
	α m³ per second

Table 6 Environmental Balance Sheets of the Regional Government (end of 1989)

Environmental Assets	Environmental Liabilities and Capital
Land Resources: 80F	Land use category: Forestry
Water Resources:	Unconstrained discharge of effluents:
water quality 1ppm: 80,000m³	2 tonnes per year
water quality 10ppm: 20,000m³	Environmental capital:
	land area compatible to forestry use
	20F
	zero-risk water supply capability
	without treatment 80,000m³
	zero-risk water supply capability
	with conventional treatment
	20,000m³

4. Expected Utility of the Proposed Accounting System

4.1 Characterization of the Environment

The environment may be defined to be the collective stock of environmental resources held in reserve, yielding over time a stream of services (mostly represented in M_I and M_O in Figure 2) for man. Haveman (1975) summarizes the services yielded by the environment as follows: 1) the services of dispersing, storing, or assimilating residuals, 2) the life supportive services such as providing a hospitable habitat for man and other forms of life, 3) the services of supplying material inputs to the economy, and 4) amenity services such as environmental recreation services.

In order to clarify the relationship among environmental services, various items in the environment-economic accounting system, and the actionof natural environmental processes, we may describe the state of the environment or the composition of environmental assets to be a vector of four state variables (S_1, S_2, S_3, S_4), for the case of an aquatic environment such as a lake, where S_1,S_2,S_3,S_4 represent the stock of water,materials such as organic chemicals, living organisms such as fish and plankton, and depoits of materials including sands on a lake bed at each moment of time t, respectively. Though S_2,S_3, and S_4 are considered to takevector forms, we simplify the notation as scalar forms. Then the time change of each state variable may be represented by the following set of differential equations:

(Water balance)

$S_1(t)= (I_{11}(S_o)-O_{11}(S_1;\ K))$

natural inflow - outflow

$+\ (I_{12}(O_{12},S_o;A,Z)\ -\ O_{12}(M_I,M_o,P;\ A,Z)\ -\ O_{13}(L,P;A,Z))$

Return flow   Industrial and municipal water withdrawal   (1)

(Mass balance of matter)

$$S_2(t) = \underbrace{I_{21}(S_0;\ A,Z)}_{\text{natural and nonpoint source}}$$

$$+ \underbrace{I_{22}(M_I,M_0,P;\ A,Z)}_{\text{industrial discharge}} + \underbrace{I_{23}(L,F;\ A,Z)}_{\text{municipal discharge}} + \underbrace{I_{24}(S,M_I,M_0,P;\ A,Z)}_{\text{aquaculture discharge}}$$

$$- \underbrace{O_{23}(S_3,O_3;\ A,Z)}_{\text{decrease due to fish catch}} - \underbrace{O_2(S;\ A)}_{\text{net natural decay}} \qquad (2)$$

(Mass balance of living organism, fish)

$$S_3(t) = \underbrace{I_3(S,M_I;\ A)}_{\text{net natural increase}} - \underbrace{O_3(S_3,M_I,P;\ A,Z)}_{\text{decrease due to fish catch}} \qquad (3)$$

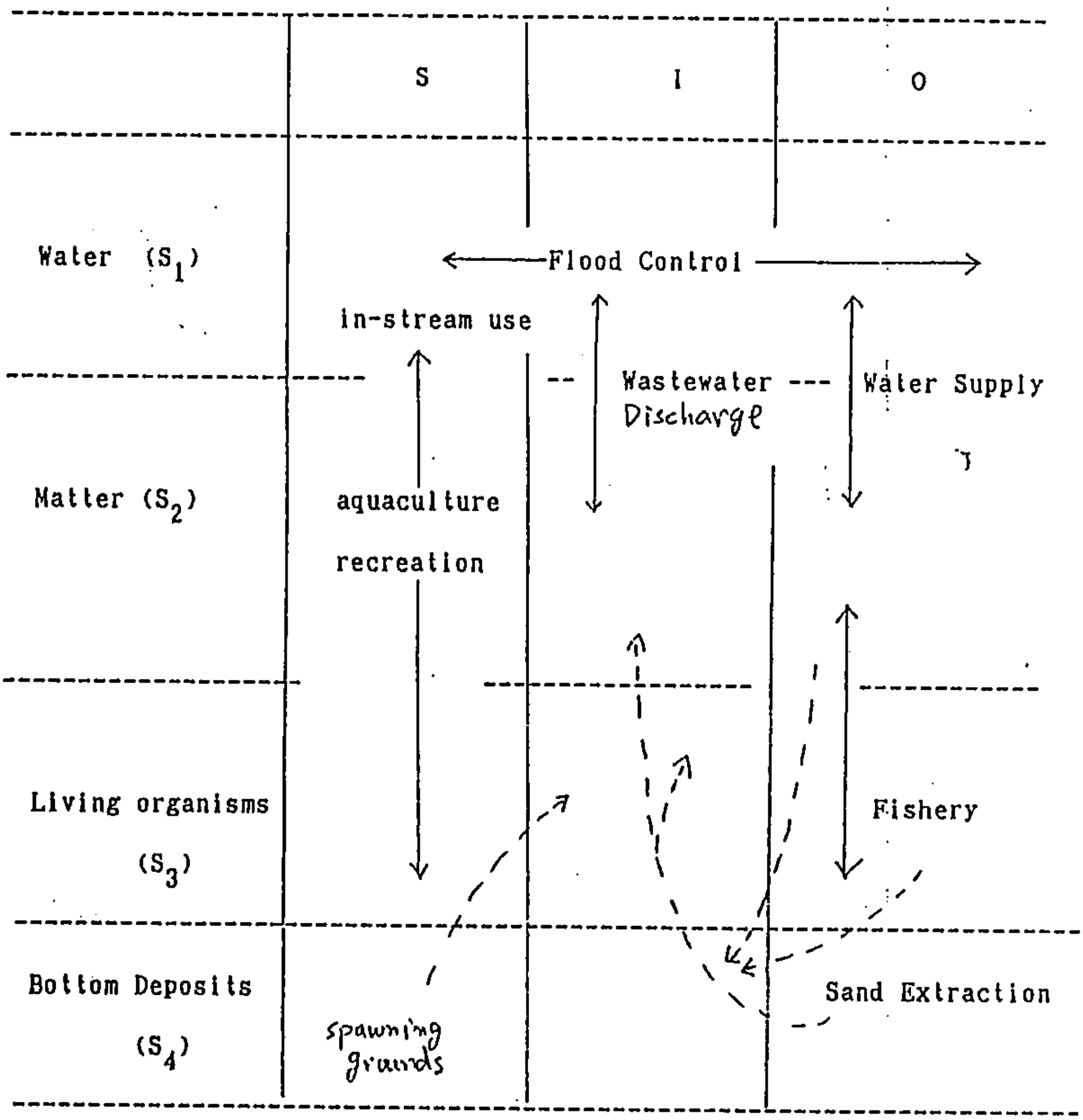
(Mass balance of deposited materials)

$$S_4(t) = I_4(S;\ A) - O_4(S_4,M_0;\ Z) \qquad (4)$$

,where I_i and O_i correspond to the rate of increase of the i-th stock and the rate of decrease of the i-the stock, respectively. S_0 represents physiographic features, such as climatic, of the environment, L the size oflabour force or of population, P the price vector of M_I and M_0, and all other symbols correspond to those in Figure 2.

In terms of (1) through (4), the meaning of the above mentioned environmental services become clear. Figure 3 illustrates various resource utilization activities. The first type of environmental services is related to the right-hand side of (1) through (4). Floods are caused by an excessive amount of water inflow, I_{11},to an aquatic environment in question. It may be defined, after Smith and Tobin (1979,p1) as a dishcarge which exceeds the capacity, S_1, in terms of a fixed volume of water, of the aquatic environment and then proceeds to inundate the adjacent land area. Physical measures of flood control are thus characterized by an increase in S_1 (ex., construction of a dam and reservoir), by decrease in I_{11} (ex.,reforestation or forest

Fig. 3 Classification of Lake Utilization activities



conservation), and by increase in O_{11} (ex., outlet channel enlargement). The other example of the first type of environmental servicesis the disposal of effluents which is directly related to I_{11} and I_{12} in equation (1) and to $I_{21},I_{22},I_{23},I_{24}$ in equation (2). For the assimilative capacity of the aquatic environment is clearly related to the solvent properties of water, and water is needed to transport matters to and from the environment.

The second type of environmental services, the life supportive services, is closely related to the ecological structure of and aquatic environment, where an example of this type of service utilization includes aquaculture.

Typical examples of material supply services, the third type of environmental services, are represented by O_{12} and O_{13} for water supply andO_3 for withdrawal of fish by fishermen. O_3 incidentally affects the mass balance equation for matter (2).

The fourth type of environmental services are represented by some function of S_1,S_2 ,S_3 and S_4 (as well as S_o) and do not affect the material balance equations such as (1) through (4), unless some residuals are discharged and /or living organisms such as fish are withdrawn through the process of man's enjoyment of amenity services.

It is important to notice that there exists interrelationships among environmental resource services. Man's utilization of such environmental services as O_{12}, O_{13} and O_3 are affected by the state (S_1,S_2,S_3,S_4) of the environment which in turn is affected by residual disposals $I_{12},I_{22},I_{23},I_{24}$. Certain level of eutrophication of a lake may be beneficial to fishery production, while an excessive inflow of matter such as nitrogen and phosphorus leads to the excessive growth of various algae and, consequently, leads to a reduction in the quality of water supply services or in the size and diversity of fishery resource stocks.

Thus, conceptually speaking, our task is two fold: One is to keep or enhance the total value (no matter how defined) of our environmental assets as large as possible; The other is to devise a socio-technological-economic institution for a regional society to recieve as large an annual sustainable income as possible from this maximized environmental assets.

4.2 Concept of Water Resource Depletion Function and Its Analytical Use

The relationship between uniform withdrawal rate of a river and the correspponding required storage capacity is called "storage-yield curves" characterized by diminishing returns to scale. As the uniform withdrawal rate of rivers approaches, with consequent increase in the number of dams, the maximum withdrawal rate of the river's mean flow rate, the total annual and marginal costs of added water supply at the storage site increase sharply (Howe, 1982). In this stage of river development, the return flows can be very important for generating surplus water. Howe et al.(1982) explains this as follows: Let us suppose each water user withdraws a quantiry W from the stream, consumes a fraction c and returns (1-c)W to the stream. Then the total quantity of withdrawals is calculated to be $W/c>W$ (quite a large number, since c is normally a small decimal number), provided that the number of sequential users becoms large.

This technical consideration of river systems naturally leads to the preference for the regulated but otherwise natural lake or a long natural river as a large water reservoir, such as in the case of Yodo River and Lake Kasumigaura in Japan. Looking back into equations (1) and (2), it is important to notice that, though the water balance may not be affected so much by an increase in the number of sequential users (that is, the second parenthesis on the RHS of (1) can be close to zero), the mass balance equation for matter, equation (2), can be greatly affected by it. Specifically, unless relevant public intervention such as effluent regulation or public investment in wastewater treatment facilities, the amount of discharged effluent can increase greatly. In this stage of water economy, the problem of using river water for the domestic water supply is not at all a question of quantity, but simply one of water quality, as Sontheimer (1976) rightly points out based on his experience in the Rhine in Central Europe. Based on this recognition, the author elsewhere (Kitabatake, 1989) proposed the concept of water resource depletion function, and clarified its analytical usefulness.

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Appendix Illustrative example of the environment-economic accounting system - the case of Lake Kasumigaura -

A1. Brief History of Lake Utilization

Lake Kasumigaura is the general name used to include altogether the main lake (Nishiura) and two other lakes (Kitaura and Sotonasakaura). It is a shallow lake with the mean depth of about 4 meter and the maximum depth of 7 meter.

Before the Second World War, environmental services of the lake are limited to flood control, fishery, and an irreversible use of land reclamation. Water withdrawals for agriculture are limited to the nearby rice field. The act of reclaiming land from the lake continues after World War II so as to alleviate the nation's pressing concerns of starvation. In total, 2660 ha of the lake surface are reclaimed in 1918 through 1967. A mojor change in resource utilization came after the War.

A major external factor is the establishment of the National Land Comprehensive Development Law (NLCD) in 1950. This law was modeled on the case of the Tennessee Valey Authority and designed to coordinate various development planning such as rice paddy development and multipurpose river development with the goals of post-war economic recovery (Shimokobe, 1981). Prevailing idea behind the law would be to liquidate previously unused or inefficiently used resources such as water resources and convert to reconstruction activities. "This law established the administrative procedures through which schemes of regional development are to be formulated. Areal framework for such schemes adopted in the Law are: (a) the whole country, and (b) extensive area cutting across several prefectures constituting a relevant developmental territory like a river basin ...., (c) group of prefectures and (d) one single prefecture" (Nagamine, 1981).

The NLCD is going to affect Lake Kasumigaura in two ways. One is related to the second areal framework (b), which is the eventual inclusion of the lake into a large-scale basinwide river management system, and the other related to the fourth framework (d) is the initiation of a major regional development project of building large-sclae industrial complexes near the lake.

In the field of multipurpose river development, the Specific Multipurpose Dam Law specifying the role of the central government and the procedures of water and cost allocation, and the Municipal Water Supply Law specifying measures for development of water supply system are both enacted in 1957. An important law is the Water Resource Development Enhancement Law (WRDE) enacted in 1961 which requires the central government to formulate "water resource development programs" for major river basin areas where industrial development and urban population increase necessitate additional water supply. The creation of the Water Resource Development Corporation (WRDC) in 1961 represents direct government intervention in water resource development programs specifyed in the WRDE, shifting the costs over time back to beneficiaries. Based on the WRDE, 5 river basin areas are designated as the water resource development areas. Two of them, the Tone River Basin and the Arakawa River Basin are related to the Tokyo Metropolitan Region.

In response to an expansion of the Tokyo Metropolitan Region, Lake Kasumigaura was designated in 1967 as a part of the Tone River regulated by the central government (the first effect of NLCD). This came after the major revision of the River Law (Kasen ho), where the Law enacted in 1896 and specifying two main strands of river management, flood control and water supply, was revised in 1964 so as to transfer general management power for a designated important river (Ikkyuu Kasen) from Prefectural governments to the central governmental body of the Ministry of Construction.

The second effec of the NLCD came in 1961, which is the initiation by Ibaraki Prectural Government of area development plan aiming at constructing a large industrial complexes near the outlet part of the lake. This development plan is backed by the Law concerning Promotion of Industrial Development in Underdeveloped Areas and has double purposes of improving regional welfare and mitigating congestion and pollution problems in major urban areas. The major industry sectors comprising industrial complexes are petrochemical and steel indutries both using a large quantity of water.

A2. Environment-Economic Accounting System Before and After the Water Resource Development Project of Lake Kasumigaura

2600 million tonnes and 300 million tonnes of precipitation in the form of rain are estimated to fall onto the basin area of Lake Kasumigaura and onto the lake surface, respectively. Some of this water, 1600 million tonnes, is to evaporate to the atmosphere. 1480 million tonnes of water are transfered through the river called Hitachi-Tone (outlet river) to the Pacific Ocean, where 180 million tonnes of water mixed with sea water return to the lake. Thus 800 million tonnes of water mixed with sea water return to the lake.

Lake Kasumigaura Water Resource Development Project is initiated in 1967 as a part of the Water Resource Development Program for the Tone and Arakawa River Basin, where the most recent revision of the plan was made in 1980. The project is mainly concerned with increasing the natural storages of 800 million tonnes by building surrounding artificial banks and the strict control of a gate at the lake outlet. The total storage of 1252 million tonnes is to be developed, where 339 million tonnes of water are reserved as flood retention storage, 278 million for water supply, and 635 million to maintain in-situ water use such as fishery. The 43 tonnes per second of developed water for domestic supply are allocated to beneficiaries in three prefectures including Tokyo Metropolitan Government.

Figure A1 illustrates annual utilization of Lake Kasumigaura's environmental resource services, which is related to (Z, M_1, M_o, R) in Figure 2. Table A1 and A2 summarize environmental balance sheets before and after the water resource development project.

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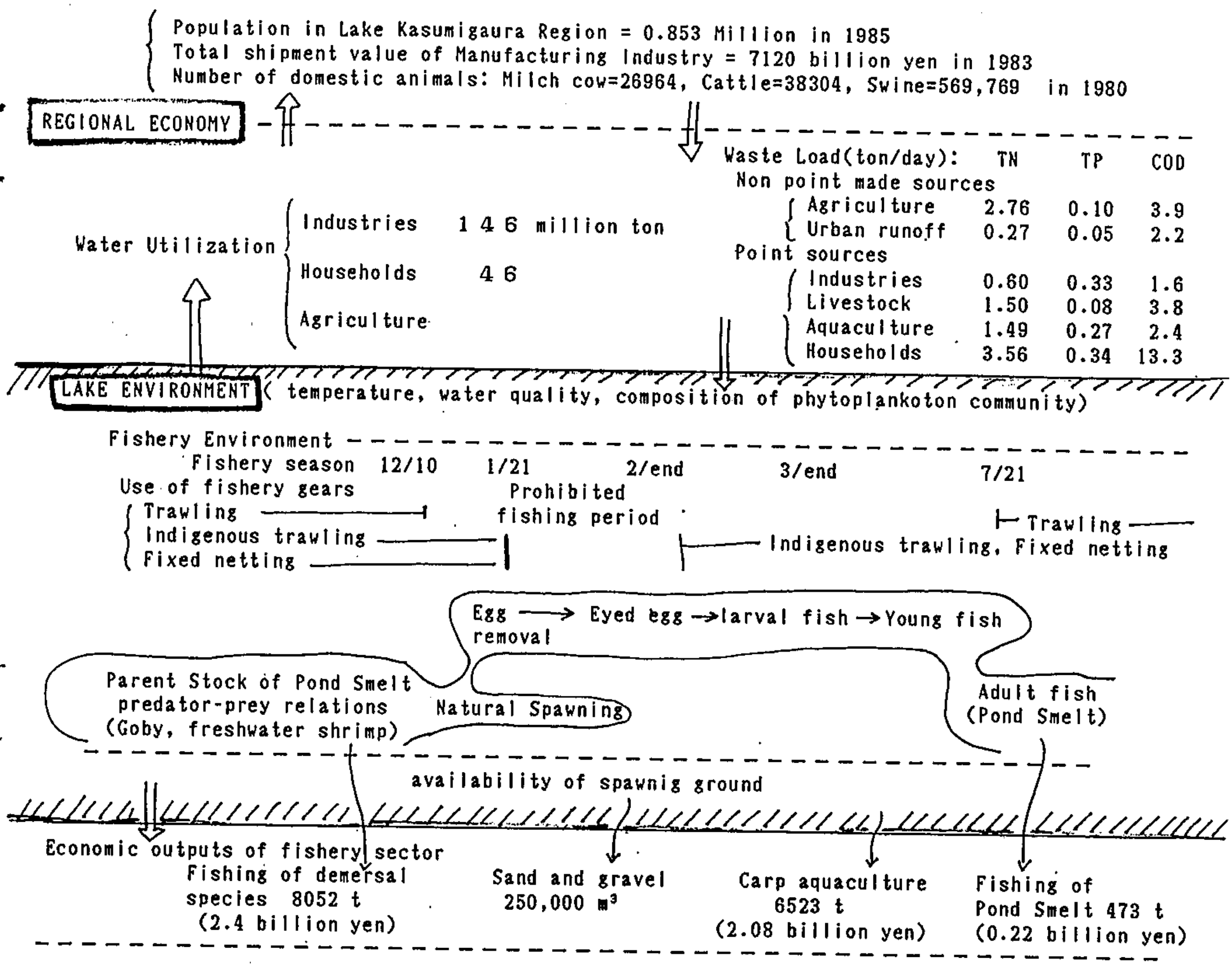

Figure A1 Man's Utilization of Lake Kasumigaura

Table A1

Lake Kasumigaura Region: Copmarison of Environmental Balance Sheets, before and after the water resource development project

Environmental Assets (mostly around 1964)			Environmental Assets (around 1985)	
1) Land use in related municipalities (1970)	km²	-------->	**Landuse in related municipalities (1984)**	km²
Agricultural land	1214.1		Agricultural land	1195.1 (-1.6%)
Paddy field	533.4		Paddy field	562.7 (+5.5%)
Upland field	680.7		Upland field	632.4 (-7.1%)
Woody vegetation	624.8		Woody vegetation	594.8 (-4.8%)
Wasteland	47.2		Wasteland	47.0
Residential, industrial	131.2		Residential, industrial	249.1 (+89.9%)
Total	2564.5		Total	2731.6
Area of the lake itself	213.7			
2) The Lake as the Stock of Water Resource		-------->	Storage capacity for	(million tonnes)
For in stream use + off stream use			Flood Control	339
850 million tonnes in total			Water Supply	298
			In-stream Use	635
			Total	1272
			(Water rights newly obtained from the outside region) m³/s	20. 07
3) Water Quality category and available Water Quantity				
Water quality (Coefficient of Variation) at a representative point				
Secchi disc reading (annual average, 1955-1964)	1. 35m (0. 27)		(annual average, 1975-1984)	0. 90m (0. 39)
4) Alternative Indicator for Stock of Fishery Resources				
Average Fish Catch (Coefficient of Variation) (annual average, 1955-1964)	tonnes		(annual average, 1975-1984)	tonnes
Pelagic species			Pelagic species	
Eel	321 (0.34)	-------->	Eel	75 (0.94)
Icefish	412 (0.23)		Icefish	95 (0.85)
Pond Smelt	1157 (0.30)		Pond Smelt	674 (0.57)
Demersal species			Demersal species	
Goby	676 (0.29)		Goby	2701 (0.37)
Carp	126 (0.33)		Carp	1272 (0.28)
Crucian Carp	560 (0.26)		Crucian Carp	1094 (0.35)
Fish total	3612		Fish total	7045
Freshwater shrimp	522 (0.54)		Freshwater shrimp	3686 (0.22)
Opossum shrimp	1917 (0.34)		Opossum shrimp	1814 (0.40)
Crustacean total	2443		Crustacean total	5563
Freshwater Clam	1615		Freshwater Clam	776
Clam total	1561		Clam total	841
Total catch	7762 (0.17)		Total catch	13450 (0.21)

Table A2

Lake Kasumigaura Region: Comparison of Environmental Balance Sheets (continued)

Environmental Liabilities (around 1964)		Environmental Liabilities (around 1985)	
1) **Endowment of Water right** (River Law) -------->		1) **Endowment of Water Right** (River Law)	
Within the region	m^3/s	Within the Region	m^3/s
Traditional Water Right		Traditional Water Right	
Farm irrigation	62.4	Farm irrigation	sharp decrease
Licenced Water Right		Licenced Water Right	
Farm irrigation	14.3	Farm irrigation	18.13
Domestic water supply	2.0	Domestic water supply	2.5
Industrial water supply	8.1	Industrial water supply	16.6
		Outside the Region	
		To Tchiba Prefecture	4.2
		To Tokyo Metropolitan Region	1.5
2) **Endowment of Fishery Right** (Fishery Law)		2) **Endowment of Fishery Right** (Fishery Law)	
Cooperative Fisehry Right		Cooperative Fishery Right	
Large-scale Fixed Netting	507	---------> Large-scale Fixed Netting	578
Small-scale Fixed Netting	1468	Small-scale Fixed Netting	1349
Fishery Right for Aquaculture		Fishery Right for Aquaculture	
Pearl culture	5	Pearl culture	9
Eel culture	3	Eel culture	1
		Carp culture	73
3) **Number of Fishery Licences** issued by Prefectural Governor			
Sailing trawl	506	Sailing trawl	6
Indigenous gear of catching demersal fish	778	Indigenous gear of catching demersal fish	605
Special gear for catching clam	302	Special gear for catching clam	226
Long line for catching eel	971	Special gear for catching eel	0
Indigenous gear for catching shrimp	352	Indigenous gear for catching shrimp	349
Flue for catching carp and crucian carp	242	Flue for catching carp and crucian carp	0
Diesel-powered trawling	0	Diesel-powered trawling	541
Total number of licences	5465	Total number of licences	3140

4) **Legal Constratints on Waste Discharges**

Specified facilities(industry, sewerage plant) must comply with effluent standards

5) **Legal Constraint on Domestic Water Treatment**