# 1

# Basic Ideas and Methodologies of the IDE Research Project on Forest Resource Accounting

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## INTRODUCTION

Based on the studies conducted during the fiscal year 1992 and 1993, the Institute started to develop physical accounts on an experimental basis. Countries selected to develop the accounts were Indonesia, Thailand, and the Philippines and as a target sector, the forest and forest products sector was selected. During the fiscal year 1994, by using the input-output table and other available secondary data in each country, a sector commodity table for the forest and forest products sector was compiled preliminarily. During the fiscal year 1995, first, a full-scale field survey was conducted; secondly, the sector-commodity table was revised based on the results of the survey; and thirdly, a mass balance table for the forest and forest products sector was compiled. The organizations participating in the project were the Central Bureau of Statistics in Indonesia, National Economic and Social Development Board in Thailand, and Resources, Environment & Economics Center for Study, Inc. together with National Statistical Coordination Board and National Statistics Office in the Philippines, respectively.

To facilitate the research activities the IDE team has provided the Asian counterpart teams with some descriptions for the compilation. This short note just show what the IDE team furnished to the Asian counterpart teams.

## 1. THE IDE RESEARCH PROJECT ON "ENVIRONMENTAL ACCOUNTING FOR FOREST AND TIMBER RESOURCES"

### 1.1 Background of the Project

The Institute of Developing Economies (IDE), a semigovernmental organ, started its

research project on Environmental Resource Accounting System focusing on its application to developing countries in the fiscal 1992. In the first two years we had mainly surveyed the literature related to theoretical frameworks and reviewed the data availability in Asian countries. As one of the results of our effort we published a book entitled *Kankyou Shigen Kanjou to Hattentojoukoku* (Environmental Resource Accounts and Developing Countries) in Japanese in 1994.

One of our main conclusions after two years research was that priority should be given to physical accounts rather than monetary accounts. First of all, environmental degradation is not monetary phenomena at all but physical ones which are caused by various kinds of human activities, particularly economic activities. Therefore, if we develop accounting system which appropriately describe interactions between economic activities and the environment in physical term, it will become a very good source of information especially for policy makers. Secondly, non-market activities are still playing important roles in developing economies and also becoming some of the main causes of environmental degradation in those regions. Those activities and their impacts on the environment should be described and evaluated directly in physical term without any conversion into monetary term.

Prof. Koike's paper entitled "Shinrin/mokuzai no shigen kankyou kankjou — Tai no jirei" (Resource Environment Accounting for Forest and Timber Resources — The Case of Thailand) which first appeared in the book mentioned above is an excellent example along this line. In the paper he briefly explains what the Norwegian Material Energy Balance (MEB) Approach is and estimates preliminarily a few tables for the forest sector of Thailand.

As Prof. Koike states in his paper, the MEB approach can be used to form a system that is self-consistent, regardless of the extent to which a country has shifted to the market economic system. This makes the approach suitable for developing countries. In addition, the MEB system can be linked to the System of National Accounts (SNA) via the sector commodity table. The MEB system is in fact considered to be a typical satellite system of SNA. These are main reasons we propose here to construct a physical accounting system through the MEB approach. And the sector chosen for an exercise in the project is the forest and forest products sector, since the sector will be important in your country both in economic and environmental perspective.

## 1.2 Objective and Scope of the Project

The Norwegian MEB system basically consists of three tables: a resource-environment stock account; a flow-based sector commodity table; and a mass balance table.

The resource-environment stock account compare stocks at the beginning and end of a given period of time in exactly the same way as a company balance sheet is used. For the forest sector, both areas and volumes (biomass) of forest are estimated.

The sector commodity table shows the sectors in which timber harvested from forest stocks is processed and ultimately consumed. Most of the cells in this table can easily filled if physical input-output tables are available.

The mass balance table converts the sector commodity table into mass number and also expresses environmental discharges and other factors in an account form.

The main objective of the project is to estimate the latter two tables and the conceptual frameworks for the estimation of the two tables are prepared by IDE team. In principle the mass balance table is estimated through the conversion of the sector commodity table into mass number (i.e. ton). Therefore the estimation of the sector commodity table should take precedence over the estimation of the mass balance table.

The followings are the scope of the project:

1. Estimation of Forest and Forest Products Account
   (1) Sector Commodity Table
   (2) Mass Balance Table
2. Analysis and Policy Recommendation
3. Recommendation for Further Study

## 1.3 Methodology and Data Required for the Compilation of a Sector Commodity and a Mass balance Tables

As mentioned above, if physical input-output table is available, then most of the cells of sector commodity table are easily filled. The problem is that few countries have compiled physical tables and this is actually the case with your countries. Thus the following steps will be necessary to estimate the sector commodity table:

1. to scrutinize procedure of input-output table compilation focusing on related sectors and/or commodities and ascertain data availability;
2. to compile and evaluate other secondary data;
3. to fill tentatively the cells of sector commodity table and identify problems encountered (first estimation);
4. to design a field survey and prepare a questionnaire for survey;
5. to conduct a field survey;
6. to reestimate the sector commodity table based on the survey results (second estimation).

Regarding the mass-balance table, data and information required to estimate the table are primarily the followings:

1. conversion factors (i.e. specific gravities of related materials);
2. data of wastes in related sectors.

To compile those data, a field survey will be again required.

## 1.4 Schedule

The followings are only a tentative schedule that the Institute suggests. The schedule as well as the contents of the project will be fixed after mutual consultation.

October to December, 1994 — to conduct the first estimation of the sector-commodity table;
January to March, 1995 — to conduct a pilot field survey and the second estimation of the sector commodity table;
July, 1995 to February, 1996 — to conduct a field survey and revise your sector com modity table and estimate the mass-balance table.

**Table 1** Framework for Sector-Commodity Table

| *(Column)* *Commodity* | | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* |
|---|---|---|---|---|---|---|---|---|---|---|
| *(Row)* | | *Industrial Round Wood* | *Sawn Wood* | *Other Forest Products* | *Firewood* | *Charcoal* | *Boards* | *Pulp* | *Paper* | *Paper Recycled* |
| Sector | | | | | | | | | | |
| Removal | | | | | | | | | | |
| Import | | | | | | | | | | |
| Export | | | | | | | | | | |
| Primary Supply | | | | | | | | | | |
| (Processing Sectors) | | | | | | | | | | |
| 1. Sawmill Industry | (I) | | | | | | | | | |
| | (O) | | | | | | | | | |
| 2. Charcoal Industry | (I) | | | | | | | | | |
| | (O) | | | | | | | | | |
| 3. Primary Processin of | (I) | | | | | | | | | |
| Other Forest Products | (O) | | | | | | | | | |
| 4. Board Industry | (I) | | | | | | | | | |
| | (O) | | | | | | | | | |
| 5. Pulp Industry | (I) | | | | | | | | | |
| | (O) | | | | | | | | | |
| 6. Paper Industry | (I) | | | | | | | | | |
| | (O) | | | | | | | | | |
| (Final Users) | | | | | | | | | | |
| 7. Agriculture | | | | | | | | | | |
| 8. Slaughtering | | | | | | | | | | |
| 9. Sugar | | | | | | | | | | |
| 10. Tobacco | | | | | | | | | | |
| 11. Apparel | | | | | | | | | | |
| 12. Furniture | | | | | | | | | | |
| 13. Paper Products | | | | | | | | | | |
| 14. Printing | | | | | | | | | | |
| 15. Medicine | | | | | | | | | | |
| 16. Rubber | | | | | | | | | | |
| 17. Ceramic | | | | | | | | | | |
| 18. Communication | | | | | | | | | | |
| 19. Shipbuilding | | | | | | | | | | |
| 20. Automobile | | | | | | | | | | |
| 21. Other Mfg. | | | | | | | | | | |
| 22. Construction | | | | | | | | | | |
| 23. Engineering | | | | | | | | | | |
| 24. Commerce | | | | | | | | | | |
| 25. Restaurant | | | | | | | | | | |
| 26. Financial, etc. | | | | | | | | | | |
| 27. Household | | | | | | | | | | |

**Table 2** Framework for Mass Balance Table

| *(Column)Commodity/Waste* | | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *(Row)* | | *Industrial Round Wood* | *Sawn Wood* | *Other Forest Products* | *Firewood* | *Charcoal* | *Boards* | *Pulp* | *Paper* | *Paper Recycled* | *To: Air (1) Air (2)*[1] | *To: Water* | *To: Soil* | *Other*[2] |
| Sector | | | | | | | | | | | | | | |
| 1. Sawmill Industry | (I) | | | | | | | | | | | | | |
| | (O) | | | | | | | | | | | | | |
| 2. Charcoal Industry | (I) | | | | | | | | | | | | | |
| | (O) | | | | | | | | | | | | | |
| 3. Primary Processing of Other Forest Products | (I) | | | | | | | | | | | | | |
| | (O) | | | | | | | | | | | | | |
| 4. Board Industry | (I) | | | | | | | | | | | | | |
| | (O) | | | | | | | | | | | | | |
| 5. Pulp Industry | (I) | | | | | | | | | | | | | |
| | (O) | | | | | | | | | | | | | |
| 6. Paper Industry | (I) | | | | | | | | | | | | | |
| | (O) | | | | | | | | | | | | | |

Notes: 1. "To: Air (1)": Wastes incinerated / "To: Air (2)": Wastes reused.

2. Free disposal in other sector.

In addition we may suggest that the Institute will hold an international workshop in 1996 and provide you with an opportunity to review and summarize the results of the project together with other countries' teams as well as the IDE team. The Institute is also expecting to publish the proceedings of the workshop in English.

## 2. Descriptions for the Compilation of Mass Balance Table

So far only two countries in the world, Norway and Finland, have developed their own mass balance tables of the forest and forest products industry on an official basis. The tables can be found in the OECD document, "Natural Resources Accounts Report on the Pilot Study Concerning Forest Resources" (1990). The report, however, only shows you the estimation results. The report does not provide you with much information on detailed estimation technique. Furthermore, you may find some inconsistencies even in the estimation results themselves. For instance, while the sector commodity table and the mass balance table for Norway have different reference years, 1985 and 1983, respectively, both tables for Finland have the same reference year, 1985. In addition, investigation of both tables for Finland suggests that the tables do not completely correspond to each other. In this exercise, you are requested to compile the mass balance table based on the sector commodity table which you already estimated in the previous fiscal year. This is just to keep the correspondence between the sector commodity table and the mass balance table as close as possible. Whenever a cell in the sector commodity table is filled with figures, the corresponding cell in the mass balance table should be filled with appropriate figures.

### 2.1 Framework of the Mass Balance Table

#### *2.1.1 Sectors and Commodities*

Regarding the framework of the mass balance table, a new version of it is attached.

The main revision is found in the sectors (row). Instead of the six sectors of the previous version, there are eight sectors in the new one. While the Primary Processing of Other Forest Products sector is deleted, the Board sector and the Pulp sector are divided into two or more new sectors. The Board sector is divided into three sectors: Veneer and Plywood, Fiber Board, and Particle Board. The Pulp sector is divided into two sectors: Mechanical Pulp and Chemical Pulp. Sawmill Industry and Charcoal Industry remain as before.

With respect to the commodities (row), corresponding revisions are made. But the most important change here is that the columns of residues and by-products are incorporated into the framework. Regarding the definitions of both categories, please refer to Additional Notes on the Framework. Now, since the Primary Processing of Other Forest Products sector is deleted from the row, Other Forest Products is deleted from the column correspondingly. Similarly, Boards is divided into three commodities: Veneer and Plywood, Fiber Board, and Particle Board. Since mechanical and chemical pulp industries provide different types of pulp, conceptually we need Mechanical Pulp and Chemical Pulp as commodities. It may be the case, however, that no mechanical pulp factory is located in your country. If that is so, then only Pulp (chemical pulp) will be needed as a commodity.

### *2.1.2 Wastes*

The basic objective of the mass balance table is to fully trace the transformation process of an industrial activity, from the beginning to the very end of the process. The very end of the process means that any kind of waste discharges by the industry have to be traced and quantitatively evaluated in a physical unit. In other words, unlike the sector commodity table, which shows us a material flow balance of a certain commodity, the mass balance table displays the input-output-emission structure of a certain industry. While each column has to be balanced in the sector commodity table, the input and output of each sector (row) involving wastes have to be balanced in the mass balance table.

As the framework shows, wastes are classified into the following categories, at least conceptually: (1) Fuel Used; (2) Emissions to (i) Air, (ii) Water, and (iii) Soil; and (3) Other, including (i) real transfer (with zero market value), and (ii) bads (with negative or minus market value). If some waste is used as fuel for the factory, it will be classified into Fuel Used. On the other hand, if the waste is only incinerated, then it has to be classified into Emission to Air, Water, and/or Soil. Real transfer means that people who need the wastes can use them for free. Finally, if the factory discharges any kind of bads (typically toxic wastes), it has to pay a garbage service agency to dispose of them.

## 2.2 Some Suggestions for Estimation

Based on the characteristics of the activities, eight sectors are reclassified into three groups: (1) Sawmill Industry and Charcoal Industry; (2) Veneer and Plywood, Fiber Board, and Particle Board; and (3) Mechanical Pulp, Chemical Pulp, and Paper and Paper Board. Some suggestions for estimation are given below by group.

### *2.2.1 Sawmill and Charcoal Industry*

Regarding the sawmill industry, from the I-O data and other related information, first you may estimate the figure for output of Sawn Wood. Secondly, if the recovery rate, a ratio (technical coefficient) converting raw logs into sawn wood, is available, then you can estimate the input to the sawmill industry. Considering the charcoal industry, if appropriate input-output data and socioeconomic survey data, etc., are available, it is possible to estimate the total amount of charcoal consumption. The total consumption turns out to be the apparent production of charcoal, the output of the charcoal industry. Precisely, the charcoal industry should be "charcoal production activities." If, again, the recovery rate is available, then estimation of input to charcoal production activities is completed. The recovery rate is central to this exercise. The role of the ratio is twofold: if you have input data, then you can get output, or vice versa; in addition to this, you can get the total amount of residues and emissions or wastes. Please notice that 100% minus the recovery rate equals the wastage rate.

### *2.2.2 Veneer and Plywood, Fiber Board, and Particle Board*

Regarding these industries, it is important to investigate their production processes and the recovery rates. According to a report written by Dr. Emmanuel T. Velasco and others in the early 1980s, the recovery rates of the veneer industry and the plywood industry in the Philippines are 50% and 90%, respectively. With respect to the Fiber Board and the Particle Board industries, the demand structure, the market structure, and eventually the production

processes are gradually changing. As diptercarp resource is becoming scarce and the price is increasing, part of the demand for plywood is shifting, for instance, to medium density fiber board. Most of the raw materials for both fiber board and particle board used to be residues of the sawmill, veneer and plywood industries. Now raw logs are partly utilized as input to fiber board production, especially to produce medium density fiber board.

### *2.2.3 Mechanical Pulp, Chemical Pulp, Paper, and Paper Board*

According to a report prepared by a semigovernmental research organ of Japan, "between 100 and 500 cubic meters of water is required to produce a ton of pulp and paper, and the industry is heavily dependent on water and accounts for one quarter of the total industrial water consumed in Japan (on a basis of fresh water replenishment)." While the industry is a raw material (such as wood) "intensive" and water "intensive" industry, it is a "pollutants intensive" industry, as well. The same report also states that "most of the water consumed returns to rivers as well as coastal waters, so-called public water areas, in the forms of "discharged waste water" and forms the origin of pollutants. "With respect to the industry, therefore, it is essential to look carefully not only at the production process but also at the waste treatment process, especially the waste water treatment process. The amount of pollutants depends heavily on the technology utilized. According to Dr. Junko Nakanishi, Professor of Environmental Engineering at the University of Tokyo, to produce a ton of paper, 320 kg of BOD is discharged in China, and only 4 kg in Japan. But the figure for Japan in 1970 was 115 kg. Most of the rapid reduction of BOD discharge can be attributed to technological innovation in the production process and the waste water treatment process.

## 2.3 Some Recommendations for Design of Field Survey

The main objective of the field survey is to collect data and information which is not commonly available in existing secondary data. Before starting the field survey, it is necessary to design the survey carefully and appropriately.

First, we need to list up related establishments, or firms, confirming the number of establishments (firms) and the size distribution of the establishments (firms). In some industries, seemingly there are only limited establishments. In such a case, we may conduct a survey on a census base. If the number of establishments is large enough, (1) we may contact industrial associations to get as much necessary information as possible, and (2) conduct a sample survey purposively considering carefully the size distribution of the establishments.

The most important information or data to compile the mass balance table will be as follows:

(1) unit of raw materials and products
(2) specific gravities of raw materials and products
(3) technical coefficient, such as recovery rate or wastage rate

First, we need to confirm the unit commonly used in a specific industry in order to estimate the volume of input and output of the industry. Secondly, to convert the volume into weight, it is necessary to elaborate and determine the specific gravity of raw materials and products of the industry. The technical coefficient will assist our work to fill in some parts of the cells of both the sector commodity table and the mass balance table.

**Table 3** Framework for Mass Balance Table (Revised)

| | | *Commodities* | | | | | | | | | *Wastes* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *(Column)Commodity/Waste* | | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
| *(Row)* | | *Industrial Round Wood* | *Sawn Wood* | *Firewood* | *Charcoal* | *Residues* | *Boards* | *Pulp* | *Paper* | *Paper Recycled* | *Fuel Used* | *Emission* | *Other* |
| Sector | | | | | | | | | | | | | |
| 1. Sawmilling | (I) | | | | | | | | | | | | |
| | (O) | | | | | | | | | | | | |
| 2. Charcoal | (I) | | | | | | | | | | | | |
| | (O) | | | | | | | | | | | | |
| 3. Plywood & Veneer | (I) | | | | | | | | | | | | |
| | (O) | | | | | | | | | | | | |
| 4. Particle Board | (I) | | | | | | | | | | | | |
| | (O) | | | | | | | | | | | | |
| 5. Fibre Board | (I) | | | | | | | | | | | | |
| | (O) | | | | | | | | | | | | |
| 6. Mechanical Pulp | (I) | | | | | | | | | | | | |
| | (O) | | | | | | | | | | | | |
| 7. Chemical Pulp | (I) | | | | | | | | | | | | |
| | (O) | | | | | | | | | | | | |
| 8. Paper & Paper Board | (I) | | | | | | | | | | | | |
| | (O) | | | | | | | | | | | | |

## 2.4 Additional Notes on the Framework

The revised version of the framework for a mass balance table includes a new column, "residues." Each row of the mass balance table should be balanced, and total input should therefore equal to total output. Total output consists of the output of main products, secondary products and wastes.

Here the secondary products are divided into two categories: residues and by-products. The definitions of residues and by-products are as follows: residues are the part of secondary products that is utilized as an input mainly in other wood processing industries, and by-products are the part of secondary products that is used by end users.

This distinction can be illustrated with the example of a saw mill. The mill utilizes industrial round wood as an input and produces sawn wood as a main product. At the same time the mill turns out some secondary products. Suppose that part of the secondary products are supplied to a charcoal factory and that the rest, say wood chips, are supplied to a pulp factory. In this case, the former should be considered an output in the "charcoal" column of the sawmilling row and the latter should be considered an output in the "residues" column of the same row. Furthermore, if the mill also provides some secondary products to a furniture maker, these should be considered by-products.

Regarding wastes, I have to slightly revise my original definition. As mentioned above, by-products are to be considered part of secondary products. Therefore, from now on, wastes should only include: (1) Fuel Used; (2) Emissions; (3) Real Transfer; and (4) Bads.

Please notice that the definitions of by-products and secondary products here are different from in the input-output tables. I, however, suggest you that the input-output tables are of course the most important source of the data and information for the compilation of a mass balance table, and that the treatment of by-products, secondary products, and scrap and wastes in your input-output tables should be investigated very carefully.

Also, please notice that as the framework for the mass balance table has been revised, in order to keep the correspondence between the sector commodity table and the mass balance table it may also be necessary to revise the sector commodity table. In particular, it might be recommended to incorporate a column of residues into the sector commodity table.

## 2.5 A Conceptual Matrix for a Mass Balance Table

The matrix attached shows how the cells should be filled for each woodprocessing industry.

The saw mill industry utilizes industrial round wood as an input (A) and produces sawn wood (D). The industry also may use some sawn wood (B) and residues (C) as input. As output the industry furnishes secondary products like firewood (E) and residues too (F). Saw mills may utilize some wastes as fuel (G). Since the input and output of each sector (industry) involving wastes or emissions should be balanced in the mass balance table, $A + B + C = D + E + F + G$.

Firewood and residues are main inputs for charcoal industry. The output is charcoal and there are some wastes. For the charcoal industry, therefore, $A + B = C + D$.

The main inputs for the plywood and veneer industry are industrial round wood and sawn wood. In addition, some residues may be utilized as input. Aside from plywood and veneer, its main products, the industry provides some firewood, residues, and wastes. Thus $A + B + B' = C + D + E + F$ for the plywood and veneer industry.

For both fiber board and particle board industries, the main input is residues, although raw logs (industrial round wood) are utilized in part. Besides their main products (fiber

**Table 4** A Conceptual Matrix for Mass Balance Table

| | | *Ind. R.W.* | *Sawn W.* | *Fire W.* | *Cha.* | *Resid.* | *P. & V.* | *F.B.* | *P.B.* | *M.P.* | *C.P.* | *Paper* | *P.R.* | *By P.* | *W.* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Saw Mill | (I) | A | B | — | — | C | — | — | — | — | — | — | — | — | — |
| | (O) | — | D | E | — | F | — | — | — | — | — | — | — | — | G |
| Charcoal | (I) | — | — | A | — | B | — | — | — | — | — | — | — | — | — |
| | (O) | — | — | — | C | — | — | — | — | — | — | — | — | — | D |
| Ply. & Ven. | (I) | A | B | — | — | B' | — | — | — | — | — | — | — | — | — |
| | (O) | — | — | C | — | D | E | — | — | — | — | — | — | — | F |
| F.B. | (I) | A' | — | — | — | A | — | — | — | — | — | — | — | — | — |
| | (O) | — | — | B | — | — | — | C | — | — | — | — | — | — | D |
| P.B. | (I) | A' | — | — | — | A | — | — | — | — | — | — | — | — | — |
| | (O) | — | — | B | — | — | — | — | C | — | — | — | — | — | D |
| M. Pulp | (I) | A | — | — | — | A' | — | — | — | — | — | — | — | — | — |
| | (O) | — | — | — | — | — | — | — | — | B | — | — | — | — | C |
| Ch. Pulp | (I) | A' | — | — | — | A | — | — | — | — | — | — | — | — | — |
| | (O) | — | — | — | — | — | — | — | — | — | B | — | — | C | D |
| P. & P.B. | (I) | — | — | — | — | — | — | — | — | A | B | — | C | — | — |
| | (O) | — | — | — | — | — | — | — | — | — | — | D | — | — | E |

board and particle board), the industries produce firewood and wastes. For both industries, then, A + A' = B + C + D.

While the main raw material for the mechanical pulp industry is industrial round wood, wood chip are the main input for the chemical pulp industry. The chemical pulp industry produces some by-products as well as pulp. Therefore, while A +A' = B + C for the mechanical pulp industry, A + A' = B + C + D for the chemical pulp industry. It is possible, however, that the pulp industry in your country utilizes bagas or rice straw as input. If this is the case, then input and output will not be balanced.

In the paper and paper board industry, recycled paper may be utilized as an input. For the industry, thus, A + B + C = D + E.

## 2.6 Intersectoral and Intrasectoral Transactions

First, please look at the table entitled "Conceptual Example: The Case of the Saw Mill Industry (No. 1)" attached. The first two rows of the table, the input and output of a saw mill (case I), explicitly show not only intersectoral transaction but also intrasectoral transaction within the saw mill industry. Here the term "intrasectoral transaction" specifically means the own-input of the industry.

This example is telling you that:

(1) The saw mill industry utilizes industrial round wood and sawn wood as a primary input and produces sawn wood as a main product. It is assumed that the secondary product is only firewood (there are no residues) and the industry emits some wastes. We also assume that recovery rate of sawing industrial round wood into sawn wood is 50% and that recovery rate of re-sawing sawn wood into sawn wood is 75%.

(2) Now suppose that the industry uses 80 units of industrial round wood and 40 units of sawn wood as a primary input. Then the total production of sawn wood will be 70 units, and also 50 units of firewood will be provided. Suppose, further, that 30 units of firewood are utilized for drying in the industry itself. The 20 units of firewood left over end up becoming the input to the charcoal industry (as the intersection of charcoal (I) and fire wood shows). And the 30 units used for drying appear again in the "wastes" cell as fuel used. Please make sure that: total input = 80 + 40 + 30 = 150; total output = 70 + 50 + 30 = 150; and, thus, total input = total output. Also make sure that the 40 units of sawn wood and the 30 units of firewood are own-input to the saw mill industry. They should be considered intrasectoral transaction.

(3) The third and fourth row of the table, the input and output of a saw mill (case II), show another notation of the transaction mentioned above. The difference is that the intrasectoral transaction is excluded this time. But please notice that total input is still equal to total output and that these two notations, namely case I and case II, are equivalent. Therefore you may prefer the latter notation (case II) to the former (case I) due to its simplicity. We, however, would like to strongly recommend you to apply the former notation in this exercise, since the main objective of the mass balance table is to fully trace out the material flow in the specific industry from the very beginning to the very end.

The second table attached, "Conceptual Example: The Case of Saw Mill Industry (No. 2)," shows the following situation: instead of 50 units of firewood, the saw mill industry produces 30 units of firewood and 20 units of residues; and the whole of the firewood produced is utilized by only the industry itself as an own-input. The remaining assumptions are same as before.

**Table 5** Conceptual Example: The Case of Saw Mill Industry (No. 1)

| | | *Ind. R.W.* | *Sawn W.* | *Fire W.* | *Cha.* | *Resid.* | * * * | *Waste* |
|---|---|---|---|---|---|---|---|---|
| Saw Mill | (I) | 80 | 40 | 30 | — | — | | — |
| (Case I) | (O) | — | 70 | 50 | — | — | | 30 |
| Saw Mill | (I) | 80 | — | — | — | — | | — |
| (Case II) | (O) | — | 30 | 20 | — | — | | 30 |
| Charcoal | (I) | ? | ? | 20 | — | ? | | — |
| | (O) | — | — | — | ?? | — | | — |

**Table 6** Conceptual Example: The Case of Saw Mill Industry (No. 2)

| | | *Ind. R.W.* | *Sawn W.* | *Fire W.* | *Cha.* | *Resid.* | * * * | *Waste* |
|---|---|---|---|---|---|---|---|---|
| Saw Mill | (I) | 80 | 40 | 30 | — | — | | — |
| (Case I) | (O) | — | 70 | 30 | — | 20 | | 30 |
| Saw Mill | (I) | 80 | — | — | — | — | | — |
| (Case II) | (O) | — | 30 | 0 | — | 20 | | 30 |
| Charcoal | (I) | ? | ? | 0 | — | ? | | — |
| | (O) | — | — | — | ?? | — | | — |