1. Basic Concepts and Methods of JEPIX

JEPIX is a set of indexes which make different types of environmental impacts comparable and ultimately make it possible to express the environmental impact caused from activity of a company with a single figure of EIP (environmental impact point). Some basic features of JEPIX are as follows:

(1) Firstly, JEPIX project was **inspired by the** *EcoScarcity* **concept** which was originally founded and advocated by Ruedi Müller-Wenk (1978, 1980) with his unique naming of *ecological accounting (ökologische Buchhaltung* in German). The theory has been further developed in the publication of Arthur Braunschweig (1990) which deals with environmental policy of several Swiss cities, and also in some publications of Swiss Environmental Agency (Bundesamt für Umwelt, Wald und Landschaft: BUWAL) [BUWAL (1990, 1998)]. The fundamental idea of EcoScarcity theory is expressed in the equation:

Ecofactor = F/Fk*1/Fk

Here the numerator F stands for "**actual flow**" of one category of environmental impact (for example: CO_2, NO_x, SO_x, etc.), whereas the denominator Fk stands for "**critical flow**" of this same category of environmental impact. As the actual flow F gradually approaches the critical flow Fk, and as the actual flow F (further) exceeds the critical flow Fk, the environmental condition will become worse, which means that the environmental scarcity increases (the latter case is the essential case, for which JEPIX Indicators are actually calculated).

(2) The second most important feature of JEPIX is the **establishment of a** *single-score index, Environmental Impact Point (EIP or Japan Environmental Policy Priorities Point: EPP/JEP)* which shall clearly indicate the priorities of action in an alternative situation because the alternative environmental measures, production processes or new products can be evaluated in completely comparable EIP figures from a pure environmental standpoint.

(3) Thirdly, JEPIX **reflects** *Japanese environmental policies*, which means that the priorities derived from applying JEPIX shall correspond with the (democratically legitimated) environmental policies of the government of Japan (in Table 1) and international treaties such as the United Nations Climate Convention or the Montreal Protocol.

12 categories covered by JEPIX	Laws and measures covered by JEPIX
Greenhouse gases	UN Climate Convention
Ozone-depleting gases	Montreal protocol
Toxic substances including dioxin	Ozone Layer Protection Law
	PRTR law
Photochemical oxidants	Voluntary control plan of toxic air pollutants
NOx	
SPM10	Automobile NOx Law
BOD	Air Pollution Control Law
COD	Water Pollution Control Law
N	Environmental guidelines set by the
P	Ministry of the Environment, etc.
Land reclamation	
Road noise	

Table 1: Environmental Categories Covered by JEPIX

The indices are, as described above, basically calculated as a ratio between the actual and the target flow of emissions, which shall indicate the distance to the target, and the estimation of the target flow reflects the environmental policies of the government of Japan. A precise list of main data sources for calculating the actual and target flows of JEPIX Indicators are shown in Table 2.

	Actual flow	Target flow	Main data sources and remarks
Greenhouse gases (GHG)	Japan's Third Report on the Framework Convention on Climate Change, by the Ministry of the Environment	IPCC Third Report on Global Warming	Calculates GHG other than CO2, on a GWP100 basis.
Ozone-depleting substances (ODP)	National CFC Phase-out Plan (July 2001)	Same as the left. Amount of foaming agent stock	Calculates substances other than R11, on an ODP basis.
Photochemical oxidants	The Ministry of Economy, Trade and Industry's voluntary control plan of toxic air pollutants. OECD.	Calculated based on differences from environmental guidelines	Numerical environmental databases of the Environmental Information Center, National Institute for Environmental Studies
Toxic substances including dioxins	12 substances are listed in the Ministry of Economy, Trade and Industry's voluntary control plan of toxic air pollutants. Dioxin	12 substances are listed in the Ministry of Economy, Trade and Industry's voluntary control plan of toxic air pollutants. Dioxin	Materials of the 5th meeting of the WG on toxic air pollutants under the Risk Management Subcommittee, Chemicals and Bio-industry Committee, Industrial Structure Council, Ministry of Economy, Trade and Industry Third report on PRTR research by the Japan Federation of Economic Organizations Dioxin

Biochemical oxygen demand (BOD)	Estimates based on household emission data from the White Paper on the Environment and data from experts in Japan	Estimated based on water quality standards	Lake research data and chronological tables of flow by the Ministry of Land, Infrastructure and Transport
Chemical oxygen demand (COD), total nitrogen, total phosphorus	Estimates virtual flows based on the actual flows of Tokyo Bay, Ise Bay, and the Seto Inland Sea	Based on water quality standards	Office of Environmental Management of Enclosed Coastal Seas, Water Environment Management Division, Water Environment Department, Ministry of the Environment
NOx	Report to the Japanese government and the secretariat of the UNFCCC	Calculated based on the target values of 6 prefectures	Automobile NOx Law, reports of the Investigative Committee on Reduction of Total Automobile NOx Emissions
SPM10	Estimates based on the composition ratio of PM emissions	Calculated by comparing data in observatories that do not meet environmental guidelines against average concentrations in prefectures that meet the guidelines	Investigation of fixed sources of air pollution in 1999 by the Ministry of the Environment Numerical environmental databases of the Environmental Information Center, National Institute for Environmental Studies
Waste landfill capacity	Materials published by the Ministry of the Environment	Same as the left	OECD Environmental Performance Review Japan
Road Noise	Total travel distance of regular cars and large-size cars and trucks	Calculated based on the achievement ratio of the environmental guidelines on noise.	Hearing from the Ministry of Land, Infrastructure and Transport Website of the Ministry of the Environment

Table 2: List of Main Data Sources for Calculating the JEPIX Indicators

As a result, the *priorities which are set by the government* will automatically be the *priorities of each company* which adopts JEPIX for its environmental management because if a national target figure of an environmental impact of government becomes *stricter* (= if target flow figure is estimated *smaller*), the corresponding eco-factor of JEPIX will surely calculated *larger*, which will bring out a *greater* amount of EIP for the environmental impact. In such a situation, a reasonable decision of management would be to focus on this particular environmental impact.

(4) Fourthly, JEPIX is **based on a** *private "bottom up approach"* as contrasted with the *Ministry Guideline*. The guideline was stipulated and published by the Ministry of Environment, and therefore it is close to a "top down approach". On the contrary, the JEPIX project was stipulated by the strong and enduring initiative of Claude Patrick Siegenthaler and has been developed by the JEPIX research team, which shall be characterized as a voluntary and private organization.

2. Management Perspective with an Overall Eco-efficiency Figure

The last part of this introduction argues about the reason why JEPIX prevails among Japanese leading companies today. It is mainly because JEPIX enables company management, especially top-management, to make it possible to calculate *overall eco-efficiency indicators* by providing *aggregate ecological figures* in a single unit EIP, which will be concretely described below.

2.1 *Eco-efficiency* as relevant management guide

In the present economy, where companies shall pursue more profit (for their own) while they reduce impact (to the environment) in their continuous business effort, a consistent pursuit of the *principles of economy and ecology* is of vital necessity for *rational and sustainable management*. Ecological consciousness is today not a necessary condition of sustainability, but also makes an inevitable foundation of *legitimacy* of a company in the society, which should be firmly built in corporate business strategy, taking high precedence over other business purposes. In this double-track situation, the most practical strategy of companies is not the *absolute reduction* of environmental impact, but the *relative reduction* of environmental impact compared with their business performances (e.g. sales, value added, net profit etc.).

Therefore, *eco-efficiency indicators* measured through the transformation or integration of a set of economic and ecological indices/indicators (one from *economic/monetary accounting* and the other from *ecological/physical accounting*, where the former is usually the numerator, and the latter the denominator) are theoretically one of the most relevant management guides for companies [Schaltegger and Burritt (2000) p. 361].

2.2 *Overall Eco-efficiency* Indicators have vital importance for management

What is important here, is that theoretically (as well as practically [see Kawamura (2003) p. 54]), a vast number of combinations of economic and ecological figures are possible, reflecting the *multidimensional character of eco-efficiency* concept, which generate quite a lot of links for deriving *overall, general and specific* eco-efficiency indicators as seen in Table 3 [Schaltegger and Burritt (2000) pp. 362-3].

Purpose: improvement of ...	Overall corporate eco-efficiency	General eco-efficiency indicators	Specific eco-efficiency indicators Output	Input
Economic performance figures (numerator)	- Income - Shareholder value - ...	- Net revenue - ...	- Sales revenue of product X - ...	- Labor costs - ...
Possible links to eco-efficiency indicators	①	⑤ ⑥ ⑦ ②	③	④
Environmental performance figures (denominator)	- Environmental impact added - NPEIA - ...	- Greenhouse warmth contribution - ...	- CO_2 emissions - ...	- Consumption of oil - ...

Table 3.   Systematic Collection of Eco-efficiency Information

*NPEIA = net present environmental impact added

Source: Schaltegger and Burritt (2000), p. 362.

Among these many links *overall (and general) eco-efficiency links* have vital importance for management decision making (especially for that of top-management) because of their ability to provide a comprehensive *view of economic and ecological situations actually faced by the company in a quantitative, explicit way*. The importance of *aggregate numbers* cannot be stressed too much, which could easily be understood by thinking about the eco-efficiency calculation without them. In such a case, there would be so many categories of eco-efficiency data as the numbers of individual environmental interventions. And these vast numbers of eco-efficiency figures might bring about only a *chaotic situation* without any *perspective on the whole*, which corresponds to the view taken by top-management.

Although there do exist various methods (e.g. CML) to asses and trace specific environmental impacts such as global warming, acidification, smog, etc., such methods leave decision-makers with a series of indices. But these methods have not yet seen comprehensive uptake by managers. Their application seems more bound to engineers, e.g. in the field of product development. But they leave an evaluation of priority to the users, who then have to decide, what relevance they feel for each impact.

In contrast, aggregate indices aim at a comprehensive evaluation and reproducible priorities. This shall ensure the accountability of eco-efficiency monitoring and communication and thereby serve the concept of Corporate Social Responsibility. And in the case of a policy based method such as JEPIX, the results can be seen as an early warning indictor for future environmental cost that might result from more stringent legal regulation to cope with the gap

between actual flows and political targets. So it can support the risk management of the company, for which top-management is most responsible with its quick action (and without fatal delay), and for whose rapid and relevant decision making JEPIX single unit indicators can be very useful.

2.3 Necessary *Aggregated Ecological Data* are not available

In the eco-efficiency schema, *aggregate figures* of economic performance, such as net income, value added, free cash flow, sales, net revenue etc. are not difficult to acquire because most of these financial figures are currently prepared in the process of their (internal) management accounting and (external) financial reporting.

Compared with such great availability of aggregated data in a single (comparable) monetary unit (or some monetary units), *aggregated ecological figures* in a common unit (or some equivalent units), such as (net present) environmental impact added etc., are usually very hard to acquire, or sometimes impossible to acquire, although they will enable the overall decision making and give the foundation for rational environmental management [Braunschweig and Müller-Wenk (1993) p.43; Schaltegger and Burritt (2000) p. 364].

2.4 Why are *Aggregate Ecological Figures* not available in Japan?

The main reason for the absence of relevant aggregate ecological data in Japan is essentially attributed to the *lack of an acknowledged ecological accounting system* (because of the *lack of an acknowledged ecological accounting standard-setting committee* or body so far)[Schaltegger and Burritt (2000) p. 276].

In Japan, to break through this difficult situation, many attempts for integrating different environmental impacts into aggregated, comparable numbers (*Green Ledger* of Takara Inc. was the most pioneering work among them) had been made for about ten years. They had not, in spite of their very valuable and creative endeavor, proven to be quite successful because, anyway, many of the leading Japanese companies have *not introduced them or follow the examples*.

Therefore, *Generally Accepted Weighting Factors (GAWF)* for environmental impacts—principles, methods and results for them—which will enable *comprehensive and relevant* ecological weighting (pricing) *have not yet been developed and made publicly available*, because these early attempts by the government have not successfully acquired substantial support and participation from industry. Considering the importance of *Generally Accepted Accounting Principles (GAAP) as a basis of availability of comprehensive and fair accounting information*, especially in American accounting practices and international accounting standards setting, this immature situation had been for all stakeholder groups far from satisfactory, or even frustrating. But, why GAWF lacked essentially?

Though the importance and much experience of the preceding attempts for making relevant valuation factors cannot be denied, it must be pointed out that they usually lacked (1) *established principles* (e.g. EcoScarcity principle for JEPIX) *with high practicability* as a basic foundation of developing any methods, (2) *enduring and consistent scientific study with international and interdisciplinary cooperation* (e.g. JEPIX international research team), nor (3) supporting sufficiently large *company organizations with eagerness and experience* (e.g. JEPIX Forum).

Regarding (3), it is here worth mentioning that with *top-down approach* by the government, the many participating Japanese companies had never seriously committed themselves in the developing work with real and positive motivation, which seems quite different from the developing work of JEPIX with bottom-up approach on their *voluntary initiative*.

On the other hand, with bottom-up approach by individual companies, generally accepted weighting factors have never been produced. Though such isolated invention of private companies adopted bottom-up approach, their valuable contribution never got general or common understanding and recognition of other companies or other industrial fields.

2.5 JEPIX as the basis of a *Standard Ecological Accounting System*

JEPIX (Japan Environmental Policy Priorities Index) is the *most recent result* of the efforts dedicated to break through these difficult situations by establishing a set of *Generally Accepted Weighting Factors (GAWF)* for environmental priorities, a *de fact standard of ecological accounting system* with a democratic bottom-up approach. JEPIX has until now been given the voluntary support of many kinds of public and private organizations including about 30 leading large Japanese industrial companies, which have enabled *full and explicit comparison* of their *aggregate environmental impact figures* and *overall eco-efficiency indicators* between participating companies of JEPIX-Forum fairly well.

3. Future Perspectives

Even now, there are some critical opinions about the so-called *arbitrary nature of* JEPIX because they are fundamentally based on *political* target figures, which practically cannot help excluding all the (undesirable) subjective elements. Hence, the logical consistency of JEPIX index figures is always required.

In order to determine JEPIX without contradiction, consideration of the following points will be in the near future of essential importance: (1) examination of appropriateness and reasonability of *categorization in 12 fundamental environmental themes* by the newest

knowledge of environmental sciences, especially LCA studies, (2) precise and objective determination of *target figures*, especially choice of environmental laws and regulations, (3) inquiry into the legislation process of environmental policy law, not excluding the possible large influence of *economic powers and political pressure groups* on environmental laws, (4) correct determination of *periodical and geographic boundary*, for calculating indicators as well as for application of them, (5) periodically correct and reasonable *matching* of EIP data with economic data [see Miyazaki and Azuma (2003)], (6) comparison with *other impact assessment methods*, especially Life Cycle Impact Assessment Method based on Endpoint Modeling (LIME) [RCLCA (2001-2003)] and Eco-Indicator 99 [Goedkoop, M. and Spriensma (2000)], (7) introduction of Excel Sheet for easy and comfortable use for *environmental reporting* with JEPIX and (8) *accreditation or certification* of JEPIX figures by authoritative third parties.

Among them, (1) *completeness*, (2) *alternativeness* and (8) *verifiability* are certainly, from accounting standpoint, the most important elements to consider as below.

About the determination (choice) of *categories* (1), there might probably be some more additional important environmental categories to consider. As long as such possibilities cannot be theoretically eliminated, periodical re-examination of the advance of scientific knowledge in environmental sciences and actual, considerable environmental issues are necessary for securing relevance of categorization. For example, the inclusion of scarcity of non-renewable resources (energy and materials) in JEPIX might be considered in the near future.

There are today, both theoretically and practically, often *alternative* **domestic and international** *laws and regulations* (2) to adopt as a target value for JEPIX. There has been no theoretical best solution for it, but at least, as in the case of BUWAL SR 297 [BUWAL (1998)], the *binding power* of each law ought to be considered and described clearly. Generally speaking, laws with bigger binding power possess priority compared with those of small binding power, however at present the best way might be to choose laws with the most strict restriction (the highest Fk value).

Thirdly, *verifiability* (8) of the Ecofactors has recently growing importance. In order to enhance the reliability and comparability of data, participation of many companies from various industrial fields is not sufficient. Most desirably, formal, established certification procedure by professional experts of neutral institutions (environmental experts, certified accountants, etc.) should be taken to both JEPIX determination procedures and application of JEPIX figures to the corresponding inventory data of each company.

The activity of JEPIX-Forum is now just in the beginning stage. Further efforts, as mentioned before, to make the *relevance, reliability and comparability* of JEPIX figures are needed to

make them more useful accounting tools for stakeholders, where more than 100 participating companies and groups in JEPIX-Forum are practically necessary to make the JEPIX impact figures fully comparable in many industrial fields, including service industries like banking and insurance and also non-profit organizations like universities, municipalities and Non Governmental Organizations NGOs.

Finally, it will be of importance to corporate with other home and abroad organizations, including legislative bodies and LCA research institutes. At the same time, critical opinions from both academic and practical field will be extremely important for the enhancement of an interdisciplinary methodology for integrated environmental accounting based on the principles of JEPIX.

List of Related Literature

Bundesamt für Umwelt, Wald und Landschaft (BUWAL 1990): Ahbe, S, Braunschweig, A., Müller-Wenk, R.: *Methodik für Ökobilanzen: auf der Basis ökologischer Optimierung*, Schriftenreihe Umwelt Nr. 133, Bern.

Bundesamt für Umwelt, Wald und Landschaft (BUWAL 1998): *Bewertung in Ökobilanzen mit der Methode der ökologischen Knappheit Ökofaktoren 1997*, Schriftenreihe Umwelt Nr. 297, Bern.

Callenbach, E., Capra, F., Marburg, and S. (1990): *The Elmwood Guide to Eco-Auditing and Ecologically Conscious Management*, Global File Report, No. 5, Berkeley.

Goedkoop, M. (1995): *Eco-Indicator 95 Weighting Method for Environmental Effects That Damage Ecosystems or Human Health on a European Scale: Contains 100 Indicators for Important Material and Processes*, National Institute of Public Health and Environmental Protection.

Goedkoop, M., Spriensma, R. (2000): The *Eco-indicator 99, second edition: A Damage Oriented Method for Life Cycle Impact Assessment, methodology draft 2000*.

Ijiri, T. (1998): "Change and Perspective of American Accounting", *Accounting*, vol. 145, No. 1, p. 117-135 (available only in Japanese).

Japan Environmental Agency (JEA) (1999): *Guideline for Recognition and Reporting of Environmental Protection Costs: toward the Establishment of Environmental Accounting (interim report)*, Tokyo (available only in Japanese).

Japan Ministry of Environment (JME) (2002): *Environmental Accounting Guideline: toward the Establishment of Environmental Accounting (revised version 2002)*, Tokyo (available only in Japanese).

JEPIX FORUM (2004): *JEPIX FORUM Annual Report 2003*, International Christian University/Yamatake Co., Tokyo (available only in Japanese).

Kawamura, M. (2003): "Age of Environmental Management Indicators: Environmental Management in the Balance of Environmental Impact and Economic Value", *Quarterly Report* Vol. 26, NLI-Research Institute, pp. 37-67 (available only in Japanese).

Research Center for Life Cycle Assessment; National Institute of Advanced Industrial Science and Technology (RCLCA, 2001-2003): *Life Cycle Impact Assessment Method based on Endpoint Modeling (LIME)*, Workshop Proceedings No. 1-5 (available only in Japanese).

Miyazaki, N. (2000): *Integrated Environmental Accounting*, Soseisha Publishing (available only in Japanese).

Miyazaki, N., Siegenthaler, C. P., Schoenbaum, T., Azuma, K. (2003): *Japan Environmental Policy Priorities Index 2003 (JEPIX)*, 21st Century COE Monograph Series 7, Social Science Research Institute of International Christian University (Japanese translation available from: www.jepix.org)

Miyazaki, N., Azuma, K. (2003): "Theoretische Grundlage der ökologischen Buchhaltung: Rechnung der Umweltbelastungen durch die doppelte Ökobilanzierung" (with a summary in English), in: Miyazaki, N., Siegenthaler, C. P., Schoenbaum, T., Azuma, K. (2003): *Japan Environmental Policy Priorities Index 2003 (JEPIX)*, 21st Century COE Monograph Series 7, Social Science Research Institute of International Christian University, pp. 60-77

Müller-Wenk, R. (1978): *Die ökologische Buchhaltung*, Campus Verlag (available only in German and Japanese).

Müller-Wenk, R. (1980): "Ökologische Buchhaltung: eine Einführung", in Simonis, U. E.: *Ökonomie und Ökologie: Auswege aus einem Konflikt*, C. F. Müller (available only in German and Japanese).

Schaltegger, S. und A. Sturm (1990): *Ökologieorientierte Entscheidungen im Unternehmen: Ökologisches Rechnungswesen statt Ökobilanzierung: Notwendigkeit, Kriterien, Konzepte*, Haupt (available only in German).

Schaltegger, S. and R. Burritt (2000): *Contemporary Environmental Accounting: Issues, Concepts and Practice*, Greenleaf (Japanese and Chinese translations also available).