Sustainability impact assessments: a new comprehensive framework for raising the bar beyond existing environmental assessments

F. Douglas Muschett

F. Douglas Muschett & Associates, 311 Miramar Road,
14624 Rochester, NY, USA
(e-mail: dmsusdev@yahoo.com)

Abstract: Much systematic research and attention is being directed towards sustainability indicators, but comparatively little towards analytical tools for comprehensive sustainability impact assessments that can guide economic activities, programmes and specific projects towards decisions and sustainable actions, which will ultimately be reflected in the indicators. Existing tools of analysis, such as environmental impact assessment, ISO 14001 and life-cycle assessment, are limited in scope towards certain environmental elements of sustainable development and are limited in geographic scale of application. However, sustainability covers a comprehensive set of social, economic, and environmental issues, and with increased economic globalization must include impacts upon multiple geographic scales. This paper discusses a new comprehensive analytical framework for asking the right questions to guide sustainability impact assessments for economic activities, programmes and specific projects. Some distinguishing features are the inclusion of indirect and support activities, social and economic issues, comprehensive environmental issues and multiple geographic scales. A case example is presented to demonstrate the framework. The existing tools noted above are analysed for their strengths and weaknesses for sustainability impact assessments and compared to the new framework. Finally, potential policy applications are discussed for government, private sector, institutions and NGOs. It is concluded that the sustainability impact assessment framework presented can significantly 'raise the bar' for promoting sustainability, but that to answer the sustainability questions raised there must be operational simplifications in using sustainability proxies and criteria during future research and applications.

Keywords: analytical framework, environmental assessment, impact assessment, sustainability.

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1 Introduction

Much has been written about sustainability indicators, and the need to define and measure parameters and indices that can tell us whether as a society we are progressing along a road to sustainability. Such indicators are presently being developed for the three axes of sustainability – economic, social and environmental – and will describe trends for many

important measures, including how much we are consuming, how much we are depleting, how we are changing the physical environment and ecology, how efficiently we use natural resources, how equal or unequal our societies are, and how we are affecting the quality of life.

Yet if we are to progress towards sustainability and measure progress in the indicators, we must take actions as individuals in our personal lifestyles and as governments, corporations and institutions. Regrettably, however, comparatively little has been written about methods to assess our economic and institutional activities and their policies, programmes and projects to make a *comprehensive* determination of how there are impacts upon the three axes of sustainability. As noted below, prior attempts have been largely directed towards fairly limited environmental assessments.

Perhaps the first prior comprehensive effort was by industrial ecologist John Warren and a few colleagues, who postulated several 'prospective sustainable development questions' in the context for assessing future actions for sustainability through projects, policies and programs at the US Department of Energy.[1] Although this approach contained many useful questions for thinking about sustainable development, it lacked a conceptual and organizing framework for performing a sustainability assessment for economic activities.

In this paper I will first discuss a philosophical basis for sustainability impact assessments. I will then review the adequacy of three existing tools of analysis – environmental impact assessments, ISO 14001 and life-cycle assessment – which are used to analyse economic and institutional activities and guide appropriate decisions that promote sustainable development and sustainability. Because, and ever more apparently as this is being written, the global economy has made the world more interdependent, it is necessary to ensure that such an analysis will include wide geographic scales and indirect effects. Finally, I will discuss a new framework for sustainability impact assessment, compare this framework with the three existing tools noted above, and illustrate the application of the framework with an example.

2 A philosophical basis for sustainability impact assessments

It is impossible to discuss the concept of a 'sustainability impact assessment' without some definition of what is meant by *sustainability* and *sustainable development.* As I use these terms, sustainability refers to a state or ultimate goal and sustainable development refers to a process to reach this goal. Having said this, one must acknowledge that there remains considerable disagreement about the meaning, theory and practice underlying these terms; such differences become readily apparent as I compare and discuss existing tools of analysis.

For the sake of convergence and agreement, one could attempt to choose the 'lowest common denominator' of agreement about sustainability and sustainable development and probably arrive at something close to the views expressed by various international business organizations who view sustainable development as *ecoefficiency* (defined later). However, more in accordance with the views expressed by the international community in Rio, I choose a very comprehensive definition. This approach will (1) enable us to consider more of the vital issues within a sustainability impact assessment and framework and (2) provide a sharper distinction of how existing tools do and do not contribute to a sustainability impact assessment.

The often-quoted Principle 3 from Agenda 21 at the 1992 Rio Conference on Environment and Development characterized sustainable development as 'the right to development must be fulfilled so as to equitably meet development and environmental needs of present and future generations'. Seldom do so few words present vast questions and implications!

It is clear what is meant by 'present and future generations', which underscores the temporal dimension of sustainable development. The question of what is meant by 'environmental needs' is not only more complicated but also subject to change as we learn more. Most practitioners in industry, as well as environmental professionals who work in the environmental industry, generally have viewed the environment in terms of human health, related to air quality, water quality and hazardous wastes. On the other hand, most practitioners in the field of natural resources view the environment as encompassing vast natural systems, which provide both renewable and non-renewable resources for the use, survival and benefit of humanity. Moreover, practitioners in the fields of ecology and geography tend to view the environment as comprising important natural systems – aquatic, forest, terrestrial and atmospheric – which sustain all of life. Finally, it should be noted that this whole discussion of 'environmental needs' is derived from a utilitarian philosophy. Many ecologists, such as Campbell and Heck, many ethicists, such as Rasmussen, many religious denominations and many indigenous peoples believe that there is inherent value to preserving the environment, habitat and species of life.[2,3] Therefore, for purposes of comprehensive sustainability assessments, I will endeavour, perhaps inadequately, to incorporate all of the above aspects of 'environment'.

It is perhaps less certain in Principle 3 what is meant by 'developmental needs', which many would argue are rather dependent on the stage of development. In the case of developing countries, the development needs probably relate more towards improving economic opportunity; improving the distribution of wealth; providing basic economic goods, services and amenities and providing more affordable goods and services. In the more developed countries, the term 'development needs' poses a problem. Conventional economic theory tells us – and human nature often confirms – that our demand for economic goods and services is 'insatiable' and business continues to act and promote accordingly within market economies. However, our sense of 'sustainability' combined with our sense of *equity* suggest that 'development' in developed countries should be more concerned with improving the quality of life rather than the quantity... an assertion that the South countries continue emphasizing in the debates over consumption.[4]

Consumption is a critical aspect of sustainability; 'intermediate' forms of consumption can be analysed, for purposes of reducing consumption, by using the sustainability input assessment framework presented later. However, 'final demand', the driving force of all economic activity, is outside the scope of this paper. In the long run, reduction of final demand to sustainable levels is dependent on moral and ethical values, education and social change.

In the United States, at least, the word 'equity' is a frequently overlooked component of Principle 3. What does it mean to 'equitably meet development and environmental needs of present and future generations'? One must suspect that the international dissension over Agenda 21 indicates that the answer is far from complete. Hence equity questions are an important aspect of the framework discussed below.

3 Existing tools for sustainability assessment

3.1 Environmental impact assessments

In 1969, before we had heard the terms 'sustainable development' and 'sustainability', the US Congress passed the National Environmental Policy Act of 1969, or NEPA. NEPA was intended to review federally-funded projects which could have adverse effects upon the environment and require the writing of environmental impact statements (EIS); however, NEPA also inspired many states to require their own state versions for projects requiring state permits.

The statement of goals of NEPA, as articulated in Title I, Section 10(b), contain many goals consistent with sustainable development:[5]

1 Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;

2 Assure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings;

3 Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable or unintended consequences;

4 Preserve important historic, cultural and natural aspects of our national heritage, and maintain, whenever possible an environment which supports diversity, and variety of individual choice;

5 Achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities;

6 Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

The NEPA directive, Sec. 102c, called for the responsible federal official to provide a detailed statement on:

- The environmental impact of the proposed action;
- Any adverse environmental impact which cannot be avoided should the proposal be implemented;
- Alternatives to the proposed action;
- The relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity;
- Any irreversible and irretrievable commitment of resources which would be involved in the proposed action should it be implemented.

Therefore, as a means of analysis, the EIS *appears* to be concerned with economic equity, intergenerational equity, resource conservation, environmental preservation and environmental quality – many of the goals of sustainable development and sustainability.[6] As a tool to guide sustainable development, however, the EIS is a limited tool at best because it does not apply to the many private sector investment, siting and development decisions made, nor to most levels of government decisions either.

It is well-recognized that Sec. 102c has laid out for decision-makers the tradeoffs and uncertainties related to Sec. 102c (ii) and (iv). One frank appraisal of a major coal slurry project acknowledged that *'it is not known whether some commitments are 'irretrievable or irreversible', including ecological habitat, wildlife, water resources hydrology and cultural impacts; and that the time frame to reverse is not known'*. However, upon a detailed legal review of the Act, Anderson concluded that NEPA was ineffective in forcing actions to change project deficiencies.[7] My own reviews of various EISs over the years has indicated that there is tremendous variability from one EIS to another in both (1) the acknowledgment of significant environmental issues and (2) the depth of analysis of these issues.

Moreover, there has been a paucity of questions raised and analyses performed with respect to *economic equity, social impacts, land use conversion, ecological impacts and ecological system integrity*, and *renewable resources* (unless of course the project itself happens to be an agricultural or forest project). There is very little consideration of environmental impacts on *geographic scales* beyond local and regional. Unfortunately the inconsistent and deficient impact assessments are often manifested in 'word engineering', such as the following:

> 'There are no alternatives to the proposed project'.
>
> 'There are no threatened or endangered species present on the 192-acre development'. (ecological review)
>
> 'Biotic operational and post-operational impacts are considered to be negligible'.
>
> 'Socioeconomic impacts are minor'.
>
> 'The project is enthusiastically supported by the mayor and Chamber of Commerce'.
>
> 'There are no irreversible impacts upon air or water quality, although the period of time for groundwater reversibility is not known'.

3.2 ISO 14001

One of the welcome outcomes of the 1992 Rio Conference was a willingness by the international business community to address environmental issues of universal importance. This willingness is being expressed particularly in a few separate, but related initiatives. Many large US and other multinational firms, such as IBM, Xerox, Hewlett Packard and SGS-Thomson, have developed a well-defined code of corporate environmental policies. Meanwhile, the World Business Council for Sustainable Development and its member companies have been promoting global acceptance of the concept of 'ecoefficiency'.

Perhaps the most widely noted initiative is the International Standards Organization (ISO) environmental management standard ISO 14001. ISO has *potentially* an important role to promote sustainability through better environmental analysis, environmental management and pollution prevention.[8,9] In the US, it must be noted that the ISO initiative is based more on what is being *said* rather than what may yet be *done*. Formal ISO procedures were adopted in October 1996, implementation is rather lengthy, and US firms have been slow to act. At the same time it should be noted that Europe has taken the lead; and a separate, but very similar, environmental management standard based upon

ISO 14001 – Eco-Management and Audit Scheme (EMAS) – is being broadly implemented within the European Union.

An underlying premise to the ISO 14001 initiative has been that with an increasingly global economy, it is important to elevate better environmental management practices to a global position of understanding, acceptance and application. Despite these admirable goals, the ISO process does have substantial critics.[10] However, my objective here is solely to examine the advantages and deficiencies of the ISO 14001 procedures for promoting sustainability.

As many readers well know, the ISO 14001 environmental management system standard covers requires procedures for several elements with considerable detail: environmental policy, planning, implementation and operation, checking and corrective action and management review. Under Clause 4, Sec. 4.3.1, it states that 'the organization shall establish and maintain procedures to identify the environmental impacts of its activities, products or services that it can control'. Another significant point is that the 'organization has freedom and flexibility to define its boundaries'. Certainly, the latter point has practical importance for business management; however, it may also neglect significant impacts upon sustainability by ignoring some of the indirect activities and support activities and their impacts at various geographic scales. (As I note below, many firms have chosen to sharply limit the boundaries for life-cycle assessment, which has diminished its utility for sustainability impact assessment.)

Both the ISO 14001 approach and the World Business Council on Sustainable Development seem to be converging towards a concept of 'ecoefficiency', which the Council describes as 'doing more with less': improved energy efficiency and raw material conversion processes, designing products to reduce material inputs and enhance durability and recycling, and redesigning processes to reduce pollution, wastes and hazardous materials. Improving the environment and saving money at the same time is thus considered to be a 'win–win', or perhaps a 'green–green' outcome.

This evolving definition of ecoefficiency as 'doing more with less' puts additional, unfortunate limitations towards promoting sustainability, in addition to those noted above with respect to ISO. It should be noted that the original, more complete definition, which originated at the Rio Earth Summit included some other important dimensions of sustainability, including quality of life, ecological impacts and carrying capacity:

> Eco-efficiency is reached by the delivery of competitively priced goods and services that satisfy human wants and bring quality of life, while progressively reducing ecological impacts and resource intensity through the life-cycle to a level at least in line with the earth's estimated carrying capacity.

3.3 Life-cycle assessment

Life-cycle analysis, or life-cycle assessment (LCA), as it is now more commonly being called, is another tool – one of the most comprehensive tools – that has been developed for analysing environmental impacts. LCA predates ISO, and the literature on LCA and its applications is increasing. However, many applications and case studies remain as 'private' internal analysis performed by industrial process companies, analogous to the findings from environmental auditing.

Although LCA is not to be confused with ISO 14001 and standards for environmental management systems, LCA is valuable enough in its own right as a tool of analysis that the ISO has been developing a separate standard for life-cycle assessment, ISO 14041.

According to the ISO, LCA is defined as 'a systematic set of procedures for computing and examining the inputs and outputs of materials and energy and the associated environmental impacts directly attributable to the functioning of a product or service system through its life-cycle'.

In turn, the life-cycle is defined as 'consecutive and interlinked stages of a product or service system from extraction of natural resources to final disposal', often referred to as 'cradle to grave'. Although in practice there sometimes is overlap, the LCA consists of four principal stages:[11,12]

1 Goal Definition and Scoping – defines the aim, system boundaries, target audience and data requirements;

2 Inventory Analysis – estimates environmental loads associated with the entire life-cycle of the product or process;

3 Impact Assessment – characterizes the effects on human health and the environment of loads identified above;

4 Improvement Assessment – lists process or product modifications to reduce environmental loads and effects

Hence LCA is frequently used to quantify the amount and type of raw materials and energy consumption in the manufacture of a product, the pollution and wastes produced by manufacturing, and the volume of solid and hazardous wastes resulting from product disposal. Based on these findings, changes are made in the product design or manufacturing process that reduce the inputs of raw materials and energy, reduce the amount of pollution and hazardous wastes produced, promote the use of recycled materials as inputs, and enable the product itself to be recycled or reused. However, in practice, the LCA often does not provide the degree of useful impact assessment of which it is capable. Shapiro observes that many firms that use LCA as an internal tool for process and product design find that LCA methods are 'too data intensive and burdensome'. Hence she notes that companies 'streamline' the LCA by limiting life-cycle stages and/or impact categories.[13]

Finally, although LCA is commonly associated with products and manufacturing processes, it should be noted that LCA also has been a useful policy tool for specifying, evaluating and quantifying impacts, benefits and costs associated with specific environmental policy initiatives (e.g. 'bottle bill' for recycling, local kerbside recycling programmes and energy-related environmental impacts of buildings.)

3.4 Summary of advantages and disadvantages

Environmental impact assessments offer a systematic means of reviewing a comprehensive set of environmental quality, natural resource and ecological impacts from proposed programmes and projects. In practice, however, in most applications natural resource and ecological impacts receive cursory treatments. Consideration of geographic scale is limited, but temporal scale is sometimes included by consideration of whether impacts are 'irreversible' and whether 'endangered' species are affected. However, for a broader assessment of sustainability, environmental impact assessments have not been designed to include social and economic impacts. Furthermore, because in the US and other countries the use of EIA has been in response to specific legal

requirements, most economic and institutional activities do not undergo comprehensive assessments.

ISO 14001 and LCA share a distinction of being proactive environmental management tools being developed in the private sector for industrial operations. In relation to sustainability assessments, for ISO it appears the potential strengths are posing a large array of questions for the evaluation of most industrial processes and related input economic activities and capital spending for raw materials, energy consumption, pollution prevention and waste minimization. The weaknesses are a neglect of social and economic aspects of sustainability and all ecosystem concerns and global climate change.[14] Moreover, impacts upon larger geographic scales are neglected, and important corporate support activities, such as facility siting, building designs, and purchased services are not widely perceived to be part of the environmental management system.

In comparison with ISO, LCA is a somewhat more comprehensive tool, which analyses product design, industrial operations and their indirect supplier activities on several different geographic scales. Like ISO, LCA is intended to promote efficiency in use of material and energy resource inputs and prevention of pollution and waste; but, in principle, LCA is concerned with the complete product life-cycle. In practice, however, LCA is often not used to its potential. Moreover, it should be noted that LCA does not evaluate either the social and economic aspects of sustainability or ecosystem impacts; neither does it generally include impacts from support activities.

In the following section I discuss a comprehensive framework for sustainability impact assessment, which seeks to improve upon the limitations of the three tools discussed above.

4 Sustainability impact assessments

4.1 A framework for sustainability impact assessments

From the earlier philosophical basis, I present a comprehensive conceptual framework for the assessment of sustainability impacts, which will include *social*, *economic equity* and *environmental* issues. The primary context discussed is the analysis of economic sector activities within a comprehensive, meaningful and consistent framework, analogous to an environmental impact assessment. However, it should be emphasized that the *sustainability impact assessment* (SIA) framework is new and distinctly more comprehensive than environmental assessments. The SIA framework is a guide to ask pertinent questions and develop options for reducing negative sustainability impacts and promoting 'positive' sustainability impacts. In this sense, the 'sustainability impact assessment framework' differs in purpose from the recent 'integrated environmental assessment' being developed by the European Forum for Integrated Environmental Assessment. The latter seeks to help guide policy decisions by using interdisciplinary scientific modelling to determine scientific answers which affect policy issues, such as climate change.[15] However, analogous to environmental impact assessment frameworks, the SIA framework does *not* provide specific, quantitative methods of analysis to answer questions.

Let us examine the basic framework in Figure 1. Note that there is a defined category 'direct economic activity'. Impacts upon sustainability are associated with *all* economic

sectors, not just a specific good or manufacturing process. So the economic activity could be an agricultural farming method, a mode of transportation, a construction activity, and so forth.

However, in the context of sustainability impact assessment, the economic activity could also be a specific government-funded project or a larger programme, which is intended to generate a specific economic activity. Some examples of *projects* could include a hydroelectric dam, an office building complex, or a highway construction project. Some examples of programmes could include incentive programmes for solar energy rooftop installations, federal land management programmes, a negotiated trade agreement, an agricultural farm subsidy programme, and so forth.

In addition, it should be noted that the definition of direct economic activities also includes *support* facilities and operations. Particularly with respect to business and manufacturing, this is a significant conceptual distinction because there is a tendency to focus upon plant manufacturing operations (as in the case of ISO 14001 noted above). However, from the perspectives of sustainability and sustainable development, many other corporate support functions are important, including

- facility siting;
- land use and real estate;
- building designs;
- energy management;
- corporate purchasing policies for office supplies, food services, printing and computer and other business services;
- capital spending projects, which can affect quality, productivity and energy efficiency.

The direct economic activity also has an impact on sustainable development through *indirect* economic activities, which supply a variety of inputs to operations and provide transport services.[16] A given economic activity, a given support activity and a given indirect economic activity will *each* act on one or more geographic scales to impact on economic, social and environmental attributes in some of the pathways noted in Figure 1.[17]

The first observation about these impacts is that there are both positive and negative impacts on sustainable development and sustainability. From a socioeconomic perspective, economic activity can either provide better opportunities and improve the distribution of wealth, or it can, as in the case of some mobile global economic capital, exploit the labour, further concentrate wealth, reinvest abroad and not help to integrate the local economy. From an environmental perspective, economic activity and actions may serve to deplete natural resource availability or conserve natural resource availability, to destroy or restore natural system/ecosystem integrity, and to impair or improve environmental quality.

At first glance, it seem to be a daunting task to examine and determine all the important pathways; and it *is*. However, the nature of the activity will dictate which geographic scales are relevant, which indirect activities are relevant, and which economic and social and environmental attributes are relevant. Consequently, many pathways will be eliminated from further analysis.

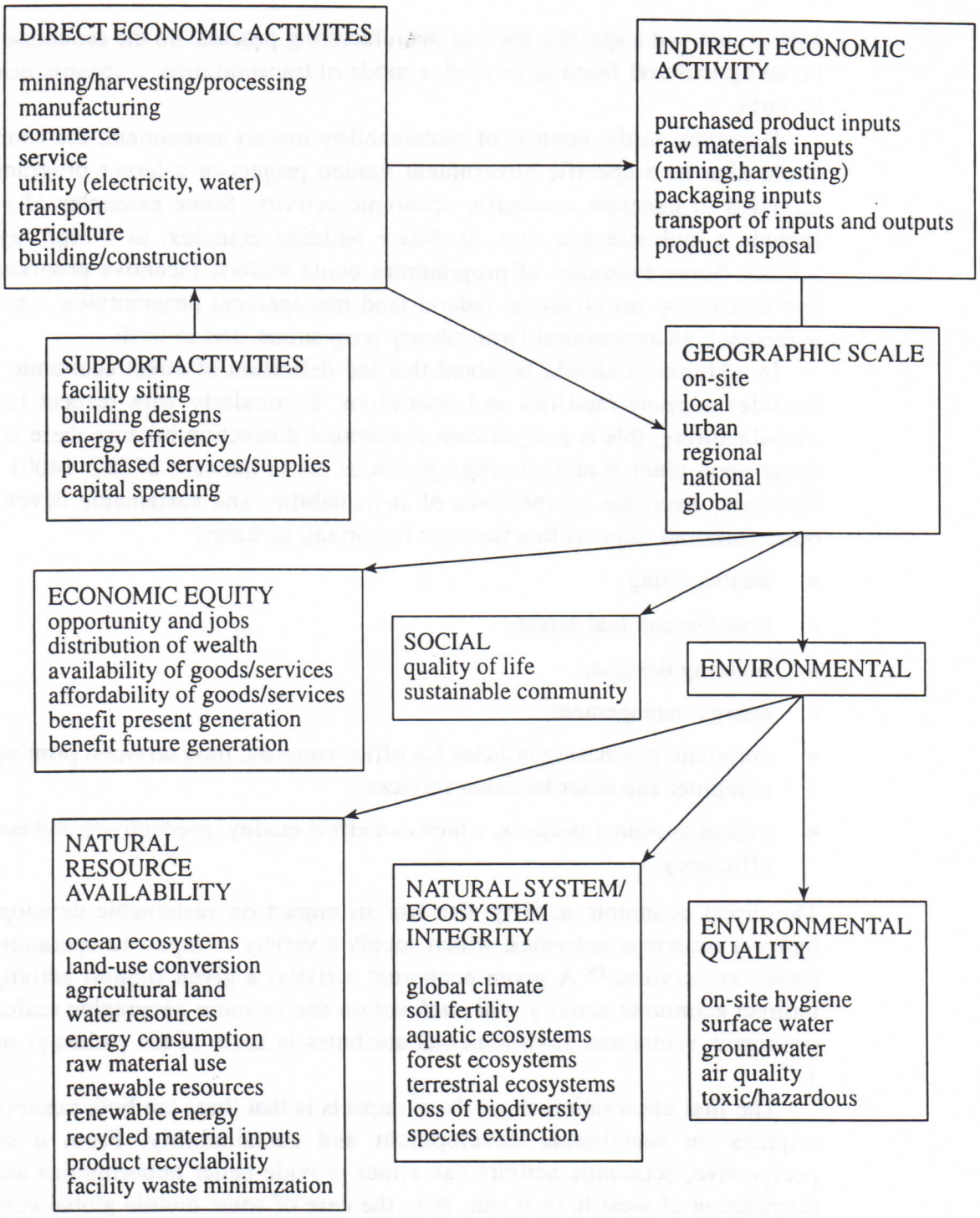

Figure 1 Framework for sustainability impact assessment for economic activity.

Because it has been observed in the previous section that the other existing tools of analysis have substantial limitations for sustainability assessment, Figures 2 and 3 illustrate how the ISO 14001 and the LCA scope of environmental issues, respectively, intersect with the more comprehensive sustainability impact assessment framework from Figure 1.

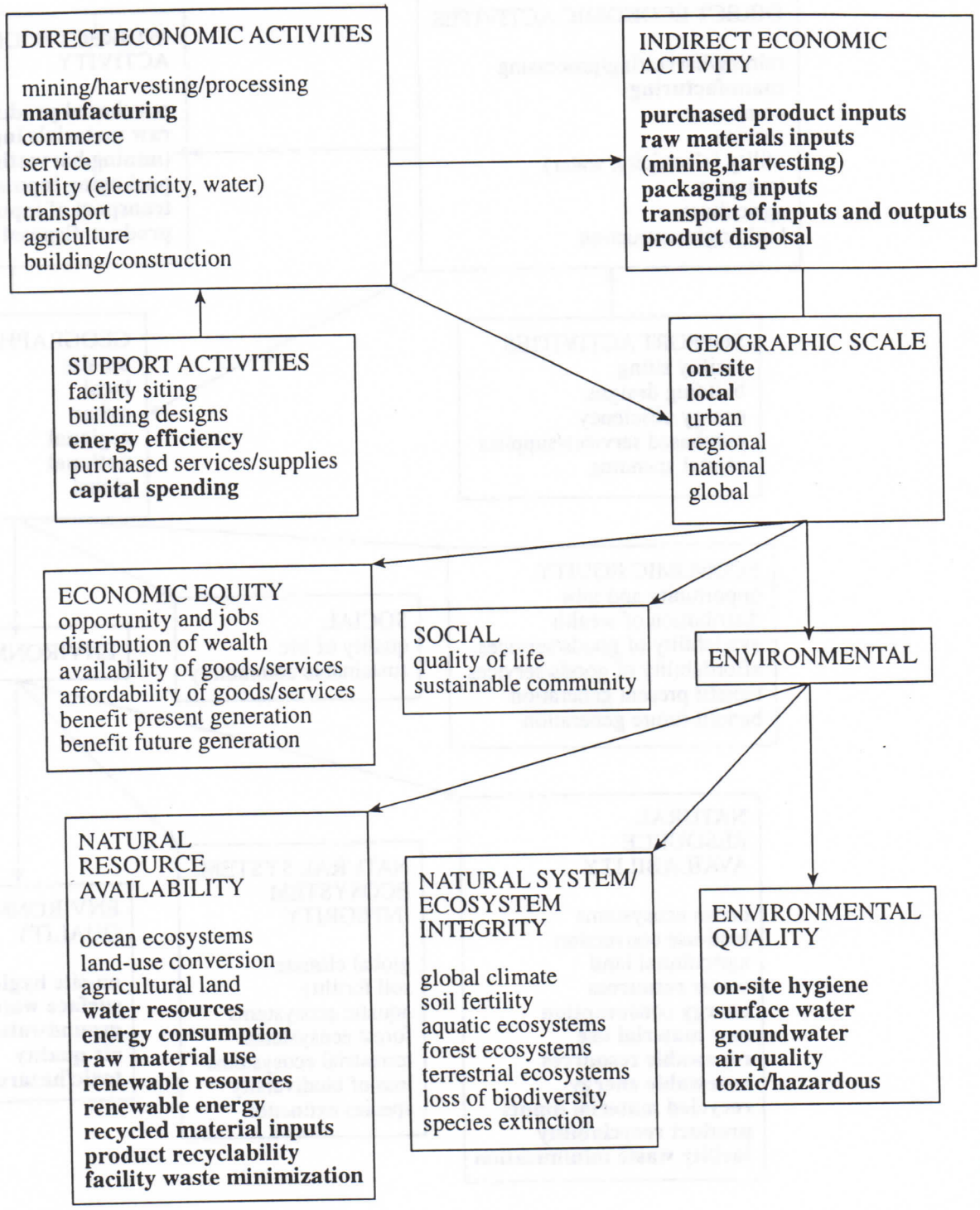

Figure 2 SIA for economic activity: generic representation of ISO 14001 intersection.

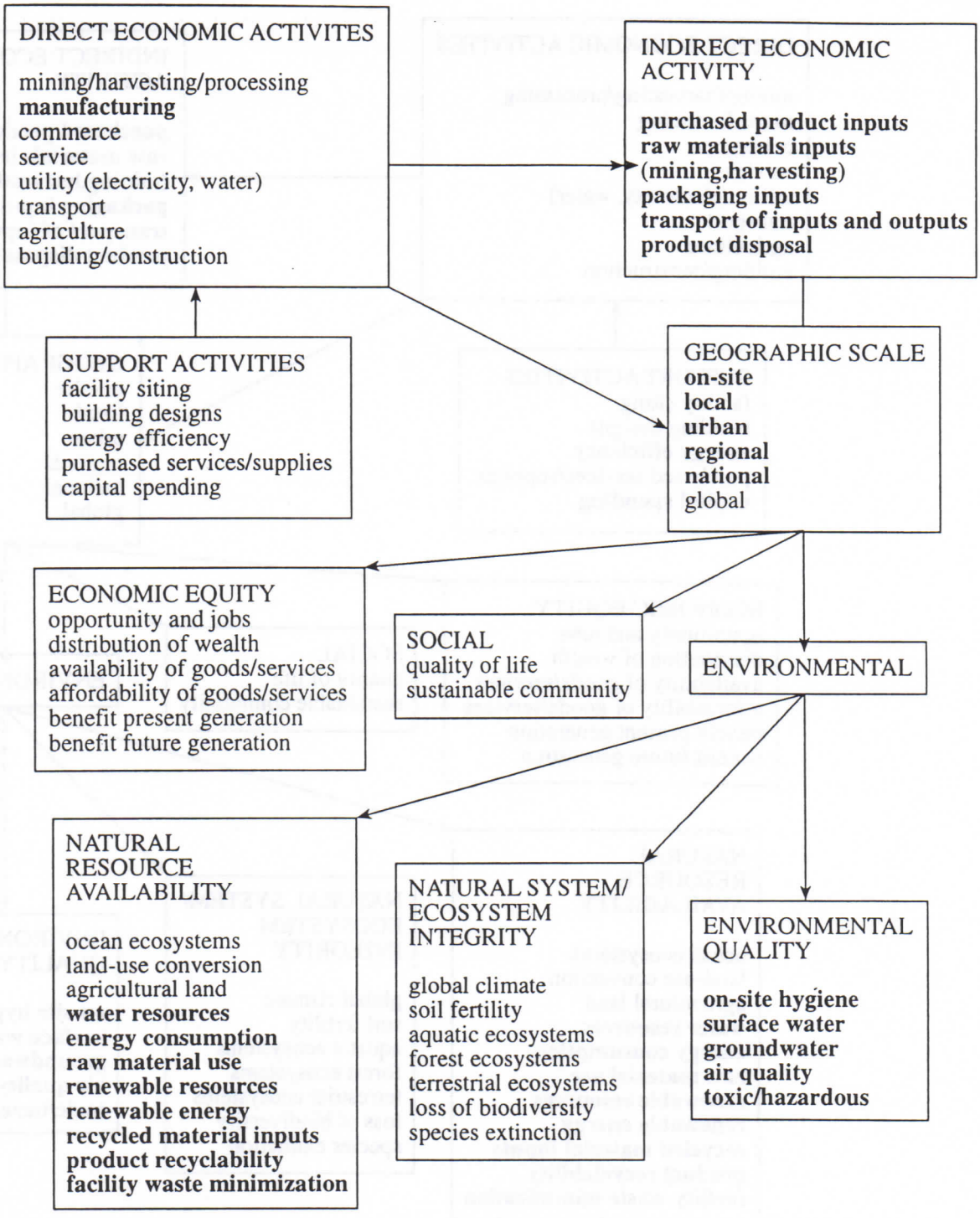

Figure 3 SIA for economic activity: generic representation of LCA intersection.

4.2 Case illustration of the sustainability impact framework

Rather than to maintain this discussion solely at an abstract stage, let us illustrate with an example how the framework in Figure 1 can be applied to ask the relevant questions to guide SIA.

Suppose that there is a US manufacturer of computer memory storage devices. In practice, it is important to identify all the direct impacts of the manufacturing process,

largely at the on-site and local geographic scales. In addition, it is important to identify the support activities and their impacts, which may occur at several geographic scales. Finally, it is necessary to examine the indirect economic activities required by the manufacturing process and their associated impacts, which also could occur at several different geographic scales.

For the sake of illustration of the SIA framework, let us simplify the analysis by assuming the following scenario and conditions:

1 The US manufacturer imports semiconductor chip materials from an Asian country and manufactures storage devices according to a proprietary engineering design;

2 The manufacturing process requires precise bundling, bonding, assembling and finishing operations using significant inputs of electricity and chemicals and generating air, water and toxic pollutants;

3 The manufacturing facility requires purchased support services, including office supplies (paper products) from a Brazilian paper company and food services from a local supplier;

4 The memory storage devices are shipped to various national manufacturers in a durable foam packaging.

Condition 1 represents an indirect economic activity. Condition 2 represents a direct manufacturing activity and indirect economic activity. Condition 3 represents the purchased support services. Finally, condition 4 represents indirect economic activity, the purchase of packaging containers and the transport of the product. Some additional observations about these four conditions and their sustainability impacts follow below. However, in the interest of being concise, the actual analysis of sustainability pathways using the framework from Figure 1 is only presented for Conditions 2 and Condition 3 in Figures 4 and 5, respectively.

Condition 1

Consider possible socioeconomic and economic equity aspects related to the US manufacturer importing semiconductor chip materials. Clearly, the market system provides inherent conflicts between a firm's ability to compete and economic equity and sustainability. It is important to ask questions that can lead to more enlightened and equitable business practices. Clearly, the US firm will help to provide jobs in the foreign country, but to what extent does it help to provide economic opportunity and a more equitable distribution of wealth? Are the jobs relatively well-paying? Is the foreign company progressive in terms of offering profit-sharing and incentives for its employees? If the foreign firm happens to be a subsidiary of the US firm, the latter is in good position to work towards these goals of sustainability. If the US firm is strictly an importer, the question may become how it can influence its foreign supplier (or find a different supplier).

It should also be noted that the same questions about economic equity could be posed to the transport company (ocean shipping) for the imported products. In this particular hypothetical example, it is presumed that there were not relevant impacts from the US firm on the other 'economic equity' variables (availability, affordability, intergenerational equity).

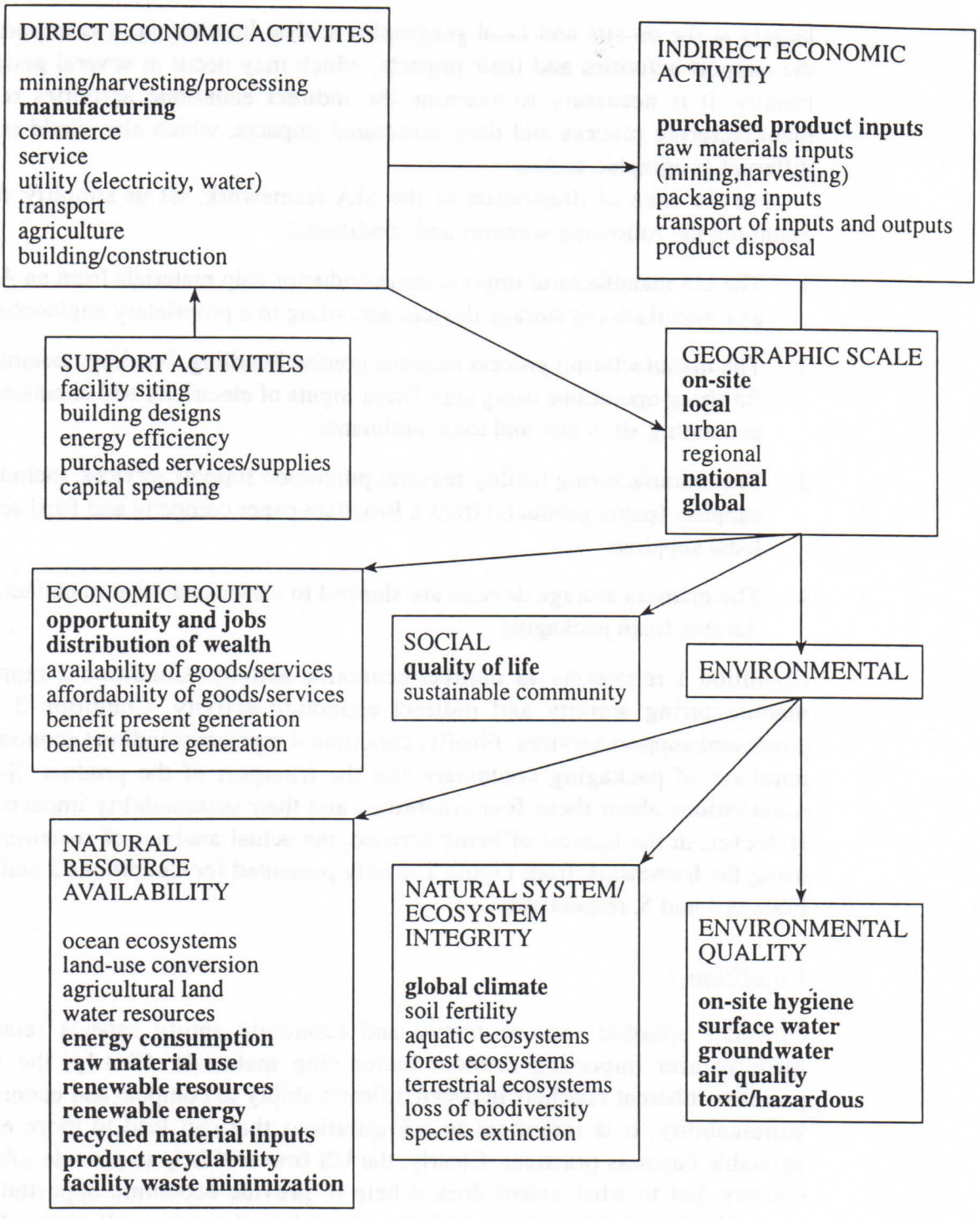

Figure 4 Framework for SIA for economic activity: condition 2.

Now let us consider the global environmental impact related to the import of semiconductor materials from Asia. There are natural resource consumption issues (raw materials, chemicals, energy consumption) related to the efficiency of conversion processes and whether the resources are abundant or scarce, renewable or non-renewable. There are also a number of environmental quality issues related to the production of the semiconductor materials, including industrial hygiene, surface and groundwater quality, air quality and hazardous wastes. Finally, there are environmental issues related to the ocean transport of the semiconductors related to the environmental record of the freighter and emissions from energy consumption.

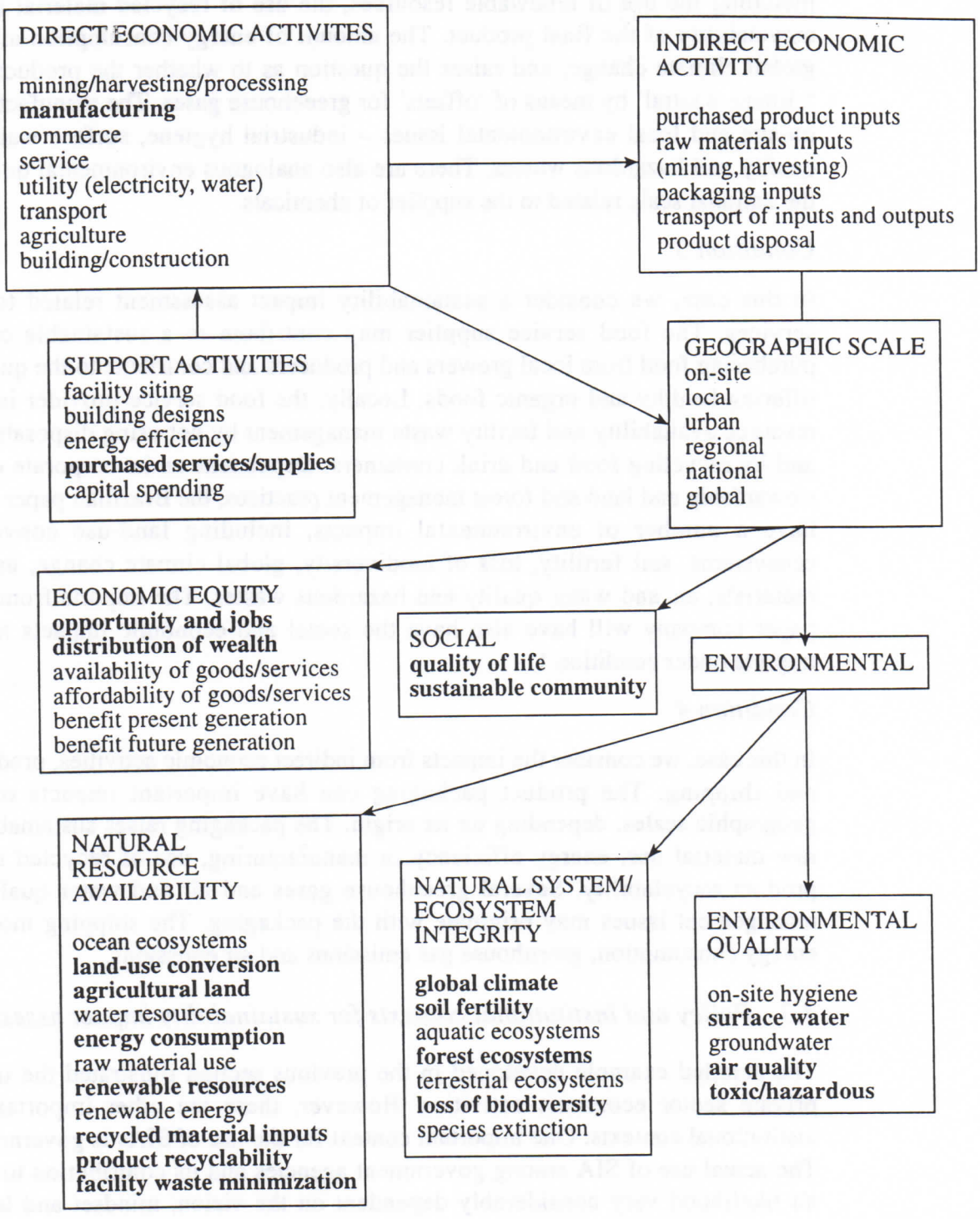

Figure 5 Framework for SIA for economic activity: condition 3.

Condition 2

It is assumed that the issues of economic equity – job and economic opportunity and distribution of wealth – are analogous to the previous discussion above in that the issues are present on the local scale in relation to the US manufacturer and its employee policies and on the national scale through the national supplier of chemical inputs.

The environmental issues cover a broader set of issues on many geographic scales. Because the manufacturing process for the memory storage devices requires processed materials, chemical and energy, there are issues of raw materials and resource use,

including the use of renewable resources, the use of recycled material inputs and the recyclability of the final product. The amount of energy consumption also impacts on global climate change, and raises the question as to whether the product can be made 'climate neutral' by means of 'offsets' for greenhouse gases. The manufacturing presents on-site and local environmental issues – industrial hygiene, surface water quality, air quality and hazardous wastes. There are also analogous environmental quality issues on the national scale related to the supplier of chemicals.

Condition 3

In this case, we consider a sustainability impact assessment related to two support services. The food service supplier may contribute to a sustainable community by purchasing food from local growers and producers and contribute to the quality of life by offering healthy and organic foods. Locally, the food service provider impacts natural resource availability and facility waste management by not using disposable implements and by recycling food and drink containers. Dependent on its corporate environmental stewardship and land and forest management practices, the Brazilian paper company may have a number of environmental impacts, including land-use conversion, forest ecosystems, soil fertility, loss of biodiversity, global climate change, use of recycled materials, air and water quality and hazardous wastes. The imports from the Brazilian paper company will have also have the social and economic impacts noted with the imports under condition 1.

Condition 4

In this case, we consider the impacts from indirect economic activities, product packaging and shipping. The product packaging can have important impacts on widespread geographic scales, depending on its origin. The packaging raises sustainability issues of raw material use, energy efficiency in manufacturing, use of recycled materials, and product recyclability. Several greenhouse gases and air and water quality and waste management issues may originate with the packaging. The shipping mode will affect energy consumption, greenhouse gas emissions and air emissions.

4.3 Policy and institutional contexts for sustainability impact assessments

The detailed example developed in the previous section illustrated the use of SIA for private sector economic activities. However, there are other important policy and institutional contexts. One important context for the use of SIAs is government agencies. The actual use of SIA among government agencies and its contribution to policy will in all likelihood vary considerably dependent on the vision, mindset and leadership at a given agency. Historically, in the US there has been a tendency to regulate and implement according to narrow legal requirements; whereas within the countries of the EU there has been more opportunity to operate using proactive and consensus approaches. Furthermore, in developing countries where there are comparatively fewer environmental laws, there are additional opportunities for innovation, such as the use of SIA.

Nonetheless, there are presently many opportunities in the US and other countries to use SIA as part of decision-making in programme development. For example, energy programmes that are concerned with developing a particular form of energy generally need to be concerned with (1) indirect programme impacts on energy use, (2) diverse environmental impacts and (3) social and economic impacts, which are critical to

building or eroding programme and project stakeholder support. In the case of solar energy, it is important to evaluate the many impacts, positive and negative, that solar energy production and installation could have, including economic and social sustainability (jobs created, sustainable community, quality of life, environmental resource impacts (land and material inputs), and environmental quality (hazardous wastes and pollution generated, environmental health). Analogous points could be made about important sustainability impacts from government programmes, such as building and procurement, agriculture, forest and land management, transportation, housing, environmental protection and even defense and diplomacy (because it is frequently observed that many future political and military conflicts will be over resource use and development rights).

International treaties for trade obviously have important effects on sustainability. Although it has been known for some time that the North American Free Trade Agreement (NAFTA) has had an adverse impact on indigenous Mexican farmers, whose sustainable agricultural methods have not been able to compete with cheap agribusiness imports, a more comprehensive analysis of environmental and sustainability impacts related to NAFTA has recently been published.[18] Notwithstanding the fact that many trade impacts are difficult to predict, the comprehensive and systematic analysis required by a sustainability impact assessment could help to strengthen trade agreements.

Global climate mitigation programmes and funded projects offer an important opportunity for public and private institutions to integrate sustainability impact assessment. In fact, Article 12, the clean development mechanism, of the Kyoto Protocol states that 'the purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention...' Thus a sustainability impact assessment could be used in conjunction with carbon mitigation projects funded by the Global Environmental Facility and in conjunction with other private investor climate mitigation projects in developing countries.

More generally, for public and private projects that have normally used environmental impact assessments (e.g. construction, mining, highway, power, etc.), a more comprehensive SIA framework can be used in a proactive way to strengthen project implementation and to reduce citizen concerns. Similarly, NGOs can also use a sustainability impact assessment framework in proactive ways to help negotiate conditions for project development.

5 Concluding remarks and suggestions for future research

This paper presents a comprehensive conceptual framework for asking important questions about sustainability impacts of economic activities, projects and programmes. This framework was compared with some other tools of analysis – environmental impact assessment, ISO 14001 and life-cycle assessment. In general, these other tools were not designed – nor are being applied – to evaluate comprehensive impacts upon sustainable development and sustainability. Rather, they are intended to examine *certain environmental* components of sustainability – frequently to the neglect of impacts from indirect and support activities; generally to the neglect of economic equity, social factors and ecological natural systems and generally for limited geographic scales. Environmental impact assessment comes closest to being a more comprehensive tool for sustainable development; but unfortunately in practice is not rigorously applied.

The sustainability impact framework presented in this paper poses a challenge to those in government, industry, institutions and NGOs to think more deeply about sustainable development and how to advance it. It is important and necessary to take actions which happen to be both good for profitability and sustainable development – as industry is now doing – but it is not sufficient. The increasing economic globalization, population growth, and technology transfer make it imperative to consider widespread impacts on people, economic equity, resource conservation, natural environmental systems and environmental quality, which can result from projects, programmes, and specific economic activities.

It may not be necessary to pass *new* laws to advance the state-of-the-art for sustainability impact assessment. For example, in the US at the federal level the existing national environmental laws contains considerable actual statutory authority, as well as 'inferred' authority to more fully incorporate the framework for sustainability impact assessment presented in this paper. Perhaps more important, in both the public and private sectors, is an attitude and will to do so in proactive ways.

The private sector could also use the framework to advance broader objectives of 'ecoefficiency' in ways that go beyond the bottom line for the greater benefit of humanity and the environment. At the same time, a more proactive approach can build support with important stakeholders. Ironically, socially responsible investors have found that the more socially responsible companies also tend to be the better investments, because of a progressive corporate culture, employee productivity and efficiency.

Finally, it should be emphasized that the conceptual framework for sustainability impact assessment is a *beginning*, but it is far from being a complete answer. Additional research is needed to *define* the analysis in response to the questions; for example, what criteria and indicators to use to answer questions about how a programme or project will impact on the socioeconomic attributes, such as increasing economic opportunity and jobs, improving distribution of income, and improving quality of life and sustainable community. Additional research is needed to determine how to *simplify* the analysis. Are there proxies that can be used in lieu of analysis of specific issues raised, such as the existence of profit-sharing and pension plans at supplier companies, the choice of an ISO-certified supplier, certification of 'climate-neutral' products, and general purchasing and shipping policies. Are there general criteria to guide decisions about which geographic scales to consider with which kinds of economic activity?

The fact that the framework for sustainability impact assessment requires operational refinements should not discourage its use. After all, the established tools of analysis, such as environmental impact statements and life-cycle assessment, have also required operational refinements.

References and notes

1 Warren, J. (1997) 'How do we know what is sustainable: a retroactive and proactive view', in Muschett, F.D. (Editor) *Principles of Sustainable Development*, St. Lucie Press, Delray Beach, FL.

2 Campbell, C.L. and Heck, W. (1997) 'An ecological perspective on sustainable development', in Muschett, F.D. (Editor) *Principles of Sustainable Development*, St. Lucie Press Delray Beach, FL.

3 Rasmussen, L. (1997) *Earth Community, Earth Ethics*, Orbis Books, Maryknoll, NY.

4 In the United States it is possible that the American electorate may be beginning a shift towards a quality-of-life concern. The mid-term elections seemed to indicate increased

concern over quality-of-life issues, such as health care, social equity, education and women's rights versus conventional self-interest economics, such as tax cuts. Time will tell whether this shift is to maintain present economic standards of living or the beginning of a change in attitude.

5 As sometimes seems to be the case with sustainable development, the reader will note that some of the goals are not completely consistent with each other.

6 It is an unfortunate, but perhaps significant, bit of wording in NEPA directive (iv) above, which refers to 'man's environment' in a possessive way.

7 Anderson, F. (1973) *NEPA in the Courts: A Legal Analysis of the National Environmental Policy Act*, The Johns Hopkins Press, Baltimore.

8 Fredericks, I. and McCallum, D. (1995) 'International standards for environmental management systems: ISO 14001', Canadian Environmental Protection.

9 Haklik, J. (1997) 'ISO 14001 and sustainable development', published on-line by Transformation Strategies, www.trst.com/sustainable.htm.

10 Notwithstanding the large dollar resource and time commitments, and the environmental impacts from extensive meetings, travel and paper generated during the ISO process development, registration, certification and publication, it remains to be seen exactly what changes in corporate stewardship, behaviour and environmental policy will result. As it stands, ISO does not require any specific environmental performance standards or changes in corporate culture or behavior. Rather, the ISO certification is contingent upon the development of procedures called an 'environmental management system'. Although I don't expect that this will be the case, there is a chance that ISO could become a corporate public relations piece and not realize its potential analogous to the failure of the environmental impact statement to reach its potential. There is one important element common to both the EIS and ISO, which tends to diminish each, and ironically it is the competition in the marketplace. When EIS are undertaken, there are competitive bids to reduce the cost from environmental firms, which tends towards a 'lowest common denominator' of analysis. In the case of ISO certification, private consultants are competing to provide this service, which may tend also towards a 'lowest common denominator' of acceptable standards and approval.

11 Veroutis, A., Aelion, V. and Castells, F. (1995) 'Life-cycle inventory analysis of chemical processes', *Environmental Progress*, Vol. 14, pp. 193-200.

12 Henn, C. and Fava, J. (1994) 'Life-cycle analysis and resource management', in Kolluru, R. (Editor) *Environmental Strategies Handbook*, McGraw-Hill, New York.

13 Shapiro, K. (1997) 'Life-cycle design at three multi-national companies', *Ecocycle*, Environment Canada.

14 It should be acknowledged that (1) there is interest within the European Union to include global climate within the ISO framework, but that interest is not yet widely echoed within the United States and (2) global climate is addressed indirectly wherever energy efficiency is addressed.

15 European Forum on Integrated Environmental Assessment (1998) 'Opening workshop', Proceedings of challenges and opportunities for Integrated Environmental Assessment, sponsored by Institute for Environmental Studies, Vrije Universiteit, 12–14 March 1998, Amsterdam.

16 It is unavoidable that this framework will be applied somewhat differently dependent on the knowledge, perspectives, value judgments and needs of the person and institution doing the analysis. As with other tools, there are boundaries that must be set. For example, with respect to 'indirect impacts', one may choose to limit the analysis to 'first order' effects and choose a supplier who is compliant with these issues.

17 It should be noted that inasmuch as sustainability includes a temporal dimension, so do the specific economic, social and environmental issues.

18 Commission for Environmental Cooperation (1999) *Assessing Environmental Effects of the North American Free Trade Agreement (NAFTA): An Analytic Framework (Phase II) and Issue Studies*, Montreal.