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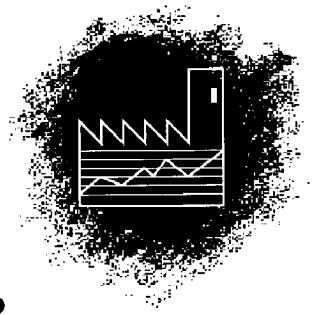
CAN THE PRINCIPLE OF THE ECOLOGICAL FOOTPRINT BE APPLIED TO MEASURE THE ENVIRONMENTAL SUSTAINABILITY OF BUSINESS?



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Ecological footprinting is an accounting tool that seeks to quantify the biological capacity that is required to support human activity. It has been used at the city or country level, but as yet it has not been applied at the lowest level of economic activity – the business enterprise. In order to assess its usefulness the technique is reviewed alongside other management tools for assessing the environmental performance of commercial organizations. This will then enable the business to develop environmental management systems and strategies to improve environmental performance and eco-efficiency.

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INTRODUCTION

Business activity causes environmental impacts – often negatively – and whilst some exemplar companies (for instance those engaged with Project Sigma) are making attempts to mitigate these impacts, many businesses seem reluctant to respond to calls for better environmental performance. The lack of real engagement of businesses in understanding environmental issues may stem from inertia through insufficient awareness or motivation, financial constraints, poor legislative pressure or the absence of a champion in the field. It may be more fundamental than this: business is an important part of the current liberal economic framework, and as such may have no real desire for change (Gray *et al.*, 1996). This is despite surveys that reveal a greater amount of activity in environmental management strategies (see, for instance, O'Riordan and Voisey, 1997). It is also relevant that environmental impacts are less readily identifiable than economic success, particularly to so-called 'non-specialists' (Mathews, 1991). This lack of greater awareness appears to conflict with activities in environmental management at the firm level, and it is suggested that this may be a second order response (i.e. dealing with the problem) to a first order problem (i.e. an understanding or

awareness of the extent to which environmental degradation is occurring and why). Hence, how are businesses to be engaged in a dialogue that aims to address environmental impacts? What would need to happen for businesses to recognize, measure and manage their environmental performance?

BUSINESS AND ENVIRONMENTAL SUSTAINABILITY

Economic activity and productivity requires ecological inputs of raw materials, energy and social inputs of labour and human-made capital, and the ecosphere's ability to absorb wastes and pollution (Ekins and Max-Neef, 1992). Environmental sustainability could be described as the systemic approach that allows economic activity to be bounded by environmental limits.

Environmental management within an organization is developed in a series of actions taken by management and requires economic activities to be analysed for their environmental impacts. What is required is a mechanism that will inform all of the elements of the cycle (Figure 1), and be acceptable, understandable, transparent and replicable in many circumstances. There has been much development in the 'business and the environment' field in many respects, but it is unclear whether in a business context there has yet emerged one mechanism that can inform all of the above stages. Some of the more recent frameworks are reported below, with an emphasis on the internal management's choices for examining its organization's environmental performance. In this way the internal processes, by moving to an external focus, can begin to inform the dialogue with stakeholders.

Figure 1. The cycle of environmental management

MEASUREMENT OF ENVIRONMENTAL PERFORMANCE AND EFFECT

Many different management approaches have been suggested and taken up. They often reflect a particular management position, motivation or philosophy, and may be internally generated or externally provided. Environmental management systems such as the European Eco-Management and Audit Scheme (EMAS) (European Union, 1993) and the International Standard ISO 14000 series (International Standards Organisation, 1996) encourage businesses to identify their environmental impacts in order to manage them (Welford and Gouldson, 1993). These emphasize a cycle of continuous improvement, with regular review and amendment where necessary. Both have been established and implemented by medium and large business and statutory organizations. EMAS is undergoing a revision that will allow it to be more responsive to stakeholders and more able to respond to the identification of indirect impacts (IEMA, 2000). These schemes and systems are in the traditional mould of management systems – they provide a systematic, ordered, rational view of management, which may undermine the nature of managing for environmental impacts. They are general, universal management approaches, which tend to treat the environment alongside other management issues such as quality, human resources etc.

Another mechanism involves one of the main information systems in the organization

– the accounting information system. Environmental management accounting proposes to make the organization more transparent (Bennett and James, 1998). The US Environmental Protection Agency's (1995) environmental accounting project suggests that the accounting system should be redesigned to reveal costs that have an environmental element, but that would not be analysed as such. Examples would be costs associated with compliance, insurance needed because a process has an environmental risk, costs or benefits associated with recycling and so on. The framework suggested by the EPA is incremental; that is, it suggests that private costs be accounted for in this manner at first, but it is hoping that public (societal) costs will also at some stage be incorporated. In this way an organization responds to its measurement of impacts in a stepwise manner, dealing with those that are easier to identify first (US Environmental Protection Agency, 1995). This allows transparency in stages, and, with the commitment of senior management, begins to make managers more accountable for the environmental performance of the organization. However, these mechanisms will only be acceptable to stakeholders if the outcomes from such a system generate actual change.

Life cycle analysis and environmental impact analysis are broad tools for examining business activities beyond the physical boundaries of the entity walls (Ditz *et al.*, 1995). These have been taken up, for instance, where businesses have analysed their supply chains and traced their products through a 'cradle to grave' pathway. This enables them to assess environmental effects outside their immediate (internal, via processes within their organization) influence, where a partnership approach with suppliers has provided a means to reduce environmental impacts along a wider part of the life cycle. A similar approach is the mass balance methodology, which aims to trace materials through the system, showing inputs of raw material and energy and outputs of product, emissions and waste (Gray *et al.*, 1993). This has been taken up in Germany, Austria and Scandinavia (for instance by the Danish Steel Works) by manufacturing organizations and highlights those parts of the process that create the most environmental impact. Unlike environmental management accounting, which assesses environmental performance in monetary units, the measurements are made in physical units, and are somewhat scientific in nature, and so lose potency because of their limited understandability.

These are all valuable measurement mechanisms, and they can all be employed without too much disruption to the business' current management information systems. Their main drawback is that they lack a holistic approach – the focus tends to be on the effect of individual environmental impacts rather than defining the overall problem/solution.

THE ECOLOGICAL FOOTPRINT METHODOLOGY

One measuring technique that has been used to indicate community environmental impacts (whether on a city, region or national resolution) is the *ecological footprint* (EF). This measures the biological capacity – measured as the amount of productive land and/or water supporting human activities and required to sustain human life – and was developed as a theoretical model and empirically tested by Rees and Wackernagel (1996). The concept is linked to the ecological carrying capacity computed for a habitat, which will be given by the population of a species supported by that ecosystem without the species causing damage (O'Riordan, 1996). However, human activity is not bounded in such a spatial way, because trade and technology allow us to exploit habitats far from our living space (Rees, 1996). What can be calculated is the resource base needed for human activity and the sinks needed to assimilate the waste flows. This can then be translated into productive land capacity, and measures human demands upon the

environment wherever it occurs (Wackernagel, undated web-site). Land categories are broadly the following.

- *Land for energy.* There are several potential categories: land area that could be used for growing biomass, the land area required to absorb (sequestrate) CO_2 or the land required to grow replacement natural capital, for instance.
- *Built land.* This is consumed by human-made infrastructure.
- *Food land.* This is 'agricultural' in that it is the area required to grow food consumed either directly or indirectly in the human food chain.
- *Forest land.* Here land is needed to provide forest products – wood and paper. This is not forest required to absorb CO_2, which will be counted in the first category above.
- *Sea area.* This is the area of water required for fish productivity.

Globally, according to Rees and Wackernagel (1996), the eco-capacity is calculated at 1.5 hectares per person. Many Northern cities far exceed this footprint.

Impacts are related to the level of consumption and not merely to the level of population, so that the footprint of the 'average' Northern city may be expected to be much larger than the equivalent in the South. This means that 'load' is a function of population and per capita consumption (Rees, 1996). The footprint methodology also compares this human 'load' with the underlying ecological carrying capacity to see how far short capacity falls compared with required load. The footprint therefore deals with 'appropriated' carrying capacity, so that it can show what area of productive land is required to support humans at a specified material living standard (see Table 1).

This graphically describes how a community's consumption of the environment far outstrips the potential availability of such an environment if all communities were to make the same demand (or how other communities would have to 'donate' their share to London's community in order for it to continue its current consumption patterns).

This is an anthropocentric approach (Hayward, 1996) because it is concerned with human activity and human requirements for life. The method requires knowledge of the interactions between humans and ecology (Rees, 1996), and it does assess biospherical impacts in a very graphical way, as it helps to record the impact humans are having on the natural world. In this way the model does attempt to measure the excesses of human activity in a way that allows solutions to some of those excesses to be developed.

Wackernagel's (1998a) study of the footprint of Santiago de Chile identified the model as useful for cities because

- most of the world's population live in cities,
- most of the political decisions are made by city-based organizations,
- the majority of economic processes take place within cities (excluding agribusiness) and
- these economic processes create ecological impacts that are felt locally and globally.

Hence, the footprint technique is important in the planning context because it allows an assessment of the current condition of the city and provides a framework in which ecological impacts can begin to be addressed. In policy terms it is not important to consider the actual productive land available but that *required*. This removes the problem of assessing land availability and the complexity of segregating 'special' or 'protected' areas. It also allows a graphical portrayal of the excess of environmental inputs that is needed for an activity to be sustained.

THE METHODOLOGY APPLIED TO BUSINESS

Simmons and Chambers (1998) identified the use of footprints for a variety of situations such as

Table 1. The metabolism of Greater London, population 7 000 000. These figures quantify London's resource use. They are listed here to emphasize the huge potential for greater resource efficiency. London's waste output could be used as a significant resource for new recycling and energy efficiency industries.

Inputs	Tonnes per year
Total tonnes of fuel, oil equivalent	20 000 000
Oxygen	40 000 000
Water	1 002 000 000
Food	2 400 000
Timber	1 200 000
Paper	2 200 000
Plastics	2 100 000
Glass	360 000
Cement	1 940 000
Bricks, blocks, sand and tarmac	6 000 000
Metals (total)	1 200 000
Wastes	**Tonnes per year**
Industrial and demolition wastes	11 400 000
Household, civic and commercial wastes	3 900 000
Wet, digested sewage sludge	7 500 000
CO_2	60 000 000
SO_2	400 000
NO_x	280 000
London's ecological footprint[a]	**Acres**
London's surface area	390 000
Farmland used @ 3 acres/person	21 000 000
Forest area required by London for wood products @ 0.27 acres/person	1 900 000
Land area required for carbon absorption (equal to acreage required for fuel production and biomass) @ 3.7 acres/person	26 000 000
Total London ecological footprint = 125 times London's surface area	48 900 000
Britain's productive land	52 000 000
Britain's total surface area	60 000 000

[a] London's ecological footprint, following the definition by Canadian economist William Rees, consists of the land area required to supply London with food, fibre and wood products and the area of growing vegetation needed to reabsorb London's CO_2 output.

@ Herbert Girardet, 1995 and 1996; www.greenchannel.com

- the impact of international trade
- the impact of individual establishments
- the sustainability of individual planning applications
- the impacts of cities and larger institutions.

If the model of ecological footprinting is useful for a variety of situations, and given that economic activity is one of the parameters in this model, can ecological footprints be calculated for businesses? In other words, it may be possible to assess how much of the biosphere is required to maintain the activities of the business, and, if so, whether the capacity required is likely to cause ecological impacts that are unsustainable. In this way business environmental impacts are linked to a wider appreciation of how the environment is being appropriated. Management of environmental impacts can then be linked to greater awareness of the role of business in environmental damage and restoration.

Hence, this would indicate that at the level of individual businesses, ecological footprints may present a means of capturing information on environmental impacts and aspects. So, footprinting at the level of the organization can act as a management tool, enabling individual businesses to address their environmental performance by identifying unsustainable demands on the biosphere, and alternative uses of capital.

OPERATIONALIZING THE METHODOLOGY

It is considered that, before it can be used at the policy level, organizations must first commit to the methodology and begin their own calculations. It is unlikely that this would happen if the methodology were complex or that there was a requirement to have a separate data collection system. Organizations usually already have sophisticated information systems in place for management and accounting purposes, and these should be able (perhaps with some adaptation) to provide the basic information for the ecological footprint calculation. Organizations would pose the question of how a business would use its existing information to assess its own footprint.

Businesses require an effective information system to be able to conduct their activities. Management information systems allow the control and planning of activities, and decision-making in both the short and long term. Accounting information feeds into this and will consist of a mass of financial data. For instance, energy consumption in terms of amounts paid will be recorded, and the underlying records will also record unit consumption. Amounts spent on waste disposal will also help to identify quantities produced. Non-financial data will include the source of raw materials and the method of transporting goods from suppliers and to customers. Where there are emissions controlled by regulations, the amounts produced will have to be recorded. It may be more difficult to produce amounts of non-controlled emissions and pollution, and the amounts of gases such as CO_2 and NO_x may need further calculation. However, the organization should have enough information in its existing systems to be able to begin to apply the ecological footprinting methodology.

CURRENT STUDIES

Chambers and Lewis (2001) have identified two organizations where the ecological footprint has been applied: Anglian Water and Best Foot Forward, a consultancy organization. Their analysis of the process and outcomes is very detailed and very informative, and provides a detailed methodology for the two companies studied. The authors also provide a critique of both the background and the methods of information capture, which establishes the EF as both a tool for internal measurement and for external communication. For instance, Chambers and Lewis (2001) identified the service unit, which was the essential first stage. For Anglian Water this was the value per ML of water; for BFF it was the value per consultancy project. These were then normalized to a common unit, for instance profit, turnover etc. To avoid double counting for such items as materials, either the inputs stage or the waste outputs stage should be used.

Chambers and Lewis use the EF in several ways – as an internal management tool, as a means of communication, as a consensus-building tool at the strategic and policy level and as a prediction tool. This is a fair assessment of the potential of the EF, but for many businesses this may confuse the purpose for which they wish to use it. It could be argued that without a clearly developed management information system, the other features of EF thus identified will have little power (and possibly little information content).

DEFICIENCIES IN THE METHODOLOGY

There are some problems with estimating footprints and with the methodology in general. Footprints measure impact in a general way; that is, they assume that the impact measured will have the same effect on the productivity of land wherever and whenever it occurs. In other words, the methodology assumes a linear relationship of impact with effect, but in reality ecological pathways are complex and rarely show total linearity over the whole scale. Pollutants reach threshold limits above which there is little scope for damage (as all the possible damage has occurred); trace elements are beneficial to plants at low levels, but toxic at higher concentrations, and acid rain may cause damage or have a fertilizing effect depending upon local conditions and circumstances (Levett, 1998). Also, biocapacity is determined by the production and assimilation of natural substances. Human-made materials are long lived and often have no counterpart in nature. Therefore, assimilation is often very difficult or impossible. Hence, the ecological footprint for such substances will be infinite (Holmberg *et al.*, 1999). Human-made substances are therefore specifically excluded form the ecological footprint calculations (Holmberg *et al.*, 1999).

Ecological footprints do not deal with risks and uncertainties in a consistent way. For instance, nuclear power presents a low risk/high damage scenario (bff web page, undated) and the public's aversion to the use of nuclear power cannot be accounted for in the same kind of scientific way as amounts of pollution produced. Similarly, the footprint cannot incorporate the views of future generations (an important consideration in the concept of sustainability (WCED, 1987)). Hence, there are aspects of the footprint calculation that must involve value judgements (Levett, 1998), qualitative assessments and a certain amount of social constructionism (in determining which environmental issues are important).

The methodology does not distinguish between the types of environmental capital that may be consumed or required. Capital can be non-renewable, and in some cases critical (as in the ozone layer), or it may be renewable and substitutable (as in solar or wind energy sources) (Gray *et al.*, 1993). Whilst the methodology is not explicitly concerned with actual use of capital, but a measurement of required capital, nevertheless different business activities may require the consumption of different categories of capital. The ecological footprint does not capture this element of environmental use. In using biological capacity to measure environmental uptake, the footprint technique assumes that all capital is renewable and substitutable. By converting environmental demands into biological productivity, no additional weighting is given to capital actually consumed, which may itself be critical or non-renewable. The methodology therefore provides a proxy, which may not be equivalent to the actual processes occurring in the environment.

In the same vein, ecological footprints cannot capture the eco-justice elements of sustainability – it cannot assess how business activity contributes towards human fulfilment, for instance, or whether human rights are being upheld (Holmberg *et al.*, 1999).

Other problems relate to the reduction of all impacts to a single 'currency', i.e. land bioproductivity. This raises two questions – different impacts may generate the same footprint, but do they really represent the same amount or significance of impact? Second, if land has other qualitative characteristics such as aesthetics or cultural value, how is this to be 'reserved' so that it too has a place in the footprint? Therefore land (i.e. environmental resources) appropriated for business activities cannot be assigned an alternative use value in this model.

Similarly, if the concept is human based, it does not incorporate the footprint required by other species. The WCED Report (1987) suggests that 12% of bioproductivity should be

reserved for other species so that biodiversity is maintained, and this suggests that the footprint calculation should include a 'biodiversity reserve' (Rees and Wackernagel, 1996).

Another consideration is whether the concept of footprinting will be subsumed into economic analysis by considering the environment as a commodity that can be traded as any other good. If, for instance, a level of bioproductivity is allocated to business activity as a whole, it may be possible to imagine a market in tradeable bioproductivity where gains (i.e. smaller land areas needed) by one organization are traded with another needing a greater biological capacity. Hence, the same arguments would apply as are currently rehearsed in terms of tradable pollution permits.

In order for the methodology to be applicable to businesses, we would need to reconsider what the footprint itself is telling us, and in what context that appeared. Before businesses took up the methodology they would need to appreciate the underlying concept of environmental sustainability. This may be the biggest disadvantage to the practical application of the technique – if managers do not have a clear vision of the need for greater environmental sustainability, or an understanding of what this means, then the results of any footprinting calculations will be at best difficult to relate to outcomes, and at worst unusable in preventing further environmental damage. Hence, what is necessary is a broad understanding of the scientific underpinning of the methodology coupled with an awareness of its general application and implications. The scientific basis for the methodology may make it more acceptable – that is, be the basis for persuasion – or create an adverse reaction because of a mistrust of science. It is therefore important that if the methodology is to be used by businesses, it is presented in a sympathetic manner.

To conclude, the concept and methodology of the ecological footprint seem to provide a mechanism for businesses to develop an environmental management information system that will help them to measure and assess their environmental performance. Land area is a readily identifiable quantity and therefore has the benefit of being understandable by many people (Simmons and Chambers, 1998) and so is useful as a means of estimating environmental impact. It is clear that footprinting does have its drawbacks, but its strength lies in its ability to focus the argument and provide an impetus for debate. It may provide feedback mechanisms so that business activity is provided with a monitoring process where improvements in performance can be measured and reinforce and strengthen the framework in which the measurement takes place. It is likely that footprinting will help business to frame policy issues rather than providing absolute solutions (Levett, 1998, Wackernagel, 1998a) – for instance policies on energy efficiency can be framed in terms of alternative sources rather than absolute amounts to be used. Another strength of the model lies in its ability as a consensus builder, and that it helps to make the hidden aspects of business more visible (Wackernagel, 1998b). It links natural science's ability to assess the human impact on nature and the social science study of ethics and the allocation of responsibility (Wackernagel, 1998b). This is perhaps its greatest strength – to incorporate hard science and ethical intuition into the assessment of business activity, so that we may ask the question of how we want businesses to behave in respect of the ecological world.

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