MEASURING SUSTAINABLE PRODUCTION

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Abstract:

Section III of the Plan of Implementation from the Johannesburg's World Summit on Sustainable Development 2002 calls for the development of a 10-year plan to accelerate the shift towards sustainable consumption and production. A necessary component of this is to insure that, at a minimum, the sum impacts from all human actions fall within earth's carrying capacity to manufacture, power and sequester these activities. Although methodologies exist to determine a sustainable and equitable maximum amount of earth's resources per individual (the ecological footprint concept), devising a means to assign these parameters to the businesses that create these goods and services has, until now, not yet been developed.

This paper offers a preliminary method to meet this challenge through a 3-step process. Step 1 equitably allocates to an individual corporation their share of biophysical resources (land, air, water, ocean) relative to their financial contribution to world revenues. Step 2 determines a corporation's actual consumption of resources through a Life Cycle Analysis of its production, with results expressed in biophysical units of land, air, water and ocean. Step 3 compares the allocated amount of land, air, water and ocean to the organization's actual consumption of these biophysical resources to both establish a tangible sustainability goal and determine the corporation's present level of sustainable production.

Utilization of this methodology offers corporations a tool to:
1. Establish a definitive goal for attaining ecological sustainability in simple and easily understood terms,
2. Prioritize efforts for attaining sustainability,
3. Realize market advantage.
4. Benchmark efforts,
5. Gain leadership recognition
6. Earn credibility through measuring their part in achieving total sustainability

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SECTION 1: SUSTAINABLE DEVELOPMENT AND INTRODUCTION OF THE ECOLOGICAL FOOTPRINT ANALYSIS

Section III of the Plan of Implementation from the Johannesburg's World Summit on Sustainable Development 2002 calls for the development of a 10-year plan to accelerate the shift towards sustainable consumption and production within the carrying capacity of ecosystems. It further delineates the need to identify specific tools for measure its progress, emphasizing the use of collaborative partnerships with private and public stakeholders.

Sustainable development is popularly defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (Brundtland 1986) This definition however, allows for deferring action until the future. It requires no real action or constraints for the present generation (Norton 1992). A second definition that is becoming fashionable is defining sustainable development as development which integrates the symbiotic and interdependent relationship that exists between the environment, the economy and the community. (International Institute for Sustainable Development, Agenda 21- United Nations Conference on Environment and Development (UNCED), Center for excellence on Sustainable Development (US Department of Energy)). Industry, in its attempts to meet corporate responsibilities, is left to use these abstract definitions in their actions towards sustainability. These definitions threaten the development of a definition of sustainability which ultimately must address the fundamental characteristics of living within earth's carrying capacity (World Business Council on Sustainable Development). So far sustainable development has been mostly ineffective in motivating overall ecological improvement of the planet, as seen in the continued degradation of earth's ecology (Worldwatch Institute 2001).

A remedy to solve this dilemma is to develop a definition that accounts for the finite biophysical services of earth, e.g. its carrying capacity. In 1991, the World Conservation Union, United Nations Environmental Programme, and The World Wide Fund for Nature, did just this with their definition that defines sustainable development as development which "improves of the quality of human life while living within the carrying capacity of supporting ecosystems". But defining earth's carrying capacity is extremely complex (Daily and Ehrlich 1992). Wackernagel and Rees, (1996) approached this by hypothesizing that, as a minimum requirement for sustainability, humanity must live within its finite resource of its productive area-a biophysical limit. Their approach quantifies society's activities in terms of the land area that would be required to sustainably produce and power the goods and services the population demands and sequester their energy and product emissions, calling the results the ecological footprint. This pedagogical calculus is becoming a policy tool in several countries for analyzing a society or region by its inhabitant's average, per capita consumption of land. Comparing the actual per capita consumption (the demand) to the available per capita area (the supply) gives a measure of sustainability. By dividing the global population by the available supply, it is possible to calculate the sustainable average 'earth share' of resources. Such a benchmark enables a region, be it a community, country or the whole planet to measure and monitor their progress on the road to sustainability.

Studies have found that, globally, humankind is not currently living sustainably (Hawken et. al 2000, Chambers et al 2001). The global ecological footprint estimates that, on a per capita basis, humans require 34% more bio - productive capacity than earth is currently providing to produce and sequester the products and services presently consumed (WWF Living Planet Report, 2002). The tangible result of which is a draw down of natural capital. The catalogue of global crises tends to support the fact that we are failing to live within the planet's sustainable capacity; global warming, increased global toxification, loss of fisheries, increased rates of extinction and reduction in water quality.

Environmental impact(I) is proportional to three factors; population(P), affluence(A) and technology(T) (Daily, Ehrlich 1992) and can be expressed by the equation: $I = PAT$. Against the background of rising population numbers, the challenge is to tackle consumer behavior and exploit technological advances to reduce overall resource consumption.

This involves consideration of the whole product and service life cycle (extraction, manufacturing, use, transport and disposal) in the search for improved environmental performance (Hawken, et al 2000).

Businesses are essential partners in delivering both the social and environmental dimensions of sustainable development. As organizations, they both meet the demand for goods and services which seek to enhance quality of life and, in the process, impact on the environment either directly or indirectly through their use of natural resources and their production of wastes.

Recent years have seen an increase in companies using Environmental Management Systems but few of these take a life cycle approach and account for flow of materials and energy. Most focus on emissions and pollution and, whilst this is necessary for compliance with regulations, the potential financial and environmental benefits of reduced resource use (or eco-efficiency) cannot easily be adduced from this approach.

A number of approaches are available to businesses wishing to assess the environmental impact of their products or services. Methods reviewed include Life Cycle Analysis (LCA), Energy and Material Flow Analyses (EMFA) or Mass Balance Analysis (MBA) and Material Intensity per Unit Service (MIPS). Ecological Footprint Analysis (EFA) is a system of accounting and expressing environmental impact which draws on all these approaches.

The issue of "how much" consumption is sustainable is also one that needs to be addressed. Various attempts have been made to quantify resource targets. Those discussed include the Dutch RIVM estimates, those from the German Wuppertal Institute and Friends of the Earth Europe.

Ecological Footprint Analysis uniquely approaches the issue of sustainability by reference to the overall "carrying capacity" of the planet. Thus it is able to link individual behavior to organizational, regional and global targets using concepts such as the 'earthshare' - the average, sustainable bio-productive capacity available per person.

The Footprint indicator is shown to have several advantages; the single index provides for ease of communication and understanding, a variety of goods, activities and services can readily be assessed and compared, a link can easily be made between local and global consumption, an assessment of sustainability is possible, the relationship between different impacts can be explored, and values are based on ecological realities rather than arbitrary weightings. Footprinting also provides a useful measurement system which can complement frameworks such as The Natural Step.

However, achieving sustainability from a consumption perspective ultimately means consuming less—aspects that are not likely to be welcome by the either consumer or producer in societies based on capitalism.

The following paper offers a preliminary methodology to address sustainability from a production perspective.

SECTION 2: DETERMINING AN ORGANIZATION'S LEVEL OF SUSTAINABLE PRODUCTION

Expressing an organization's level of sustainability requires allocating an equitable share of earth's resources to the corporations that produce human's goods and services and then comparing that to the actual amount used.

The first step is to estimate how much earth is available to businesses. Not all human activities produce revenues; therefore, not all of earth can be allocated for revenue production. Activities such as rural agriculture, childcare, and recreation are not done for financial reasons; yet require a portion of earth to accomplish. To reflect this fact, a share of earth's biophysical resources is reserved for this 'informal economy". Based on the work of Hazel Henderson and her estimate of the informal economy, a figure of 30% is used. Thus total available land, air, water and sea attributable to businesses are reduced by 30%. (See figure 1)

Additionally, a certain percentage of land, air, water and ocean is reserved for the exclusive use of biodiversity that is intolerant of mankind's development. Estimates vary for the amount of land etc. which need to be reserved, and range anywhere between 25 and 75% for land alone. (Reed Noss, 1991a 1991b, Noss and Cooperrider 1994, Eugene Odum 1970) Currently, 3% of the earth's land is protected. For purposes of demonstrating the model, a figure of 12% of the earth is reserved for biodiversity. See Figure 1

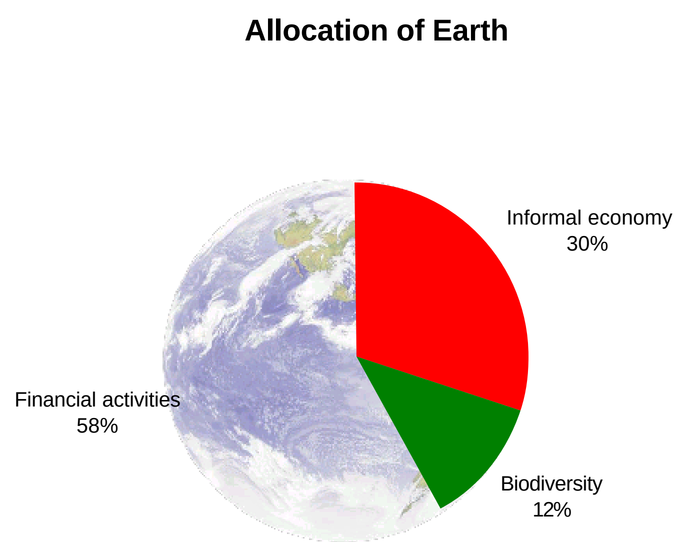

Figure 1 *Estimated allocation of formal, informal and biodiversity shares of earth*

The result of subtracting biodiversity and informal economy from the total biophysical resource is seen in Figure 2.

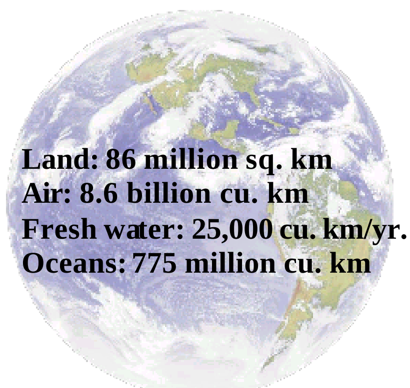

Figure 2 *Total biophysical resources attributable to businesses*

The second step is to use a fair means to divvy up business's share of the earth's biophysical resources relative to the number of customers each organization serves. This is accomplished through using the proxy ratio of company revenues to world revenues, which can also be expressed in biophysical resource allocated per dollar ($) revenue. World revenues are approximately US$ 32 trillion. Dividing the biophysical resources by world revenues gives the following allocation table.

Biophysical Unit	**Biophysical resource allocated per given unit of revenue**
Land = 86 x 10^6 sq km / \$32 x10^{12}	= 2.7 sq km/\$m revenue
Air = 8.6 x 10^9 cu km / \$32 x10^{12}	= 270 cu km/\$m revenue
Water = 25,000 x 10^{12} liters / \$32 x10^{12}	= 780 liters/\$ revenue
Ocean = 775 x 10^6 cu km / \$32 x10^{12}	= 24 cu km/\$m revenue

Table 1 ***Allocation table of biophysical resource per given unit of revenue***

Once the total amount of land, air, water and ocean is calculated for the full life cycle of businesses' products and services (extraction, transport, manufacturing, use and disposal), it is compared to the amount of land, air, water and ocean allocated to it.

If the amount used by the company is less than the amount allocated to it, the company is operating in a restorative manner, if equal, the company is "sustainable", and if it uses more than its allocated share, the company is running with an ecological deficit.

The following example illustrates one practical application of this methodology.

SECTION 3: AN EXAMPLE

ACME Semiconductor Company manufactures specialty silicon chips for data storage. It has total revenues of 2 billion dollars. A full life cycle assessment of its products was conducted and translated to land, air water and sea areas. Only the land assessment is detailed in this example and is given on figures 3 and 4.

Sq. km of land used to produce, use and dispose

- Suppliers 17,000
- Mfg. 13,500
- Transport 5,600
- Use 13,300
- Disposal of products 8,700

Total of 58,100 sq. km of land required to produce, use and dispose of ACME product

Figure 3 *Total land required*

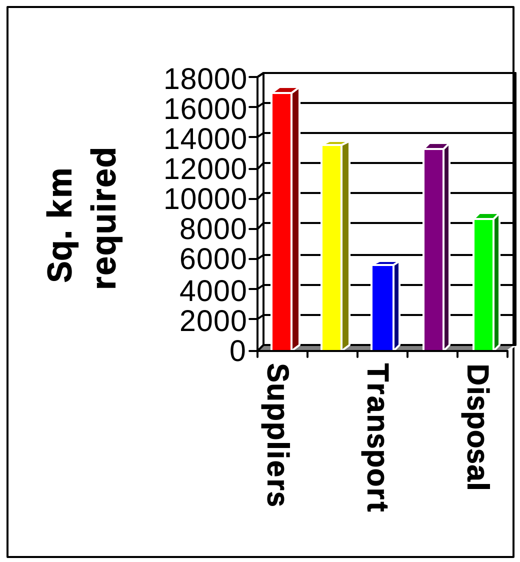

Figure 4 *Life cycle contributor to total requirement*

ACME Company, with US$ 2 billion in total revenues, contributes 0.00062% to gross world revenues and is thus allocated:

- 5,330 sq. km land
- 534,000 cu km air
- 1,575 billion liters fresh water
- 48,100 cu. km. sea

From the land perspective, ACME's level of sustainability is 58,100 sq. km/5,330 sq. km or 1,100% in ecological deficit or 'overshoot'.

ACME has thus far determined their level of sustainability and production and helped develop a sense of its goal or 'distance to target'. They have also been able to discern where to prioritize their efforts to attain sustainability. Suppliers, which require 17,000 of its total 58,100 sq. km, have the largest requirement for land (see figures 3 and 4).

Suppliers are thus targeted first for analysis. These break down into four main categories of supplies: silicon, chemicals, metals and plastics.
(See figure 5)

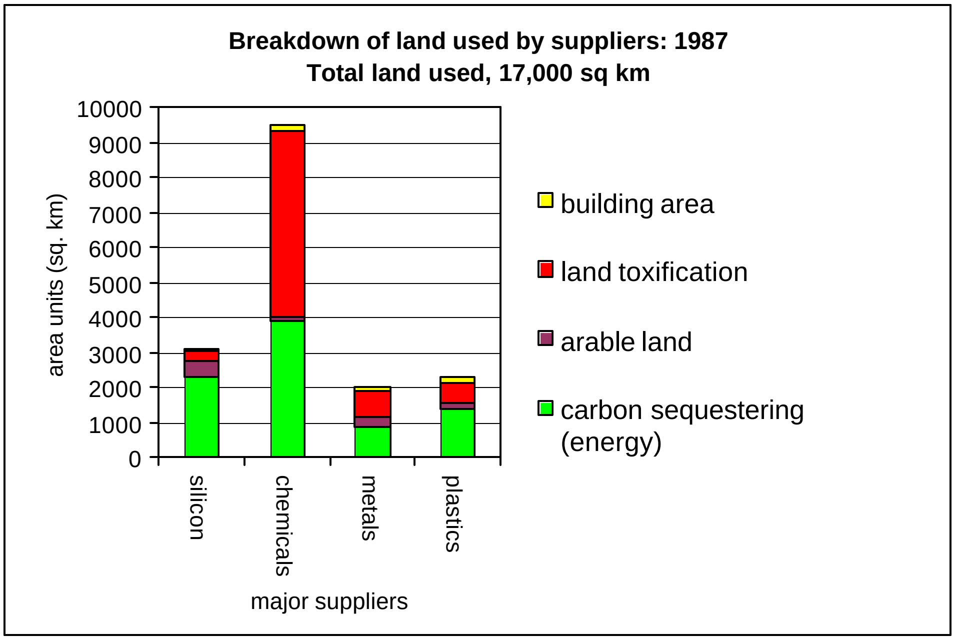

Figure 5 *Breakdown of supplier and their land requirements prior to efforts to reduce impacts*

Further analysis shows that the major contributors to land requirements from the suppliers are due to land toxification from the chemicals and in carbon sequestering from all suppliers (figure 5).

Over the years, ACME was able switch to non-toxic chemicals and to purchase energy generated from renewable energy sources (solar/wind/geothermal). This brought its total land requirement to 3,600 sq. km, as seen in Figure 6.

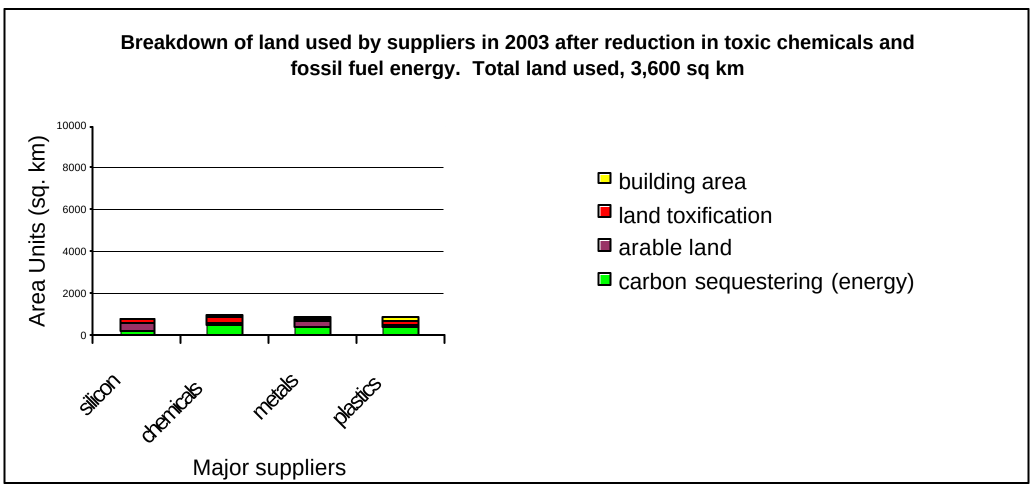

Figure 6 *Breakdown of supplier and their land requirements <u>after</u> efforts to reduce impacts*

Similar analysis was made in the other phases of the product's lifecycle and land requirements were subsequently reduced:

- **Manufacturing**: From 13,500 sq. km to 730 sq. km due to radical reduction in virgin materials, toxic chemicals and fossil fuel.

- **Transport**: From 5,600 sq. km to 300 sq. km due to the use of rail transport, community sized production, and bio- and hydrogen fuels used which were generated by solar power.

- **Use**: From 13,300 sq. km to 200 sq. km due to using electricity which was generated from solar/wind renewable sources.

- **Disposal**: From 8,700 sq. km to 500 sq. km due to the new product take back program by ACME

The results reduce land use from 58,100 sq. km to 5,330 sq. km. This equals the land allocated to the corporation and thus achieves the status of a sustainable product for land.

This process is then repeated for air, water and sea in order to calculate its complete level of sustainability.

Besides determining tangible goals for attaining corporate sustainability, this methodology can also be used to compare the relative level of sustainability between corporations and their products within a specific industry sector.

SECTION IV BENEFITS AND OPPORTUNITIES

Organizations of all types (businesses, NGOs, governments and universities) play important roles in creating products, incentives and market forces to motivate sustainable development. All would profit from this encompassing understanding of sustainability that bridges the knowledge between economics and ecology and carries forward a tangible and rigorous methodology to measure sustainable enterprises relative to earth's carrying capacity.

A methodology that measures sustainable production benefits organizations in the following ways:

1. It gives a concrete, simple and easily understood measure of an organization's sustainability goal and an internal understanding of the effort needed to meet this goal.
2. It allows a company to prioritize its sustainability efforts on the specific business phases that consumes the largest amounts of biophysical resources.
3. It gains organizational leadership and credibility from its stakeholders (investors, environmental groups, employees and public citizens). When used to publish its level of sustainability and efforts made toward attaining it, the company informs stakeholders of its situation relative to the big picture of global carrying capacity.
4. It presents a market advantage to organizations offering products with a higher level of environmental performance (sustainability). Business opportunities can be realized by marketing this enhanced credibility to the growing group of environmentally conscious purchasers, investors and workforce.
5. It can be used as a compliment to CERES Global Reporting Initiative (GRI) by giving a contextual overview of the various efforts made to attain sustainability.
6. It shares responsibility with the consumer for attaining sustainability by leveraging its corporate actions for their customers.
7. It creates a synergy along the whole supply chain.
8. Higher levels of eco-efficiency often translate into financial savings (less waste = lower costs).

Funding, development and testing acceptable metrics for measuring sustainable production will come from establishing a balanced, multi-stakeholder coalition of progressive corporations, non-government organizations, academia and government entities. Research costs are estimated at $65,000 per year for the next 4 years, If you would like to participate in this progressive coalition, please contact the author David Burdick <dwburdick@sustainablesteps>.

Reference

Bruntland Commission (1986), “Our Common Future”, in The World Commission on Environment and Development, Oxford University Press, New York

Chambers, N., Simmons, C and Wackernagel, M. (2001) Sharing Nature's Interest, Earthscan Publications Ltd, UK

Daily, G.C. and Ehrlich, P.R (1992), “Population, Sustainability and Earth’s Carrying Capacity: A framework for estimating population sizes and lifestyles that could be sustained without undermining future generations”, BioScience, November 1992

Hawken, P, Lovins A, Hunter, L. (2000) Natural Capitalism, Earthscan, UK

Norton B. (1992) “Sustainability, human welfare, and ecosystem health”, Environmental Values, vol. 1, no. 2, pp. 97-111

Noss, Reed F. (1991) “From endangered species to biodiversity” pp 227-246, in KA Kohm, (ed) 1991, Balancing on the Brink of Extinction: The Endangered Species Act and Lessons for the Future, Washington, DC: Island Press

Noss, Reed F, (1991) “Sustainability and wilderness”, Conservation Biology, pp 120-121

Noss, Reed F. and Cooperrider, Allen Y. (1994), Saving Nature’s Legacy-Protecting and Restoring Biodiversity, Washington DC: Island Press

Odum, Eugene P. (1970) “Optimum population and environment: A Georgia microcosm”, Current History, 58, pp 355-359

Wackernagel, M. and Rees, W.E. (1996) Our ecological footprint: reducing impact on the earth, New Society, Gabriola Island, BC, Canada

World Conservation Union (IUCN), United Nations Environment Programme (UNEP), and World-Wide Fund for Nature (WWF), (1991) Caring for the Earth: A Strategy for Sustainable Living, IUCN, UNEP and WWF, Gland, Switzerland:

Worldwatch Institute, (2001) “Vital Signs”, W.W. Norton & Company, NY, NY