Ecological Indicators 18 (2012) 91–97

Contents lists available at SciVerse ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

Analyzing the ecological footprint at the institutional scale – The case of an Israeli high-school

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ARTICLE INFO

Article history:
Received 7 March 2011
Received in revised form 20 October 2011
Accepted 24 October 2011

Keywords:
Ecological Footprint Analysis
Sustainability
Institutions
Ecological indicators
Schools

ABSTRACT

One way in which institutions can implement the idea of sustainability is through the use of ecological indicators that will characterize the current situation and help determine where to focus efforts in order to achieve the goal of sustainability. The use of the 'Ecological Footprint Analysis' (EFA) represents an innovative attitude to calculate the load that an institution imposes on the natural environment. The goal of this study is to illustrate the benefits of using EFA at the institution scale. Our case study is the ecological footprint of one high school in the city of Haifa, Israel. We present a unique method integrating between institutional and individuals' sourced data concerning consumption patterns at the institutional level. We then present the breakdown of the school footprint into four main components: electricity, transportation, food and materials. The results of our research reveal an overall footprint of 314 global hectares (gha), from which food and electric power are the main components followed by materials and transportation. Based on the results, we developed scenarios for potential future reduction of the high school ecological footprint.

1. Introduction

In recent decades, several indicators and concepts for measuring sustainability have been suggested. One indicator receiving a lot of attention in academic, policy and education circles is the Ecological Footprint Analysis (EFA). EFA is a quantitative tool that uses material and energy flows to estimate the biophysical 'load' that human populations or industrial processes impose on ecosystems around the world (Rees, 1992; Wackernagel and Rees, 1996). It recognizes that energy and resource exploitation (and the assimilation of CO_2 emissions) can be associated with a corresponding dedicated land/water ecosystem area. EFA, therefore, determines the total ecosystem area (global hectares) required to produce the resources consumed and to assimilate certain CO_2 emissions produced by a specified human population.

Footprint accounts have been calculated for various scales: the entire planet (e.g., Wackernagel et al., 2002; GFN, 2011), specific nations (e.g., Kitzes et al., 2007; Wackernagel et al., 1999; Haberl et al., 2001; Monfreda et al., 2004; Moran et al., 2008), cities and regions (e.g., Warren-Rhodes and Koenig, 2001; Barrett et al., 2002; Wood and Lenzen, 2003; Aall and Norland, 2005; Collins et al., 2006; Wackernagel et al., 2006; Kissinger and Haim, 2008; Scotti et al., 2009), and for specific industrial production and supply processes (e.g., Kissinger et al., 2007; Kissinger and Gottlieb, 2010).

Another scale receiving attention in recent years is the institutional scale. Calculating the ecological footprint at the institutional level has two potential merits: (1) approving the environmental accounting of institutions by monitoring sustainability performance; (2) raising awareness to sustainability principles and practices by collaborating individuals (e.g., students, employees) in the process of monitoring, collecting data, results and derived action plan for reducing the institutional ecological footprint.

Holland (2003) and Weidmann et al. (2009) focused on business EF, where the latter used an Environmental Input Output approach to calculate the EF. Weidmann (2008) presented the EF of governmental institution (the Scottish parliament). Several studies including Conway et al. (2008), Flint (2001) and Li et al. (2008) focused on higher education institute footprint. To date no academic paper focused on the ecological footprint of schools.

The overall goal of the present study is to illustrate further the potential use of the EFA as an indicator of sustainability at the institute scale, by exploring the case of an Israeli public high school. We present a detailed, step by step footprint calculation procedure adjusted for institutions pursuing sustainability.

Our paper presents the results of a one-year research project (2008/9) in one of the largest public high schools in the city of Haifa, Israel. The study presents an original, unique calculating approach adjusted to the institute scale. As different from other studies at

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doi:10.1016/j.ecolind.2011.10.010

the institutional scale, this study integrates between existing institutional data and a detailed survey among the institute students. The research measured the size of the school's EF, and its components were analyzed and discussed. Analyzing the EF enabled us (researches, teachers and students) to monitor and identify the school's 'ecological loads' and to explore directions for minimizing those 'loads'. In a recent paper (Gottlieb et al., 2012), we discussed in details the educational process and implications of EF in schools. That paper described an educational program for sustainability that was held by the first author at the studied school. The current paper highlights the methodological procedure and presents a detailed analysis of the school EF components. Furthermore, while indeed as suggested by some researchers EFA presents a snapshot of the current situation (e.g., Van Vuuren and Smeets, 2000), the present study attempted also to develop footprint reduction scenarios at the institutional level based on changing behavior and consumption patterns.

2. Background

2.1. The EF as indicator for sustainability in institutions

The measurement of sustainability for institutions, cities, regions, and nations is a complex undertaking. The broad nature of sustainability makes it difficult to find indicators that not only encompass a wide range of aspects, but also remain specific enough to allow explicit policy and action plan formation at the national, regional and organizational levels. One indicator that seeks to address the full scope of sustainability is the ecological footprint. The EF was defined by Rees (1992, 2000) as the total area of land and water ecosystems required for defined population to produce their resources and to assimilate their wastes, wherever these ecosystems are located.

While the EF has been calculated previously for institutions (Wood and Lenzen, 2003), studies have generally focused on regions and nations (see for example, Bicknell et al., 1998; Lenzen and Murray, 2001; Simmons et al., 2000; Van Vuuren and Smeets, 2000; Wackernagel et al., 2004). Such studies have highlighted the global impacts of consumption, but have not provided the intricate information at the local level needed for remediation. Detailed local information is particularly important for institutions, which have the opportunity to mitigate their impacts by controlling and directing their own institutional behavior. In fact, an institutional EFA provides guidance on where effort to achieve sustainability is best focused. Institutional EFA allows consumption to be viewed in two related ways. First, it is possible to determine where the greatest impact is occurring. Second, it is the ability to rank-order consumption based on contribution to the footprint.

Universities are one type of institutes which have a particular role in promoting sustainability. In recent years, a number of campuses have published EFA studies (Conway et al., 2008; Dawe et al., 2004; Flint, 2001; Klein-Banai and Theis, 2011; Li et al., 2008; Venetoulis, 2001). Venetoulis (2001) calculated the ecological footprint of the U.S. University of Redlands. The calculation involved three main components: water, energy, and waste output.

In more recent studies, Conway et al. (2008) and Li et al. (2008) have calculated the EF of the University of Toronto at Mississauga (UTM), Ontario, Canada and Northeastern University (NEU), China, respectively. The calculated EF was comprehensive and included beyond water, energy and waste, also, food and transportation. There are several similarities among the above mentioned studies and other, in results and methodological aspects. From the result aspect, closer examination of the calculated components reveals the largest component was the ecological footprint of energy (above 50% of the total EF). Most of the data required for calculation was collected from the institution (for example, faculty administrations). However, as noted by Rees (2003), it is the individuals' components of the institutional footprint that offer the greatest benefit for sustainability management.

2.2. The EFA as an ecological indicator (calculator) for individuals

A significant means for developing the EF as a popular indicator for sustainability has been the development of several on-line calculators (Franz and Papyrakis, 2010). Environmental NGOs, such as the World Wildlife Fund, the Global Footprint Network, and several government ministries, such as the Austrian agriculture ministry and the Australian ministries of environment and forestation, are offering an on-line EF calculator as a service on their websites.[1] Such online calculators enable individuals to calculate their load on the natural environment and estimate the degree of environmental damage in terms of the area of land that would result if all residents of Earth were to consume as they do (GFN, 2011). However, most calculators do not quantify the volume of consumed items, but rather convert the monitory value of purchased products or behaviors patterns. For example, data related to food consumption or regarding travel methods are measured according to the cost of purchase in money terms and the corresponding number of hours in which the various means of transport are used (e.g., the WWF calculator). Another way of gathering data is through posing questions to the user regarding the degree of frequency in the use or consumption of various products. For instance, in the field of food consumption, among other things, the question would be: "How often do you eat meat?" The scale of responses would vary between "never" and "very often" (e.g., the Global Footprint Network calculator). These methods of data gathering are convenient for the user, but they are not as precise as data gathering based on quantitative consumption figures per kW h (energy consumption) or per kg (food consumption). Furthermore, in EF calculators, local factors (e.g., the mixed sources of electricity production, agricultural yield per hectare, specific modes of transportation, etc.) are not taken into account or are not available to the user, such as conversion factors through which one can convert food and material consumption (e.g., paper) into area size in EF terms. As a result, the data on which the measurements of EF calculators are based do not allow for the development of reliable calculations and scenarios through monitoring and the intelligent management of resources. Therefore, in order to be more adjusted as an indicator of sustainability in institutions, the EF analysis should be based on detailed quantified and localized data, integrate a more dynamic analysis of key variables, illustrate clearly the links between individual action and aggregate environmental impacts and should combine between data from administrations and individuals. Furthermore, the method of calculation should be transparent with regard to the way in which EFA is conducted.

3. Method

Since its first appearance, EF measurements are calculated either using the compound or component-based method, or with a hybrid combination of these methods.

The choice of method is determined primarily by scale (size of the entity measured) and the format of available data. Like most other footprint studies at the institute scale we used the component EF approach. The component approach initiated by Barret (2001), Chambers et al. (2000), Simmons et al. (2000) divides the overall studied institute into the different components of its activity

[1] www.footprint.wwf.org.uk, www.ecologicalfootprint.com, www.myfootprint.org.