Sustainable Development
Sust. Dev. **16**, 1–16 (2008)
Published online 31 May 2007 in Wiley InterScience
(www.interscience.wiley.com) **DOI**: 10.1002/sd.327

Can Eco-Footprinting Analysis Be Used Successfully to Encourage More Sustainable Behaviour at the Household Level?

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ABSTRACT

The human family is currently on an unsustainable development path, which is likely to lead to a full blown environmental crisis. Humanity is overshooting nature's carrying capacity by over 20%. In the absence of politically applied environmental limits to growth, some authors believe the solution to environmental sustainability has to include a bottom-up approach, whereby individuals are encouraged to take action to reduce their own environmental impact. One factor that has limited the potential to develop this approach to date has been the inability to measurably personalize the link between global unsustainable consumption and individual lifestyles.

Ecological footprinting analysis (EFA) has the potential to bridge this gap. EFA aggregates a range of individual consumption and waste components and converts them into the bioproductive land area required to support this activity. This empirical pilot study tests whether there is scope to utilize EFA at the household level to see whether it can be used to encourage changes in behaviour towards less resource intensive lifestyles. The results support this hypothesis in that all participating households took some action to reduce their ecological footprints. Copyright © 2007 John Wiley & Sons, Ltd and ERP Environment.

Received 19 July 2006; revised 25 February 2007; accepted 8 March 2007

Keywords: ecological footprinting analysis; sustainable development; environmental sustainability; sustainable consumption; environmental impact aggregation; eco-footprinting

Introduction

APPROACHING 20 YEARS SINCE SUSTAINABLE DEVELOPMENT FIRST ENTERED THE GLOBAL POLITICAL agenda, there is widespread agreement that conventional interpretations based on a *weak sustainability* paradigm are failing to ensure global environmental sustainability. Reasons offered to explain this failure include the flexibility within Brundtland's definition, and a lack of

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political will to promote reduced consumption in favour of the prevailing mantra of economic growth (Gowdy and O'Hara, 1997; Kaivo-oja, 1999; Carvalho, 2001; Tisdell, 2001; Farley and Costanza, 2002; Giddings *et al.*, 2002; Rajeswar, 2002; Rees, 2002; Ekins *et al.*, 2003). Wackernagel and Rees (1996) suggest that the politically acceptable (*weak sustainability*) is ecologically disastrous, whilst the ecologically acceptable (*strong sustainability*) is politically impossible. Kaivo-oja (1999, p. 148) cites Smith (1991) in suggesting that the *triple bottom line* (weak sustainability) approach to sustainable development favoured by most governments is fundamentally flawed, and amounts only to a policy of 'how to destroy the environment with compassion', whilst Bartelmus (2003, p. 70) puts it more strongly when he suggests that a solution is required to 'blast away the obfuscating polemics of growth, and the devious politics that go along with it'.

Local Governments of the World (2002) argued that ten years after the Rio conventions of 1992 progress was so slow that the horrors of global environmental degradation and human poverty were becoming ever more overwhelming. The human enterprise is overshooting nature's carrying capacity by over 20%, which it is only able to do by degrading critical natural conditions and resources (WWF, 2004). According to Rees (2003), this is a potentially catastrophic situation. For Tainter (1995) the consequences of environmental collapse are so serious that environmental sustainability should be the primary topic of research and discussion in every nation.

However, Ravetz (2000) argues it is unlikely that environmental sustainability would be imposed by governments, even if there was a consensus on how to do it. Gore (1992, p. 11) charged governments with a 'failure of candour, evasion of responsibility and timidity of vision' in dealing with the environmental crisis facing humanity. Carvalho (2001) sums up the dilemma when she says that in order to avoid a full blown environmental crisis there needs to be a significant shift in attitudes and behaviour towards the causes, namely excessive consumption and waste production.

Barr (2003) agrees that *strong sustainability* cannot be implemented from above. He advocates the need for public participation if sustainable development is to have any chance of addressing environmental overshoot. He is supported by Finco and Nijkamp (2001), who conclude that a bottom-up strategy may increase support from the general public for lower impact lifestyles, and in turn provide a mandate for governments to promote environmental sustainability. This need to engage the public is further supported by Wackernagel and Rees (1996, p. xi). In his foreword to *Our Ecological Footprint*, Rees states 'this environmental crisis is a behavioural and social one . . . and the solution depends on co-operation over competition'.

It can be argued that one of the challenges for those seeking to promote environmental sustainability is to find a way to inspire the required changes in individual behaviour. If this is the case, perhaps the first step involves personalizing the link between the lifestyles of individuals and global overshoot.

Ecological Footprinting Analysis

Among the suite of tools to emerge in recent years within environmental management, one appears to fulfil the necessary criteria to bridge this gap. Ecological footprint analysis (EFA) is grounded in the biophysical reality that to live sustainably humans must use nature's renewable products and services no more quickly than they are replaced, and produce waste no more quickly than nature can absorb it (Wackernagel and Rees, 1996). Utilizing EFA as a key environmental sustainability metric finds support from Robert *et al.* (2002) when they state that it is important to define a future 'landing place', or ultimate target before embarking on a course for sustainability. EFA is the only sustainability metric, with its *one planet living* target, that can do this. *The Guardian* (2001) suggests that it is a compelling measure in its ability to convey graphically and simply the effect on the global environment of excessive consumption and increasing population. WWF (2002a) consider EFA the most rigorous and useful way of

DOI: 10.1002/sd

measuring and interpreting human environmental impact, arguing that it provides a benchmark for environmental sustainability that no other tool is able to offer.

EFA was pioneered by Professor William Rees in British Columbia, Canada. Development since has included work by Mathis Wackernagel (an ex-student of Professor Rees), and more recently by a number of organizations around the world, headed by the Global Footprinting Network, an umbrella group of practitioners. In the UK there are two centres of excellence, Best Foot Forward Ltd. in Oxford and The Stockholm Environmental Institute in York (Chambers *et al.*, 2000).

EFA measures the area of bio-productive land required to meet the prevailing consumption and waste patterns of a given entity (person, organization, city or nation). It measures the following components: food and renewable material consumption, transport use, energy use, built land and waste production (WWF, 2002a). EFA compares the area required to sustain a given pattern of consumption and waste (the *footprint*, or demand for nature) with the land available (the *earthshare*, or supply of nature). By comparing demand for nature's goods and services with supply it demonstrates whether prevailing consumption levels are environmentally sustainable. It is the only metric to offer the prospect of managing individual lifestyles towards environmental sustainability, and importantly provides the users with the opportunity to *measurably* reduce their aggregated environmental impact.

In the measurement of the bioproductive land area required to support consumption of nature's goods and services, it largely avoids the reliance on subjective values and weightings implicit in other environmental impact aggregation techniques such as cost–benefit analysis, environmental impact assessment and life-cycle assessment. On the global scale it illustrates the gap between prevailing levels of consumption and the planet's carrying capacity, or the *distance to target* to achieve environmental sustainability (Wackernagel and Rees, 1996).

EFA is not without its critics. There has been debate over its perceived methodological limitations and assumptions, such as the following.

- Its inability to take account of some pollutants (Robert *et al.*, 2002).
- Concerns over using a global average land productivity value (van Vuuren and Smeets, 2000; Haberll *et al.*, 2001).
- Suggested flaws in the method used to measure CO_2 absorption (Ferguson, 2001).

In response, practitioners point out that work continues within the Global Footprint Network to take account of pollutants, with early indications suggesting that they can increase footprints significantly. Discussions are also taking place within the network regarding the most appropriate method for accounting for atmospheric waste from energy, though sequestration remains the preferred method at the moment (Simmons, 2005). Despite their criticisms however, van Vuuren and Smeets (2000) acknowledge that EFA has been successful in providing the basis for discussion on the effects of consumption and equity.

To date, EFA has been applied largely on the macro scale (Webb, 2002). Ecological footprint analyses exist for most countries, and for numerous cities and regions (Wackernagel *et al.*, 1999; Best Foot Forward, 2002, 2005). A small number of UK local authorities have carried out eco-footprint analyses (SEI, 2005), and it appears to have been an influential tool in the Mayor of London's development strategy (Best Foot Forward, 2002). It has also been adopted as a key performance indicator for sustainable development in the Welsh Assembly. On the UK national level, the March 2005 publication by DEFRA *Securing the Future; Delivering UK Sustainable Development Strategy* mentions the potential for EFA to contribute to the UK sustainable development strategy, though it does not offer a firm commitment for incorporating it into policy (DEFRA, 2005).

The reluctance of national policy-makers to fully engage with the only tool to measure environmental sustainability perhaps reflects the earlier comments of Gore (1992) and Ravetz (2000), and their criticisms of politicians' lack of willingness to engage in environmental sustainability at all. Kaivo-oja (1999)

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suggests that governments may not even be aware of the scale of the problem, and this is another reason why visionary leadership has been missing. The following section highlights the scale of the global environmental challenge, whilst illustrating the potency of the tool.

Global Overshoot

EFA is unique in its ability to demonstrate the extent of global ecological overshoot. The global average bioproductive land and sea area available *per capita* (*earthshare*) is 1.8 hectares. In 2001 the world average footprint was 2.2 hectares per person, an excess of 21% over carrying capacity (WWF, 2004). As such effectively 1.21 planets would have been needed to cope sustainably with global consumption and waste patterns in that year. Such excessive consumption is only possible in the short term by liquidating natural capital, such as forests, soil, biodiversity and clean water, and through additions to concentrations of greenhouse gases.

Few countries operate with a domestic ecological surplus. If everyone in the world enjoyed the same lifestyle as the average UK citizen, there would need to be three planets to cope; this rises to five for the average North American citizen (Wackernagel *et al.*, 1999). This is typical of most developed countries, which operate an ecological deficit. For Rajeswar (2002) these deficits are fuelled by the profitability of companies, relying largely on relentless production and consumption, and promoted through the marketing and advertising of unsustainable lifestyles.

Most developed countries rely on importing ecological capacity from less developed countries (meaning less for the latter's citizens), and/or depleting natural capital (Wackernagel and Rees, 1996). Recently, populous less developed countries such as China and India have adopted rapid economic growth strategies. These growth strategies, along with dramatic increases in the world's human population projected by 2050, mean that the global footprint looks set to rise considerably if no action is taken, or if technological efficiencies do not keep pace with growth (Chambers *et al.*, 2000; Hands, 2002). Figure 1 graphically displays the inequity between national footprints. For Tisdell (2001), these

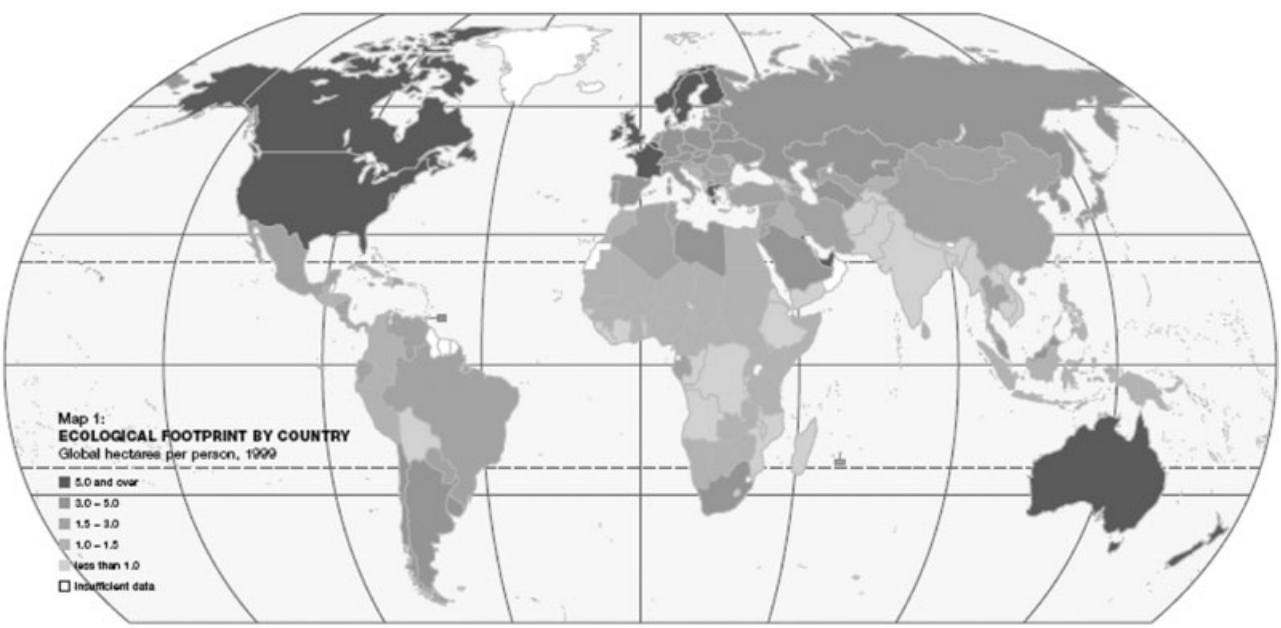

Figure 1. National ecological footprints
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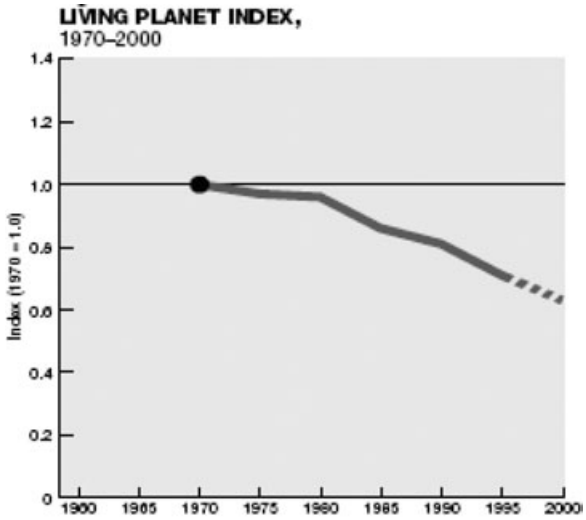

Figure 2. Living Planet Index 1970–2000
Living Planet Report 2002 – Published in 2002 by WWF – World Wide Fund For Nature (formerly World Wildlife Fund), Gland, Switzerland © text and graphics 2002 WWF. All rights reserved.

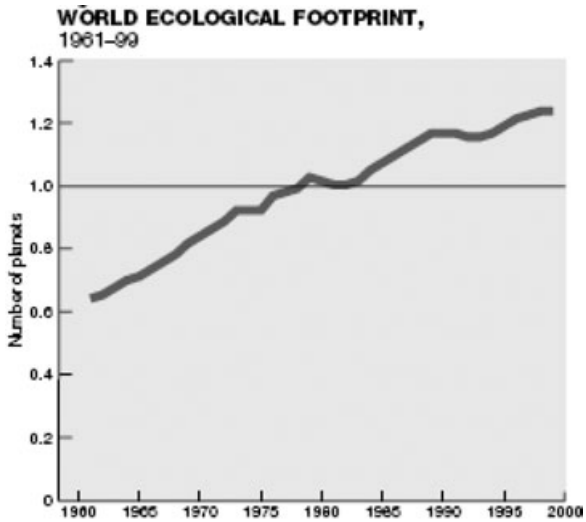

Figure 3. World Ecological Footprint 1961–1999
Living Planet Report 2002 – Published in 2002 by WWF – World Wide Fund For Nature (formerly World Wildlife Fund), Gland, Switzerland © text and graphics 2002 WWF. All rights reserved.

factors require that urgent international cooperative action is needed to balance environmental consumption with the planet's biocapacity.

One indicator of the effect that global overshoot is having on natural capital can be seen in the Living Planet Index, which monitors global populations of wild species. This shows a 35% decline in total species populations since 1970 (WWF, 2002b). Figure 2 illustrates this trend, whilst Figure 3 illustrates the increase in the global ecological footprint within a similar period. The trends suggest that the effect of increasing footprints on other species is significant; as footprints increase, biodiversity reduces.

WWF (2002b) state that another 50 years of ecological deficits at today's rate will lead to a severe ecological backlash, though recently there have been commentators who have suggested that a more rapid

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and catastrophic backlash is conceivable from climate change alone (BBC, 2005; Monbiot, 2005; Lovelock, 2006). With individual levels of consumption rising in developed countries, populous less developed countries enjoying periods of unprecedented economic growth and global human population set to increase by 50% in the next 45 years, the challenge appears daunting. If Wackernagel and Rees (1996) are right, and indeed the ecologically acceptable is politically impossible, then perhaps the required journey towards environmental sustainability relies in part on individuals (and organizations) reducing their own footprints. To enable this, individuals will need to be convinced that they are part of the problem and the solution, and that their actions can make a measurable difference. Furthermore, they will need to be given information with which to make informed choices. EFA appears well placed to provide this stimulus.

EFA challenges humanity to find a way to live peaceful, comfortable and satisfying lives on less than 2 hectares *per capita*, whilst taking into account the needs of other species. For Rees (2003) the alternative appears to be resource wars and geopolitical chaos. If humanity is to find ways to return to environmentally sustainable living, fundamental changes are required to individuals' patterns of consumption and waste production (WWF, 2002a). Wackernagel and Rees (1996, p. 102) frame the question succinctly when they ask 'does humanity have the moral and political will to negotiate a global social contract governing more equitable access to ecological goods and services for all the World's people, whilst staying within the limits of the biosphere?'. EFA provides a powerful metaphor to convey the immediacy of the challenge and appears to be the only metric that offers the prospect of individuals managing their lifestyles towards environmental sustainability.

Adapting EFA for use at the individual level is supported by Ekins *et al.* (2003), who suggest that sustaining a balanced environment will require the identification of those activities having a negative effect, whilst devising ways of easing these pressures. For example, the amount of land required for a typical meat based diet is six times greater than that for a wheat based diet (Gerbens-Leenes and Nonhebel, 2002). As such, switching to a wheat based diet can significantly reduce an individual's environmental impact. This empirical pilot study tests whether individuals can be inspired into adopting less resource intensive lifestyles by providing them with their eco-footprints and linking their consumption patterns to global ecological overshoot.

Case Study

Approaches so far using EFA have concentrated on a top-down approach, i.e. measuring the footprints of nations, regions and cities. Methodologies utilizing a bottom-up approach to EFA will need to evolve, and may use different strategies in the short term (Barr, 2003). This iterative approach offers an initial methodology for using EFA at the household level. Figure 4 illustrates the methodology used in this study. Households completed a sequence of four questionnaires over a 3 month period, and they were provided with a mini-report to read between Questionnaires 2 and 3, which linked global overshoot to individuals' lifestyles. This study was made possible thanks to kind permission from Best Foot Forward Ltd. who provided access to their *Personal Stepwise* EFA software.

The results to each questionnaire are presented in sequence after the description of the content within.

The Study Group

The study group was composed of 18 households, reflecting the UK typical age and household composition mix as follows (Office for National Statistics, 2001).

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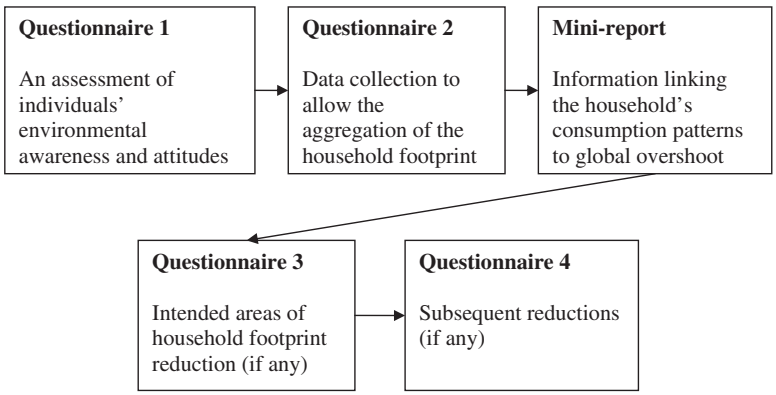

Figure 4. Methodological flowchart

Household composition	Number in the group
One-parent families	2
Single people aged 18–59	3
Single people aged 60+	3
Couples aged 18–59	3
Couples aged 60+	3
Families with children at home	4
Total households	18

Within the 18 households, there were 38 individuals.

Questionnaire 1

Each individual of secondary school age and over was asked to complete the first questionnaire to establish the following.

1. The individuals' own perception of their environmental awareness.
2. An objective assessment of their environmental awareness.
3. Individuals' attitudes towards the environment.

This was to allow for cross-referencing at the end of the study to establish whether awareness and attitudes were important factors in determining specific emergent environmental behaviour. It was thought that requesting responses from those of at least secondary school age was appropriate, as children of that age should be capable of understanding the questions and should have a reasonable comprehension of environmental issues, whilst there is the potential for a degree of influence over their household's consumption patterns. All 32 individuals of secondary school age and over duly completed this questionnaire. Table 1 presents the results from Questionnaire 1.

There was a wide range of scores for all three sections of the questionnaire, demonstrating wide variety within the group in terms of environmental awareness and attitude. Where appropriate, comments relating awareness and attitudes to emergent behaviour are included in the results to Questionnaire 4 and in the discussion.

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Summary	A	B	C
Lowest score	14%	3%	39%
Highest score	100%	86%	100%
Range	86%	83%	61%
Average score	73.00%	34.28%	74.18%

Table 1. Questionnaire 1 results (an assessment of the environmental awareness and attitudes of participants)
A: Participants' own perception of their environmental awareness.
B: An objective assessment of their environmental awareness.
C: Participants' environmental attitudes.

Questionnaire 2

Respondents were asked to provide consumption and waste data for their household footprint to be calculated. This included data for food and energy consumption, transport use, house and garden size, waste production and consumer spending. From these data the household footprints were calculated, using *Personal Stepwise*. Footprint scores were produced for each household and were then divided manually by the number of occupants to arrive at individual footprints, given as *global hectares* (gha) per person. In addition, *Personal Stepwise* calculated the number of planets that would be required if everyone in the world had the same footprint as individuals in the household in question.

Figure 5 shows the top section from the *Personal Stepwise* Eco-footprinting software package used in this study, in this case demonstrating a footprint similar to that of the average UK citizen[1].

Questionnaire 2 Results (Household/Individual Footprints)

Individual footprint scores ranged from 2.05 to 9.85 hectares, the equivalent of 1.06–5.17 planet living.[2] The average scores were 4.33 hectares or 2.26 planets per person. These scores are below the UK average of 5.2 hectares or 3 planets per person[3] (Wackernagel *et al.*, 1999). There were only four households where individuals scored on or above the UK average three-planet lifestyle. However nobody operated within a one-planet lifestyle, symptomatic of the wider situation in developed countries (Chambers *et al.*, 2000). Hands (2002) highlights the gap between affluent western lifestyles and typical Asian and African consumption. Average *per capita* North American footprints are 9.6 hectares, average Western European footprints are 5.0 hectares, whilst average African and Asian footprints are 1.4 hectares.

After calculating each household's footprint, reduction scenarios were calculated, showing where specific reductions in impact could be made if individuals or the collective household wished to do so. At this stage a mini-report was produced for each household and sent accordingly, giving the following information.

[1] Figure 5 displays output data at the top of the spreadsheet, expressed in three formats. 1. *Gha* (global hectares) *per capita* (5.29). 2. The number of planets that would be required if everyone had the same size footprint (2.7). 3. The contribution of each component to the total footprint (the pie chart). In the pie chart, Shelter incorporates energy and built land required for the home. Below the output data, users are required to input data for the various components, starting with Nourishment and Mobility. The other components follow accordingly, but are not shown in this figure.
[2] *Personal Stepwise* allows for bioproductive seas, and therefore the average earthshare increases to 1.9 hectares.
[3] It is possible that this could represent under-accounting by respondents in the data they submitted for the calculations, although it is possible they are true reflections of the household footprint and are lower than the UK average.

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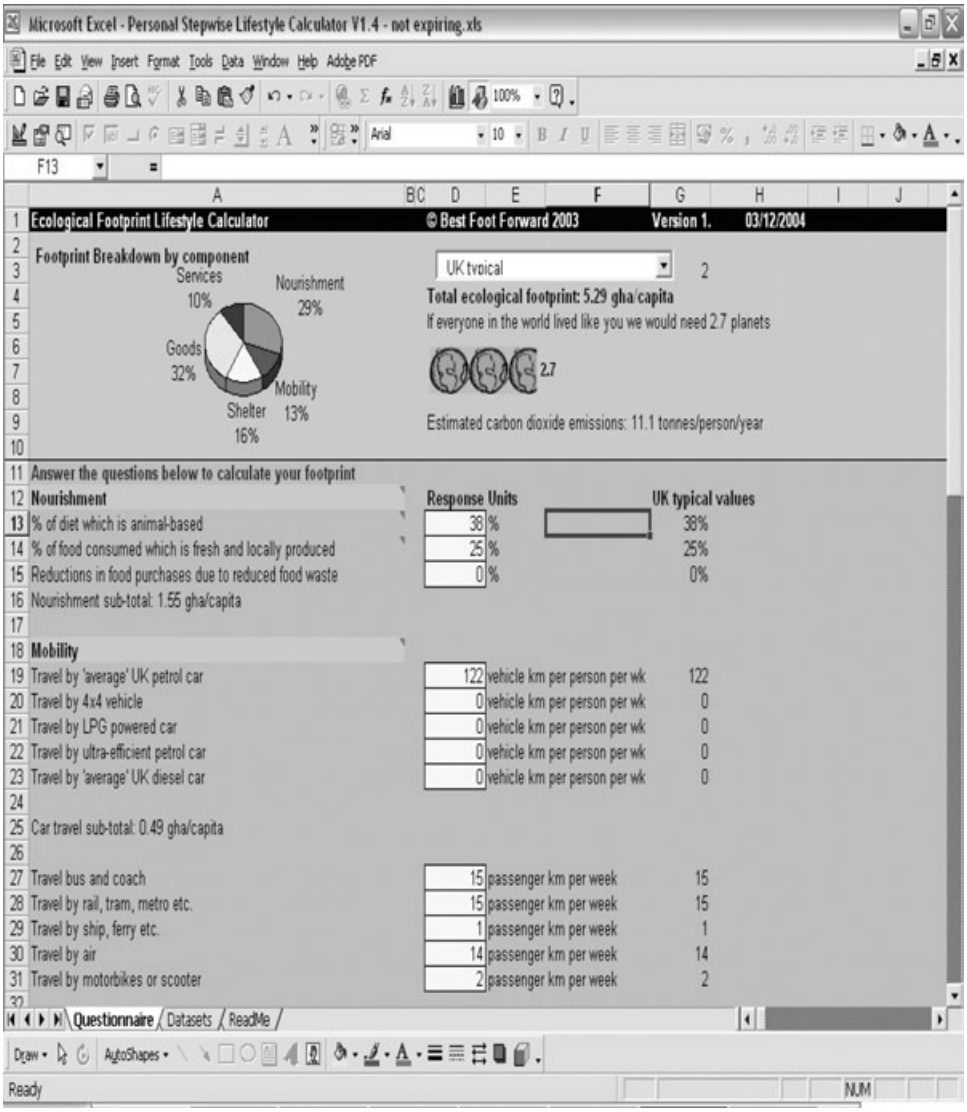

Figure 5. Top section of *Personal Stepwise©*
Reproduced by permission of Best Foot Forward Ltd, 2006.

- Household footprint and reduction scenarios.
- An explanation of the contribution of (Western) environmentally unsustainable lifestyles to global overshoot.
- Information explaining how household footprints could be reduced if individuals in the household were inclined to take action.

It was thought that this report would take around 20–30 minutes to read and absorb.

Questionnaire 3

Respondents were asked to confirm their understanding of the household footprint and reduction scenarios, and confirm whether they were likely to consider changes in behaviour to reduce their footprints

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Category	Intended reductions (No. of households)	Percentage of households	Actual reductions by deadline	Conversion rate	Reductions intended after deadline
Nourishment	11	61%	**10**	91%	1
Transport	8	44%	**6**	75%	2
Home energy	10	56%	**7**	70%	2*
Waste	13	72%	**12**	92%	3*
Consumer spending	1	6%	**0**	0%	0

Table 2. Questionnaire 4 results (post-EFA changes in consumption behaviour)
* denotes one family who joined the study late in order to replace an original family from whom delays in receiving information were experienced. The replacement family did not have sufficient time to complete Questionnaire 4 before the deadline for writing up the results. As such, they have been included in the 'Reductions intended after deadline' column. It is possible that they might have made changes to the Home energy and Waste components they highlighted as intended reductions in Questionnaire 3 had they been given the same time as everyone else.

in light of the information provided. If so, they were asked to highlight which areas they were intending to reduce.

Questionnaire 3 Results (Areas of Intended Reduction)

All 18 households indicated that they understood the information provided and would make changes to either behavioural practices, such as nourishment habits, transport use or waste disposal, or fixed issues such as their electricity supplier. An average 2.35 components per household were highlighted for intended reduction (43 in total; see Table 2). A summary of the components highlighted for reduction are listed in descending order as follows:

- Waste 13 households (72%)
- Nourishment 11 households (61%)
- Home energy 10 households (56%)
- Transport 8 households (44%)
- Consumer spending 1 household (6%)

Number of components per household	Number of households
1	1
2	9
3	8

Questionnaire 4

Two months later, households were asked whether they had incorporated any changes since the communication of their footprint and production of the report (Table 2). At this final stage respondents were also asked to give an honest assessment of the methodology employed in the study. The comments received are presented in Table 3.

The method employed in this study relied on the honesty and accuracy of participants at all stages, and they were asked explicitly to respond to all questions as honestly and accurately as possible. Of the 18 households who intended to make reductions to their footprint, 17 responded positively in Questionnaire 4 when asked whether they had carried out any or all their intended actions. This is classified

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Positives	Number of votes	Negatives	Number of votes
Interesting	11	Dull and uninspiring	0
Enlightening	11	Pretty boring really	0
Easy to follow	7	Difficult to follow	1
Very interesting	5	Too long	1
Easy to understand	6	Difficult to understand	0
Will tell friends about this	8	OK, but it won't make any difference	1
I think this issue is really important	13	No over-riding impression	1
		Complicated	3
Total	61		7

Table 3. Study group feedback summary

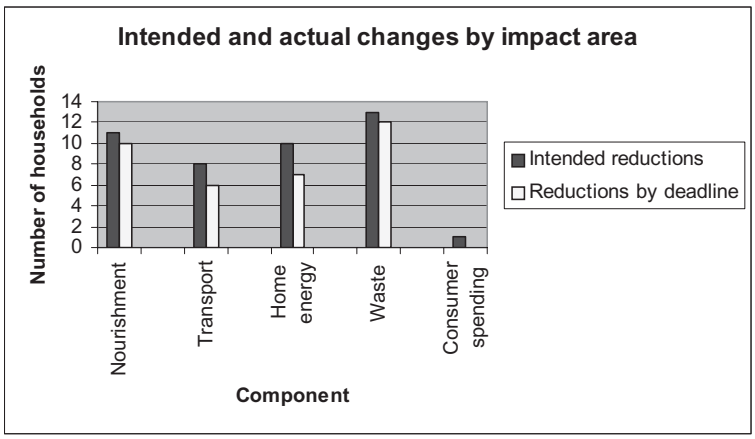

Figure 6. Summary of intended and actual changes by impact area

as a 100% conversion rate, due to the issue raised in Table 2*. Five households reported reductions from one component, six from two components and a further six from three components. The average number of components of reduction per household was 2.05 (35 across 17 households) compared with intended reductions of 2.39 (43 across 18 households). Time restraints inherent in the iterative method employed in this study did not allow for a systematic evaluation of responses to Questionnaire 4 in order to test their integrity, though there was substantive anecdotal evidence from observations of a number of households along with unsolicited feedback received during and since the study duration to support the assumption that respondents were recording behavioural change accurately and honestly. Future studies may wish to test the validity of responses.

Figure 6 summarizes the intended and actual changes graphically.

Future research may also wish to investigate the reasons behind such changes in behaviour at the household level, though anecdotal evidence from comments made by participants in Questionnaire 4 suggested that EFA proved to be a powerful agent in driving positive responses, both in terms of attitudes and behaviour (see responses to participants' experience of the study below).

The results are largely consistent with Kaiser *et al.* (1999) and Rowlands *et al.* (2003), who suggest a positive link between environmental attitudes and emergent behaviour. The high average

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environmental attitude score in Questionnaire 1 (74%) was followed by unanimous impact reductions in Questionnaire 4 (100%). Interestingly, the participant with the lowest attitude score (39%) was also the one with the lowest intention for change, the only participant to highlight just a single component for reduction. However, even this participant reported subsequent reductions in the component highlighted, suggesting an acceptance of personal responsibility despite a low attitude score.

The results appear to contradict Hinchcliffe (1996), however, who argued that scope to induce even slight changes in lifestyles is extremely limited (Barr, 2003, cites Hinchcliffe, 1996). The mini-report provided to all households linked the size of their footprints to the global, not local or personal threat, and yet there was clearly a high uptake in intended and actual change, with all households effecting some reduction. It is possible of course that participants perceived global threats as having the potential to become personal threats in the longer term.

At the end of the final questionnaire, participants were asked to rate their experience of the study from a list of positive and negative criteria. It was hoped to elicit feedback in order to develop further a suitable methodology for utilizing EFA as a tool for engaging individuals in reducing their environmental impact. Households were invited to choose those comments from the listed options that they believed best described their perception of the study. Of the 15 alternatives, 7 were areas of strength and 8 were areas for improvement. Of the 68 responses, 61 highlighted areas of strength, whilst 7 highlighted areas for improvement, a ratio of approximately 9/1 (see Table 3). As such, it is thought that there is potential for developing this methodology, although some adjustments may be needed to simplify the process as three respondents described it as complicated.

Discussion

This study was underpinned by the premise, supported by Farley and Costanza (2002), that most sectors of society would agree that environmental sustainability is a desirable end. However it is argued that the prevailing economic paradigm based on unlimited growth and consumption will not provide such an outcome (Finco and Nijkamp, 2001). Carvalho (2001) argues that structural change on the political/economic scale threatens the *status quo* of a powerful political and commercial elite in Western economies. Like Gore (1992) and Tainter (1995) she questions whether governments, often influenced by a powerful business lobby, will take up the challenge of environmental sustainability, which ultimately requires reduced consumption *per capita*, at least in material terms. If the journey towards environmental sustainability is to begin then, perhaps it will need to start from the bottom up. Barr (2003) cites Burgess (1998, p. 1446) when he suggests that 'sustainability is predicated on the belief that individuals and institutions can be persuaded to accept responsibility for environmental problems, and change their everyday practices to alleviate future impacts'.

Bhate (2003) argues that the shift towards environmental sustainability must happen simultaneously from the top down (governments) and bottom up (individuals). Individuals need to display support for change before governments will adopt such policies to channel this support. In this study individuals appeared to accept a level of personal responsibility for wider global unsustainability once the link had been explained, and showed a desire to make behavioural changes towards more environmentally sustainable lifestyles.

Hands (2002) summarizes the areas of potential reduction for less resource intensive lifestyles. Examples offered include eating locally produced food, more walking and cycling, green electricity supply and increased levels of recycling. Measures relating to all of these areas were identified in the mini reports sent to households following footprint analyses, with specific guidance as to how they might be incorporated into lifestyle changes. By taking these measures, or a combination of them, Lazarus (2002)

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argues that it is possible to maintain quality of life, whilst reducing environmental impact. The subsequent unanimous uptake in reduction commitments by the study group was consistent with Barr's conclusion that a clear appreciation of the environmental impacts of individual lifestyles can lead to positive attitudes and subsequent behavioural change (Barr, 2004).

The universal uptake of reductions in individual and household environmental impact within this study indicates a willingness to undertake the lifestyle changes that Gerbens-Leenes and Nonhebel (2002) consider to be powerful options in reducing the use of natural resources. Changes were made to four of the five components, the exception being consumer spending.[4] This is arguably the most intractable component, as it conflicts with the dominant Western view of value residing in material possession.

There was widespread behavioural change from the following components; nourishment, transport use, home energy and waste. The following section addresses each in turn. The willingness to change nourishment habits can be regarded as consistent with a modest trend in the rise in popularity of community farms and food markets to serve local districts identified by Chambers *et al.* (2000). Numerous respondents reported attempts to source locally produced food, and one had agreed to join a local food-growing cooperative as a direct result of receiving his EFA and understanding its content. Perhaps unsurprisingly, this individual had scored 95% on the attitude questionnaire.

The willingness to make changes to transport methods is consistent with the conclusions from a study by Barrett and Scott (2003), who noticed that changes in behaviour could be influenced when highlighting the impacts of different modes of transport along the same route. In this study, changes included those who were prepared to move to a lower impact mode of transport in the short term, to those who confirmed a desire to purchase a vehicle next time that has a lower impact (shown in the intended future changes column, Table 2).

Behavioural change from the home energy component may have been influenced by the relative ease with which reduced impact could be achieved. The group were advised that they could switch to renewable electricity suppliers by making one phone call (telephone numbers were given for two suppliers), and a number of participants recorded that they had done so.

High levels of engagement with household waste reduction coincided with the introduction of a more extensive door to door recycling scheme in one area containing 12 households in the study. The scheme was introduced during the study's duration, thereby maximizing the potential for participants to change behaviour. Waste featured strongly in responses to objective understanding of environmental issues in the first questionnaire, suggesting that participants had a good understanding of how reductions could improve their impact. Barr (2003) argued that high levels of recycling can be achieved when convenience and subjective norms are maximized, which appears to have been the case in this study.

Van Vuuren and Smeets (2000) suggest that EFA is only an indication of the current situation, and not a solution to overshoot. This study attempted to take this premise to the next stage by offering reduction scenarios to households to see whether they are interested in reducing their environmental impact. It is clear that all households made some efforts to reduce their impact in the short term. Sustaining reduced impact lifestyles may require additional stimulus. Barr (2003, 2004) suggests that only those who gain personal satisfaction from environmental action are likely to sustain these changes, whilst recognizing that the potential for wider acceptance of lower-impact lifestyles exists if behaviour such as recycling becomes more socially accepted. He suggests normative behaviour can lead to a social

[4] *Personal Stepwise* includes a component for the land area required for house and garden, and therefore has six components. Whilst this component was included in the households' footprint it was not included in the reduction scenarios or given as a component that could be reduced, although improving the conditions for biodiversity in the garden would have a positive effect on the footprint. As such, only five components were identified for the study group, of which changes were observed in four.

DOI: 10.1002/sd

pressure that serves to increase the sustainability of new, reduced-impact lifestyles, and argues that this process can be helped by local authorities providing facilities to enable short-term changes to become long-term habits, such as recycling facilities and local produce availability.

In terms of finding new solutions to long-term behavioural change, it is interesting to note a comment from DEFRA (2003) which mentions the concept of an ecological consumption budget for each household that individuals could choose how to spend. Evidence that this approach may now be the subject of (at least academic) discussion is further provided by Porritt (2004) and Fawcett (2005), who confirm that a household life-long consumption budget for CO_2 is also the subject of discussion as a potential tool to reduce long-term emissions of greenhouse gases.

Were such concepts to gain momentum, they would need metrics that could cope with the complexity of data involved, and provide a simple, easily understood and clear visual output that could be used to support change. As far as ecological consumption budgets are concerned, EFA appears to offer potential for use as such a tool. The results from this study appear to show that individuals made reductions to their environmental impact as a direct result of understanding the size of their ecological footprint and the resultant environmental unsustainability of their lifestyles. Future research may wish to test this approach against a larger study group.

Conclusion

It appears that the time has come to break out of past patterns of development and consumption, which have only served to increase social and ecological instability. In spite of mounting evidence of increasingly unsustainable development, there has been little success to date to balance human consumption patterns within environmental limits. Only considerable reduction in the consumption levels of individuals in developed countries is likely to meet the goal of environmental sustainability in the short term. The logic of the eco-footprint demonstrates that humans must learn to live within the planet's carrying capacity, and find a way to live comfortable, satisfying lives by using no more than 2 hectares per person. The question remains as to whether people can be persuaded to reduce their eco-footprints to this level. The results from this study suggest that EFA can be used successfully to inspire reductions in the environmental impact of individuals. As such, it is believed that the tool could have an important role to play in empowering individuals to adapt more environmentally sustainable lifestyles.

Acknowledgements

Grateful thanks to Craig Simmons, director of Best Foot Forward, for his kind permission to use the company's EFA tool *Personal Stepwise* throughout the course of this project.

Thanks to every member of the study group, without whom this project could not have happened.

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DOI: 10.1002/sd