

A critique of Ecological Footprinting as a tool for measuring the impacts of food-related lifestyle on sustainability

Elanor Alun

Level 6, BSc (Hons) Environmental Conservation

Crynodeb

Mae sicrhau cynaliadwyedd (h.y. diwallu anghenion cymdeithasol, economaidd ac amgylcheddol poblogaeth) wedi mynd yn broblem fyd-eang o bwys, yn enwedig yn wyneb y cynnydd ym mhoblogaeth y byd. Datblygwyd nifer o ddulliau i helpu i fesur cynaliadwyedd, un o'r rhain yw'r Ôl-troed Ecolegol (EF). Yn y cyfamser, yn aml wrth i'r ddemograffeg newid, cynhyrchir EF sy'n wahanol, oherwydd eu harferion sy'n amrywio o ran ffordd o fyw ac o ganlyniad, gofynion adnoddau. Un enghraifft yw effaith ffordd o fyw sy'n gysylltiedig â bwyd; mae astudiaethau wedi dangos bod gan y rheini sy'n dweud eu bod yn llysiuwyf fwy o gydymdeimlad ag achosion a mudiadau amgylcheddol na'r rheini sy'n dweud nad ydynt yn llysiuwyf (Hoek *et al.*, 2004; Ruby, 2012; Ruby *et al.*, 2013). Fodd bynnag, gan fod yr EF rhagdybio'n syth fod llysiuwaeth yn fwy cynaliadwy, a yw'r gwelliant yn y sgôr yn deillio'n unig o'u deiet, neu'n wir o ffordd o fyw sy'n gysylltiedig â bwyd? Mae'r astudiaeth hon yn ystyried addasrwydd defnyddio EF yn ddull o asesu'r cwestiwn hwn.

Datblygwyd y Rhaglen Dadansoddi Adnoddau ac Ynni (REAP Petite), gan Athrofa Amgylcheddol Stockholm. Fe'i dewiswyd ar gyfer yr astudiaeth oherwydd ei system addunedu – sef dull sy'n caniatáu i'r defnyddiwr gyfrif yr EF a ragfynegir ar ôl newidiadau yn ffordd o fyw rhywun. Rhoddwyd holiadur i 60 o drigolion Abertawe, de Cymru, ynghylch eu ffordd o fyw ym mhym categori cartref, bwyd, teithio, deunyddiau bwytadwy, a gweithgareddau. Nododd 30 o'r ymatebwyr eu bod yn llysiuwyf, a 30 eu bod yn hollysuddion. Ar sail llenyddiaeth bresennol, rhagdybiwyd y byddai gan y llysiuwyf EF cyfunol is; wedyn gellid gwneud i'r hollysuddion addunedu dilyn deiet heb gig, a byddai'r EF a ragfynegir yn datgelu a oedd newid y deiet ynddo'i hun wedi cau'r bwlch rhwng y naill grŵp a'r llall, neu a oedd y llysiuwyf yn parhau i fod yn is oherwydd eu ffordd o fyw o ran bwyd.

Dangosodd y canlyniadau, mewn gwirionedd, fod gan y llysiuwyf sgorau EF uwch, Ôl-troed Carbon a defnydd dŵr, a chyfraddau ailgylchu is, er nad oedd unrhyw wahaniaethau yn arwyddocaol o safbwynt ystadegol heblaw am categori bwyd. Yn ogystal, nid oedd modd defnyddio'r system addunedu am na allai REAP Petite wahaniaethu rhwng deietau cig isel a heb gig. Gwnaed argymhellion ar gyfer ymchwil y dyfodol er mwyn archwilio ymhellach y telerau ymchwil.

Geiriau allweddol: Ôl-troed Ecolegol, cynaliadwyedd, bwyd, llysiuwaeth

Abstract

Achieving sustainability (i.e. meeting the social, economic and environmental resource needs of a population) has become a major global issue, especially in the face of global population rise. Many tools have been developed to help measure sustainability, one of which is the Ecological Footprint (EF). Meanwhile, different demographics often achieve differing EFs, owing to their varying lifestyle practices and therefore resource demands.

An example is the impact of food-related lifestyle; studies have shown that self-identified vegetarians have greater affinity for environmental causes and movements than non-vegetarians (Hoek *et al.*, 2004; Ruby, 2012; Ruby *et al.*, 2013). However, since the EF automatically assumes that vegetarianism is more sustainable, is the improved score from diet alone, or truly from food-related lifestyle? This study examines the suitability of using the EF as a tool to assess this question.

The Resources and Energy Analysis Programme (REAP Petite), developed by the Stockholm Environment Institute, was selected for the study owing to its pledge system – a tool that allows the user to calculate the projected EF after alterations are made to a person's lifestyle. 60 residents of Swansea, South Wales, were given a questionnaire covering aspects of their lifestyles in the five categories of home, food, travel, consumables, and activities. 30 respondents were self-identified vegetarians, while 30 were omnivores. Based on existing literature, it was assumed that the vegetarians would have a lower combined EF; the omnivores could then be pledged to a meat-free diet, and the projected EF would reveal whether dietary change alone brought the two groups in line, or if the vegetarians were still lower owing to their food-related lifestyle.

The results in fact showed the vegetarians had higher scores in EF, Carbon Footprint and water use, and lower recycling rates, although no differences were statistically significant other than the category of food. Additionally, the pledge system could not be utilised owing to REAP Petite being unable to differentiate between low- and zero-meat diets. Recommendations were made for future research to better examine the research terms.

Key words: Ecological Footprinting, sustainability, food, vegetarianism

1. Introduction

1.1. Rationale

Since its first introduction to public consciousness by Rachel Carson in 1962, sustainability has become a key logistical issue for governments at all levels as they attempt to meet their social, economic and environmental resource needs (Brundtland Report, 1987), an issue that has become increasingly important, among other factors, in the face of global population growth (Vörösmarty *et al.*, 2000; Population Institute, 2007). In order to help policy-makers measure sustainability at different levels and thereby create suitable environmental strategies, various measurement tools have been developed.

One such tool is the Ecological Footprint (EF), which utilises the concept of a global carrying capacity – its “maximum persistently supportable load” (Catton, 1986; cited in Wackernagel and Rees, 1996). First proposed by Rees (1992) and Wackernagel (1994), EF measures resource demand against the planet’s biocapacity – the “capacity of ecosystems to produce useful biological materials and to absorb waste materials generated by humans” (Michel Serres Institute, 2014). The Earth’s biocapacity has been estimated at 1.8 gha, or global hectares per person – the area of biologically-productive land required to support the human population (Global Footprint Network (GFN), 2010a). In this way, the environmental impact of an entity – be it an organisation, a community or an individual – can be estimated through measuring multiple lifestyle factors.

This latter ability makes it well-suited to assessing the impacts of particular demographics, a vital area of knowledge in policy-making. One such demographic relates to food, an unavoidable area of resource use. In recent years, studies have found that diets high in animal products are less sustainable than those high in vegetable products (Food and Agriculture Organisation (FAO), 2006; Goodland and Anhang, 2009). However, there are social aspects related to food that should be considered. Vegetarianism in the Western world correlates strongly with a generally left-wing, liberal philosophy, characterised by higher levels of empathy and concern for their own impacts on the world, both environmentally and morally (Hoek *et al.*, 2004; Ruby, 2012; Ruby *et al.*, 2013), a phenomenon known as a ‘food-related lifestyle’. This begs the question: impacts of diet itself aside, do vegetarians have a generally more sustainable lifestyle, and can this be measured by an EF?

Some specific calculators may have that capacity. In Britain, the Resources and Energy Analysis Programme (REAP), created by the Stockholm Environment Institute (SEI), is used to calculate EF at a local authority level, with a variant – REAP Petite, used for very small communities. One of the primary trappings of REAP Petite is its pledge system, a tool allowing an individual to pledge a new behaviour in their lifestyle (e.g. pledging to travel by bus instead of car) and view the difference this would make to their EF. This ability theoretically allows the issue of diet to be removed, and the remaining lifestyle factors to be assessed.

1.2. Aim and Objectives

Aim: to examine whether the EF is a useful tool for evaluating the impacts of food-related lifestyle on EF.

Objectives:

- To conduct a case study of individuals in the Swansea area who self-identify as either vegetarian or omnivorous and issue them with questionnaires about aspects of their lifestyles.
- To use REAP Petite to calculate their EFs
- To use REAP's pledge system to determine if diet alone is the influencing factor in predicted differences between the two groups' EFs

It is hypothesised that the overall EF of the vegetarians will be lower than that of the omnivores.

1.3. Geographical Background

Swansea is a small city in South Wales with a population of around 239,000 (Office for National Statistics (ONS), 2012). It holds around 104,800 households with an average size of 2.25 residents (City and County of Swansea, 2014). Its average EF is 5.15 gha, with the highest areas of consumption comprising fuel, food, and personal travel (SEI, 2008). In terms of deprivation, it has 17 Lower-Layer Super Output Areas classed as *deprived* in the top 190 of the Welsh Index of Multiple Deprivation, 2011, while 130 are classed as *less deprived*. Figure 1 shows the distribution of Swansea's Townsend Deprivation Scores; the higher the score (and darker the colour), the more deprived a ward is.

Politically, Swansea leans left wing: the Council has been under the control of either Labour or a Liberal Democrat coalition since 1996, with the primary third party being Plaid Cymru.

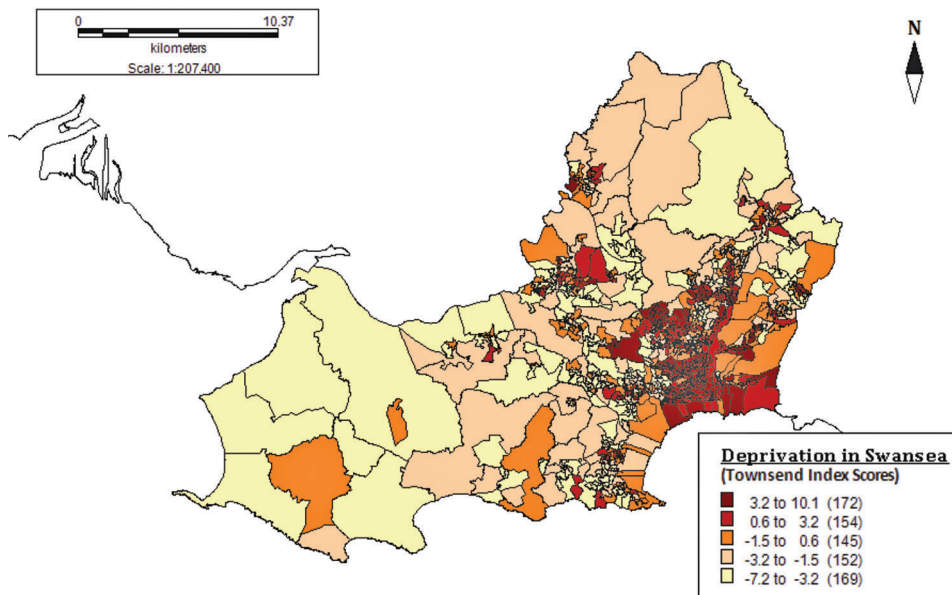


Figure 1: Deprivation in Swansea.

Prifysgol Cymru Y Drindod Dewi Sant

2. Literature Review

2.1. Ecological Footprint

Although generally accepted, there have been criticisms of the EF, most of which address its inability to predict natural capital degradation (Schaefer *et al.*, 2006; Giljum *et al.*, 2007; Best *et al.*, 2008; Fiala, 2008; Maguire *et al.*, 2008). It has also been criticised for inherently holding the position that zero greenhouse gas (GHG) emissions are to be desired (van den Bergh and Verbruggen, 1999), which Fiala argues is not a clear necessity from an environmental or economic standpoint. Most, however, agree that the EF is not only successful at gauging impacts on regenerative capacity, but also integrates all resource use in these terms, which has led the European Commission (EC) and countries such as Switzerland, Ireland and Germany to all recommend and adopt its use, provided it is used alongside other methods (Schaefer *et al.*, 2006; Giljum *et al.*, 2007; Best *et al.*, 2008; Maguire *et al.*, 2008). In a general sense, Gondran (2012) makes the case that the EF is a particularly useful tool at communicating information to the public, since overly-complex systems tend to be ignored (Moser, 2014).

This, however, is study at a national level; much less analysis has gone into the efficacy of the EF at a sub-national level, where calculations and methodology vary (El Bouazzaoui *et al.*, 2007; Gondran, 2012). However, the pattern of correlation between high income, consumption and high EF at a national level (Stechbart and Wilson, 2010) has been found also at a local level (Barrett and Scott, 2003; Mackenzie *et al.*, 2008; House *et al.*, 2010).

REAP has similarly had little in-depth analysis. Paul *et al.* (2010) wrote that its greatest advantage lies in its input–output methodology, which allows it to account for emissions in every sector. Additionally, it can be used at multiple scales, both small and large, and is a powerful tool for modelling scenarios to measure the impact a policy might have. However, the Local Carbon Frameworks (LCF) programme's Expert Group contend that it cannot convert policy into changes in the footprint directly, and instead must convert policy change into variables to measure these impacts (LCF, n.d.).

2.2. Dietary Impacts

The EF holds the fundamental viewpoint that meat and animal products are automatically less sustainable than plant-derived foods, and this is an intrinsic part of its methodology. While CO₂ is widely discussed as a GHG, methane is much more efficient at capturing radiation and thus arguably is a greater contributor to climate change (BBC, 2014). Over 60% of global methane emissions are from anthropogenic activities (Environmental Protection Agency (EPA), 2010), the primary source of which is livestock rearing (EPA, 2014). In 2006, the FAO of the UN reported that cattle rearing globally produces more GHG emissions than car driving, and is responsible for 18% of global GHG emissions. Goodland and Anhang (2009) argued that this was a conservative estimate owing to methodological flaws, such as the exclusion of animal respiration, and claimed that the figure is actually 51%.

However, these standpoints are not without criticism. Herrero *et al.* (2011) argue that, while there is generally international consensus that livestock rearing is an important methane contributor, the numbers vary wildly between scientists and

methodologies and make policy-making difficult; they also direct attention away from the most important anthropogenic GHG sources. Additionally, Goodland and Anhang specifically were criticised for ignoring the importance of livestock rearing to huge numbers of people in the world, particularly in areas of regular crop failure such as sub-Saharan Africa. Similarly, Pimentel and Pimentel (2003) claim that, while in a “limited sense” a vegetarian diet is more sustainable than the average US meat-based diet, the US food system’s heavy reliance on fossil energy renders a diet of any kind unsustainable. It should also be noted that there is ongoing research into reducing livestock emissions, such as the so-called anti-methane vaccine, which has reported some success (Wright *et al.*, 2004).

Other critics have gone further. David Riley (1993) argued that having a vegetarian diet is a personal affectation that does nothing to bring about systemic change that would actually have an impact. In 2009, the Natural Resources Conservation Service (NRCS) in the US published a report highlighting the complexities of the issue beyond the simple matter of GHGs. They showed that soil erosion, itself a highly important environmental issue, is higher on cropland than livestock pastureland; and, as mentioned, this is an area the EF cannot measure.

2.3. Food-Related Lifestyle

A major difficulty with performing empirical research into this area is the conflicting and blurred definitions of vegetarianism (Weinsier, 2000; Hoek *et al.*, 2004). Self-identified vegetarians vary in their eating habits; the National Institute of Nutrition (1997) found in Canada that 90% consumed dairy, 78% fish, and 71% eggs. More surprisingly, 61% sometimes ate poultry and 20% red meat(!) Similarly, Krizmanic (1992) and Kwan and Roth (2004) both found US American vegetarians who consumed meat.

However, plentiful studies have emerged over the last two decades in particular, and general trends are discernible even with this barrier. Ruby (2012) reports multiple studies that have found Western vegetarians are significantly more likely to be women than men. Additionally, the differing worldviews of vegetarians and omnivores are well attested. Dietz *et al.* (1995), Kalof *et al.* (1999), Allen *et al.* (2000), Hoek *et al.* (2004), and Gale *et al.* (2007) all found (in different Western nations) that vegetarians were more likely to be altruistic and left-wing in their views, while omnivores were more likely to be traditional and right-wing. Furthermore, Dietz *et al.*, Kalof *et al.* and Hoek *et al.* all found that vegetarians placed greater value on environmental issues than their omnivorous counterparts. Ruby (2012) concluded that vegetarians in the West tend to be liberal in their views, and “place emphasis on environmental protection”.

Nonetheless, there are important distinctions to be made. Firstly, this research is all on vegetarians in the West – other cultures hold very different views on vegetarianism itself, and have different associated values and world views (Haidt, Koller and Dias, 1993; Haidt *et al.*, 1999). Secondly, even within the West, this is far from a unilateral truth. Predominantly there are two reasons that people chose to adopt vegetarianism: ethics, and health (Ruby, 2012). These motivations have a big impact on food-related lifestyle, since one is based on concern for others, and the other on concern for health. Both Lindeman and Sirelius (2001) and Fox and Ward (2008) found that ethical vegetarians have greater humanistic values, while health-based vegetarians place greater value on personal safety and security.

3. Methodology Review

3.1. Outline

Two groups (hereafter referred to as ‘communities’) of 30 people each – one of self-identified ovo-lacto vegetarians, one of omnivores – were surveyed via questionnaire on their lifestyles in five categories: home, food, travel, consumables, and activities. These data were then uploaded into REAP Petite to produce an EF and a Carbon Footprint (CF) for each category, an overall EF and CF, and also water use and recycling rates. These group data were then analysed with independent samples t-tests; the first tests looked for association between diet and age/gender, to ensure the data’s validity. None was found.

3.2. Analysis

3.2.1. Data

The questionnaire was highly flawed in its question design. Multiple questions were badly phrased or didn’t allow for a “None of the above” or “N/A” option, leading to respondents either answering incorrectly or not at all. Since REAP cannot accept blank answers, researchers were forced to fabricate some of these data in order to generate an EF, with obvious consequences concerning the veracity of the data.

A box and whisker plot showed there were two anomalies in each group (see Figure 2). These data were removed from the subsequent analysis to attempt a higher level of accuracy.

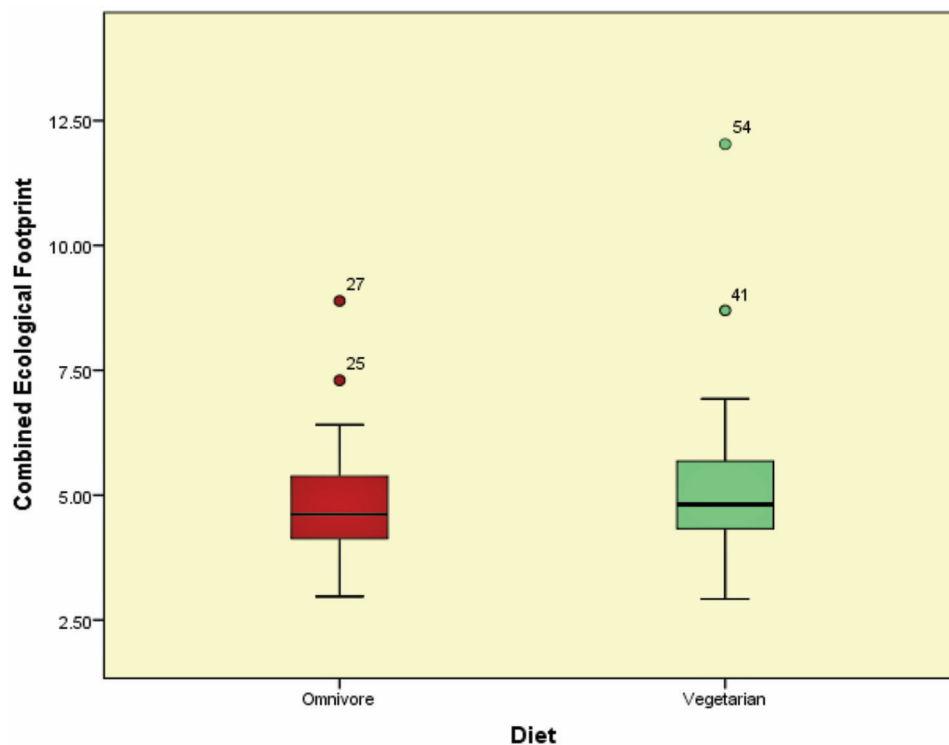


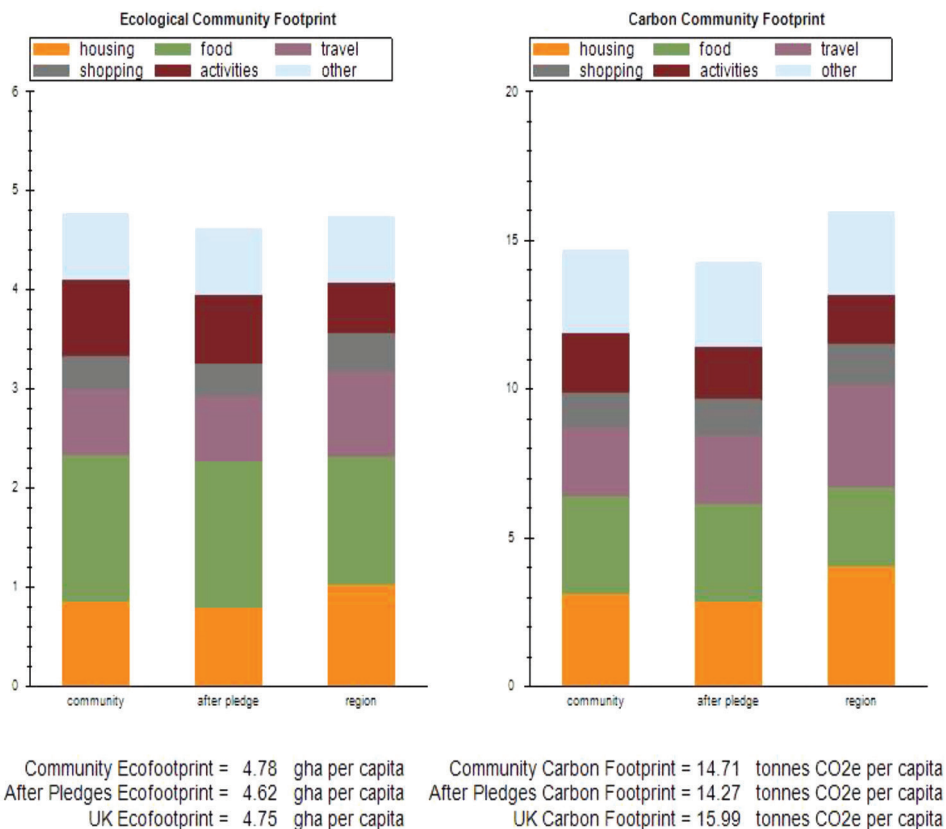
Figure 2: Box-and-whisker plot of the range, medians and quartiles of each community.

3.2.2. REAP Petite

REAP Petite is an internationally recognised software, developed by the SEI. This, in principle, makes it a reliable material to use. However, its programming does not include zero-meat diets; only low-meat diets, which comprise three meat meals a week or less. Seven of the omnivores surveyed were therefore functionally considered to be vegetarians according to the software, making it unsuitable to test the study’s hypothesis. Crucially, this also meant that REAP’s pledge system could not be used to measure food-related lifestyle impacts on the omnivores’ EF.

4. Results and Evaluation

Figures 3 and 4 show the overall community EFs, CFs, water use and recycling rates for both groups generated by REAP Petite. In fact, the data suggests vegetarianism increases, rather than reduces, an EF in Swansea – the opposite result to the hypothesis. This pattern is continued in the five sub-categories, with only Food reversing the trend. Additionally, the omnivores had a lower CF, lower water use, and higher recycling rates.



Community Recycling = 77.93 %
 Community Water Use = 145.61 Litres per day per capita

Figure 3: REAP Petite Results: Omnivores.

Prifysgol Cymru Y Drindod Dewi Sant

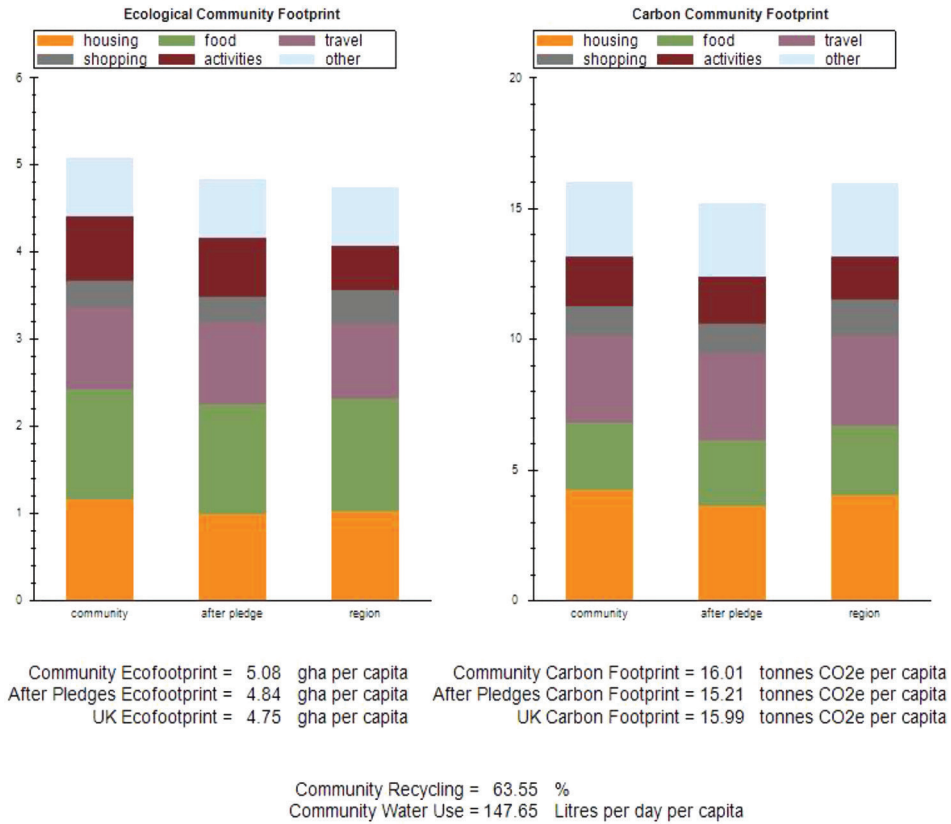


Figure 4: REAP Petite Results: Vegetarians.

There are multiple possible explanations for these results. Firstly, it may be that the vegetarians surveyed (or a majority thereof) were health-motivated vegetarians; as Lindeman and Sirelius (2001) and Fox and Ward (2008) found, this actually does not indicate any higher environmental concern than an omnivore might. Secondly, and perhaps more tellingly, the vegetarian community in this study was wealthier than the omnivorous community. The modal average income for omnivores was the £5000–£9999 bracket, compared with the more affluent £10,000–£19,000 for vegetarians, who overall had far more representation in the higher brackets (see Figure 5). Affluence often leads to higher EF owing to higher consumption patterns (GFN, 2010b; Stechbart and Wilson, 2010; Davies and Denner, 2012). Similarly, the Prudential’s Soggy Lettuce Report (2004) found that more affluent households produce more vegetable waste, a factor that may be increased by diet in this case; a Brook Lyndhurst survey in 2007 reported that consumers of more fresh vegetables throw away increased amounts of inedible vegetable produce such as peelings. This may have an influence on the differing recycling rates of the communities.

Thirdly, respondents were drawn from both rural and urban areas. Rural and urban areas tend to produce different EFs owing to the varying needs of their inhabitants, with cities often touted as greener owing to lower travel and energy needs (Dodman, 2009; Glaeser and Kahn, 2010). Conversely, Heinonen and Junnila (2011) found that population density is a far less relevant factor than affluence in EF size, with the frequent concentrations of urban deprivation giving a ‘false positive’ to population

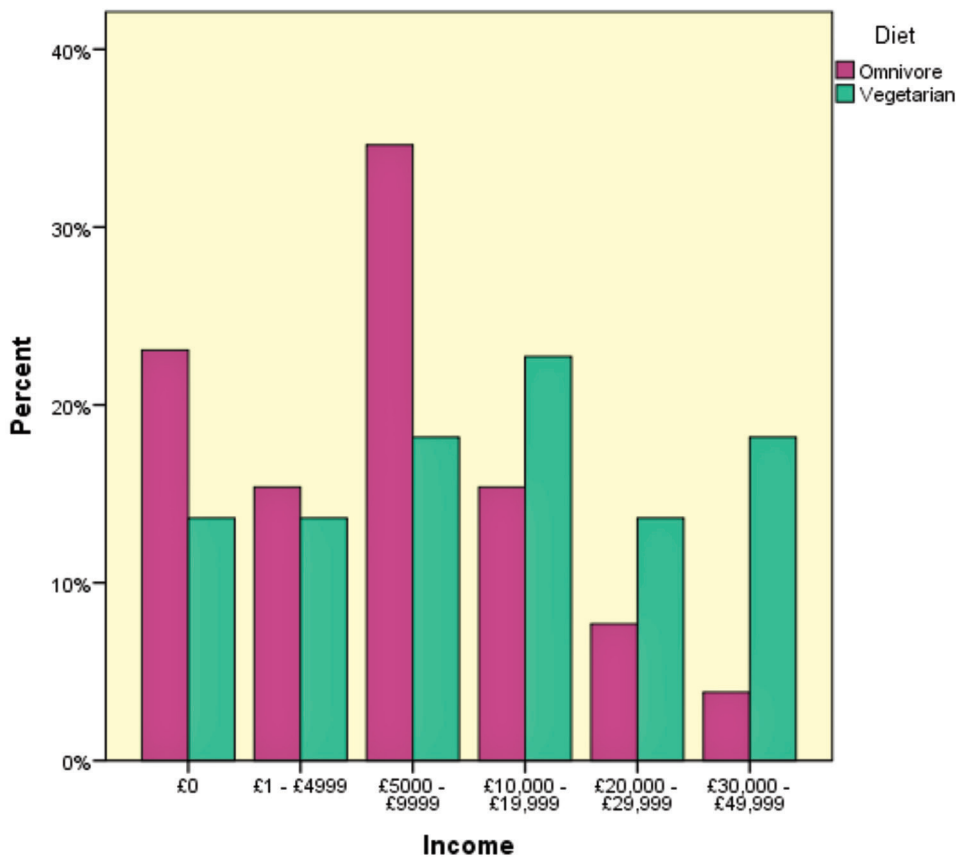


Figure 5: Income by diet.

density. Given that both communities varied in urban/rural locations, yet one scored higher than the other, this may account for the discrepancy.

However, analysis of the data found otherwise. While the figures were higher for vegetarians than for omnivores, no statistical significance was found in any area – except for Food, where the vegetarians naturally scored significantly lower with a confidence level of more than 99% (and was inevitable, given that REAP Petite’s programming automatically calculates low-meat diets as more sustainable). The test statistics may be viewed in Table 1. In effect, it cannot be determined that the figures weren’t reached by random chance, and thus it must be concluded that, in this study, no diet had a measurable effect on EF.

Naturally, all of this makes it somewhat hard to test REAP Petite’s efficacy. Given that its programming is built on a fundamental assertion that vegetarianism is automatically more sustainable, we can’t even test the hypothesis in reverse. However, the greatest barrier proved to be not from the unexpected data results, but from the pledge system itself. On examination, it transpired that REAP Petite does not have a concept of vegetarianism; only of low-meat diets (three or fewer meals per week containing meat), meaning that seven of the 30 omnivores were functionally considered to be vegetarians by the programme anyway. But, this is possibly less of a barrier to future study than it may seem; as discussed, much literature has revealed that vegetarianism is a blurry definition, and the self-identification aspect is likely more

Table 1: T-Test Results.

T-Test Results	
Total EF	t=0.901, df=58, p=0.371
Total CF	t=-1.106, df=58, p=2.73
Recycling Rates	t=1.520, df=58, p=0.134
Water Use	t=-0.189, df=58, p=0.851
Home EF	t=-1.518, df=58, p=0.134
Home CF	t=-1.519, df=58, p=0.134
Food EF	t=2.927, df=50, p=0.005
Food CF	t=3.815, df=49, p=0.0004
Travel EF	t=-1.126, df=58, p=0.265
Travel CF	t=-1.140, df=58, p=0.259
Consumables EF	t=0.634, df=58, p=0.529
Consumables CF	t=0.452, df=58, p=0.653
Activities EF	t=420, df=58, p=0.676
Activities CF	t=0.382, df=58, p=0.704

important in a measurement of food-related lifestyle than strict adherence to a given definition. Nonetheless, it should be noted that it is impossible to test if a low-meat eating omnivore could improve their EF by becoming vegetarian using REAP Petite.

5. Conclusions and Recommendations

The study hinged on a particular hypothesis to work – that of self-identifying vegetarians reporting lower EFs, CFs and water use, and higher recycling rates. This was not supported by the data, and this rendered the research impossible to conduct. REAP Petite's programming also revealed some issues with definitions of vegetarianism; this, too, impaired the study's ability to fulfil its research aims.

Furthermore, the fundamental method of data acquisition for REAP Petite is marred by poor questionnaire design, and thus necessitates data fabrication. This is hardly appropriate for scientific research. Between these factors, it must be concluded that REAP Petite could not test the hypothesis, and so the appropriateness of the EF as a tool to examine the impacts of food-related lifestyle cannot be ascertained.

Recommendations for future research are:

- Different software. It is possible that an EF calculator other than REAP Petite could analyse the data appropriately.
- Larger Sample. While REAP Petite is designed for smaller groups, it's possible a larger sample would produce results more in line with those indicated by literature.
- Better Sample Selection. Respondents need to be matched better for variables such as income; additionally, it may be valuable to examine the possibility of including motivation for vegetarianism in the selection process (or, at least, including it as a variable in its own right).

- Overhauled Questionnaire Design. Most questions need to have a ‘None of the above’ or ‘N/A’ option included to avoid necessary fabrication of data. Include a non-binary option for gender.
- Digitised Questionnaire Design. Programs such as Survey Monkey can be set to not allow a respondent to skip out a question.

It is to be hoped that an improved study of this type would prove far more effective at assessing the effects of food-related lifestyle on EF.

6. Acknowledgements

I would like to thank Chris House for his unwavering support (which managed to be equal parts instructive and humorous), both in this paper and across my degree. Without him, this paper would certainly not have been written, much less published. I would also like to thank my family, without whom I would have never even walked through the campus gates.

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