



Assessing the environmental impacts of mega sporting events: Two options?

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ABSTRACT

At a time when public and private agencies recognise the importance of sustainable development, the environmental impacts of mega sporting events are commanding increasing attention. However, despite event sponsors often flagging the importance of environmental as well as socio-economic legacy components, the environmental impacts of events are difficult to assess quantitatively, being complex and often occurring over extended periods. The general assessment issue is particularly acute with regard to mega events such as the Olympic Games and FIFA World Cup. The practical issues mean that any quantitative techniques seeking to assess environmental impacts are likely to be partial in scope. This paper examines two such approaches for quantitative impact assessment of selected environmental externalities connected with visitation at sporting events. The paper considers the use of Ecological Footprint analysis and Environmental Input–Output modelling. It provides examples of the applications of these techniques to discrete sporting events in a UK region, and discusses whether these techniques are appropriate for exploring the environmental impacts of mega events.

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1. Introduction

This paper examines and reflects on two possible approaches for the quantitative impact assessment of selected environmental externalities connected to sporting events. We stress that the focus is on selected externalities and a quantitative assessment, and accept at the outset that the approaches discussed are necessarily partial and would only form part of a wider sustainability assessment. However, we argue that the selected approaches are useful in assisting with the different organisational challenges and questions facing event organisers and sponsors who wish to understand the environmental consequences of their events. The paper shows how the selected techniques have been used to assess the environmental impacts of discrete sporting events in the UK, and then examines whether these same techniques are likely to provide useful insights into understanding the environmental effects of mega sporting events including, for example, the Olympic Games.

The first approach examined is the Ecological Footprint. The presentation of the forthcoming London 2012 Games as staging

a 'One Planet' Olympics (a concept developed by the World Wildlife Fund (WWF) in association with the Bio-Regional Development Group) suggests a focus on the Ecological Footprint as a way of assessing the resource use involved in staging this specific event in comparison to those available globally (London 2012, 2005a; WWF, 2006). The second approach examined is Environmental Input–Output modelling (ENVIO) using National Accounting Matrices with Environmental Additions (NAMEAs). This is a method of quantitatively assessing the resource use and environmental outcomes associated with specific activities by tracing the economic effects of additional economic activity through the host economy. There are similarities between these two techniques with, for example, recent methodological developments in Ecological Footprinting making use of Input–Output frameworks to attribute Footprints to industry sectors and elements of final demand (see Wiedmann, Minx, Barrett, & Wackernagel, 2006).

The paper discusses a case where the Ecological Footprint has recently been used to explore the impact of resource consumption at a discrete event (the 2004 FA Cup Final at Cardiff's Millennium Stadium). This provides the opportunity to reflect on the suitability of this tool, how it has been used to evaluate smaller discrete events at the local level, and then the extent to which the method is adaptable for examining resource use at larger events. The paper then considers an event case that used Environmental Input–Output modelling (the Great Britain round of the 2004 World Rally

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Championship), and the strengths and weaknesses of this approach are also explored. It is suggested that the application of these techniques, even in the relatively small and discrete cases noted, was not without conceptual and practical difficulties.

This paper focuses on these two techniques for a number of reasons. Clearly, in understanding the environmental implications of events there are a series of alternatives. For example, in terms of evaluation, benchmarking or certifying the effects of policies to mitigate environmental impacts, there is the opportunity to use life cycle analysis, cost benefit analysis, and with procedural and process tools available such as sustainable procurement, ISO (International Organisation for Standardisation) certification, and environmental management systems. However, the techniques outlined in this paper focus on quantifying selected externalities linked to event infrastructure and event-related consumption in particular. Moreover, the selected techniques are able to deal in varying degrees with the environmental consequences of travel outside the event areas, with the strong expectation that it is travel patterns that are an important driver of the environmental impacts of event visitation. For example, Gössling, Hansson, Horstmeier, and Saggel (2002) show that transport is responsible for the bulk of environmental impacts connected to long distance tourism, and add that existing concepts such as Environmental Impact Assessments (following Green & Hunter, 1992) are less able to provide useful information about the resource implications of different travel patterns. The focus on consumption also means that both techniques may be useful in deriving comparative results for different events, and could also inform strategic and operational questions faced by event organisers.

The paper also reveals that the two approaches offer different spatial perspectives, with the Ecological Footprint majoring on the global impacts of resource consumption activity, while the Environmental Input–Output approach focuses on more local effects.

The following section briefly recounts the debate on the environmental consequences of major sporting events. Section 3 then provides some background to Ecological Footprint analysis and Section 4 Environmental Input–Output modelling. Here we consider the merits and weaknesses of each approach *in general terms* and in assessing the environmental impacts of sporting events. This includes reference to how these techniques have been used to examine the environmental effects of the two sporting events in the UK and the practical issues encountered. Section 5 concludes, and turns to consider to what extent these techniques might be useful in examining the selected environmental consequences of the largest events such as the Olympic Games, and FIFA World Cup.

2. Background

Many public and civic agencies have in recent years explicitly recognised the need to consider the environmental externalities consequent on their activities. Key international agreements, for example following the Rio and Kyoto Summits, have resulted in national, regional and local governments (and their agencies) announcing their commitments to behave in more environmentally sustainable ways (see for example Ross, 2005).

Particularly following the 1984 Summer Olympic Games in Los Angeles, the potential for major sporting events to have significant effects on economic welfare, positive and negative, in addition to their sporting and cultural importance has been recognised and debated (Crockett, 1994). Sports institutions, teams and sponsoring organisations have recognised the need to better understand the environmental impacts of the activities they sponsor, host and regulate. This has been considered alongside debates that have encompassed the social impacts of major sporting events and of

associated facilities; for example, including the imposition of costs (noise, congestion, pollution etc.) on existing populations and businesses (see for example, Hiller, 1998; Lenskyj, 2002; Olds, 1998).

Whilst the environmental impact of both 'day to day' sports activities and organisations' own processes has received attention, the most high profile contribution that such agencies have made has been the attempt to 'green' mega sporting events (Chernushenko & Stubbs, 2005). Events potentially impact upon local ecosystems; utilise reserves of irreplaceable natural capital; and contribute to carbon emissions-related to climate change (Cantelon & Letters, 2000; Jones, 2008). However, as stressed above, environmental externalities can be both positive and negative. For example, major events can involve the significant physical redevelopment of the host city, both for sporting facilities and event-related transport improvements. These may provide a stream of future benefits to local populations. The very scale of infrastructure developments and planning surrounding mega events can also provide the opportunity for significant 'demonstration effects', where sustainable procedures and actions can be 'piloted' and their efficacy assessed for wider implementation. For example, Olympic Organising Committees have been increasingly aware of the potential for using Olympic activities and facilities as 'experiments in living', path-finding for wider society the technologies that may have important, even critical positive benefits for sustainability if widely adopted. Thus, the London Organising Committee for the Olympic and Paralympic Games is seeking to build an Olympic Village which obtains an 'excellent' eco-rating, and to use hydrogen fuel-cell vehicles as transport between venues (London 2012, 2005b).

Conversely, mega events (and the Olympic Games in particular) have often attracted criticism for their perceived negative impacts on sensitive locations, and more latterly in terms of contributing to climate change (Greenpeace, 2004). It is notable that the International Olympic Committee (IOC) has been increasingly keen to stress the importance of environmental considerations in the planning and staging of Summer and Winter Games. For example Steiner (2006) states that: "From the Games in Lillehammer in 1994 through to Sydney 2000, and more recently in Torino in 2006 the environment has increasingly become a key and a winning competitor in the Olympic Games" (p. 1). In 1996, the Olympic Charter was amended to specifically address Agenda 21 and sustainable development (SD) issues, and the environment is now regarded by the IOC as the third 'pillar' of the Olympic movement along with sport and culture (Cantelon & Letters, 2000; International Olympic Committee, 1996).

This commitment has been transmitted to local Organising Committees for Olympic Games (OCOGs) which, since the Lillehammer Winter Games in 1994, have promised to consider the environmental consequences of their organising activities, albeit with variable levels of success (Greenpeace, 2002, 2004). For example plans for the Torino Winter Games in 2006 included measures to reduce greenhouse gas emissions, minimise water use in snow making, promote eco-friendly hotels, and with plans to offset carbon emissions linked to the event. These types of issues have also majored in the run up to the Beijing Summer Games in 2008, with the hosts meeting with environmental NGOs to discuss the implementation of a Green Olympics, with the Beijing Municipality using the Olympics as a vehicle to promote environmental awareness among citizens, and with the Beijing Organising Committee committing to a "zero net emissions" games in similarity to the 'standard' laid down at the Salt Lake City Winter Games in 2003 (see e.g. G-Forse, 2007). It was indeed a strong commitment to a sustainable Games along with its plans for youth involvement and a lasting legacy, which led London to be successful

in its bid to host the 2012 Summer Games. As far back as February 2004 the London 2012 team highlighted that “Environmental quality and sustainability are critical aspects of the London bid” (Stubbs, 2004). Early on the Olympic Delivery Authority (ODA) in London launched a Sustainable Development Strategy to minimise carbon emissions, waste and water use, whilst maximising the use of environmental friendly transport and material (ODA, 2007; Weaver, 2007).

Increased emphasis on mitigating negative environmental impacts has become a theme underlining other mega events. For example, zeal in the realm of carbon off-setting has spread to other mega events. In 2006, FIFA’s Green Goal programme aimed to make the World Cup the most environmentally friendly ever, working to reduce resource use in terms of water, refuse, energy and transport, and with plans to offset the 100,000 tonnes of carbon emissions which were expected to be generated by the event (see Stahl, Hochfield, & Schmied, 2006). The Victoria State Government set out to make the Melbourne Commonwealth Games in 2006 carbon neutral, low waste and characterised by minimal water use (Victoria Government, 2007). The general theme of ‘greening’ sports events has also been taken up by the UN Environmental Programme (UNEP) with its Global Forum for Sports and the Environment bringing together stakeholders to review the impact of sporting events on the environment. Environmental concerns have also been brought to the fore in the next Commonwealth Games in Delhi in 2010, particularly in relation to the stadium’s location (see Dutt, 2007).

The importance with which environmental considerations are viewed across the Olympic movement and others is undoubted. Environmental strategies undertaken by local Organising Committees to date have concentrated on the implementation of ‘environmentally friendly’ approaches to construction and event hosting activities; for example in building energy efficient and renewables-powered accommodation and facilities, or implementing waste avoidance and water-use minimisation measures (see for example London 2012, 2005b). Additionally, Organising Committees have concentrated, quite rightly, on ameliorating the critical local negative welfare impacts of Games, or remediating locally spoiled areas then used for events (Greenpeace, 2002). Whilst this focus on local impact is critically important, in an environmental sense, it is only part of the story. There is little in the way of a blueprint or accepted strategy by which the holistic global and local environmental consequences of major sporting events hosting can be assessed and minimised. Indeed it is only now that we reach a point at which the environment is being mainstreamed into the organisation of mega sporting events. Whilst this is unsurprising, given that sponsors of mega sporting events are not typically comprised of environmental professionals, the consequence is that environmental strategies vary significantly between mega events. The common concentration on local issues has also led to a situation where the environmental impacts and effectiveness of strategies implemented by hosting cities cannot easily be compared or assessed across different events.

There is additionally limited assessment of the scale of event contribution in specific areas; for example as a driver of climate change or in the use of scarce natural resources. Extant qualitative assessments are useful to identify key local environmental considerations and ‘pressure points’, however, they are less able to provide a ranking of sustainable development policies in terms of either their overall impact on environmental outcomes – for example, a measure of the environmental impact of actions relative to the (financial or personnel) resources necessary to implement them. Event organisers and managements may thus be faced with alternative sustainable actions which are mutually exclusive due to time or resource constraints – for example fuel-cell propulsion for

event vehicles versus renewable energy generation for athletes’ accommodation – and with little information on which is the better option in terms of declared environmental variables of interest.

The above discussion indicates some progress among mega-event organisers to better recognise the environmental externalities surrounding development and execution of strategies, and with some evidence of a mainstreaming of environmental concerns. The outline of developments surrounding the Summer and Winter Olympic Games, FIFA World Cup, and Commonwealth Games in particular also provides an acknowledgement of local-ecosystem impacts together with more global ecosystems and resources’ effects of event-related consumption. The review suggests there is still some way to go towards an all encompassing framework that fully explores the trade-offs between the achievement of economic, socio-cultural and environmental goals. There is also a strong desire on the part of institutions such as the International Olympic Committee and FIFA to be seen as part of the solution and not part of the problem, for example, through their adoption of ‘environmentally friendly’ bidding and planning processes.

The discussion also shows that the questions facing event organisers and management in the realm of sustainability are necessarily complex. Moreover, it is accepted that in the above, the discussion of environment has majored on the physical and natural environment with decision makers in an event sustainability assessment also having to grapple with the socio-cultural and economic dimensions of sustainability. This means that event organisers and managers face increasingly complex questions, for example, in terms of the nature of the trade-offs between economic, environmental and social impacts of events; and how far losses in one ‘area’ can be made up in others. Furthermore, in planning for and staging the largest events including the Olympics, Commonwealth Games, and FIFA World Cup there is a need for tools that can provide insights into questions at both strategic and more operational levels. For example, Organising Committees of the Olympics face issues in terms of what should the future of the event be, i.e. questions at the ‘hyper-strategic level’, whilst there are then a series of ‘more-strategic’ questions perhaps in terms of how far existing waves of sporting activity can be made more sustainable, or more operational questions in terms of the placement of events, or how far mitigation of negative externalities can be achieved by policy changes (see also Morrison-Saunders & Therival, 2006, on issues in the conceptualisation of a sustainability assessment). It is unlikely that one set of quantitative tools can provide information to assist in every element of a sustainability assessment.

In conclusion, in spite of progress, the outcomes of such ‘environmentally friendly’ actions can be extremely difficult to assess. Moreover, qualitative environmental assessments and ‘sustainable’ procedures associated with mega-event planning cannot always provide organisers with a prioritisation for actions to limit resource use and change developer or visitor behaviours connected to intensive patterns of resource use. Evaluations may not provide organisers with sufficient information on which to base the best decision when faced with a multitude of potential ‘sustainable’ actions or priorities. Thus, whilst any sustainability action plan may be better than no action plan, qualitative assessments of events and procedural tools may only provide part of the answer for organisers wishing to spend time and resources most efficiently in achieving environmental goals. In addition to the above, environmental assessments do not provide a framework where events can be judged against each other on any environmental criteria, or against any notional ‘best case’ scenario. For example, whilst it is theoretically possible to estimate the carbon savings associated with some ameliorative activities (for example, the use of renewable energy at an athletes’ village) the process rather than outcome oriented

nature of sustainable event planning means this has not been done, and thus negative environmental impacts cannot then be compared to positive economic benefits to ascertain how the event performs in comparison with others.

The remainder of this paper thus suggests complementary quantitative approaches that may assist in addressing some of these evaluative gaps. In what follows we consider first the appropriateness of the Ecological Footprint as a tool from which to evaluate the environmental impact of a sporting event, drawing on previous work undertaken to examine the Ecological Footprint of the 2004 FA Cup Final (Collins et al., 2007). Second is a consideration of a complementary approach; utilising Environmental Input–Output analysis to ascertain the direct and indirect environmental consequences of an event (the 2004 World Rally Championship, Wales Rally GB).

In both cases, we provide a brief synopsis of the analytical technique, the nature of results in terms of the two reference events, and the strengths and weaknesses of the approach in the context of the discrete events examined. This leads to conclusions examining whether these techniques can really add utility in the context of exploring and assessing the environmental effects of mega sporting events.

3. Ecological Footprint analysis of sporting events

The Ecological Footprint initially pioneered in the early 1990s is an aggregated indicator of the global ecological impact of resource consumption, roughly analogous to GDP as a representation of the dimensions of the financial economy (see Wackernagel & Rees, 1995). The footprint is measured using a standardised area unit equivalent to a world average productive hectare or 'global hectare' (gha) and is usually expressed in global hectares per capita (gha/capita).

The Ecological Footprint seeks to account for the consumption of the Earth's available resources. The Footprint approach provides a snapshot estimate of the demands placed on global bio-capacity and the supply of that bio-capacity. Lewan and Simmons (2001) provide a useful analogy that also reveals something of the limits of the technique: "The footprint has been compared to measuring one's own weight. You find out how heavy you are, and the difference from your ideal weight, but the process of measuring does not tell how you how to lose weight. However, you can speculate that if you do certain exercises and eliminate certain calorific foods from your diet you will shed a certain number of kilos" (Best Foot Forward, 2006, p. 1, see also Lewan & Simmons, 2001). In most cases Footprint techniques are used to show the area of bio-productive land required to provide the resources for a reference population and assimilate their waste. The 'reference population' is normally a nation or region, but the Footprint technique is now being applied to individual sectors, organisations and in the case of this paper, to events.

The Ecological Footprint is an additive model. The basic approach adds together the uses of bio-productive land, for example, in terms of pasture, arable land, woodland (which produces timber but is also an important conduit for carbon sequestration), brownfield land and sea. Clearly the process hinges on an estimate of the world's bio-capacity which can effectively aggregate the bio-productivity of land and sea areas with vastly different qualities. Here areas of different quality are normalised by multiplying the land areas by equivalence factors linked to the different land bio-productivities. For example, these factors work to highlight the land category's relative yield in comparison to a global average space having a factor of one. This allows for the fact that a hectare of best quality farmland will be many times more productive than a global average hectare. The equivalent areas are reported in terms of a standardised area unit.

In this way, for example, one can estimate the area of bio-productive land required to support the demands of a reference area. Reference area demands on global bio-capacity can then be compared to a global average which has been estimated to be around 1.8 global hectares per capita (for 2001, see WWF, 2006).

In the UK, some of the early Ecological Footprint studies were undertaken for the Isle of Wight, Oxfordshire, Guernsey, London and York. These studies tended to show that the per capita Footprints of these areas were substantially above the global average, leading to the problem of a real reduction in the Earth's ecological capacity.

Traditionally, national Ecological Footprints (National Footprint Accounts) have been calculated based on a country's domestic production, imports and exports of primary and secondary products together with an estimate of the embodied energy of secondary products. More recently Wiedmann et al. (2006) demonstrate a method through which national Ecological Footprints can be disaggregated to provide information by industry sector, final consumption categories, sub-national area and by socio-economic group. This approach uses Input–Output tables (Supply and Use tables as opposed to Transactions tables) to allocate Footprints to categories. It has been argued that this methodological development permits greater consistency across Footprint estimates, and that the Footprint results can then be used to provide better quality information for scenario development, and policy formulation on sustainable consumption patterns. In particular through the ability to allocate the Ecological Footprint to different final consumption categories, consumer responsibilities can be better highlighted. The method also means that Footprints can be more easily estimated at sub-national level, and this is of direct relevance for this paper, with the technique at the heart of recent Footprint estimates for the region of Wales, and its capital city, Cardiff (see Barrett, Birch, Cherrett, & Wiedmann, 2005; Collins, Flynn, & Netherwood, 2005).

3.1. The FA Cup Final

As part of a study to measure Cardiff's Ecological Footprint, several novel applications of the Footprint method have been developed (see Collins et al., 2005; Collins, Flynn, Wiedmann, & Barrett, 2006; for background). One such application involved measuring the Footprint of the 2004 Football Association (FA) Cup Final (see Collins et al., 2007). The findings from this study provided for the first time detailed information on visitors' consumption patterns at a major sporting event and a measurement of their global ecological impacts. Full details of the process involved in calculating a Footprint estimation for this case can be found in Collins et al. (2007). Here we focus on the main findings, and strengths and weaknesses of the approach in terms of the reference event.

The Ecological Footprint of the FA Cup Final was calculated based on a component approach and required an analysis of visitors' physical consumption in terms of; travel to and from the event, food and drink consumed at the event, infrastructure of the event venue and waste generated at the event. In terms of these areas of consumption, the estimated event Footprint was a little over 3000 global hectares (gha), or 0.0422 gha/visitor (see Table 1). However, it was necessary to consider a counterfactual scenario i.e. visitors resource use had they simply stayed at home and undertaken normal consumption activities. Then it was estimated that the additional Footprint connected with the visit to the event (in the majority of cases this represented a day visit to Cardiff from either London or Manchester, the home cities of the competing teams: Millwall Football Club and Manchester United Football Club) was around 2700 global hectares or 0.037 gha/visitor. In summary the

Table 1
Summary of Ecological Footprint of 2003/04 the FA Cup Final.

Category	Visitor Total Ecological Footprint [gha/day] (gha/visitor)
Travel	1670 (0.0228)
Food and Drink	1413 (0.0194)
Stadium Infrastructure (Capital Investment)	0.10 (0.000001)
Total	3083 (0.0422)
Total Additional Ecological Footprint	2695 (0.0369)
Waste (satellite account)	146 (0.002)

Notes: the Ecological Footprint for waste is not included in the 'standardised' Footprint calculations but instead is treated as a satellite account as the impacts of household consumption can only be counted once, either as 'inputs', when products are bought or consumed, or as 'outputs', when these products are discarded. As the Footprint methodology used here considers the environmental impacts of consumables, double counting would occur if the impact of waste from these consumables was included in the final result.

Source: derived from Collins et al. (2007).

overall Footprint effects of a typical visitor attending the event were found to be seven times greater than if that person had stayed at home going about normal every day activity. The key driver of the high marginal Footprint was that in attending the event, supporters were engaged in a very different pattern of consumption which subsequently generated a larger Footprint.

The largest driver of the Ecological Footprint in this event case was consumption linked to visitor travel patterns. Event-related travel led to an estimated 54% of the total Footprint, and with car travel accounting for around two-thirds of this. Travel was followed by the food and drink consumption category, creating a Footprint of 1413 gha. The scale of this Footprint figure links to the type of food and drink consumed and the large amounts of energy and resources to produce it. The infrastructure of the event venue (Millennium Stadium) had a relatively small Footprint (around 0.10 gha per event) with its Footprint apportioned over the estimated total number of events that will be hosted at the venue over its 100 year expected life span. The amount of waste generated by the event and how it was subsequently disposed of resulted in a total waste Footprint of 146 gha or 0.002 gha/visitor (see Table 1). Food waste, and food and drink packaging accounted for 80% and 11% of this waste Footprint figure respectively.

Although this study accounted for four Footprint components in its calculation (travel, food and drink, event infrastructure and waste), if the total Footprint for the average visitor at the event is compared with the average 'earthshare' per person per day (i.e. 0.0049 gha), the impact is almost nine times greater.

Whilst the Ecological Footprint approach is well established, the above represented something of a novel application of the method. In the case of the FA Cup Final, the technique was able to shed light on the connection between different types of event-led consumption and estimated resource and land use. It is accepted that elements of the Ecological Footprint method are less than transparent to the non-specialist. However, the analysis provided one means of highlighting to event sponsors where negative externalities may be greatest, and where resources might be focused in order to reduce impacts. Importantly, it provides more than just a local perspective on event impacts, linking event-related consumption to more global consequences. The approach points to elements of consumer behaviour which are connected to the greatest use of land and resources, this meaning that, correctly communicated, the results can offer a useful awareness raising tool 'personalising' the impacts of different patterns of consumption. Indeed in more recent FA Cup Finals there was increasing media interest in the ramifications of the Footprint estimates. For example, at the 2007 FA Cup Final between Manchester United and Chelsea reference was made to the fact that the Ecological Footprint

was an estimated 3000 times greater than the size of the Wembley pitch (by this time the FA Cup Final had returned to its traditional Wembley venue in London). At the Final in 2007 the organisers actively encouraged fans not to bring their cars. The stadium organisers were also using sensors on the pitch to prevent over-watering and cleaning systems that used half as much water. The stadium also aimed to recycle at least 50% of its total waste and used electricity generated from renewable sources (Randerson, 2007).

There is a need to consider some of the limitations of this technique in general terms, and then more specifically in respect of the case considered above. Wiedmann et al. (2006) note that in spite of the progress and popularity of the Footprint method it has been refuted for not reflecting the full impacts of consumption activity, and providing inadequate material that is useful for policy formulation. Recent improvements led by Wiedmann et al. (2006) to tie Footprints to industry sectors and final consumption categories would counter some of the above problems. However, this still leaves general issues relating to the appropriateness and transparency of the algorithms used to link production and consumption with notional global land areas (see Ferng, 2002; Lenzen & Murray, 2001; Van den Bergh & Verbruggen, 1999). Additionally, McGregor, Swales, and Turner (2004) argue that the method does not allocate the responsibilities for negative impacts correctly. This could be an important issue with respect to the 'responsibility' for the effects linked to air travel in particular and whether it is allocated to the national energy use of the source nation, or the nation where an event is located. This was less of an issue with the FA Cup Final where air travel to the event was limited, but would be significant in respect of mega events drawing a significant number of international visitors and participants.

A further general issue with the Footprint, particularly where one is attempting to derive policy foresight from the technique, is that there is a strong underlying assumption that an equal distribution of global resources is a desirable outcome. Clearly, an 'equal' distribution may not be an 'equitable' one, with some people perhaps needing a larger earth share to maintain a comparable level of consumption due to local environmental conditions. Under these circumstances Environmental Impact Assessments with a stress on local conditions have a complementary role (see for example, Gössling et al., 2002) but with Footprint analysis providing some insight into global environmental sustainability issues. The issue here is that Ecological Footprints do not deal well with genuinely local effects. Indeed Collins and Flynn (2007) and Munday and Roberts (2006) in their reviews could find few instances in the UK where the results from Ecological Footprinting analyses had actively been used in policy development.

Finally here there is the tendency to report Ecological Footprints in point terms, and with very few studies attempting to grapple with the underlying uncertainty surrounding estimates. This issue will become more acute as allocated estimates come to rely more on Input–Output accounting frameworks which are characterised by high degrees of imprecision (Wiedmann et al., 2006).

The general critiques and limits noted, there are a series of practical issues surrounding the use of the Ecological Footprinting in regard to sporting events, and which were evident in the reference case of the FA Cup Final. It was only possible in the case to consider selected consumption categories. For example, the event made extensive use of many elements of Cardiff's infrastructure including roads, hospitals, security services and car parks. These were not considered due to the high burden on survey resources required. Even given this omission, the development of the Ecological Footprint still required good quality information on quantities consumed and distances travelled by event visitors. Visitors (and event sponsors) are often more at ease talking in

terms of expenditures rather than physical quantities of goods used in the course of preparing for and attending an event. At a practical level collecting the necessary information is resource intensive. In the FA Cup Final case this required face-to-face surveys of visitors, combined with surveys of those selling goods and services in the area, and officials in the local council to derive information on levels of waste associated with the event. This was a complex task even for a one day event where the demographic and geographic profiles of visitors were well established. This general type of data issue is also discussed by Gössling et al. (2002) in developing an Ecological Footprint for the Seychelles. They noted that while the Footprint concept can be useful for making statements about sustainability, the Footprint can be difficult to apply because it needs a detailed statistical base on consumption as well as information on biomass yield figures. They note in the Seychelles case that data can be difficult to gain because of poor statistical databases, lack of transparency and unwillingness of key players to cooperate. Similar issues were evident in this attempt to estimate the Footprint for the FA Cup Final.

With the FA Cup Final case there was also a problem of additivity of consumption activities. While an attempt was made to explore the marginal addition to consumption as a result of event visitation, a complete assessment would also have had to gauge how far residential consumer patterns were disturbed on the day of the event. On event days the Cup Final case provided evidence of permanent retail displacement. Estimating true additional consumption with more complex events over extended time-scales would be quite difficult. Additionally, whilst the study estimated additional 'marginal' footprint compared to a 'stay at home' scenario, perhaps a more persuasive model would include substitution between different types of leisure activity, meaning attendance at a sporting event (perhaps partially 'greened') should be properly compared with other leisure activities, often including large travel and consumption behaviours.

Finally here, with the FA Cup Final a significant amount of time was required to analysis primary data and so Footprint results were not available to event organisers until some time after the event. While this evidently provides information for future rounds of an event it places an additional constraint on using the technique for planning purposes. These types of issues could be more acute with the long term cycle of activity leading up to larger event, and the longer term analysis needed to consider legacy effects. In the case of the FA Cup Final the focus was very much on the day of the event. While consideration was given to selected elements of capital infrastructure used to support the event (i.e. the event venue), no consideration was given to the preparation stages of the event. With mega events, for example, the very process of bidding, and then development of soft infrastructures and networks can be resource intensive. We return to the discussion of the use of the Ecological Footprint to examine the environmental effects of mega events in the final section.

4. Environmental satellite accounting and Input–Output: application to sporting events

Input–Output analysis is a well established method of evaluating the indirect economic or environmental consequences of new (or lost) economic activity, through the Leontief-inverse matrix (Leontief, 1970). This is despite the fact that the use of Input–Output accounts for policy modelling is limited by assumptions and methodological limitations, many of which are problematic in the context of the analysis of major events (see Miller & Blair, 1985 for a review of limitations and Jones & Munday, 2004 for a synopsis of modelling techniques adopted for major events). Despite these problems Input–Output and associated 'multiplier' techniques

remain the most common way of estimating the overall (direct and indirect) economic consequences of sporting and other events. Here, the limiting nature of the assumptions is offset by a number of significant benefits. Primarily, the method is relatively transparent and low cost when compared to more complex approaches such as Computable General Equilibrium (CGE) models (Madden, 1998). Moreover, there is a long (and well debated) experience in the 'regionalisation' of national Input–Output tables which enables adoption of these techniques in areas without a developed economic account or macro-economic model (Miller & Blair, 1985). More recently, a number of national and regional accounts (in Input–Output form) have been refined by the addition of satellite accounts. A satellite account can reveal further detail of a national account that has formerly been hidden in wider industry or functional definitions, with examples of this including household and tourism satellite accounts (OECD, The European Commission, United Nations, & World Tourism Organization, 2001; Office for National Statistics, 2002). Other satellite accounts extend the national account into new areas. An environmental satellite account (or NAMEA) links a statement of environmental account to an economic account (OECD, 2004). Development of satellite accounts has further refined the policy modelling capabilities of Input–Output frameworks. Tying Input–Output analysis to environmental information can lead to a better understanding of selected externalities linked to the consumption demands connected to sporting events.

A complete Environmental Input–Output approach would aim to explore a series 'transactions' between the economy and the environment. A complete accounting would be represented by a partitioned matrix as follows (McNicol & Blackmore, 1993)

$$\begin{matrix} A_1 & A_4 \\ A_2 & A_3 \end{matrix}$$

Here:

A_1 : a matrix of coefficients representing economy–economy interactions, showing for example how changes in final demands for one product creates demands for other goods and services up the supply chain.

A_2 : a matrix of coefficients representing economy–environment transactions (showing the output of environmental good per unit of economic good). This enables an accounting of how production of a good or service is connected to environmental externalities. This could be in terms of greenhouse emissions resultant on elements of visitor demands connected to an event.

A_3 : a matrix of coefficients representing environment–environment interactions. This reveals the effects of the input of environmental goods on the production of other environmental goods. For example, the effects of sulphur dioxide emissions on water quality.

A_4 : a matrix of coefficients representing environment–economy transactions (showing the output of economic good per unit of environmental good). This reveals the impacts of environmental goods inputs on economic activity, for example, showing how climate change impacts farming output.

A holistic assessment would need to include each element of the above model. However, studies have tended to focus on the addition of the A_2 matrix to a pre-existing A_1 matrix, and this is the approach described here. Clearly, this approach necessitates a complete set of Input–Output tables, alongside accurate information on externalities arising from industry production. Under these conditions, information on emissions and natural resources used by industries can be used in association with the Input–Output framework to

estimate, for example, the direct and indirect amounts of pollutants resulting from changes in industry final demands and consumption patterns. The framework permits one industry's production to be associated with another industry's pollution creation.

While the principles of Environmental Input–Output modelling are well established, and Input–Output has long been used to examine the economic impacts of visitor events the process of linking tourism and environmental satellite accounts together is more novel. Recent work by [Patterson and McDonald \(2004\)](#) in New Zealand uses the method in part to show how tourism activity has implications for environmental outcomes. Similarly, an environmental extension to an available Input–Output framework can be used to establish the environmental consequences of visitor events. The technique is straightforward; following standard practice, the additional (regional or national) economic demand consequent on a sporting event is predicated as 'direct' increased output of the appropriate industry (or commodity) in a symmetrical transactions matrix ([Miller & Blair, 1985](#)). Use of the Leontief inverse then provides an estimate of the increases in 'indirect' output of other regional/national industries as they supply the needs of the directly affected industries, and (in some cases) service the increased household expenditure as workers in all affected industries increase spending. The total (direct and indirect) increase in output can be decomposed to estimate the impact on gross value added or income, and ratios of output to employment for affected industries provide an indication of 'event-dependent employment' (albeit a potentially problematic one; [Jones & Munday, 2004](#)).

An Environmental Input–Output framework can provide an estimate of how production processes affect key environmental indicators, for example giving ratios between the value of the resultant economic output and atmospheric emissions, post-industrial waste or water use ([REWARD, 2003](#)). Thus, the event dependent impacts upon such variables can be calculated in a similar fashion to that on economic factors of production. There are a number of advantages to the use of this approach for event environmental assessment. Firstly, and critically, the existence of established environmental accounts linked to an Input–Output framework means that analysis can be very low cost. Indeed, its placement within an explicitly economic framework reported in financial units means that an environmental assessment can be undertaken in parallel with an economic impact assessment, and reliant on largely the same dataset and modelling procedures – the environmental impact is assessed from increases in economic activity. Thus, a survey of organisers, spectators and others to assess economic impact can be of dual use, often with minimal alterations or additions to establish environmental impact (e.g. with additional questions covering mode and distance of transport etc.). Secondly, and related to the above, the analysis provides details of impact for specific industry (or commodity) groups, and by types of environmental impact.

In what follows we show the results of this approach when applied to a specific event – the 2004 World Rally Championship, Wales Rally of Great Britain. This reveals that the results can be practically used to inform policy. For example, policymakers can judge exactly in which industry the largest environmental impacts are likely to occur, and of which type, thus implementing ameliorative action (for the event in question or for future events). This is important as the largest environmental impacts may not be in industries directly affected, or in those intuitively thought to be most at risk.

[Table 2](#) summarises findings for the event. Key data sources included a spectator survey, and with ticketing information provided by the event sponsors. A third (1260 tonne) of carbon-equivalent impacts were a result of spectators' travel, the next largest impact was in the agriculture, forestry and extraction sector,

Table 2

2004 Wales Rally GB carbon-equivalent emissions by sector.

	Tonnes	Percent
Spectators' Fuel Purchases	1260	35.6
Supply chain effects (direct + indirect)		
Agriculture, Forestry & extraction	912	25.8
Manufacturing & construction	502	14.2
Energy & water	239	6.8
Hotels & distribution	219	6.2
Transport & communications	228	6.4
Other services	180	5.1
Total Supply-chain	2280	64.4
Total Emissions	3540	100.0
Tonnes CO ₂ per £1m Value Added (Rally)	932	
Tonnes CO ₂ per £1m Value Added (Wales Industry Average)	1456	

Source: authors' own estimates. For methodological information see [Jones \(2008\)](#). Notes: spectators CO₂ emissions estimated from mode & distance of travel: direct only; supply chain effects include Type II household impacts.

driven by the level of preparation and ameliorative works needed on forestry roads for the event ([Jones, 2008](#)).

Following its integration into an explicitly economic modelling framework, an Environmental Input–Output approach can also be used to compare economic benefit with environmental cost. For example, the analysis can provide one means of estimating carbon emissions per unit of economic value added created. This estimate of environmental-economic efficiency can potentially be compared to both other events and established economic activity, and is thus of some policy interest. Clearly, this covers just one aspect of eco-efficiency, and of itself the information does not show whether the event is actually sustainable or not, and this may then limit the questions that can be answered using this approach. However, [Table 2](#) shows that the environmental performance of the Wales Rally of Great Britain (in terms of carbon emissions per £1m of value added) was better than the average of established activity in the reference region.¹

Whilst the above advantages are significant, there are a number of limitations that must be borne in mind if the methodology is to be adopted. Primary amongst these are those associated with any form of Input–Output modelling, including assumptions that range from linear production functions and unlimited regional/national supply to relatively fixed prices. We do not rehearse these limitations here but a general review can be found in [Miller and Blair \(1985\)](#) and particular problems in the context of Input–Output applications to sporting events in [Jones \(2001\)](#).

There are, however additional limitations that must be addressed specific to an environmental analysis of major event impacts using this approach. A number of these relate to the environmental account industrial or commodity structure. Environmental Input–Output accounts are typically less disaggregated than a full Input–Output table, and their structure will reflect firstly, data availability, and secondly, the policy needs of the reference economy in terms of general environmental policy ([Office for National Statistics, 2006; Ross, 2005](#)). This may mean that the accounts cover sectors important to the visitor or event economy in a single broad sector; for example, the distribution, hotels and catering classification of the UK Environmental Account datasets ([Office for National Statistics, 2006](#)). Thus, the environmental

¹ [Table 2](#); but note that this 'average' for Wales comprises a large number of sectors which are relatively low-polluting per £1m value added, and a small number of very polluting sectors including steel, agriculture and construction.

impacts of this broad sector can only be reported in aggregate, leading to estimation errors if, as is likely the case, the environmental consequences of (say) accommodation activities differ between catering and distribution. There is a further concern that the type of activity that a major event engenders is different from the established activities on which the Environmental Account is based. For example again in the Wales Rally of Great Britain, the significant carbon and waste impacts following agricultural activities were probably erroneously estimated, based as they were on established agricultural activities rather than on the remedial (construction-related) works to forestry roads associated with the Rally (Jones, 2008).

Quite apart from the structure of the Environmental Account in question, there are also limitations in scope. An Environmental Account covers the emissions, resource use and environmental impacts of activity within the reference economy. Many variables of policy interest in the environmental sphere have global impacts (carbon emissions primary among them) and are best measured at this scale. Also economic activity spurred by an event may have implications for the environmental consequences arising in other economies (for example through international supply chains) and to trace these impacts requires a fairly sophisticated accounting of materials and services flows. More importantly, the event might lead to environmental impacts following economic activity that occurs wholly outside the reference economy. For example, whilst the organisers of the Sydney Olympics succeeded in enabling almost total access to Olympic venues and events by public transport, this had no impact on how international spectators arrived in Australia – overwhelmingly by air. The same issue might arise on a regional level should event attendees purchase travel tickets or fuel for private vehicles to travel to the event prior to entering the reference region.

Any event activities that do not cause a rise in demand in the reference economy but do have environmental impacts must then be separately accounted. An Environmental Input–Output approach to an environmental assessment of major events therefore is only a partial picture, requiring complementary analysis – for example tracing economic demand and consequent impacts outside the reference economy using geographically wider accounts and inter-regional or multi-regional Input–Output analysis (Miller & Blair, 1985). However, its relative ease of operation, low cost, detailed industry-specific results and the potential comparability between events renders it worthy of consideration in major event evaluation.

5. Conclusions

Our review suggests that quantifying the environmental impacts of major sporting events will become increasingly important as sustainable development commitments become mainstreamed into the constitutions and mission statements of sports organisations, and in the statutes of the public sector bodies. The Olympics movement appears to be leading the way in this respect but other organisations with global sporting reach are also working to make events more sustainable. However, commitments are of limited use without a programme to translate them into organisational action, and without an evaluative system that can assess the efficacy of such action. Here, there is currently something of a vacuum. Event organisers are taking steps towards more sustainable procedures, such as encouraging visitors to use public transport when travelling to events and the adoption of ‘environmentally friendly’ building materials and methods, but there is currently no way of assessing their overall effect on reducing environmental impact. A holistic and consistent environmental impact ‘toolkit’ for major events is some way off.

In the paper we profile two techniques for examining selected environmental impacts of events. The objective here was to examine whether the application of the techniques provided useful information for policymakers and sports organisations, and to tease out the practicalities of operationalising the techniques for a sporting event. Both of the techniques provided insights into event-related consumption behaviours, and it is argued that the techniques may be used to assist in strategic and operational decisions to manage selected environmental impacts of events.

The two approaches outlined were Ecological Footprint analysis and Environmental Input–Output analysis. In some measure the approaches are complementary. For example, the Environmental Input–Output approach permits an estimate of the within-nation environmental impact of a sporting event, whilst the Ecological Footprint reveals a more global estimate of impact. There are also methodological linkages between the approaches with Input–Output tables potentially informing the allocation of Ecological Footprints to consumption categories and sectors. It is also noted that the primary data needs for the two approaches can be linked together, with the Ecological Footprint analysis requiring information on event-related consumption in physical terms, and the Environmental Input–Output analysis requiring the spending information underlying the physical consumption.

A key issue underlying this paper is whether such techniques which are beginning to be used to examine event-related consumption, and the impact of leisure and related travel activity more generally, are suitable for exploring the environmental consequences of the largest events including the Olympics. Our analysis would suggest that care is needed in this respect with the smaller scale cases revealing a series of issues – practical and methodological (see Table 3). Whilst the reference events were fairly discrete, it was difficult to practically consider all of the environmental ramifications of event-related consumption. Indeed the costs of considering all elements of event-related consumption would have been very high. Issues of displacement and deadweight were also difficult to consider for these two events. These types of problems would be multiplied many times over in the case of events such as the FIFA World Cup, or the Winter and Summer Olympic Games.

This paper also hints at the data needs of the two approaches, particularly in terms of gaining information from visitors and others on event-related consumption (see also Gössling et al., 2002 on this issue in regard to Ecological Footprint analysis). The review revealed the methodological limitations underlying both approaches, and the assumptions that needed to be brought into play to make these techniques workable. The Ecological Footprint, for example, does not take account of all human impacts on the environment and it does not consider whether or not the reference consumption patterns work to impact the bio-capacity of the planet itself. Furthermore, being a carrying capacity measure, it deals poorly with the fact that many communities live beyond their carrying capacity and have no ill effects, and local populations can live beyond their carrying capacity by running down natural capital. Furthermore the approach aggregates land types to estimate Footprints and therefore assumes an element of substitution is possible. This is clearly not the case. Moreover care is needed with any carrying capacity measure with resource yields of land subject to productivity increases (see for example, Van Kooten & Bulte, 2000). The Environmental Input–Output approach has the benefit of using straightforward and transparent methods to ascertain the impact of specific event activities by industry affected – both directly and indirectly. However, the underlying linear Input–Output framework means that the approach makes restrictive assumptions about price changes, and the technical coefficients of industry production. The passive supply side assumptions of the

Table 3

Summary strengths and weaknesses of Ecological Footprint & Environmental Input–Output analysis in major event evaluation.

	Strengths	Weaknesses
Ecological Footprint analysis	– Strong ‘consumer’ responsibility element. – Provides a measure of global environmental impact. – Good communication and educational tool. – Highlights those consumer activities that have the largest environmental impacts. – Can be used to assess the impact of future policy options.	– Difficulties in accounting for all event-related consumption. – Difficulties in accounting for displacement effects. – Non-transparent & inflexible causal link from economy to environment. – Single aggregative indicator limits analysis in some cases. – Issues relating to availability of data.
Environmental Input–Output analysis	– Detailed results by industry. – No of environmental indicators. – Transparent.	– Industry structure may be inappropriate. – Generally restricted to national analysis.
Both	– Widely accepted methodologies. – Quantitative results aid strategy formulation & policy prioritisation. – Comparability across events & with other forms of economic activity.	– Extant coefficients may not represent event activity. – Limitations of Input–Output analysis in event evaluations.^a

^a Ecological Footprint analysis also uses an Input–Output matrix for assessing the indirect impacts of changes in consumption.

Input–Output framework may be more defensible with smaller discrete events, but the largest events such as the Olympic Games may be of sufficient scale to actually alter the nature of the supply side in a reference economy (although it is noted that Computable General Equilibrium modelling techniques might be used to overcome some of these problems).

Both of the methodologies also share the limitation that they are essentially ‘backward looking’, using established coefficients and algorithms relating economic activity to environmental outcomes; however, there is no guarantee that major event-related activity will be typical of existing whole economy patterns, leading to potential errors. This is important as the limits and assumptions of the approaches will place limits on the types of decisions that they actually improve. A time series of event studies using the techniques would possibly provide ex ante information for organisers on types of consumption that lead to greater environmental impacts. Strict benchmarking between events is expected to be more problematic. Given the intervals between some of the largest events, factors such as global bio-capacity could change. More likely progress might be in terms of the generation of typologies that link environmental outcomes to the characteristics of events. Both of the techniques could provide useful insights in this respect, therefore informing more strategic decisions relating to the operational characteristics of future events.

The above suggests that in using these techniques to assess the environmental impacts of the largest events some care would need to be taken. However, this paper illustrates that obtainable data on visitor and organisers’ activities related to an event could be coupled with established and widely accepted techniques to provide both an estimate of selected environmental impacts of an event, and also an indication of which activities are the most problematic in terms of particular behaviours or particular sectors.

Clearly, the development of more sophisticated models based upon the above conceptualisations of economic–environmental relationships would provide a better appreciation of the types of environmental impacts discussed in this paper. However, we reiterate the fact that even more sophisticated approaches are unlikely to overcome all of the general limitations inherent in these methods: in particular a reliance on (historical) relationships is expected to remain, and the very uniqueness of each major event means that evaluative techniques and strategic tools must be adapted to each new context. This issue is pertinent with the

Summer and Winter Olympic Games, and the FIFA World Cup featuring venues that are very different, and face different economic structures and local environmental pressures. Such local issues (including local impacts on bio-diversity) will continue to be best addressed by the procedural and case-by-case approach typified in current Olympic Bid documents.

Notwithstanding the above, the adoption of one or more quantitative methodologies for tracing the environmental impacts of large events would have a number of significant benefits. As highlighted, strict benchmarking using the reference techniques would be difficult. However, either of the techniques outlined here would enable some comparison of event impacts across space and time, and enable comparisons between sporting events and other public policy options aimed at achieving social or economic goals (be this in terms of carbon emissions, ‘global hectares’ or other indicators). Additionally, only a quantitative analysis can enable a proper account of the extent to which particular event-related activities or development is especially damaging, thus aiding strategic approaches to minimising negative impacts. It is therefore likely that quantitative environmental impact assessments and evaluations will find their place as part of a suite of impact and monitoring tools that must also include more qualitative and process-related evaluation measures on the part of both mega-event organisers and the public sector.

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