

Assessing the impact of a major sporting event: the role of environmental accounting

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Government support for major sporting events is usually predicated on their assumed economic benefits. Yet there has been little parallel consideration of their potential environmental costs, at a time when the same governments are citing the importance of sustainable development. Environmental performance of major sporting events has hitherto been judged, if at all, on qualitative, activity and procedural criteria, rather than by attempting to estimate the overall impact of an event on measurable externalities. This paper examines the UK round of the 2004 World Rally Championship, using environmental accounting techniques to estimate its economic and environmental impacts on its host region.

Keywords: mega-events; economic impact; environmental accounting

Sporting organizations (similarly to those involved in other elements of communal activity) increasingly have taken note of the environmental impacts of the activities they manage and the need to incorporate sustainable processes and procedures into these activities (International Olympic Committee, 1996; DETR, 1999; Ross, 2005). The increased significance of broad sustainability issues is evident at a number of levels, including the day-to-day management of sporting activities; the development and construction of new sports facilities; and, pertinent here, the organization and management of sporting events (Chernushenko and Stubbs, 2005). Indeed, in 1996, the Olympic Charter was amended specifically to address Agenda 21 and sustainable development (SD) issues (International Olympic Committee, 1996).

A dedication to SD implies the ability to incorporate its principles into an organization's activities, processes and decision making and also, ideally, the ability to measure and monitor the range of positive and negative environmental externalities resulting from this activity (see, for example, Welsh Assembly Government, 2004). Consistent measurement and monitoring is, however, far from easy, particularly when organizations work in a very time- and cost-limited context (witness, for example, the Athens' Olympics poor performance on SD, despite the substantial promises made by its organizing committee during the

bid process; Greenpeace, 2004). Where an organization does make progress towards incorporating SD principles into its operations and behaviour, evaluation is typically in terms of changes to internal processes and with organizational *activities* being monitored rather than outcomes (London 2012, 2005). Changing such behaviours is, indeed, likely to impact beneficially on important environmental indicators. For example, the commitment shown by the Sydney Olympics organizers to renewable fuel use will have reduced greenhouse gas emissions, and by a calculable amount (although this was not, in fact, calculated – other indicators were more qualitative and judgemental). Moreover, as Sydney 2000 and other events show, environmental debate can often centre on local concerns and issues (in this case, toxic waste and land reclamation), rather than on developing evaluation and analysis tools that are consistent and replicable through time and space (Greenpeace, 2000a,b). Additional problems arise with the development of multiple standards. For example, the 2012 London Olympics bid incorporated the WWF ‘One World’ approach to SD, rather than explicitly adopting the (arguably more stringent) *Greenpeace Olympic Guidelines* (Greenpeace, 2000b; London 2012, 2005). This makes it difficult to judge either trends in the environmental performance of a series of similar events or to assess one event against another. Additionally, the lack of a ‘gold standard’ means that major events cannot be assessed easily on SD criteria against other forms of economic activity, and this may be important when regional or national governments must assess major events’ bids for public sector support. A further issue is the estimation of the *indirect* environmental externalities of event-based activities. For example, in 2000 immediate access to the Australian Olympic sites was almost wholly via public transport, but there was no evaluation of how visitors reached New South Wales (most, probably, by air). Other indirect environmental effects, for example along supply chains, are even more difficult to trace.

Following the above, this paper examines the environmental impact of a major sporting event on its host region. By way of illustration, it estimates carbon-equivalent emissions and levels of industrial waste resulting from the activity associated with the 2004 Wales Rally of Great Britain. A developed regional accounts matrix with environmental accounts (or *R-NAMEA*; de Haan and Keuning, 1996; OECD, 2004) is used to estimate the impacts from the ‘supply side’ (that is, resulting from increased demand and hence industries’ output and activity in the reference region). Direct emissions resulting from spectators’ travel activities are also estimated.

The next section of the paper provides a review of the issues in evaluating environmental externalities consequent on major events, followed by a brief description of the case study event. Then, the empirical methodology is outlined, based on Leontief manipulation of input–output matrices with associated environmental and tourism satellite accounts. The quantitative results are then presented, followed by a short conclusion that suggests that an environmental accounting of major events can provide a useful policy tool by contextualizing events within the wider environmental and economic policy debate and indicating where ameliorative policies might be best targeted.

Major events, sustainable development and environmental externalities

The UK and UK-regional governments adhere to the tenet of SD, whereby:

‘The goal of sustainable development is to enable all people throughout the world to satisfy their basic needs and enjoy a better quality of life without compromising the quality of life of future generations.’

UK Government and Devolved Institutions (2005)

The idea of intergenerational equality is at the heart of this (and many other) definition of SD (see also the Brundtland Report; WCED, 1987): however, there is considerable debate on the strength and nature of the actions needed to guarantee future welfare. For example, the protection of natural resources (both quality and quantity) and wider ecosystems is considered a high priority but, with little information regarding the carrying capacity or critical ‘breakdown points’ of such systems, it is difficult to take account of these issues in individual policy formulation (Getzner, 1999), or to value the depreciation of different forms of capital against each other (for example, a degradation in air quality versus the use of mineral resources, or indeed versus human-created economic capital; Turner, 1992). Problems associated with the quantitative valuation of natural capital and of changes in environmental variables are, in part, the reason why ‘on the ground’ policy performance in the implementation of SD principles has been poor in comparison to rhetoric (House of Commons Environmental Audit Committee, 2004).

The environmental evaluation of sports events suffers similarly. In common with other forms of economic and communal activity, sporting mega-events will impact on the environment, encouraging infrastructure development, increased travel and energy use. Whilst these impacts will be very small compared to the ongoing impact of wider economic systems and consumption patterns, they are, nevertheless, very important. Major events have a very high profile and government attitudes to sustainability and the hosting of events can be illustrative of their wider SD commitment – particularly in assessing how public policy handles trade-offs between economic development and environmental cost. Sporting events can generate a variety of externalities; economic, social and environmental, albeit of often uncertain scale (Solberg, 2002). Indeed, public sector support is often predicated on positive externalities, including the economic impact of spectator spending and ‘spin-off’ benefits for the host region following media coverage (Jones, 2001). However, there is an extensive body of evidence that suggests sports events can also have significant *negative* externalities, including financial losses and a wide range of social costs including noise and congestion and, in some cases, the widespread forced relocation of existing populations and businesses (Hiller, 1998; Olds, 1998; Greenpeace, 2000b; Lenskyj, 2002). Moreover, such social costs fall unevenly across society, with some commentators suggesting that sports facilities and games can result in the ‘re-taking’ of formerly abandoned urban spaces by a middle class elite from poor populations (Kidd, 1995). Beyond uneven social impacts, it is clear that there are significant environmental costs associated with

event staging. The construction of new sporting facilities occurs far above the counterfactual (or identified local need) following the winning of sporting events, especially the Summer Olympics. Whilst developers may seek to employ 'environmentally friendly' processes and materials, such actions, even if followed rigorously, can only minimize the marginal negative impact of extra activity, not obviate it (Nelms *et al*, 2005). Construction activity involves relatively heavy materials flows and consequent carbon emissions, and these should only be annualized over the operational lifetime of the facilities if they can be shown to be in full use following, and between, events – which is far from given (Hiller, 1998; REWARD, 2003c,d; Collins *et al*, 2005). Moreover, direct event-related environmental costs can be substantial. Olympic organizers have taken some steps towards minimizing on-site environmental costs; for example, through 'green' building; predicating renewable energy sources for the Olympic Village; and encouraging public transport access to venues (although progress here has been patchy; EREC, 1998; Greenpeace, 2004; Chernushenko and Stubbs, 2005). This does not, however, treat *indirect* environmental costs – for example, resulting from the air travel necessary for spectators to arrive in the host country, or as event-related economic demand stimulates increased economic activity along various supply chains. Also, such approaches imply adherence (if at all) to weak, rather than strong sustainability where, to summarize crudely, ecosystems and natural resources are considered primarily in terms of their continuing ability to serve human needs (Turner, 1992). Whilst the staging of a large event might be considered 'environmentally friendly' if procedural measures are in place to reduce marginal impacts, there is no discussion of whether such events actually are sustainable and therefore perhaps better not undertaken at all. More recently, work has been undertaken examining the overall environmental impact of a sporting event, using an ecological footprint methodology. Collins *et al* (2005) examined the ecological footprint of the 2005 FA Cup in Cardiff. This methodology has the benefit of, firstly, assessing something of the global environmental consequences of the event and, secondly, utilizing a methodology consistent with that used to evaluate many other forms of economic activity. However, whilst the production of a single measure of environmental impact (in notional global hectares) has the benefit of clarity and consistency, the production of this figure requires assumptions that are not always clear to policymakers.

Getzner (1999) suggests that 'weak' sustainability indicators in particular (that measure incremental changes in environmental variables/output with no inherent valuation of natural capital) are inherently difficult to operationalize, in some contrast to those associated with strong sustainability, which make direct reference to the finite limits of a resource. The qualitative environmental assessments associated with the Olympics illustrate this point. They cannot easily provide organizers with a *prioritization* for actions to enhance sustainability. Such evaluations will not provide organizers with information to make the correct choices when faced with a multitude of potential 'sustainable' actions or priorities. Thus, whilst any sustainable action plan may be better than *no* action plan, qualitative assessments of events may only provide part of the answer for organizers wishing to spend time and resources most efficiently in achieving environmental goals.

Additionally, environmental assessments do not provide a framework where

events can be judged *against* each other on any environmental criteria. And, in any case, as Hiller (1998) points out, event impact assessment is still firmly placed within an economic (rather than social or environmental) context. *Ex ante* impact assessments (that may, indeed, determine whether an event takes place or benefits from public support) are almost always economic, with any environmental plan then relegated to minimizing the impact of an event which is a *fait accompli* in terms of location, date and broad organizational structure (Greenpeace, 2000a). Moreover, the kinds of environmental analyses undertaken for the Olympics require substantial resources and expertise, either on the part of organizers or concerned third parties. As such, they are unlikely to be appropriate or possible for smaller events. The remainder of this paper suggests that a complementary approach may fill some of these evaluative gaps. A quantitative environmental accounting of a sporting event can not only provide an estimate of its impact on well-established environmental variables such as (here) carbon emissions and waste, but also illustrate which aspects of event hosting have the greatest impact, thus aiding policies aimed at mitigation (Environmental Protection Agency, 2000).

The case study event: the World Rally Championship in Wales

The Wales Rally GB is not, in terms of spectator numbers, a mammoth event, attracting around 50,000 spectators over its four days in 2004. However, it has substantial impact, both economically and in terms of media exposure. Expenditure related to the 2004 event was estimated to lead to £7m additional output in Wales, and the World Rally Championship as a whole attracted a global audience second only to Formula 1 in motorsport (Econactive Ltd, 2005). Thus, much importance is attached to the event by both the Welsh Development Agency and Welsh Assembly Government, which are its primary sponsors. Indeed, the rally is the centrepiece of the wider *Wales Motorsport Initiative*, which seeks to promote the region as a centre for high performance and motorsport engineering (Welsh Development Agency, 2003). In many ways, the rally is atypical of a major sporting event. Firstly, it is repeated along (roughly) the same course over a number of years, thus enabling relationships to develop between organizers and local actors. Secondly, traversing South Wales (rather than being stadium based), it enables Wales to display its tourism offer more effectively to spectators and broadcast media. In terms of environmental impact, the rally also differs from other major events. It requires little or no construction or infrastructure development, other than extra maintenance on forest roads. However, the mode of attendance is overwhelmingly via private car, and to this must be added the environmental impacts of the competitors themselves as they complete 1,200 km in high performance machines. There has been an explicit attempt to encourage rally organizers to source goods and technical and general services within the region, rather than from outside. Whilst this is done primarily for economic reasons (to maximize indirect supply chain effects on the Welsh economy), it will also likely reduce the environmental impact of the event as (final) goods and food products are transported over lower distances to service the event.

An environmental assessment of this regional government-sponsored event

has become increasingly relevant in the context of contemporary regional duties towards SD. Wales has the only legislative body in the UK with a *duty* (legal obligation) towards SD. As part of its interpretation of its SD duty, the Welsh Assembly has sought to promote sustainability in the way that it funds activities (Welsh Assembly Government, 2004). Consequently, recipients of regional government funding increasingly are required to pay greater attention to the environmental impacts that may arise from sponsored activity and set these against economic effects. However, there is the practical issue of there being few tools available with which the economic and environmental effects associated with sponsored activities (including event tourism) can be analysed. Notwithstanding, research in Wales is developing the tools through which the economic and environmental effects of events can be assessed properly.

Methodology and data

Input–output analysis and environmental and tourism satellite accounting

Input–output analysis has a long history in policy use, being a relatively straightforward method of evaluating the indirect economic 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 laden with assumptions and methodological limitations (see Miller and Blair, 1985, for a review). 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 formerly has been hidden in wider industry or functional definitions, with examples of this including household and tourism satellite accounts (OECD *et al*, 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 (de Haan and Keuning, 1996; OECD, 2004). Wales benefits from both an experimental NAMEA (REWARD, 2005a–e) and a tourism satellite account that is now in its second iteration (Jones and Munday, 2006).

With the input–output account as the ‘planet’, it is technically straightforward to link activity in one satellite to outcomes in another. This linking of two satellites is, however, a relatively new development, although core input–output accounts have been used to establish environmental outcomes for decades (Leontief, 1970). In this case, increased activity in the tourism sphere has implications for environmental outcomes (see Patterson and McDonald, 2004, for a thorough exposition on the environmental consequences of New Zealand tourism). Similarly, although input–output techniques have long been used to examine the economic impact of major events, they have not been used in conjunction with a NAMEA to establish their environmental consequences.

The data

The data sets that inform this analysis consist, firstly, of a sample of 590 spectators at the 2004 event, interviewed on site. Sample quotas by age, gender

and group size were intended to provide a sample representative of the visiting population, the character of this population being assumed from a much larger (cf 2,500) random sample of rally visitors undertaken at the 2001 event. Spectators were interviewed face-to-face, with the intention of collecting expenditure (by detailed category) and attitudinal data that could inform an economic evaluation of the event. Secondly, around half the participating teams and a small number of media and VIP/business attendees were surveyed face-to-face. An important part of economic (and hence in this methodology, environmental) impact arose from the spending of rally organizers in Wales, amounting to well over £1m per annum, and this spending was examined by the research team in detailed interviews with organizers (Econactive Ltd, 2005).

The collection of this data for an economic (rather than environmental) impact assessment led to some weaknesses in its appropriateness for this latter use. Although the estimates of additional economic demand were well served by the reliable estimate of expenditure by commodity *within* Wales, important data, including mode of transport and country of residence of overseas visitors, were not collected directly. In the first case, this was assessed using indirect means (for example, level of spend on transport fuel versus public transport). In the latter case, the lack of information meant that the environmental impact on Wales alone was calculated, rather than that associated with the entire journey.

Table 1 summarizes the methods by which direct spectator mileage and carbon impacts were estimated. For overnight visitors, (round trip) distances from the Welsh border to their accommodation were calculated according to where in the UK the respondent was resident; for those who visited as a day-tripper, the start/finish point was their home unitary authority (UA) and they were assumed to visit the stage/day closest to that UA. Overseas residents were assumed to enter Wales via coach, car or rail, as Cardiff airport has only a small range of international services. Within-rally mileages (that is, following the event around) were calculated using the round trip distance from the three major accommodation locations (Cardiff, Brecon and Swansea) to the rally on each day,¹ this weighted by the number of survey respondents staying in each town.

The outlined methodology may underestimate spectator impacts somewhat. Many single-day attendees would not necessarily have attended the stages geographically nearest their home or taken the shortest routes. Additionally, carbon emissions per mile for the 'average' private car are taken from the DTI (1998), whilst casual observation of spectators' transport suggests these may be conservative. Moreover, it is very difficult to estimate fuel consumption for rally competition cars as it varies widely, depending on the terrain and, further, such information is competitively sensitive. The competitor-related fuel (and hence CO₂) estimates in Table 1 are based on the maximum stage length between fuel stations during the rally; this itself being dictated by fuel tank size. The estimated fuel-related carbon impacts detailed above can be added to supply-side impacts estimated through environmental input-output techniques described below to produce an estimate of the carbon emissions resulting from the 2004 event.

Table 1. Estimates of CO² impacts from travel fuel consumption.

IMPACT	Individual person miles (IPM)	Total person miles (TPM)	Assumed persons per vehicle (PPV)	Total vehicle miles	CO ₂ per vehicle mile
<i>Overnight visitors – to & from rally (non-Wales resident)</i>	Round trip (RT) Wales border – accommodation (shortest route) from M4/A40/A465 as appropriate	IPM * no of overnight visitors	2.8 (average reported group size for 1–4 member group adjusted upwards to account for coach party/minibus attendees)	TPM	0.36 kg (DEFRA/DTI private car)
<i>Overnight visitors – to & from rally (Wales resident)</i>	RT – home UA to accommodation	IPM * no of overnight visitors			
<i>Overnight visitors – during rally</i>	RT distance between 3 most used accom. locations to rally activities (on each of 3 days) weighted by no of respondents at each accom.	IPM * no of overnight visitors			
<i>Day attendees – to rally</i>	RT – home UA to nearest rally stages	IPM * no of day visitors	2.7 (average reported group size for 1–4 member group adjusted upwards to account for coach party/minibus attendees)	PPV	
<i>Day attendees – during rally</i>	Flat assumption of 15 miles between stages	IPM * no of day visitors			
<i>Competitors & course recce</i>	Rally distance: 750 miles (210 miles on timed stages)	(IPM * no of finishing competitors) + (IPM/2 * no of non-finishers) + (IPM * no of teams – reconnaissance run)	2 (driver & co-driver)		2.25 kg (calculated from 15 mpg on recce/non-timed and 5 mpg on timed stage)

Methodology

This paper links the structure of the Welsh Tourism Satellite Account for 2000 with the experimental NAMEA for Wales, as developed by the REWARD project (Jones and Munday, 2006; www.reward-uk.org). Table 6 of the Welsh TSA (in OECD/WTO compliant product-by-industry form) is manipulated arithmetically to produce a symmetrical industry-by-industry transactions matrix, and this then embedded within the wider input–output tables for Wales, also for 2000 (Bryan *et al*, 2004). The resultant matrix is then aggregated to match the 44-sector NAMEA structure² (Miller and Blair, 1985; OECD *et al*, 2001). Estimates of the carbon-equivalent air emissions and industrial waste arisings are then calculated for each industry, based on coefficients from the REWARD data set (Leontief, 1970; REWARD, 2003a–e). The methodology followed in this paper posits the 2004 rally as resulting in a shock to economic demand as spectators, teams and organizers demand more Welsh goods and services. This initial demand shock (estimated for each industry) has indirect consequences as, firstly, those industries demand goods and services from other Welsh firms along their supply chains and, secondly, as wage payments increase due to rally activity (directly and indirectly) and these wages then partly result in increased household expenditure in Wales. Following Miller and Blair (1985), dividing the elements of the transactions table results in a direct coefficients matrix which can then be solved simultaneously to find the new production levels for each industry required to satisfy the demands of those sectors directly servicing rally-related expenditure in Wales. This vector of new demand by industry is then associated with increased levels of carbon emissions and waste (Leontief, 1970; REWARD, 2003a–e).

It was decided to estimate the environmental effects on Wales only, thus discounting event-related impacts outside the region (for example, air travel from overseas to London airports; teams' carriage between the last and subsequent rally, etc). This was driven by two considerations. Firstly, limitations in the data meant we could not estimate the distance travelled (and hence carbon arisings) for overseas visitors (who comprised around 10% of the sample). Secondly, we did not have access to the full interregional modelling framework that would enable UK-wide effects to be estimated through Leontief manipulation. Such a system does exist for Scotland and the rest of the UK and has been used to estimate the out-of-region environmental impacts of within-region production and demand and, crucially for Scotland, *vice versa* (see Ferguson *et al*, 2005).

The Welsh NAMEA reports a number of environmental coefficients relating to carbon emissions, acid rain precursors and pollution by heavy metals. In this analysis, however, the indicators reported are restricted to greenhouse gases (in tonnes of CO² equivalents) and waste (total kilotonnes). This restriction is justified in the immediate regional context, with carbon emissions and waste arisings the most policy-relevant of the indicators available. Additional to the impacts on environmental outcomes via industry/supply-side effects are those related to the behaviour of spectators' travel. Here, the analysis is restricted further and only CO² equivalents are reported for travel-related behaviour. Whilst it is, of course, possible to obtain per household, and hence per person, waste coefficients, they will not represent attendees' behaviour at a sporting

event, and thus 'household' waste is not considered. The majority of spectator-related carbon impacts will be accounted for already as they cause additional demand for Welsh industry, leaving by far the largest element unaccounted for that being the fuel burned in Wales but bought outside. In order to avoid error involved in estimating these fuel purchases, an estimate was made of total spectator mileage and consequent CO₂ impact within the region, rather than modelling this as a shock to the Welsh oil processing/distribution sectors.³

There are, of course a number of issues with the above methodology. The limitations of linear input-output analysis are reviewed in Miller and Blair (1985). Key difficulties relating to the assumption that existing production and import behaviours also characterize new activity are particularly problematic in the evaluation of tourism and major events compared to other framework applications (Harris and Aying, 1998). Other errors may arise with the use of a 2000 NAMEA to assess activity which occurred in late 2004. Not only may relative input prices (and hence production behaviours) have changed between the two dates, but energy technology and production in the region may also have changed. A major problem in analysing event behaviour within the Welsh (or any other) NAMEA is the developed structure. For example, in the Wales 44 NAMEA sectors, there is no distinction between the activities of accommodation and restaurant sectors. This is typically the most important part of spectator expenditure and evidence reveals that the economic production structure of these activities differ considerably, suggesting that the same will be true of environmental impacts (DCMS, 2004). Further, there is also the question of how visitors' behaviour will differ from typical behaviour *within* an identified sector, such as serviced food, with visitors perhaps considered *a priori* more (or in the rally case, *less*) likely to purchase high value serviced food rather than 'takeaways', with consequent implications for waste and other outputs. Here, critical elements will relate not only to the nature of food purchased, but also its source. There is some evidence that smaller (an indigenously owned) tourist-facing businesses in Wales, such as B&Bs, are more likely to source food products locally than large chain hotels and restaurants, with this probably lowering environmental arisings (Collins *et al*, 2005; Jones and Munday, 2006). However, this level of disaggregation, available in the TSA, is lost in the conversion to NAMEA sectors – and with it much policy-relevant detail.

There are some further issues associated with analysing the rally event within the NAMEA that should be accounted for properly for a reasonable estimate of environmental impact to be ascertained. For example, a major environmental impact of the rally relates to the remedial forestry activities following the event; this activity must be allocated to the NAMEA group, *agriculture, forestry and fishing*. This, however, will not give an accurate estimate of forestry-related carbon emissions and waste arisings, as they will be very different from the (relatively polluting) agricultural activities within this wider primary grouping. Meanwhile, the predominance of private transport to attend and follow the event will mean that spectator-related externalities will be relatively higher than (for example) stadium-based events. The rally stages are almost wholly inaccessible via public transport (excepting those in Cardiff) and, except for VIP guests, organizers do not operate coach or minibus transport for spectators.⁴

Table 2. The environmental impact of the 2004 Wales Rally GB.

	CO ² equivalents (tonnes)	Waste (total kilotonnes)
<i>Fuel-related effects</i>		
Spectators to/from rally	375	—
Spectators during rally	635	—
Competitors & teams	250	—
Total direct fuel impacts	1,260	—
<i>Supply side (inc Type II household effects)</i>		
Spectator spending	950	1.07
Teams & associated spending	1,330	1.88
Total supply side	2,280	2.95
Total rally-related	3,540	2.95

Results: the environmental impact of the Wales Rally GB

As Table 2 shows, the total CO² equivalent impact of the 2004 Rally in Wales is estimated at a little over 3,500 t. Over a third of this, 1,330 t, is accounted for by the direct and indirect impacts of organizer and team spending in Wales, with a further 950 t due to spectator spending (excluding spending on fuel). The 'supply-side' effects together total 65% of all carbon emissions, even where, as here, spectators are arriving overwhelmingly by private car. Further examination reveals that much of the carbon emissions on the supply side associated with the rally, around 40%, are in the *agriculture, forestry and fishing* sector (Figure 1). Much of this supply-side impact is, as noted earlier, related to remedial works on forest roads and may produce different impacts compared to agriculture in general, highlighting the difficulty involved in assessing the impact of very individual and distinct visitor-related activity within an established NAMEA – even when, as here, the sector at issue is not one typically associated with the visitor economy. Other sectors which emit high levels of carbon as a consequence of the rally include, unsurprisingly, *oil processing* and *electricity* (generation), along with *other land transport* and *hotels and restaurants*.

Supply-side waste impacts of 2.95 kt are even more concentrated in *agriculture, forestry and fishing* (two-thirds of all such impact), but this figure is likely to overestimate substantially the waste impacts of what are mostly forestry operations. Other sectors which produce significant levels of waste include *hotels and restaurants* (0.4 kt) and *coal extraction* (0.2 kt) (Figure 2).

In terms of fuel use, travel *during* the rally has more consequence in terms of carbon emissions than travel *to and from* the rally, although this is due to the limitation of only accounting for travel to the event that occurs *within* Wales, which is a relatively small region.

Contextualizing the environmental impact of the rally is difficult, with few, if any, comparator events yet having undertaken similar analysis. It can, however, be useful to compare the environmental cost of the rally to its economic

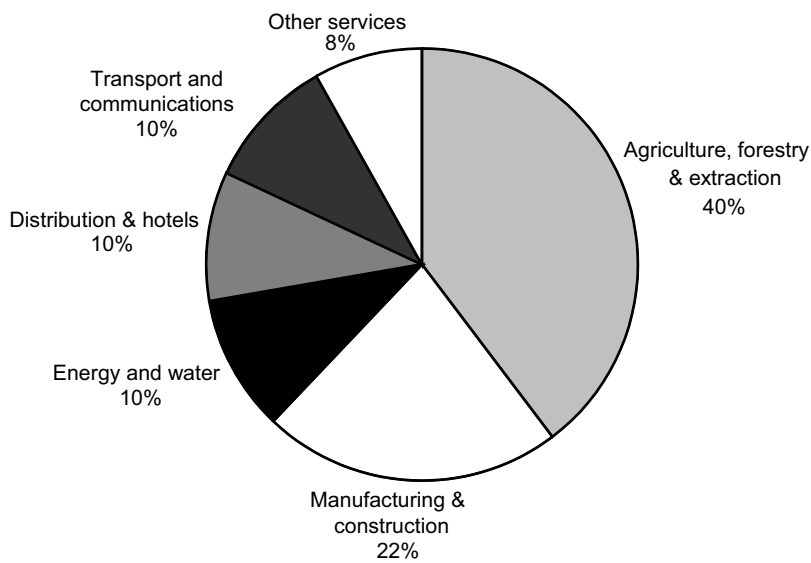


Figure 1. CO² impacts by broad sector.

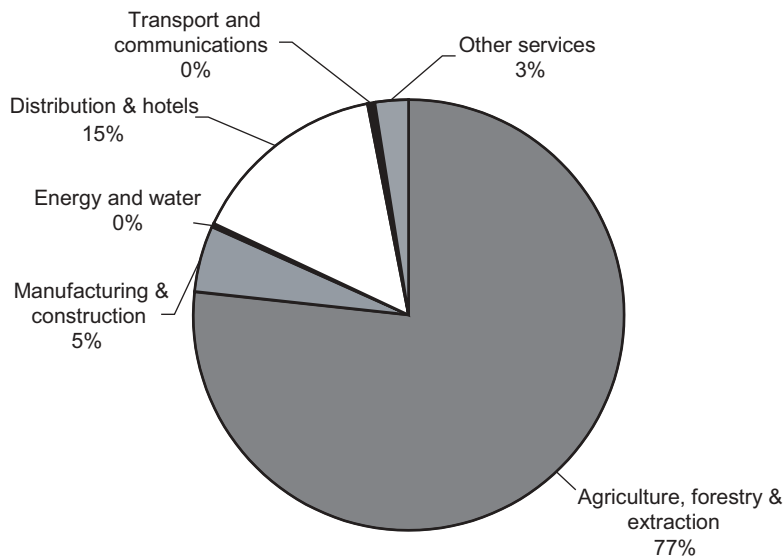


Figure 2. Waste impacts by broad sector.

benefit, to judge how it performs in comparison to, for example, established activities in Wales. Table 3 shows that for every £1m of additional value added in Wales, 930 t of carbon are produced. Spectator and team impacts are very similar in overall terms (920 and 946 t per £1m value added, respectively). Much of the spectator-related effects are due to fuel purchases (which have very small value-added impacts in Wales following exchequer and import leakages);

Table 3. CO² and economic impact.

Total value added (expenditure impacts)	Total value added (£m)	CO ² equivalents (tonnes)	Tonnes CO ² per £1m value added
Spectator spending (inc fuel impacts)	2.13	1,960	920
Teams and others (inc fuel impacts)	1.67	1,580	946
<i>Total event value added</i>	<i>3.8</i>	<i>3,540</i>	<i>932</i>

the remaining spending of spectators (largely on hotels and food in Wales) is more 'CO² efficient' per £1m value added than organizers and teams (which demand, among other things, relatively polluting transport services and manufactures). Overall, the rally does not perform particularly well compared to established sectors on carbon emissions per pound of value added, as it would rank 32nd of the 45 NAMEA sectors (including the rally itself) in Wales (Figure 3).

Examining waste production, the rally fares badly (39th), with only five NAMEA sectors in Wales having worse performance, albeit far worse for each sector – the 'next worst' sector, *construction*, produced (in 2000) around 2.5 kt of waste per £1m of value added, compared to 0.77 kt for the rally (Figure 4). However, as noted earlier, much of the rally waste arisings are associated nominally with primary economic activity, which is very different to that consequent on the rally – and excluding this element of waste increases rally performance such that it would rank 33rd of the 45 NAMEA sectors.

Conclusions

This paper suggests that assessing the environmental impact of major sporting events is important, and will become increasingly so as SD commitments become enshrined in the constitutions of sports organizations and in the statutes of the public sector bodies often asked to support such events. Commitments, however, are of little use without a programme to translate that commitment into organizational action and without an evaluative system that can assess the efficacy of such action. Here, there is currently something of a vacuum. Event organizers can take steps towards encouraging more (*a priori*) SD procedures, such as the encouragement of public transport to attend events and the adoption of 'environmentally friendly' building materials and methods. However, there is currently no way of prioritizing such activities or of assessing their overall impact on reducing environmental impact. Event organization almost always occurs in a time-limited (and money-limited) context where organizers strive to meet a myriad of sporting, logistical and economic needs. How, then, can they decide between the relative merits of placing resources into (for example) developing renewable energy sources for the event or leasing a fleet of low-carbon vehicles, if they are mutually exclusive?

A holistic and consistent environmental impact 'toolkit' for major events is some way off. However, this paper illustrates that obtainable data on spectator



Figure 3. Tonnes of CO₂ equivalents per £1m of value added – Wales, 2000.



Figure 4. Waste total kilotonnes per £1m value added – Wales, 2000.

and organizer activities related to an event can be coupled with established environmental accounts to provide both an estimate of the overall environmental impact of an event and also an indication of which are the 'big hitters' in terms of particular behaviours or particular sectors. Moreover, this method can give an indication of the 'enviro-economic efficiency' of hosting major events by comparing CO² or other environmental indicators to regional economic value added.

There are a number of limitations associated with the current analysis, some data related and some methodological. Whilst a regional government might be interested in the within-region economic impact of a sporting event, for larger scale events in particular, a national or global estimate of impact would be more appropriate (Collins *et al*, 2005). Such an assessment, following the methodology outlined here, could be reasonably straightforward given the existence of a NAMEA covering the area in question (or an interregional set of such accounts) and some improvements in the scope of data collected from or about attendees, particularly regarding travel behaviours and distances. This paper has highlighted the fact that the industrial/activity structures and stylized behaviour of those sectors in published NAMEAs may be inappropriate or inadequate in impact measurement of visitor activity (although this may be true of many other activities). At the regional level, there may be opportunities for bespoke primary research to be undertaken to enable the NAMEA to represent current regional emission production functions better – for example, survey work is under way to examine and represent the characteristics of regional energy production better. Other limitations are more difficult to resolve. Issues arise when using 'standard' input–output methodologies to examine the indirect economic impact of event activity, then relating this to environmental indicators. The likelihood that the modelled activity will replicate existing regional activity in terms of input and labour use is low. It may be that more sophisticated analyses, including computable general equilibrium (CGE) models, can be adapted, firstly, to include environmental variables (as has the AMOS model; Ferguson *et al*, 2005) and, secondly, be structured in a way which enables a detailed appreciation of event impacts, which is itself policy relevant (Madden, 1998). Here, the impact of changing relative prices could be modelled and structural relationships allowed to vary in response to changes in economic demand.

The development of more sophisticated models based, essentially, on economic relationships would provide a better appreciation of the types of environmental impacts discussed in this paper. However, there are wider, more general limitations inherent in these methods: they will always rely on established (historical) relationships and sophisticated models will be expensive to construct and maintain, thus perhaps being outside the reach of smaller events and regions. It is therefore likely that economic accounting-based impact assessments will form only a 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 event organizers and the public sector. However, without a quantitative assessment of environmental impact, it will be extremely difficult to ascertain whether SD actions and public sector support are appropriate and effective.

Endnotes

1. There are a number of rally stages on each of the three main days, but they are geographically close to each other on any given day.
2. Each NAMEA sector was congruent with one or more input–output sectors and so no aggregation problems were encountered.
3. This will result in minimal errors due to the exclusion of *indirect* CO₂ impacts from this source, with oil processing having very low within-region supply links.
4. Not that, given the nature of the event and fan-base, such a service would be especially popular. Rally fans *like* their cars.

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