



INTERNATIONAL ORIENTEERING FEDERATION

NUMERICAL METHODS OF CALCULATING  
ENVIRONMENTAL IMPACTS OF  
SPORTS ACTIVITIES

ENVIRONMENT COMMISSION,  
INTERNATIONAL ORIENTEERING FEDERATION,,  
RADIOKATU 20, FI-00093 SLU, FINLAN

# **Numerical methods of calculating environmental impacts of sports activities**

ERKKA LAININEN  
IOF Environment Commission

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## Summary:

The most important environmental impacts caused by sports activities are land use for venues and related infrastructure, material use caused by production of sporting equipment and construction of venues, energy consumption and emissions from the passenger traffic of athletes and sports tourists and transportation of materials, and waste production.

Indicators for material flows and CO<sub>2</sub> emissions have been calculated, e.g., in the World Championships in Athletics (Helsinki, Finland, 2005) and Nordic Ski World Championships (Lahti, Finland, 2001). Research studies have shown that the most important source of CO<sub>2</sub> emissions and material flows is the passenger traffic in connection to major sports events.

Particular reference is made in this paper to the sport of Orienteering. This differs from many other sports disciplines because it does not require permanent, constructed venues. Also the extension of passenger traffic caused by orienteering events is much lower compared to many, but not all, other disciplines.

From orienteering's perspective, it would be advisable to collect information on such indicators that may help demonstrating the actual environmental impacts of orienteering activity. For instance, calculating an estimate of the total annual land use of orienteering on the national level is a good way to put the impact of orienteering in its right scale. The benefits and possibilities of obtaining information on the material flows and CO<sub>2</sub> emissions caused by orienteering activities and events should also be investigated.

It is important to remember that calculating environmental indicators of orienteering does not secure the environmental performance of the sport. Therefore, each national federation in the IOF should develop a national environmental policy, and set targets for the management of environmental issues in its all activities, including indicators for the achievement of the targets and follow-up of the state of environmental issues.

## **1. Environmental impacts of sports**

On the global scale, the most important environmental impacts of sports activities are:

- Land use for venues and related infrastructure
- Use of material for sporting equipment, and during construction and in carrying out the sporting activity
- Energy consumption and emissions from traffic of athletes and sports tourists, and transportation during construction and in conducting the activity
- Waste production

From the ecological point of view, land use by sports activities can have substantial impacts on ecosystems. For instance, in Middle Europe, ski sports have, in places, changed the sensitive nature of the Alpine terrain by the construction of massive alpine ski slopes, roads, and accommodation facilities. Organising big sports events like Olympic Games or World Championships requires land use for the construction of modern venues and accommodation for athletes and tourists who come to watch the games. This can have impacts on the living conditions of local flora and fauna.

However, according to *Friedrich Schmidt-Bleek (1993)* from the Wuppertal Institute in Germany, the most severe impacts that man causes to the environment are due to mass flows. By production of energy and items, and by construction of buildings, roads, etc., we actually create a global mass flow that changes the ecosystems all around the world.

The third important viewpoint is the energy consumption and the resulting emissions of CO<sub>2</sub> that have influence on the greenhouse effect and global warming. From the perspective of sports activities, these emissions are mainly due to the production of energy used for constructions, and traffic and transportation. Of these, the traffic of athletes and sports tourists has the greatest impact on CO<sub>2</sub> emissions.

Waste production is usually linked to sports events through the use of disposable items in catering services. Another important source of waste is paper: printed products like posters and brochures, and office paper sheets used for result services. From the viewpoint of waste production it is important to strive after as high recycling percentage as possible so that the minimum amount of waste ends up in landfill. Especially important is to avoid placement of biowaste to landfill, because the lack of oxygen during decomposition causes emissions of methane, which is a strong greenhouse gas. Therefore, biowaste should be composted by aerobic processes.

## **2. How can we measure the global environmental impacts of sports?**

In the development of indicators for global environmental impacts of sports, attention should be paid to the impacts that are related to the most important global environmental problems and targets of sustainable development policies. From this point of view, we should be able to answer for instance the following questions:

- How much do sports activities have direct impacts on biodiversity and ecosystems?
- How big are the material flows of sports activities?
- How much CO<sub>2</sub> emission do sports activities cause?
- How much waste is produced in sports activities?

Because indicators estimating these same impacts are also used to measure the impacts of other human activities, it is possible to assess the relative significance of

sports to the causes of environmental problems. Furthermore, the use of these indicators also makes it possible to compare the impacts of different sports activities. However, it is important to ask whether it is in the best interests of the sports community to concentrate on such comparisons between sports, or should it be better to focus on using the indicators for improving the environmental performance of individual disciplines.

The following types of indicators can be used to estimate the impacts mentioned above for the annual total activity of a particular sport or single events of that sport:

- 1) Land use: annual total land area taken for particular sports activities (km<sup>2</sup> of land)
- 2) Material flows: direct and indirect material use caused by an individual sports event (tons of mass)
- 3) CO<sub>2</sub> emissions:
  - direct and indirect emissions caused by a particular sports event (tons of CO<sub>2</sub>)
  - direct annual emissions of traffic due to all activities of a particular sports discipline (tons of CO<sub>2</sub>/ year)
- 4) Waste production: amount of different types of waste in individual sports events (tons of waste, e.g., paper, biowaste, landfill waste)

### **3. Examples of research studies and methods**

#### ***Land use***

The author has not seen any research papers or statistics on the indicators of land use for sports activities, but believes that this perspective has been investigated, e.g., by the IOC. Producing this kind of indicators should be fairly easy, because it is simple to calculate areas from aerial or satellite photographs.

#### ***Material flows***

Material flows for sports activities have been calculated for instance in the Nordic Ski World Championships 2001 Lahti, Finland (*Neopoli et al. 2001*). The research was conducted by the environmental consulting company Neopoli and consisted of a qualitative phase in which the material flows of the games were identified, and a quantitative phase in which the numerical material flows were calculated using the MI (Material Input) factors developed by the Wuppertal Institute. The analysis was quite extensive, because a total of 2237 different material flows caused by e.g., traffic, transportations, items and materials used, facilities, etc. were taken into consideration. However, as the researchers emphasised, it is impossible to take into account all sources of material flows.

The MI factors used make it possible to estimate the total material consumption of, e.g., items or energy used, because these factors take into account all material flows during the whole life cycle of a product from acquisition of raw materials, refining and productions processes, and delivery to the use and service of the product as well as its disposal.

In short, the result of the study was that the total calculated material flow due to Lahti WC games was 8 275 tons of material, of which 41,7% was due to traffic and transportation, 22,2% due to constructions, and 10,9% (perhaps a little surprisingly) due to producing a commemorative coin of the games. Catering services were responsible of 8,5% of the total material flow, printed products of 6,2%, and energy used for electricity and heating of venues caused 5,4% of total material flows.

## **CO<sub>2</sub>-emissions**

The CO<sub>2</sub> emissions of IAAF World Championships in Athletics, Helsinki 2005 were investigated in a project "Eco-Mass" by the Helsinki University of Technology Lifelong Learning Institute Dipoli, WWF Finland, and the energy advisory centre Motiva Ltd. The results of the project were published in the *Eco-Efficient Major Event Manual (Helsinki University of Technology Lifelong Learning Institute Dipoli, 2006)*. In the project, a computer programme "Climate Calculator" was developed. The calculator is a web application that is designed to help offices and organisers of mass events to measure CO<sub>2</sub> emissions and find ways of reducing them.

The calculator takes into account the emissions due to heating and electricity, consumption of materials and items, travelling and transportation and paper consumption. The user is able to easily input the data in the system, because the programme asks the required information in the form that can be readily found in the organisation's accounting figures and invoices. The programme uses certain assumptions and factors to calculate the emissions based on the given data. The limitation is that the factors used by the programme are based on Finnish national emission factors. These factors may vary from country to country.

The main result of the project was that the total of 97% of the CO<sub>2</sub> emissions produced by the Athletics World Championships 2005 was due to passenger traffic (athletes and sports tourists). Only 3% was caused by electricity and heating, and less than 1% for logistics and paper consumption. This example illustrates the dominance of passenger traffic as the main source of greenhouse gas emissions in connection to major sports events.

## **Waste production**

The waste production of sports events has been calculated on several occasions. In Finland it is possible to obtain data directly from the waste transportation company. In the case of sports events, the data are often more reliable, because the vehicle picking up the waste may not collect waste from any other site and it is thus possible to get directly the weight of the waste. Otherwise, the calculation must be done indirectly using the volume and degree of filling of the waste containers, and the information on how many times the containers have been emptied.

## **4. Suggestions for orienteering**

### **Land use**

Orienteering differs from many other sports disciplines because it does not require permanent, constructed venues. However, information on the land use for orienteering may have significance, because organising an orienteering event may have impacts on flora and fauna. Thus, for instance the total annual land use for orienteering is an indicator of magnitude of potential disturbance.

In Finland, a national estimate for the land use of orienteering has been calculated based on the data of 1999 (*Laininen, 1999*). It was estimated that there are approximately 5000 competitions and recreational orienteering events organised annually in Finland. These events take place in 1000 different venues (rough estimate), and the land area required for one event is approximately 4-5 km<sup>2</sup>. Based on this information it can be estimated that orienteers use annually a land area of 400 000 hectares, which represents some 1,7% of the total forest area in Finland (23 000 000 ha). In the research study of Jukola relay 1995 (*Myllyvirta et. al., 1998*) it was estimated that

the maximum area on which the traces of orienteers can be observed directly after the competition was 0,5% of the competition area. Using this result, we can say that traces of orienteers can be found annually in Finland in an area of 2000 hectares. According to *Kardell (1974)* and *Myllyvirta et. al. (1998)*, these traces will vanish depending on the forest type during 1-3 growing seasons.

Recommendation: This kind of indirectly calculated indicator would be useful to illustrate land use of orienteering on the national level. The indicator is easy to calculate, but has uncertainty involved.

### ***Material flows and CO<sub>2</sub> emissions***

These kinds of indicators have not been calculated for orienteering events. It seems that they are becoming the standards for calculating impacts of different types of human activities. It is believed that these indicators will be central for calculating environmental impacts of sports activities. If orienteering wants to actively take part into discussion of global environmental impacts of sports and demonstrate its own share of these impacts, it is advisably to take actions on applying these methods to orienteering events. It is also believed that these indicators could be useful for the development of new, more environmentally-friendly practices in orienteering, and they could also have a strong educational perspective by demonstrating the orienteers the most important factors which influence the environmental impacts of our sport.

The problem with the use of these calculation methods is the fact that they require quite a lot of work and expertise. However, they could provide interesting subjects for theses made in different educational establishments. There is also a possibility to use EU programmes and funds to finance this kind of research studies.

Recommendation: The benefits / possibilities of obtaining information on the material flows and CO<sub>2</sub> emissions caused by orienteering activities and events should be investigated.

### ***National performance indicators***

In Finland, the Council of the Finnish Orienteering Federation (FOF) has recently ratified a new strategy for FOF. The strategy includes environmental issues as one area of actions. The idea has been to consolidate the strategy by defining actions and indicators by which the achievement of strategic targets and state of environmental matters in FOF can be monitored. The author has acted as consultant to FOF in making a self-evaluation of the current state of environmental issues, as well as defining follow-up indicators. The process is in hand.

The following are some examples of indicators that have been suggested for monitoring the state of FOF's environmental performance:

- number of occasions in which the land use for orienteering has been prohibited by landowners or authorities
- number of complaints from stakeholders (landowners, hunters, environmentalists, authorities, etc.) related to organisation of events
- opinions and stands of stakeholders on orienteering (e.g., national barometer of forest owners, feedback after big orienteering events)
- number of discussion events with stakeholders on the national / regional level
- number of articles discussing environmental matters in Orienteers' magazine

- number of club members that have received environmental education in different lines of operation (event organisers and course setters, youth educators, coaches, etc.)
- implementation of environmental management in FOF: activity of environment group, update of the FOF's environment programme, self-evaluations, etc.

Recommendation: Each national federation in the IOF should develop a national environmental policy, and set targets for the management of environmental issues in its all activities, including indicators for the achievement of the targets and follow-up of the state of environmental issues.

#### 5) References:

Helsinki University of Technology Lifelong Learning Institute Dipoli, 2006. Eco-Efficient Major Event Manual.

Kardell L. (1974). Vegetationsslitage I samband med orienteringstävlingar. Skogshögskolan, Stockholm. (*Study of orienteering competitions' impacts on vegetation*)

Laininen, Erka (1999). Suomen Suunnistusliiton ympäristöjärjestelmän kehittäminen, diplomityö, Teknillisen korkeakoulun vesitalouden ja vesirakennuksen julkaisuja, TKK-VTR-2. Espoo. (*Master's Thesis: Development of Finnish Orienteering Federation's Environmental Management System*)

Myllyvirta T., Henriksson M. & Aalto V. (1998). Sipoon Jukolan viestin 1995 kasvillisuusvaikutusten seurantatutkimus. Itä-Uudenmaan ja Porvoonjoen vesien- ja ilman-suojeluyhdistys r.y. (*Jukola Relay 1995, Follow-up study of impacts on vegetation*)

Neopoli Oy, Ympäristöministeriö, Hämeen ympäristökeskus, Hiihdon MM-2001 kisaorganisaatio, 2001. Suurtahtuman materiaalivirtaselvitys. (*Material flow analysis, Lahti Nordic Ski World Championships 2001*)

Schmidt-Bleek, F. 1993. Wieviel Umwelt braucht der mensch? MIPS – Das Maß für ökologisches Wirtschaften. Birkhäuser. Berlin, Basel, Boston. (*Handbook on the use of material flow analysis as a measure of eco-efficiency*)