Greenhouse gas emissions during the 2003 World Summit

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Abstract
In recent years, global warming and climate change have become international issues for both industrialized and developing countries. Increasingly we will need to understand and manage our Greenhouse Gas (GHG) risks in order to comply with national and regional policies aimed at reducing GHG emissions. It is for these reasons that it is fast becoming critical to know which processes cause GHG emissions and how much they are causing.

This article will describe the link that exists between processes and GHG emissions. As a demonstration, the article will describe how these GHG emissions was generated during the 2003 World Summit on Sustainable Development (WSSD) and how a model was developed to determine what the GHG emissions were during the WSSD.

The GHG study, and subsequent model development, was done in order to keep the WSSD in line with its principles for the ecologically sound management of the environment and the issue of climate change. It was proposed that the WSSD be made carbon neutral. This meant that all the GHG (and thus carbon or carbon equivalent) emission generated by actions of the WSSD be offset over a period of time.

In order to offset the GHG emissions of the WSSD it was essential to have a good assessment of the amount of emissions that was generated during the Summit. An emission Footprint model was developed, based on information obtained throughout the Summit. The method used a number of resources to determine the emissions resulting from delegate air travel to and from the host city, road travel to and from Summit venues, energy consumption at hotels and venues and waste generation amongst others.

This paper will provide the critical factors that influenced and contributed towards the model. The results of the model will also be provided and discussed.

Keywords: methane, carbon dioxide, greenhouse gas, global warming, Footprint model, nitrous oxide, Johannesburg Climate legacy, World Summit on Sustainable Development

Nomenclature

CH_4	*Methane*
JCL	*Johannesburg Climate Legacy*
CO_2	*Carbon dioxide*
N_2O	*Nitrous oxide*
GHG	*Greenhouse gas*
WSSD	*World Summit on Sustainable Development*
GWP	*Global warming potential*

1 Introduction

The world was taken by storm as a result of efforts to address the issue of climate change and global warming. Not only is it an issue for large developed countries, but also for developing countries such as South Africa. The economies of developing countries are vulnerable to climate change through impacts on agriculture to name an example. Climate change has a direct and very real impact on many environmental, economical and political levels. A country's actions against climate change and GHG emissions will play an ever-increasing role when participating in international trade and agreements in the future. Increasingly we will need to understand and manage our GHG emissions in order to comply with national and regional policies aimed at reducing GHG emissions.

Greenhouse gasses have the function of trapping heat in the atmosphere. Climate change is caused when additional man-made GHG emissions are allowed into the atmosphere, increasing the amount of heat trapped. These additional GHG emissions are the result of years of industrial development and progress.

The combustion of fossil fuels and a number of thermal and manufacturing processes cause GHG emissions. The most common GHG emissions are

Carbon Dioxide (CO_2) and Nitrous Oxide (N_2O), which result when fossil fuels are burned to produce thermal and electrical energy in boilers, heaters, furnaces, kilns, ovens, dryers, and any other equipment or machinery that uses fuel. Another common source for CO_2 is road- and rail vehicles as well as airplanes (UNEP 1997). Methane (CH_4), another common GHG, generally result from the anaerobic digestion of waste on landfills and wastewater sites (USEPA 1999).

Footprint model

During September 2002, Johannesburg played host to the WSSD. Approximately 21,000 international delegates attended the WSSD (Ministry of Environmental Affairs and Tourism 2002). Each of these delegates contributed to increased GHG emissions by attending the WSSD. This was done through electricity consumption; fuel consumption for travel and waste generated that will end up on South African landfills.

A project was launched by the Johannesburg Climate Legacy (JCL) to achieve a carbon neutral WSSD, meaning that every tonne of CO_2 and CO_2-equivalent emissions that was generated during the WSSD by the delegates needed to be balanced out with GHG emission reducing projects in South Africa. The JCL consisted of a number of representatives from the International Institute for Energy Conservation, Future Forests, Eskom, SouthSouthNorth, KPMG and the Northwest University.

However, the question was: How much GHG emissions are caused by the delegates attending the WSSD? A need was consequently identified for a tool that could be used to link factors such as electricity- and fuel consumption (together with others factors) with the resulting GHG emissions.

It was decided to develop a Footprint tool to provide that link in a fast and accurate manner. The function of the Footprint was to estimate the quantity of CO_2 or CO_2-equivalent emissions that were caused by the 21,000 delegates. This would provide a GHG emission estimated offset target for the JCL project. Once the target was set, JCL could start implementing a group of selected offset project to achieve a carbon neutral WSSD.

The Footprint and emission factors

Each and every one of us, like the WSSD delegates, contributes to GHG emissions on a daily basis. For every single kilowatt-hour (kWh) that South African citizens consume in their homes or at work, 0.89 kilograms of CO_2 emissions are emitted on the utility supply-side (Eskom 2001). If we take transmission losses into account, the value becomes 0.979 kg CO_2/kWh.

With every liter of fuel that we use in our cars, we emit 2.4 kilograms CO_2 emissions for a petrol vehicle and 2.8 kilograms CO_2 for a diesel vehicle (WBC/WRI 2001). These factors that link an activity to GHG emissions are called emission factors. These emission factors form the backbone of the Footprint model.

The GHG emissions that were incorporated into the Footprint model are the following:

- Carbon dioxide CO_2; and
- Methane CH_4.

There are a number of other GHG emissions such as nitrous oxide, hydroflourocarbons, perflourocarbons and sulphur hexaflouride not covered by the model since these emissions were outside the scope of the Footprint or their contribution to total emissions was neglectable for this project.

In order to place the various GHG emissions on an even playing field, the factor of Global Warming Potential (GWP) had to be incorporated into the Footprint model. The GWP for the GHG emissions used in the Footprint model are provided in Table 1. The GWP of a greenhouse gas is the ratio of global warming, or radiative forcing – both direct and indirect – from one unit mass of a greenhouse gas to that of one unit mass of carbon dioxide over a period of time (100 years). Hence this is a measure of the potential for global warming per unit mass relative to carbon dioxide.

Table 1: Global warming potential for selected GHG emissions.

Greenhouse gas	*Global warming potential*
CO_2	1
CH_4	21

The GWP is used to convert CH_4 emissions to CO_2-equivalent emissions. This means that 1 tonne CH_4 is equivalent to 21 tonnes of CO_2. If we consider a case where we have 1 tonne of CO_2 emissions and 1 tonne of CH_4 emissions, we will have CO_2-equivalent emissions totaling 22 tonnes of which CH_4 contributed 21 tonnes. This value has actually been updated to 23 for CH_4 by the Intergovernmental Panel on Climate Change. The value of 21 was however used as a political decision to continue with the GWP from the 2^{nd} Assessment Report.

Boundaries of the Footprint model

The first step in the development of the Footprint model was to identify the processes and activities that contributed to GHG emissions. The following activities and processes were identified as contributing factors to the total WSSD GHG emissions for the scope of the project:

- Electricity use at hotels;
- Electricity use at the WSSD venues;
- Air travel to Johannesburg from international destinations including international connecting flights;

- Air travel (connecting flights) within South Africa;
- Road travel between hotels and venues;
- Waste;
- Paper production;
- Water provision and pumping; and
- Wastewater.

The Footprint was developed only to consider CO_2 and CH_4 emissions. The N_2O emissions that were found during the project were minor, even with the high GWP for N_2O (310).

The Footprint model was divided into three parts. The first part dealt with electricity use related emissions, the second part with travel related emissions and the third with emissions from sources not included in the previous two parts. Each part is described in more detail in the sections that follow.

The footprint model did not include emission sources such as venue construction, demolitions, organisational transport during venue preparations or food preparation at the venue.

Footprint model – electricity use emissions

As was mentioned in previous sections, 0.979 kg CO_2 emissions are generated on the utility supply-side for every 1 kWh that is consumed by the end-user. This factor was used to determine the impact of 21,000 delegates attending the WSSD. It was assumed by the technical working group of the JCL that each delegate attended the WSSD for the full 10 days. Data was also obtained to approximate the average electricity consumption per delegate per day for their stay at the hotels. The resulting CO_2-equivalent emissions were calculated as 6,420 tonnes (Den Heijer and Grobler 2002).

The same rationale was followed to determine the impact of electricity use at the venues. A list of venues and energy accounts was obtained and used to calculate a value for the daily electricity consumption. The total amount of energy consumed during the 10 days of the WSSD could then be calculated. The total energy consumption was then multiplied with the factor of 0.979 kg CO_2 emissions per kWh[4] to obtain a value of 930 tonnes CO_2 emissions over the 10-day period. A total of 7,351 tonnes of CO_2-equivalent emissions was thus generated due to direct electricity consumption of the delegates (Den Heijer 2002).

Footprint model – travel emissions

The next part of the Footprint model was to determine the GHG emissions that resulted from travel. The first section for travel was concerned with air travel between Johannesburg and international locations.

The direct distances for major flights from Africa, Asia, Australia, Europe, Middle East, North

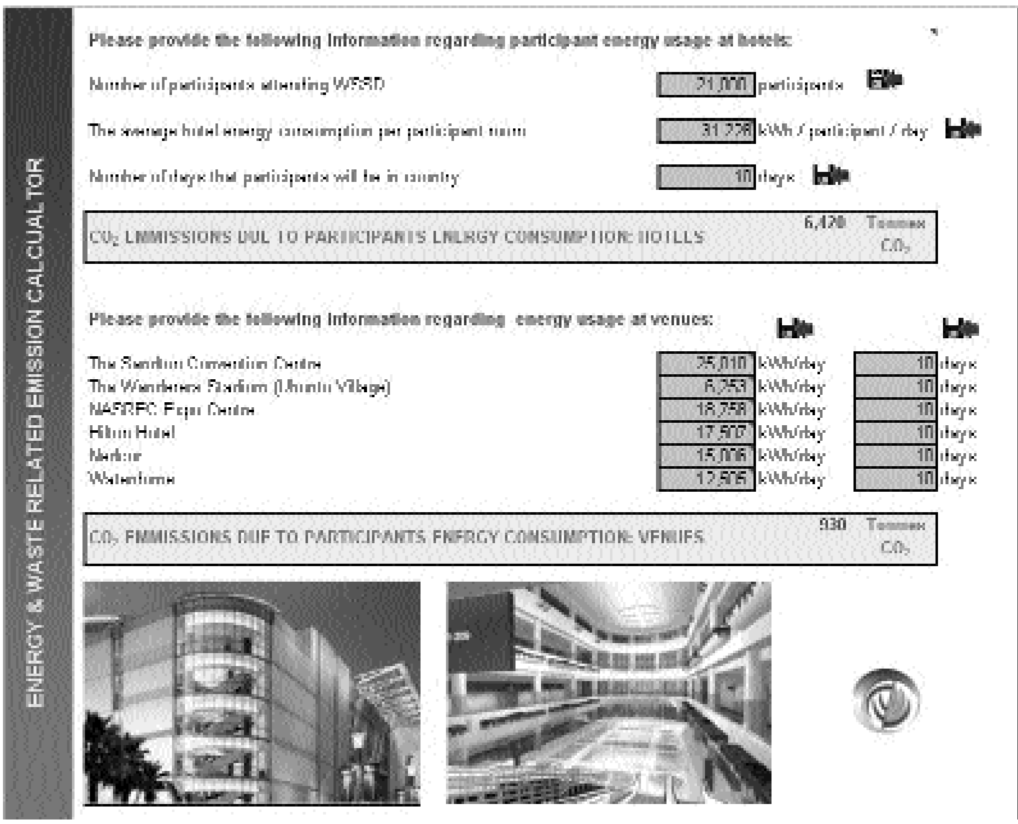

Figure 1: Electricity use input sheet for Footprint model

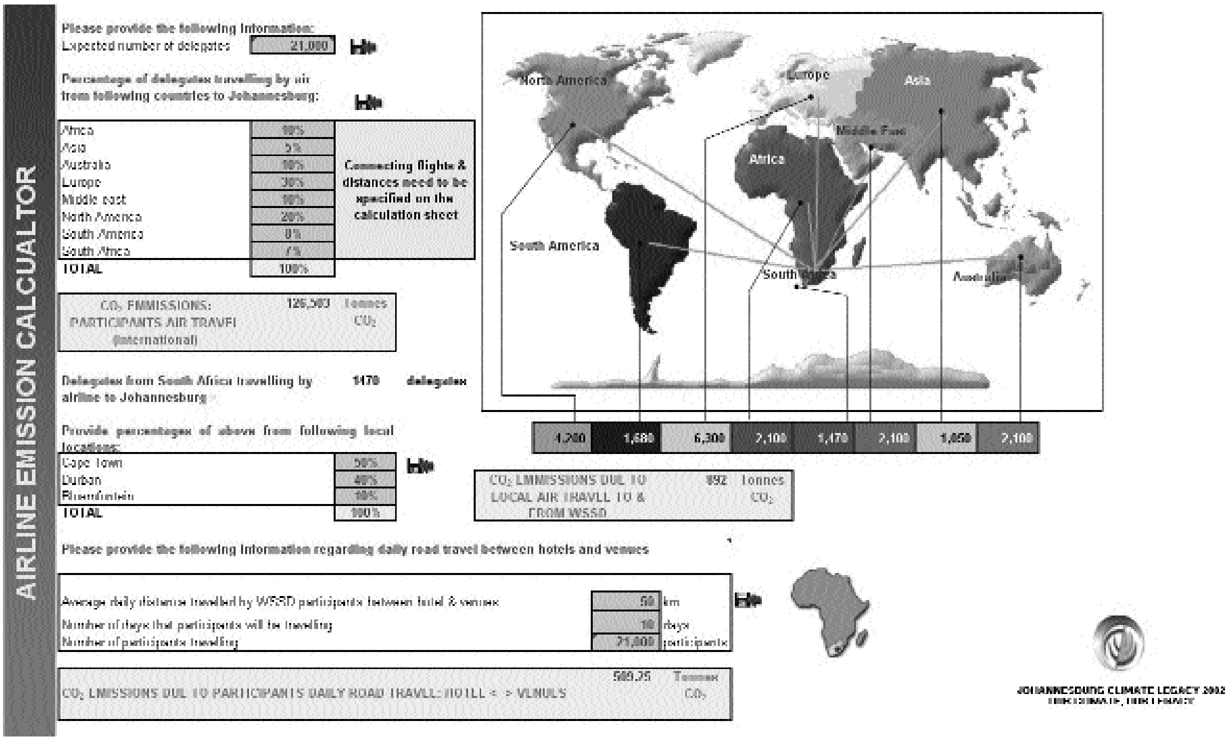

Figure 2: Transportation input sheet for Footprint model

America and South America was combined with average flight distances for connecting flights to these locations. The number of delegated that traveled these distances with air travel was assigned by the JCL project team and the governing body as percentages of the total 21,000 delegates attending. We thus had the quantity of people taking flights and the distances for each group of people. The emission factor that was used to calculate the CO_2 emissions from air travel were 0.35 kg CO_2 per passenger per km traveled [5]. This resulted in a CO_2 emission estimate of 126,503 tonnes.

The same process was followed for delegates taking flights within South Africa. It was assumed that 7% of the 21,000 delegates made use of flights within South Africa to travel to Johannesburg from various locations within South Africa (Den Heijer and Grobler 2002). The JCL project team also calculated this number. The emission factor of 0.35 kg CO_2 emissions per passenger per km traveled was used again. The resulting CO_2 emissions from local flights were determined as 892 tonnes.

The last section of the Footprint model under travel dealt with road travel of the delegates between the hotels and their venues. It was assumed that each delegate traveled 50 km by road vehicle per day (Den Heijer et al 2002). This would be approximately 500 km for the 10 days of the WSSD. The emission factor use in this case was 0.0485 kg CO_2 per passenger km per day 5. The total CO_2 emission over the 10-day period was calculated as 509 tonnes for all 21,000 delegates combined.

The total of 127,905 tonnes of CO_2-equivalent emissions was generated due to travel (air and road) of the delegates. The largest contributor to this total, and the overall Footprint emissions, was the airline emissions.

Footprint model – other emissions

The last part of the Footprint model dealt with emissions from other sources than direct electricity consumption or fuel combustion. These sources included CH_4 emissions from the anaerobic digestion of the waste generated by the delegates. Sources was found that estimated that the average person produce 2.04 kg waste per day that ends up on landfill sites and contribute to CH_4 emissions. The problem with CH_4 is its GWP factor of 21. An emission factor of 0.13 kg CH4 per tonnes of waste was used in the Footprint (Den Heijer and Grobler 2002). The waste emissions due to the 21,000 delegates attending the WSSD for 10 days was determined at 55.7 kg CH4 which is equivalent to 1.17 tonnes CO_2 emissions.

The delegates attending also used a large quantity of paper during the WSSD. It was assumed that the 21,000 delegates used approximately 5,000,000 sheets of paper (Den Heijer and Grobler 2002). CO_2 was generated through the electricity that was consumed during the production process of the paper. The electricity consumed for the production of the 5-million sheets was calculated and linked to the CO_2 emissions. It was determined that the CO_2 emissions resulting from paper production were 29.68 tonnes.

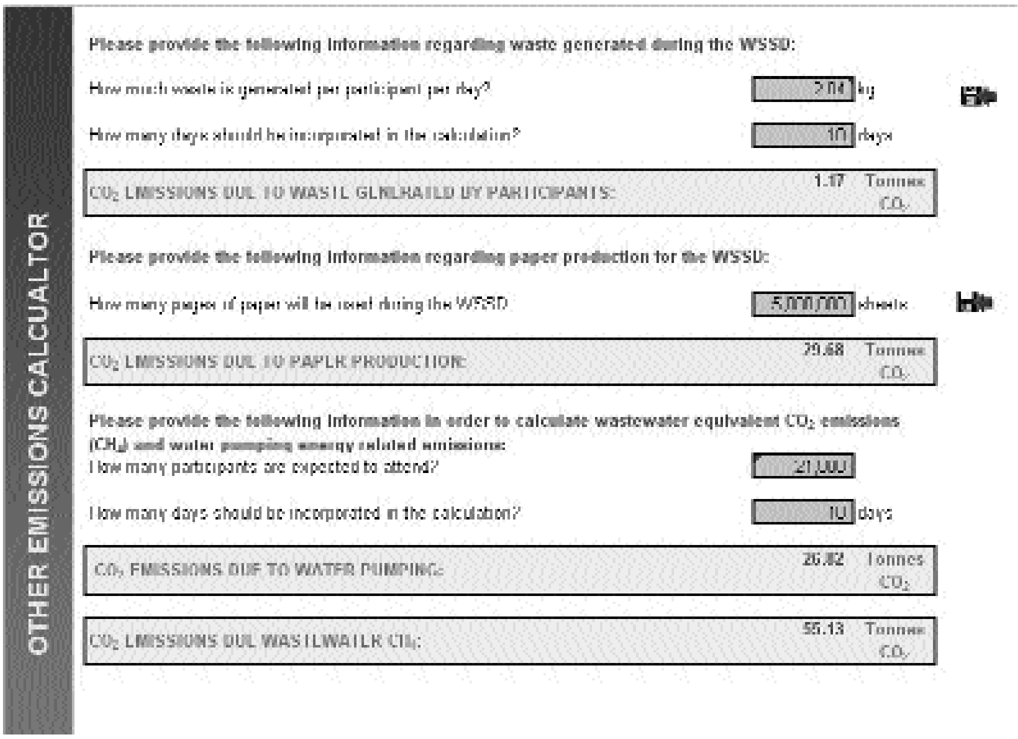

Figure 3: Input sheet for other emissions for Footprint model

Water pumping contributed towards GHG emissions through electricity use at the pumping stations. It was assumed that each delegate used 250 liters of water per day (Den Heijer et al 2002). Electricity consumption data for pumping stations was obtained to determine the average electricity consumption per liter of water pumped. This data was combined with the emission factors for electricity consumption to obtain a total of 26.82 tonnes CO_2 emissions due to water pumping.

The last section determined the CH_4 emission that resulted from wastewater and sludge in much the same manner as in the case of waste. Here a number of default values were however assumed for factors such as degradable organic carbon fraction, methane conversion factors and oxidation factors. It was determined that the delegates caused approximately 55 tonnes of CO_2 emissions due to wastewater and sewerage.

The last part of the Footprint model estimated that all the sources other than direct electricity consumption and travel emissions, contributed 113 tonnes of CO_2 emissions.

The total GHG emissions generated by the 21,000 delegates over the 10 days of the WSSD was estimated at 135,400 tonnes of CO_2-equivalent emissions, of which air travel contributed approximately 93 percent. This is calculated to approximately 6.4 tonnes CO_2-equivalent emissions per delegate.

Discussion of results

This figure of 135,400 tonnes of CO_2-equivalent emissions provided the JCL with a target that could be used when evaluating which offset projects would best contribute towards a carbon neutral WSSD. This target would be only illustrative and should not be taken as the quantity of CO_2-equivalent emissions that was generated over all of the WSSD activities. The main problem experienced when these emissions were calculated was the complete lack of accurate data of delegate activities.

The JCL had a monetary target of $3-million, but only managed to raise $350,000. The cost per delegate ranged from $10 to $90. A large portion of these funds went onto the operation of the JCL programmes, monitoring and verification, marketing and the development of the project itself.

The JCL Project resulted in two offset projects being funded. The first of these projects were a renewable energy demonstration through photovoltaic energy generation at the GreenHouse People's Environmental Centre. The second project was approved for the Oude Molen Village Association for a solar water heating project. These two projects would jointly offset just over 5,000 tonnes of CO_2-equivalent emissions over a period of 10 years. The total JCL funding for both these projects were slightly less than R1-million. This would result in an offset cost of R200 per tonne CO_2-equivalent emission reduction. The monitoring and verification of the emission reductions is however an ongoing process at this stage.

It can be clearly seen from the above that the JCL project did not manage to achieve its goal of a carbon neutral WSSD. The JCL managed to offset

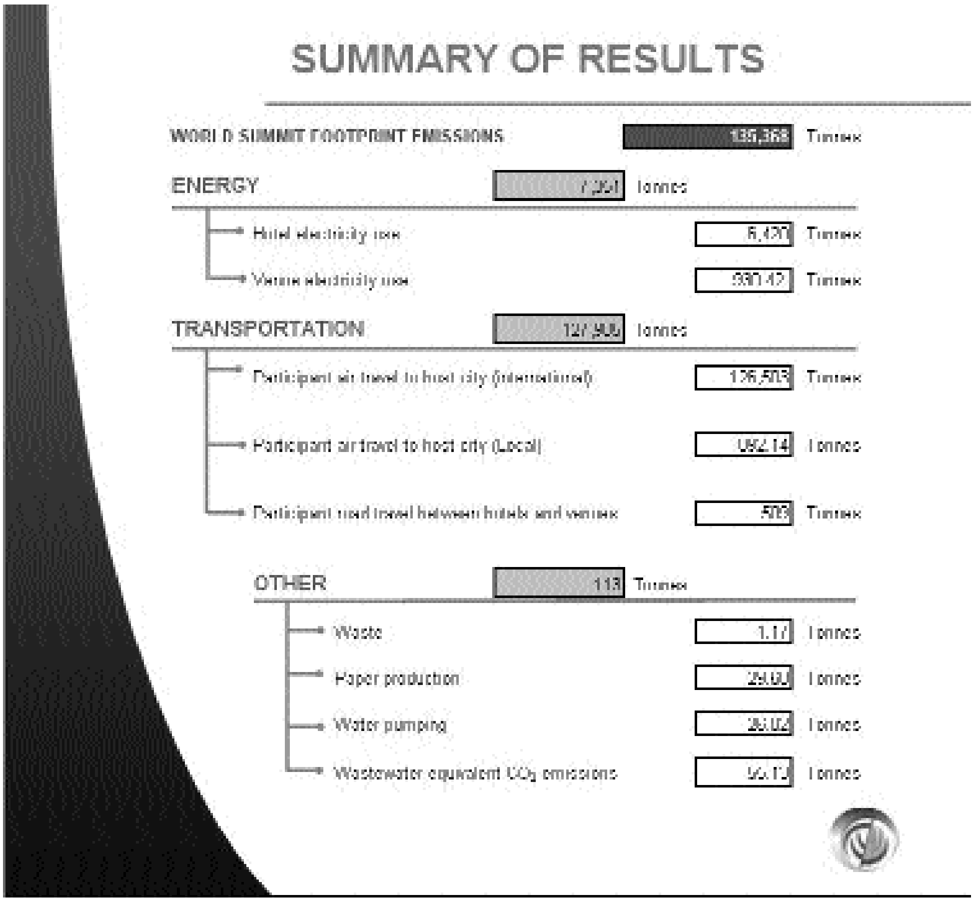

Figure 4: Summary of results from the Footprint model

less than 4% of the target emissions. Although the JCL project was not a success in achieving a carbon neutral WSSD, we must not lose sight of the fact that the JCL was a success on many levels. These include the following for the project:

- pioneered an initiative which sets an example that can be improved and used into the future, especially in relation to establishing a sustainable development legacy;
- engaged WSSD participants and the wider public on the climate change issue in a way that demonstrates and encourages pragmatic action towards a reduction in climate change impacts;
- encouraged a progressive policy response from governments with respect to climate change by 'proving' that there is a widespread support for action;
- gathered commitments from 110 businesses, 60 national or local governments, 43 intergovernmental organisations, 68 non-governmental organisations and 22 associations either as organisations or individuals;
- raised a total of $350 000; some of which was used to implement sustainable development projects in South Africa;
- facilitated a hands-on training programme for project developers, owners, communities and the public at large.
- ensured that the concept of 'Beyond Compliance' measures such as the becoming Carbon Neutral is now more widely known and accepted.

A number of lessons were learnt from the JCL project. They included:

- A mechanism such as the JCL offers should be integrated into planning of events from the outset of organization of the conference or event;
- The scheme should have high-level support and a champion at the outset;
- The projects that are to be included in the basket for funding should be chosen at least 6 months before the event in order to be able to promote the human face of the projects, their full benefits for previously disadvantaged communities and ensure that the training process is achieved;
- One of the biggest mistakes that were made with the JCL was the setting of a monetary target. This target of $3 million is now how the JCL will be judged. Instead one should set the aim of offsetting 100% of the emissions. If this figure is not reached, it is down to the delegates attending the event and not the failure of the scheme.

Conclusion

A large number of our every-day actions contribute to increasing the amounts of GHG emissions in the atmosphere. These actions can range from something as simple as switching on a light in our homes, using a piece of paper, driving our car to work of taking a flight to an international destination.

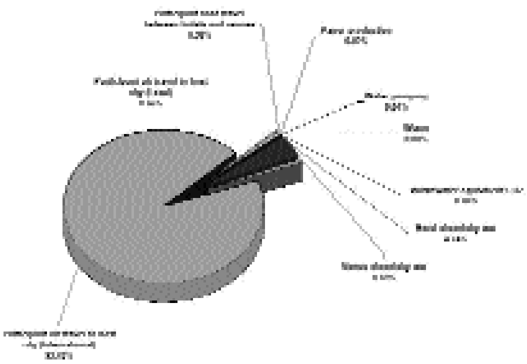

Figure 5: Sectional contribution towards total Footprint emissions (CO_2 equivalent)

During the WSSD, a project by JCL aimed at balancing out these GHG emissions caused by 21,000 delegates attending. In order to balance their GHG emissions, it was firstly needed to determine how much GHG emissions they are causing.

A Footprint model was subsequently developed that could link activities with the GHG emissions they caused. This model incorporated a number of processes, ranging from international flights to the waste the delegates generated. The GHG emissions for each of these activities were calculated to produce a total emission footprint of 135,400 tonnes of CO_2-equivalent emissions. The Footprint model proved to be an effective tool to calculate GHG emissions.

The Footprint model will play a valuable role in the development of GHG emission target for future events similar to the WSSD. The model can be expanded to include more sources and can easily be updated to reflect more accurate emissions estimations as research provide more accurate emission factors.

The JCL only managed to raise $350,000 in funds against the target amount of $3-million. Two offset projects were funded, but only managed to offset less than 4% of the offset target. Although the JCL project was not successful in achieving a carbon neutral WSSD, it did provide valuable lessons for similar projects for future events.

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