Douglas Cunningham, Petra Hofstedt, Klaus Meer, Ingo Schmitt (Hrsg.): INFORMATIK 2015
Lecture Notes in Informatics (LNI), Gesellschaft für Informatik, Bonn 2015

ON THE ENVIRONMENTAL FOOTPRINT OF AN IS CONFERENCE

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Abstract: The IS research community has paid significant attention to climate change and other ecological problems. However, the communities own environmental footprint has been subject to little research so far. This work reports on the results of a Life Cycle Assessment that was conducted to identify the main determinants for the environmental footprint of an IS conference. It brings up the painful subject that also the scientific community has its substantial contribution to environmental degradation. Our work suggests that this contribution can be significantly reduced by only a few very effective instruments. Scientists are encouraged to enter the discourse on the environmental footprint of academic work in order to enhance Green IS research.

Keywords: Green IS, Environmental Footprint, Life Cycle Assessment, Academic Practice, Greenhouse Gases, Water Depletion, Emission of Toxic Substances, Umberto Software

1 Introduction

The impact of information systems and information technology on our modern society and organizations has been a controversial topic for many decades [OH02, We72]. Sustainable development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" [Wc87] is still a grand challenge of our time that information systems research is called to accept [Br13, HC12]. Our work was inspired by [Br13], particularly by the directive to set examples for sustainable academic practice. They suggest that " [IS] scholars need to be more aware of the environmental footprint of their work"[Br13]. Recent studies suggest that attending conferences is one of the main sources of academic environmental impact [HH02, SL13, St08], such as greenhouse gas (GHG) emissions. We take a closer look at the environmental footprint of an IS conference in order to inform IS scholars about the environmental impact of their work behavior by answering the research question:

1. *What are the main determinants of the environmental impact of an IS conference?*

To answer this research question the *life cycle assessment* (LCA) method [Is09a, Is09b] was chosen. This work makes use of predictive and explorative scenarios [Bö06] in order to rate the environmental impact of future IS conferences [Fi09]. A special focus is put on dematerialization, a potential instrument used to reduce a conferences

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environmental impact [Br11]. A distinct explorative scenario is analyzed in order to answer the following research question:

2. *What are effective instruments to reduce the environmental impact of a conference?*

The paper is structured as follows: The results of recent work are reviewed in section 2. Section 3 presents the method of this work. The results of this work are then presented and discussed in section 4. Finally, section 5 encompasses the concluding remarks as well as prospects of future work in the field.

2 Recent Work

Two literature searches were conducted by using the guidelines of [Co88], [WW02] and [Br09] in order to identify recent environmental footprints. The analysis is documented by using concept matrixes [WW02]. The search strings (Work OR Conference OR "Research Travel*") AND ("Carbon Footprint" OR "Life Cycle Assessment" OR "Environment* Impact") and (Paper OR Dematerialization OR "Digital Media") AND ("Life Cycle Assessment" OR "Carbon Footprint") were used querying the databases ScienceDirect, ISI webofscience CoreCollecion and AIS electronic library. Moreover, a backward search has been performed in order to identify additional sources. The first search revealed 6 results as shown in Tab. 1. A similar matrix was compiled for the second literature search. The results are depicted in Tab. 2.

Author(s), Year of Publication	Reference value	Metric	Subject area[3]	Scenario Analysis
[HH02]	1 conference	EIP[4]	Environmental Science	Yes
[MC07]	1 meeting	GHG	Medicine	Yes
[St08]	1 researcher/year	GHG	Earth and Planetary Sciences	No
[CHB12]	1 conference	GHG	Social Science/ Computer Science	Yes
[AAM13]	1 PhD project	GHG	Environmental Science	Yes
[SL13]	1 conference trip	GHG	Biochemistry/ Medicine	Yes

Tab. 1: Recent work on the environmental impact of science

Author, Year of Publication	Reference value	Metric	Subject area	Scenario Analysis
[GK02]	1 article	Energy	Environmental Science	Yes
[Mo10]	1 newspaper	Full LCA	Environmental Science	Yes
[TP10]	1 invoice	GHG	Information Systems	Yes
[MBF11]	1 book	Full LCA	Environmental Science	Yes
[MRS13]	1 managed form	Full LCA	Environmental Science	Yes
[ZZ13]	28 600 books	GHG, Energy	Environmental Science	Yes

Tab. 2: Recent work on the environmental impact of dematerialization and digital media

[3] Subject areas according to http://www.scimagojr.com
[4] Eco-indicator points [Mi00]

The literature documents an interest for the environmental impact of science in various subject areas, particularly during the last 2 years. Especially GHG emissions are of major interest. [HH02] suggest that the focus on GHG is reasonable since the choice of metric in their opinion does not significantly affect the decision-relevant aspects of the results. Moreover, all authors agree that traveling is the main source of science related environmental damage. [St08] and [CHB12] therefore introduce detailed mathematical models for the estimation of CO_2 emissions by travelling distance. A contrasting picture is drawn by the research on the environmental impact of dematerialization (paper print vs. digital media). The results of [MBF11] show that the choice of different metrics can turn the results of an environmental assessment into the direct opposite: Comparing e-books and paper books by the associated GHG emission leads to the assumption that the use of an e-books is beneficial when around 25 paper books are substituted. Using freshwater ecotoxicity as the leading metric the environmental trade-off for using paper books is reached at around 400 books. This contrasting use of metrics is of particular interest concerning RQ 2. Also the results of [MBF11], [Mo10] and [MRS13] suggest that a focus on GHG emissions is not sufficient to adequately support decision making. Moreover, the literature exposes that it is doubtful whether mathematical models for the calculation of traveling related GHG emissions are sufficient in order to answer RQ 1. The literature shows that the knowledge base concerning the environmental footprint of science is interspersed throughout different subject areas. Nevertheless, data, models as well as premises, simplifications and allocations from recent work provided a promising starting position for this research.

3 Methodology and Data

The goal and scope of this work was to explore environmental footprint associated with a scientific conference and to suggest effective instruments to establish sustainable academic practices within the IS community. The inventory analysis includes the collection of data, the model implementation, model parameterization as well as parameter variation (scenarios) [Gu02, Is09a]. The analysis involves a computer based calculation using the LCA software tool Umberto[5], based on petri-nets [Mu89], a tool that is frequently applied for LCA studies. Within the calculation we used data, models and instruments from two different sources: 1. specific data and specific partial models from recent work (c.f. section 2), 2. generic data for downstream activities from the leading LCA database ecoinvent[6]. Due to the high number of influencing variables, we made use of object petri-nets in order to model “nets within nets” [Va04]. The petri-net model was used to depict the material and energy flows associated with the activities of a scientific conference. We adapted [HH02] classification of environmental relevant conference activities, where the emissions of 3 main group activities are calculated via 12 subgroup activities as presented in Fig. .

[5] Umberto NXT Universal Version 7.1, more information at http://www.umberto.eu/
[6] Leading Life Cycle Inventory Database, more information at http://www.ecoinvent.org/database/

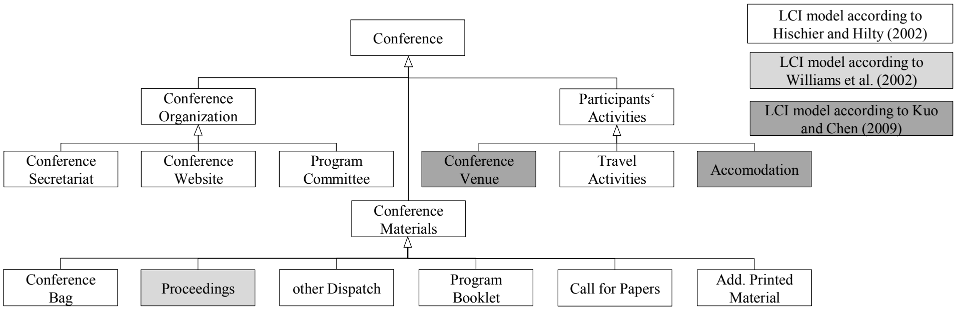

Fig. 1: Main model of the environmental relevant activities associated to a conference

For each of the 12 subgroup activities, we implemented material and energy flow models. Each subgroup activity model consists of one conference-specific activity as well as generic downstream activities. The generic downstream activities contain lists of material and energy flows (input and output) that are ascribed to a specific amount of product or service, e.g. 1 *km freight transport or 1 kg paper. The conference-specific activity contains the quantities of products and services that are used for one individual conference. The starting point for the implementation of the subgroup activities was the work of [HH02]. However, since [HH02] excluded the environmental impact of accommodation and conference venue, we extended the model by the results of [St08], [KC09] and [AAM13]. Moreover, we updated the material and energy flow model of the *proceedings* subgroup activity. The model by [HH02] includes a paper-based publication of conference proceedings, which was not the case for the last years IS conferences (Informatik, MKWI, WI, ECIS, ICIS). Therefore, the model was updated to publication by .pdf documents and USB devices. The material and energy flow model of the *proceedings* subgroup activity was based on the work of [WAH02]. For the parameterization of the model, we added data to the conference-specific activities as well as the generic downstream activities within the scope of 3 scenarios: A baseline scenario for a conventional conference in Central Europe, a remote location scenario for a Conference with long travelling distances and a dematerialization scenario by which conference materials are reduced to a minimum. In the baseline scenario, data from [HH02], [St08], [KC09], [AAM13] and [WAH02], was used to parameterize the conference-specific activities. Data within the literature was gathered for a 3-day conference in Central Europe with 308 participants. The data was linear extrapolated to an estimated number of 800 participants including 2400 overnight stays at a hotel in order to depict an average IS conference. Different transport systems were be estimated depending on the travelled distance d as shown in Tab. 3 [HH02].

Travelled Distance (one Way)	Amount Car	Amount Train	Amount Airplane
d < 300 km	10 %	90%	0 %
300 km < d > 1000 km	0 %	50 %	50 %
d > 1000 km	0 %	0 %	100 %

Tab. 3: Estimation for travel distances [HH02]

In contrast to existing works on the environmental impact of science [AAM13, CHB12, HH02, MC07, SL13, St08] we used data from the latest version of the ecoinvent database, ecoinvent 3.1, to parameterize the generic downstream activities. For the remote location scenario, we manipulated the travelling and accommodation data of the baseline scenario. The baseline scenario assumes a conference in a Central European country with a moderate climate and short travelling distances. As opposed to this, the remote location scenario depicts a conference with longer air travels and a warmer, subtropical climate at the conference venue. Tab. 4 shows the changes within the parameters compared to the baseline scenario. According to [KC09], the accommodation related wastewater discharge and water consumption level are doubled in order to model a warmer climate. Moreover, the datasets for the generic downstream activities are changed from European average datasets to Central and South American datasets. In the dematerialization scenario, the use of materials was reduced to a minimum. All information (call for papers, program booklet, etc.) is shared via email or homepage. Conference proceedings are provided solely online, no paper prints are used during the conference meetings and a conference bag is no longer needed. Additional energy consumption due the increased use of PC's, laptops and mobile devices for accessing the information have been neglected due to the results of [GK02]. An overview of all parameters for the conference-specific activities, the related ecoinvent downstream activities of the baseline scenario as well as examples for the petri-net models are available online[7] or available on request.

Parameter	Baseline Scenario	Remote Location Scenario
Amount of Car Travellers	5,5%	0,5 %
Amount of Train Travellers	58,6%	5,0 %
Amount of Short Distance Airplane Travellers	19,9%	20,0 %
Amount of Medium Distance Airplane Travellers	9,3%	24,5 %
Amount of Long Distance Airplane Travellers	5,8%	50,0 %
Water Consumption per Person and Night	292 L	584 L
Wastewater Discharge per Person and Night	200 L	400 L

Tab. 4: Estimation for the use of transportation [HH02]

4 Results and Discussion

The ReCiPe impact assessment method[8] was applied using the impact assessment engine of the Umberto software. Fig. shows the results of the impact assessment including 3 different metrics: greenhouse gas emissions measured in kilograms CO_2-equivalent (kg CO_2 eq), emission of environmental toxines (terrestrial ecotoxicity) measured in grams para-dichlorobenzene equivalent (g para-dichlorobenzene eq) and water depletion measured in cubic meters (m^3). More metrics (natural land transformation, urban land occupation, particular matter formation, etc.) were applied within the conduct of this

[7] http://bit.ly/1HJLTG1
[8] ReCiPe methodology for Life Cycle Impact Assessment, more information at http://www.lcia-recipe.net/

work but did not provide any additional information concerning the underlying research questions. The results of the baseline scenario are used to estimate the environmental impact and identify its main determinants. GHG emissions of around 211 t CO_2 eq. are estimated. This amount can be compared to the amount of CO_2 that is stored by woodland in the size of around 211 football fields in one year [BM03]. The majority of these emissions is determined by the conference related travelling activities which echoes the findings in recent work [AAM13, CHB12, HH02, MC07, SL13, St08]. However, emissions related to hotel stays and conference venue also account for more than third of the total GHG emissions which is significantly more than the literature suggests.

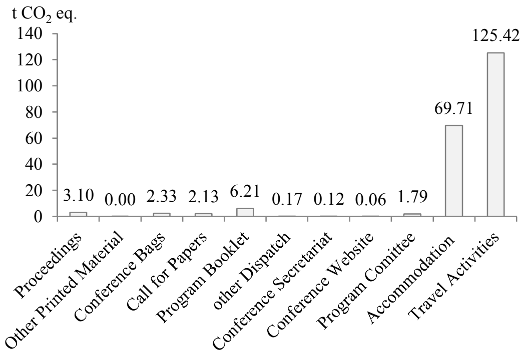

Fig. 2: GHG emissions of a conference (baseline scenario)

The use of additional metrics draws an even more differentiated picture as depicted in Fig. 3. Toxic substances equal to 30 kg para-dichlorobenzene are emitted into the earth's ecosystems. This amount can be compared to a lethal dose for 21 adults [Au14]. 47 % of the toxin emissions can be traced back to the use of pesticides and chemicals for cultivation and processing of cotton to produce conference bags. The amount of water that is used for a conference (1 835 m^3) would be enough to fill three quarters of an Olympic swimming pool. Almost the entire water consumption is determined by hotels stays and the use of conference venues. These results contradict those of [HH02], who argue that the choice of metric does not significantly affect the decision-relevant aspects of an environmental impact assessments results. Rather, the results suggest that the use of different metrics can lead to different focus areas to reduce environmental impact. The remote location scenario and the dematerialization scenario illustrate how the choice of the conference location and the organization of the conference can be used as effective instruments to reduce the environmental impact of a conference. The scenarios also draw a more complex picture of conference related environmental problems compared to [AAM13, CHB12, HH02, MC07, SL13, St08]. Fig. shows the results of all scenarios.

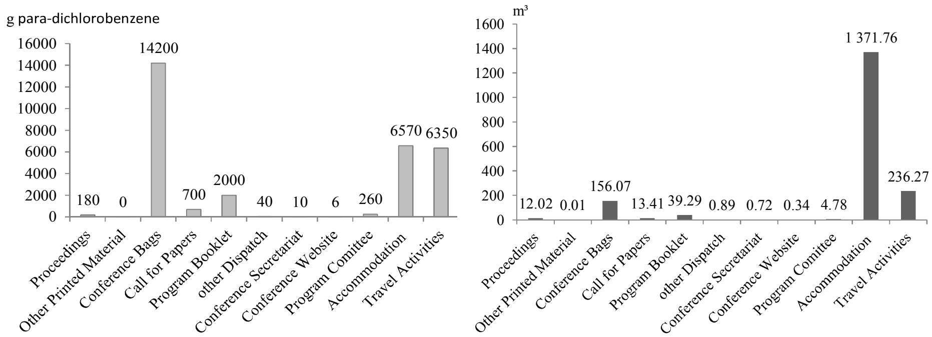

Fig. 3: Emission of toxic substances and depletion of water (baseline scenario)

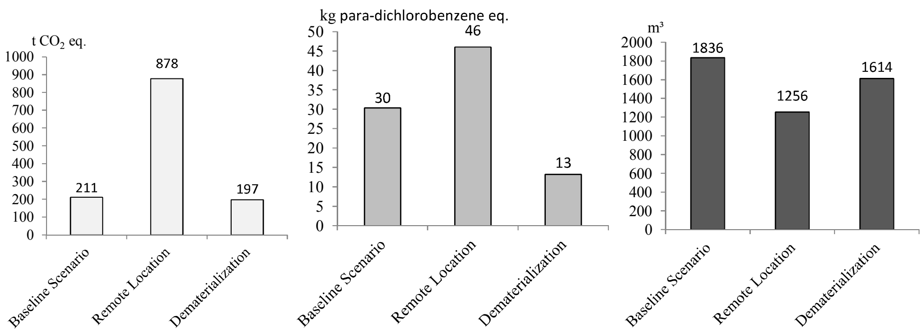

Fig. 4: Comparison of the three scenarios

The remote location scenario shows the consequences of a conference location requiring significantly more participants to take intercontinental flights. As a consequence, the GHG emissions increase by about 415 % and the emission of toxic substances by about 150 %. Besides the longer traveling distances, the increase can be explained by different types of electricity generation. Whereas the Central European energy mix contains huge amounts of nuclear and renewable energy sources, the global average energy mix is mainly determined by fossil energy sources [Ma10]. An unexpected result of the remote location scenario is the decrease of water depletion from 1 835 m³ to 1 255 m³ (31.6 %) per conference. A more detailed view on the calculation results reveals that the savings are mainly determined by more water-saving waste disposal in the global average data compared to the Central European data. This can be explained by a higher share of waste incineration in Central Europe, which requires significantly more water than a landfill [CBU09]. The dematerialization scenario reveals just a slight decrease in GHG emissions (about 6.6 %) and water depletion (12.1 %) due to diminished paper consumptions. GHG and water savings are quiet low because the major part of paper consumptions for a conference includes private printouts, those done by reviewers and authors at home. However, the dematerialization scenario shows a sharp decrease in terrestrial ecotoxicity (56.5 %) because cotton containing conference bags are not necessary.

The results reveal implications for the scientific discourse on sustainable academic practicing. Three main determinants for the environmental footprint of major IS conferences have been identified: travel activities, accommodation and conference material. Effective instruments for organizers are accessing route minimization (e. g. by avoiding remote locations), reducing the number of hotel stays (e.g. by tightening the conference program, setting more conference events in parallel and arrive/depart straight after/before the conference) and avoid an extensive amount of conference material (e. g. share information online to avoid the use conference bags, print outs and booklets).

Due to the methodological nature of this work there are several limitations. The use of life cycle models requires idealizations and approximations that may be applied differently by different people. Therefore, the use of data and implementation of models are carefully documented. Another limitation results from the limited availability of empirical data about scientific conferences. We used linear extrapolation in order to apply data from the literature within our models. This however makes the model unsuitable to identify potential economics of scale or to determine an exact environmental footprint. Additionally energy consumption due the increased use of IT infrastructures for accessing the information have been neglected due to the results of [GK02]. As an additional scenario, a full video-conference scenario could complement the scenarios presented in this work. More research is therefore needed to implement more realistic and detailed models and collect empirical data.

5 Conclusion and Future Work

This work presents a life cycle assessment approach to understand more about the environmental impact of academic practicing. We suggest that measures with a focus on travel activities, accommodation and conference material are the most effective instruments to reduce the environmental footprint of major IS conferences. As a next step we will address the limitations of this work. Empirical data will be collected during a major IS conference in 2015 by using surveys and interviews. This data will be used to refine the presented model and improve the parameters in order to derive more reliable quantitative data.

Acknowledgement: This work is part of the project “Sustainable Consumption of Information and Communication Technologies in the Digital Society − Dialogue and Transformation through open innovation”. The project is funded by the Ministry for Science and Culture of Lower Saxony and the Volkswagen Foundation (VolkswagenStiftung) through the “Niedersächsisches Vorab” grant programme (grant number VWZN3037).

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