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Environmental impacts of an international conference

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1. Introduction

A conference in the conventional form is a very resource-demanding process with considerable environmental impacts. As the host of the 15th International Environmental Informatics Symposium, held in Zurich, October 10–12, 2001, EMPA assessed the effectiveness of different measures to reduce the environmental impact of the conference using the life cycle assessment (LCA) method.

During the preparation of the conference, we considered the following measures to make the symposium more "environmentally friendly":

(1) Reducing the conference materials produced for the participants to a minimum, but keeping the proceedings in book form.
(2) Eliminating the proceedings in book form, and giving participants a CD ROM instead.
(3) Holding a virtual conference to which no one travels, as all speeches and discussions could be offered on the Internet.

Measure 3 was included as a hypothetical scenario because we were not in a position to completely "virtualize" the conference. However, this scenario gave us

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some interesting insights that could be worth considering in the organization of future conferences.

This study dealt exclusively with the direct environmental impacts caused by holding the conference, and did not deal with the—hopefully positive—indirect environmental effects that resulted from the fact that the conference promoted scientific progress and personal contacts. Of course, we are of the opinion that these indirect effects of an environmental informatics conference make a great contribution towards solving environmental problems. We want to demonstrate with this LCA study how a comparably positive effect could be had with less environmental impact.

2. Goal and scope definition

The system boundaries for the LCA study were determined in such a way that all relevant aspects of the conference could be included, categorized into

- Conference organization,
- Conference materials and
- Participants' activities.

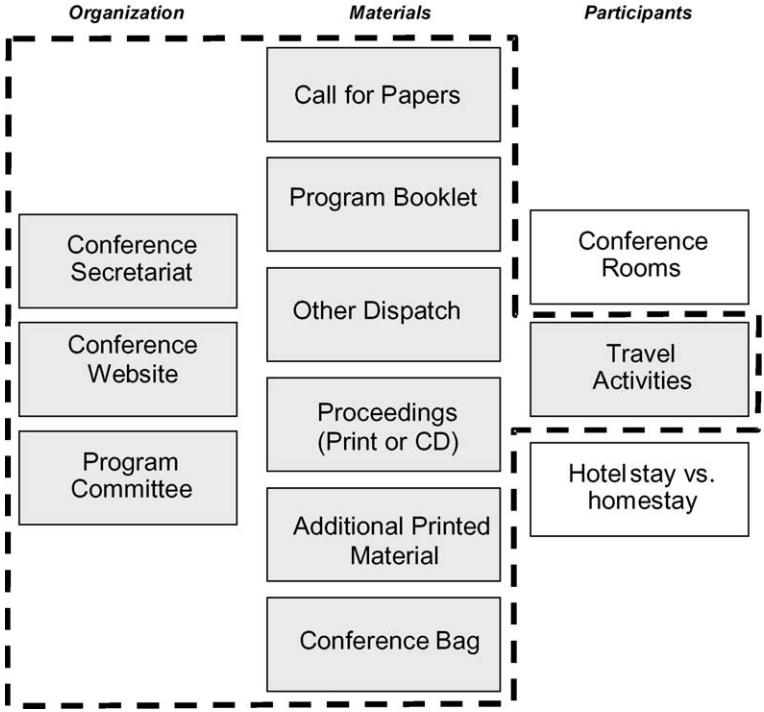

Fig. 1. System boundaries for the LCA of "Environmental Informatics '01."

The broken line in Fig. 1 shows which aspects were covered by our evaluation (system boundary). The reason for excluding the conference rooms as well as the hotels from the system under study is due to an utter lack of data in this field. However, our results suggest that taking these aspects into account would hardly affect our principal conclusion.

Preparing and holding the 3-day conference was chosen as the functional unit. We do not assert that the various alternatives that we are investigating (according to the possible measures that we have described in the introduction

Table 1
Characterization of conference materials

	Material	Production	Distribution
Call for papers	8.2 g recycled paper with deinking; 6.0 g wood-free, uncoated paper (Letter C5)	Offset printing, two colours	12,300 copies, 100 km train, 100 km truck, 28 t
Program booklet	30.5 g recycled paper with deinking; 8.2 g wood-free, uncoated paper (Letter B5)	Offset printing, two colours	13,000 copies, 100 km train, 100 km truck, 28 t
Other dispatch	Authors: 30.6 g wood-free, coated paper; 16.4 g wood-free, uncoated paper (Letter B5). Participants: 10.2 g wood-free, coated paper; 8.2 g wood-free, uncoated paper (Letter B5). Media: 20.4 g wood-free, coated paper; 8.2 g wood-free, uncoated paper (Letter B5)	All: Laserjet printer (230 W, 20 pages/min)	Authors: 150 copies. Participants: 500 copies. Media: 300 copies. All: 100 km train, 100 km truck, 28 t
Proceedings, print version	32.0 g cardboard (GC) for cover; 1880 g recycled paper with deinking	Offset printing, four colours (cover) and b/w (content)	1000 copies
Proceedings, CD-ROM version	15.3 g polycarbonate, coated (CD-ROM); 17.7 g cardboard (GC) for packaging; 501.0 g wood-free, coated paper, (printing of 10 papers from the CD-ROM)	Offset printing, four colours (packaging) Laserjet printer (230 W, 20 pages/min)	1000 copies
Additional printed material	100 g wood-containing, coated paper; 400 g wood-free, coated paper	20% offset printing, 80% gravure printing	–
Elaborate nylon bookbag	500 g nylon 66	Production energy: 22.5 MJ electricity	–
Plain cotton bag	100 g cotton	Production energy: 2.25 MJ electricity	–

Table 2
Characterization of organizational activities

	Material	Production	Power consumption
Conference secretariat	None (covered by the materials listed in Table 1)	832 h computer work	Computer: 145 W
		416 h printer on	Printer (stand-by): 28 W
Conference website	None	500 h computer work	Computer: 145 W
Program committee	Review process: 8030 g wood-free, coated paper; 2680 g recycled paper with deinking	Laserjet printer: 480 min (1 abstract/min)	Printer: 230 W
	Meeting: 16,000 g recycled paper with deinking	Laserjet printer: 40 min (20 pages/min)	Printer: 230 W
	Travel: 10 persons by train, average 500 km, 10 persons by car, average 150 km The program committee members living at greater distances to the meeting place did not attend physically		

above) be functionally equivalent. Functional equivalence is in general a difficult issue among alternatives involving the introduction of electronic media because the new media often bring disadvantages with them if one regards them as one-to-one replacements for conventional media (for instance, taking a CD as a substitute for paper, telecommunication as a substitute for direct contact). However, if one regards them as an opportunity to find new forms of communication, with which specific advantages also come into play along with the disadvantages as compared with conventional media, the bottom line can be quite positive. To draw a comparison assuming functional equivalence would then be missing the point. We are currently examining in another project what

Table 3
Characterization of the travel activities of the participants

Mode of travel	By car	By train	By airplane		
			Short distance	Middle distance	Long distance
Average distance (one way) (km)	300	335	680	1670	8240
No. of participants	17 (5.5%)	182 (58.6%)	62 (19.9%)	29 (9.3%)	18 (5.8%)

Table 4
Characterization of a virtual conference

	Energy consumption
Participants: 1000	(i) Computer: 145 W
Duration of the conference: 3 days; online time per participant: 5 h	(ii) Server: 500 W
Data transfer time per participant: 3 h	(iii) Router: 0.01 W h per kByte raw data, assumption 10 routers -> 0.1 W h per kByte
Transfer rate: 64 kBit/s	(iv) Telephone network for Internet access from home: confidential information
No. of printed conference papers per participant: 10	(v) Printer: 231 W
Printer paper: wood-free, coated	
Average size of one conference paper: 10 pages (330 kByte)	

consequences the fact will have for the LCA methodology that the concept of functional equivalence appears less and less adequate in the area of information technologies.

Based on facts that were known to our team as the organizers of the event and additional assumptions, the aspects shown in Fig. 1 were characterized in detail. Tables 1 and 2 show the characteristics of the various materials and organizational activities considered.

Table 3 indicates the average travelling distances based on an examination of the list of participants and the following assumptions:

- Participants living less than 300 km from Zurich: mainly travelling by train, some participants by car—airplane only exceptionally.
- Participants living between 300 and 1000 km from Zurich: 50% train/50% airplane—car only exceptionally.
- More than 1000 km from Zurich: 100% airplane.

The scenario of a virtual conference was examined as one of the alternatives. In this scenario, the organization as characterised in Table 2 remains unchanged, but not all conference materials (Table 1) are taken into account (only the "Call for Papers," the "Program Brochure" and "Other Dispatches" are considered). No physical travel activity occurs, but the traffic on the Internet is now considered to be relevant, as indicated in Table 4. We suppose that more participants would attend this kind of conference because it is easier to access (estimate: 1000 participants). On the other hand, the participation will probably be more selective: Who would spend three whole days sitting in front of his computer to attend a virtual conference? For this reason, we assumed an average online-time for the 3-day conference per participant of 5 h.

3. Inventory analysis

For the inventory analysis, we relied on results from earlier studies (Reichart and Hischier, 2001; Hischier and Reichart, 2001), on standard data from the

Table 5
Overview of data sets used for inventory analysis

Process	Data source	Time	Remarks
(i) Energy consumption			
Electricity production (oil, gas, coal, water, uranium)	Habersatter et al. (1996)	Early 1990s	Data based on Frischknecht et al. (1994, 1996)
Heat production (oil, gas, coal, etc.)	IFU/ifeu (1998)	Early 1990s	
Kerosene, diesel fuel, petrol	Fritsche (1994)	Early 1990s	Situation in Germany
Electricity consumption for data transfer in Internet (including Routers, etc.)	Estimation	2000	Based on SWITCH (2000) and our own research
Electricity consumption of the telephone network	Swisscom	1998–1999	Confidential information
Electricity consumption of computer and printer	Meyer and Schaltegger (1999)	1999	
Electricity consumption for production of the bag	Estimation		Based on Mila i Canals (1998) and our own research
(ii) Devices and materials			
CD-ROM	Own research	1999	Company-specific data
Printing (Offset)	Reichart and Hischier (2001)	end of 1990s	
Recycled paper with deinking	Haberstatter et al. (1996)	1993–1995	One Swiss company
Recycled paper without deinking	Haberstatter et al. (1996)	1993–1995	One Swiss company
Paper (wood-free, coated)	Haberstatter et al. (1996)	1993–1995	One Swiss company
Paper (wood-free, uncoated)	Haberstatter et al. (1996)	1993–1995	Two Swiss companies
Paper (wood-containing, coated)	Haberstatter et al. (1996)	1993–1995	One Swiss company
Newsprint paper	Haberstatter et al. (1996)	1993–1995	One Swiss company
Cardboard	Haberstatter et al. (1996)	1993–1995	eight companies in D, GB, S, SF
Cotton	IFU/ifeu (1998)	Early 1980s	Global average
Nylon	IFU/ifeu (1998)	Early 1990s	European average, based on APME (1997)
(ix) Transport of persons			
By car	IFU/ifeu (1998)	Mid 1990s	Situation in Germany
By train	IFU/ifeu (1998)	Mid 1990s	Situation in Germany
By aircraft	Lufthansa (1996)	1995	

umberto database (IFU/ifeu, 1998) as well as from other European studies. Table 5 gives an overview of the data sets used for this study.

4. Impact assessment

The following evaluation methods were applied in this study.

- Eco-Indicator '99 (Goedkoop and Spriensma, 2000): A so-called fully aggregating method based on scientific facts as far as possible. The results are presented in "Eco-Indicator points."
- The Swiss method based on the concept of ecological scarcity (Brand et al., 1998): This method has been widely used in Switzerland since the beginning of the 1990's and was updated in 1997. It is a fully aggregating method like Eco-Indicator '99 and is based on political targets. The results are presented as "Eco points (UBP '97)."

Because aggregated impact factors are difficult to comprehend, we included the total amount of emitted CO_2 as a third method of reducing the results to one single indicator. This means, of course, that other impact factors are neglected in this case.

The sensitivity analysis with respect to the three methods (Eco-Indicator '99, Eco points (UBP '97) and "just CO_2") showed no significant difference in the decision-relevant aspects of the results (relative impact of the alternatives that are compared). We, therefore, consider our results to be quite robust with respect to the aggregation method used, and will focus on the results from Eco-Indicator '99 in the following section.

5. Results and interpretation

The organizer of a conference can—first of all—influence the amount and kind of materials (e.g. printed matter) produced for organizing and holding the conference. We assumed that distributing a printed call for papers (besides e-mail distribution) as well as a printed program brochure is still inevitable in order to motivate enough people to submit papers to the conference and to participate. However, it is possible to reduce the additional printed material usually handed out to conference participants (city maps, notepads, all kind of booklets, as well as the bag holding all the conference materials) to a minimum. Fig. 2 shows the results—expressed as eco-indicator points (EIP)—for the printed matters used before and during the event, as well as an elaborate nylon book bag, as is common at many conferences.

The results in Fig. 2 are dominated by the elaborate nylon bag and the printed version of the proceedings—on our conference actually a two volume book with about 1000 pages (Hilty and Gilgen, 2001). We examined alternatives for both of

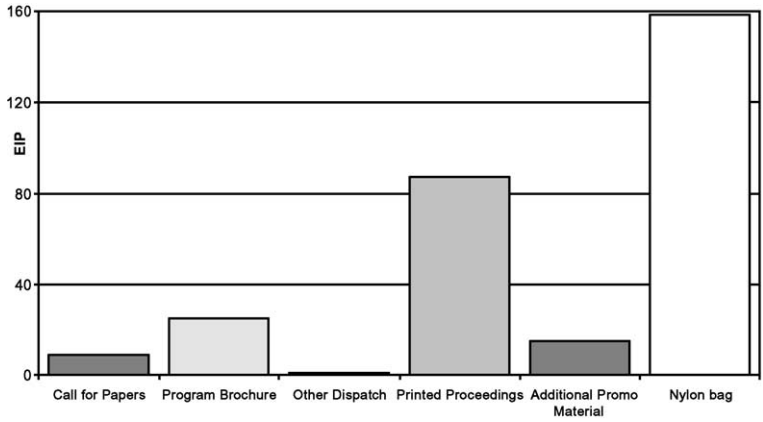

Fig. 2. Environmental impact (expressed in eco-indicator points) of the different materials used for the conference.

them: A plain cotton bag was compared to the nylon book bag, and a CD ROM version of the proceedings was compared to the proceedings in book form. We assumed that each CD owner will print out about 10% of the content, which means about 10 conference full papers with a total of 100 pages.

The results are shown in Fig. 3. Replacing the elaborate nylon bag by a simple cotton bag will lead to an obvious reduction of the environmental load. Therefore, we decided to use just a plain cotton bag on our conference. Furthermore, we abstained from producing a specific bag for the conference (i.e. printing the conference title and date on it), which enables it to be reused for other purposes.

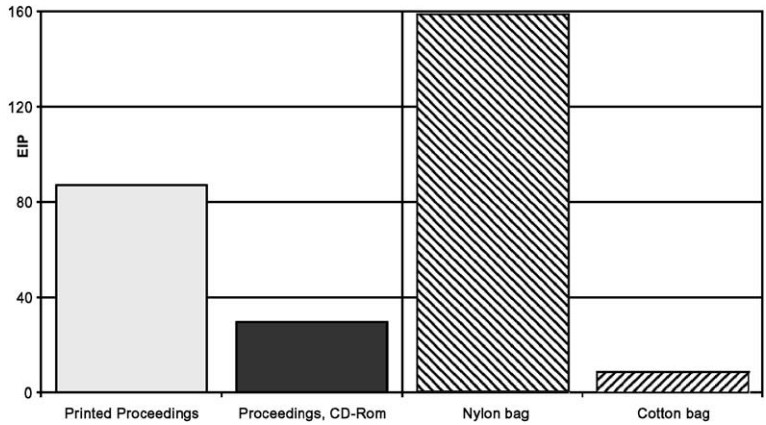

Fig. 3. Environmental impact (expressed in eco-indicator points, EIP) of the alternatives concerning proceedings and conference bag compared with the base case.

As Fig. 3 shows that replacing the printed proceedings by a CD ROM would also result in a significant reduction of the environmental load. However, we decided to keep the printed version due to several reasons. One reason is that proceedings on CD would have a completely different character. Normally, participants can consult the printed version to help them decide which lectures to attend and even take handwritten notes on the same page. CD proceedings would be hard to browse through during the event without additional equipment.

A compromise for the future could be to print a book containing only the abstracts (as is common at many conferences) instead of the full papers and to edit a CD containing the full papers (even updated versions) after the conference. The abstract volume would have only about 1/8 of the size compared to the current form of the proceedings of this conference series. However, this alternative would imply that the proceedings would no longer be sold in bookshops, and that a book series that has been edited since 1994 would be discontinued. Furthermore, if we assume that the average CD ROM owner would print out 20–30% of its content, the full content can be printed in book form at the cost of roughly the same environmental load.

As Fig. 4 shows, when we look at the environmental impact caused by participants' travel, the discussion about the conference materials appears insignificant in comparison. The travel activities of the participants account for 96.3% of the total environmental load of the conference, the remaining 3.6% including, among other things, the full paper proceedings in book form and a simple cotton bag.

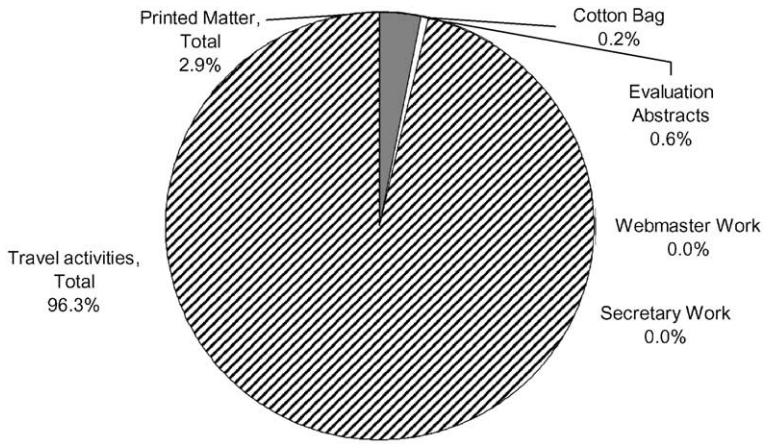

Fig. 4. Environmental impact (expressed in eco-indicator points, EIP) of the materials compared with the organization and the participants' travel activities.

Table 6
Damage assessment (expressed in eco-indicator points, EIP) of the materials compared with the organization and the participants' travel activities

	Eco-Indicator '99	Damage due to (%):		
		Mineral and fossil resources	Ecosystem quality	Human health
Printed matter, total	136.5	42	9	50
Cotton bag	8.4	45	7	49
Evaluation abstracts	27.5	58	6	35
Webmaster work	0.3	38	7	55
Secretary work	0.5	38	7	55
Travel activities, total	4476.6	75	4	21
Total	4649.8	74	4	22

Table 6 shows the amounts of each of the different types of damage types as percentages of the total eco-indicator result for all the materials and activities mentioned in Fig. 4 above.

As apparent in Table 6, the percentages of damage to ecosystem quality are in all cases negligible. In the case of travel activities, the damage to resources is responsible for 75% of the total eco-indicator result, while for the different types of materials and activities, the resources are responsible for around 40% and the damage to human health is responsible for around 50% of the total eco-indicator. As travel is the only significant item in the system examined, the whole system has a distribution very similar to that of the travel activities.

The results for travel are based on an analysis of the list of participants attending the Zurich conference. Fig. 5 shows the ratio of the different mode of transportation: 6% of the participants are responsible for almost 60% of the environmental load of the travel activities due to their long distance flights.

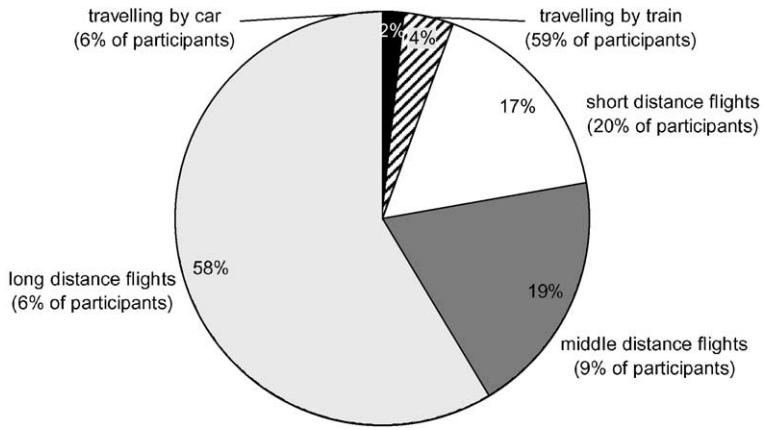

Fig. 5. Environmental impact (expressed in eco-indicator points EIP) of the participants' travel activities split into different modes of travel.

Table 7
Detailed results (CED = cumulative energy demand; kg carbon dioxide, Ecopoints '97 and Eco-Indicator '99) of the materials compared with the organization and the participants' travel activities

Step	CED (MJ)	CO_2 (kg)	Ecopoints '97 (points)	Eco-Indicator '99 (points)
Printed matter, total	147,671.8	1760.3	2786,600.8	136.5
Cotton bag	28,129.4	202.4	160,285.1	8.4
Evaluation abstracts	59,536.4	478.7	353,537.6	27.5
Webmaster work	1061.8	7.2	5485.0	0.3
Secretary work	1937.3	13.1	10,008.3	0.5
Travel activities				
By car	14,773.0	1066.3	737,084.9	68.7
By train	117,160.9	4049.3	3,319,172.4	184.8
By airplane (short)	162,790.0	12,334.9	7,192,584.1	743.6
By airplane (mid)	186,840.0	14,157.0	8,255,100.7	853.4
By airplane (long)	574,800.0	43,563.9	25,402,599.6	2626.1

Travelling by train, on the other hand, is less harmful to the environment: 60% of the participants who came by train are responsible for only 4% of the environmental impact caused by travel to the 15th International Environmental Informatics Symposium.

Minimizing air travel is, thus, the only way to reduce the environmental load of a conference significantly.

As apparent in Table 7, one alternative that would avoid the travel activities almost completely is a virtual conference, where all presentations and discussions are offered via the Internet. Fig. 6 shows how this would change the picture. Obviously, this type of meeting would result in a huge reduction of the total

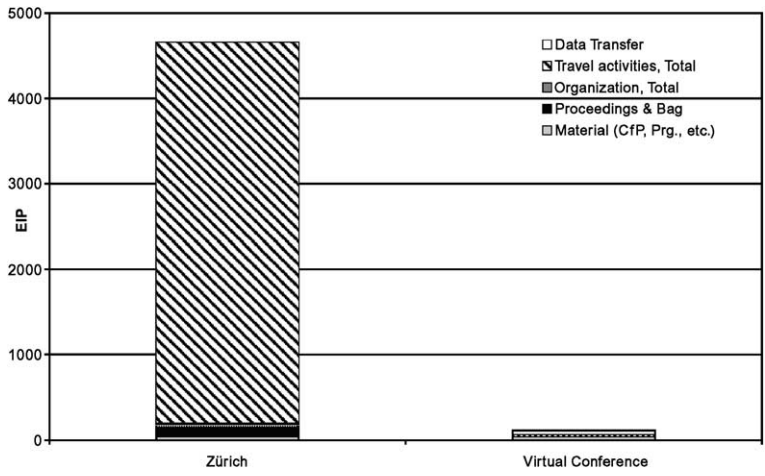

Fig. 6. Environmental impact (expressed in eco-indicator points, EIP) of the conference held in Zurich compared to a virtual conference.

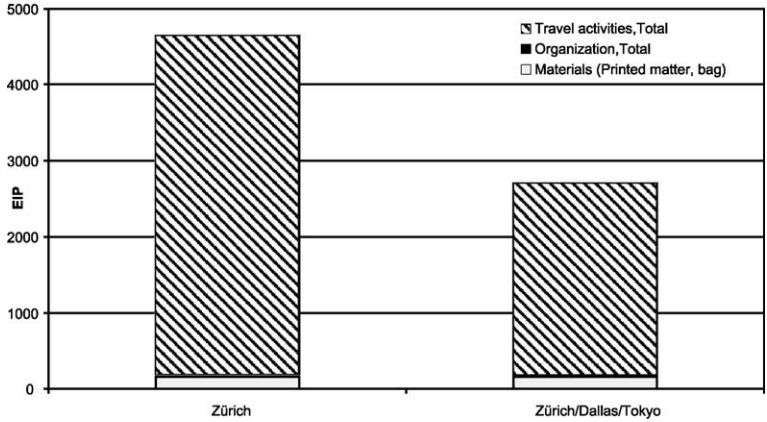

Fig. 7. Environmental impact (expressed in eco-indicator points, EIP) of a centralized conference in Zurich compared to a decentralized conference in Zurich, Dallas and Tokyo simultaneously.

environmental impact, even if we assume that more people would participate and that all of them would print out relevant parts of the proceedings (for more details see Table 4 above).

On the other hand, one important function of a conference is to make direct personal contact with other participants possible—something that modern information technology has not yet been able to replace.

Taking this into account, a third alternative comes to mind which might deserve consideration in the future: a decentralized conference which takes place

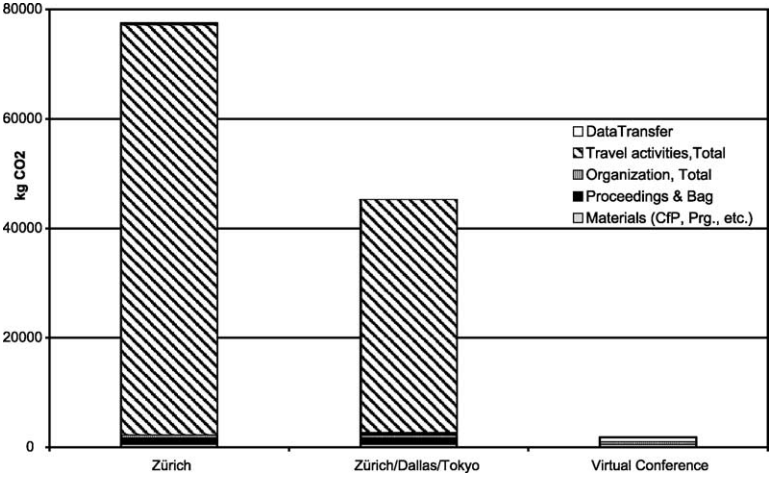

Fig. 8. Environmental impact (expressed as kilograms of CO_2 emitted) of the conference held in Zurich compared to a decentralized conference in Zurich, Dallas and Tokyo simultaneously, and to a completely virtual conference.

at several locations that can be reached with much less air travel, which are connected to one another live by suitable telecommunication facilities. Then the experience of direct contact to a smaller group would be available, and a global dialog would still be possible. Fig. 7 shows the results for this scenario (assuming the same geographic distribution of the participants).

We emphasize once again that we are not presupposing the functional equivalence of these alternatives. Instead, it is a question of different forms of communication in the scientific community, which have their specific advantages and disadvantages. In case these new forms (including the completely virtualized conference) become part of our culture, though, it would be interesting to know how their direct environmental impacts would roughly relate to one another.

The right bar shows the environmental load that would result from a conference taking place simultaneously in Zurich (for European and African participants), in Dallas (for American participants) and in Tokyo (for Asian participants). Under the assumption that the audience would be the same, the environmental load attributable to travel activities is more or less halved, while the rest of the is constant. Of course, it is more plausible that this form of conference would attract more people from the American and the Asian area than the Zurich conference because it could be accessed more easily. This would result in an increase of the absolute environmental load caused by the conference, while the environmental load per capita should remain roughly the same. This would be a typical example of the so-called rebound effect.

As mentioned in Chapter 4, the sensitivity analysis with respect to impact assessment methods (Eco-Indicator '99, Ecological Scarcity, CO_2 only) resulted in very low sensitivity. This can be explained by the fact that, according to our analysis, the ecologically critical factor in holding an international conference is travel-related energy use, and that fossil fuels (as well as the resulting atmospheric emissions) are the dominating energy carrier in travel.

For the purpose of illustration, we present the absolute CO_2 emission values for the three types of conference considered (Fig. 8).

6. Conclusions

The environmental impact of an international conference such as "Environmental Informatics 2001" is clearly dominated by the travel activities of the participants. Among travel activities, the long-range flights are the dominant element. Minimizing air travel is, thus, the only way to attain a significant reduction in environmental impact. On the other hand, a conference has the important function of making personal contact with other participants possible—something that modern technology has not been able to replace thus far. This should be taken into account, as should the indirect ecological benefits of an environmental conference, which will hopefully contribute to a reduction of environmental impacts by means of scientific progress.

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Dr. Lorenz M. Hilty is in charge of the research programme "Sustainability in the Information Society" at the Swiss Federal Laboratories for Materials Testing and Research (EMPA), and is a professor for Business Information Systems at Solothurn University of Applied Sciences Northwestern Switzerland (FHSO). He finished his postdoctoral thesis (habilitation) at the Informatics Department of the University of Hamburg in 1997. His research is focussed on environmental informatics and the relationship between information technology and sustainable development.