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Talk

Green conferencing for the Italian Society of Ecology

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Abstract

During the social dinner of the XIV SItE National Meeting, a few of us discussed about ways to compensate the carbon emissions we produce every year during the conference. A provoking article which appeared in Nature some weeks later (18 Nov 2004) encouraged the group to elaborate a procedure aimed at: 1. estimating the carbon emissions caused by the attendees; 2. calculating the number of trees (*Populus* sp.) that should be planted to redress the CO_2 balance over a time horizon of seven years. Although a precise evaluation of the impacts is difficult, we present a procedure to estimate them using several parameters provided by the attendees: distance travelled, type of vehicle, kind of lodging. The results presented here can certainly be improved, but our ultimate scope is to take action as a Society well before more correct analyses are available and to stimulate further research. The estimated number of trees compensating the emissions with the proposed method were planted in October 2006 in a restored wetland area along the Po river, where the SItE established a little Kyoto forest, to be used also as an education center for school children and the general public.

Keywords: CO_2 emissions; global warming; Kyoto protocol; carbon cycling; reforestation.

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1. Introduction

According to the Kyoto Protocol, a good way to mitigate Global Warming on Earth consists in coupling actions aimed at reducing CO_2 emissions with C sequestration programs, such as reforestation. As Italian Society of Ecology (SItE), we decided to promote a concrete, although little, gesture for redressing the carbon balance of our activities, starting from the annual National meeting. Here we present the method we followed to evaluate and compensate the CO_2 emissions of the participants to the XVI National Meeting (Tuscia 2006). The implicit contradiction pointed out in a brilliant Editorial appeared in Nature a couple of years ago (*Clean, green conferencing*, **432**: 257, 2004) is, in fact, too provocative for scientists in general, and ecologists in particular, to be left unanswered. How can people, who meet expressly to discuss possible pathways to save and manage ecosystems at all scales, disregard the fact that also their conferences can significantly contribute to global warming? Also, inviting many prestigious International speakers at National meetings clearly enhances the scientific quality of the congress, but has the side-effect of sharply increasing CO_2 emissions.

We are not the first Society of Ecology that tries to compensate the CO_2 emissions of its meetings. For example, our elder sister ESA (Ecological Society of America) started this year, posed to the attendees of its 91st annual meetings in Memphis (more details at http://www.esa.org/memphis/greenmeeting.php) the goal "*to reducing the environmental impacts of our Annual Meetings as much as possible*". Interestingly enough, however, a box on the previously mentioned webpage says that "*Meeting attendees are invited to calculate the carbon emissions created in the process of traveling to the Annual Meeting and to donate an equivalent dollar to the support of environmental projects to offset these emissions. If you would like to provide such support to offset your carbon usage, you may visit one of the links below.*
http://www.sustainabletravelinternational.org
http://www.carbonfund.org"

The main scientific drawback of such an approach is that the rules used to calculate both the emissions and the number of plants needed to compensate the emissions remain hidden. All the packages available online to perform the above calculations (including those suggested by ESA) are *black box* models, i.e. do not explicitate the algorithm used to obtain the results. This is most probably why the organizers of Memphis annual meeting write "*These links are provided for the convenience of meeting attendees. ESA does not endorse, support, or guarantee the services or information described or offered at these internet sites. Meeting attendees are asked to use their own judgement before making donations. The views and opinions represented by these sites do not necessarily state or reflect those of the ESA.*".

Our goals in this study are (A) to make the entire analysis clear, transparent and repeatable; (B) to permit further improvement on the many aspects we have not discussed or have treated too naively; and (C) to make each of the participants aware of the environmental consequences of her/his choices. In fact, we analyze the different impacts of each attendee in terms of her/his CO_2 emissions. We then estimate the number of seedlings (*Populus* sp.), that have to be planted in order to absorb these emissions during a fixed time horizon (we choose seven years).
Thanks to the Municiaplity of Villanova sull'Arda and the environmentalist association "Aironi del Po" we finally had the opportunity to realize the Kyoto forest of the XVI National meeting of the Society along the Po river at Isola Giarola. Isola Giarola was formerly a sand quarry, which is now restored and composes of small wetlands and forested transitional zones (Viaroli et al., 2002).. Fig. 1 shows the "planting group" before (top panel), during (middle panel) and after (bottom panel) the park foundation. The Society has proposed to repeat this experience for the future meetings, to give a concrete example of taking action on the principles of the Kyoto Protocol.

Fig. 1 Foundation of the Kyoto forest of the XVI National meeting of the Italian Society of Ecology at Villanova d'Arda (PC). Top panel: the group is instructed by Stefano Barborini on how to plant the young trees (*Ulmus spp.*). Middle panel: the major of Villanova d'Arda and the former President of the SItE are planting a tree. Bottom panel: The planting group celebrates the foundation of the park.

2. Impacts of the participants

The attendees were provided with a form, also available online on the meeting website, and were asked to answer some questions about their participation to the meeting. In particular, we asked the mean of transport used to reach the meeting location, the distance traveled (round trip), the kind of accommodation chosen and the number of days spent at the meeting. We treated each of the previous indicators of "warming pollution" as described in the following sections.

2.1 Means of transport

The impact due to transport was calculated on the basis of the data provided by the Italian *Ministero delle Infrastrutture e dei Trasporti* (2003), which are summarized in Table 1. The four options we considered are (i) the airplane, (ii) the train, (ii) the taxi, and (ii) the car. For the first two categories we used average emissions, while for cars we asked the specific model used by each attendee. The data concerning the emissions of different car models are detailed in a long list available online at (http://www.infrastrutturetrasporti.it/page/standard/mop_all.php?p_id=02053). The emissions of a taxi were estimated as the average emission of all car models in the above mentioned list . It is interesting to notice that the most efficient gasoline car (in terms of CO_2 emissions) produces 104 gCO_2 per kilometer, i.e. about 2/3 of the airplane, but the worst car model produces 570 gCO_2/km, roughly four times an airplane. As a general result, if used by a single attendee, taxis and cars cause higher emissions than airplanes on reasonable distances, quite a surprising result. However, it must be remarked that if more attendees share the same car or taxi the emissions must be divided by the number of passengers. Hence, using a car is not *a priori* worse than other means of transport: it very much depends on the number of participants reaching the meeting with it. Once we obtained the kilometers traveled by each participant, her/his mean of transport, and the possible number of other attendees coming with her/him (cars or taxis only), it has been just a matter of multiplying and summing up numbers in order to obtain the warming pollution associated to her/his participation.

1.2 Accomodation

We classified the type of accommodation into four categories: (I) 4 to 5-star hotel, (II) 2 to 3-star hotel, (III) 1-star hotel or hostel, and (IV) the apartment of relatives or friends. The colleagues that attend several scientific meetings will surely recognize that behind each of the above accommodation categories there is a different type of participant, from the prestigious invited speaker to the graduate student presenting her/his master thesis as a poster.

Table 1: Data used to evaluate the emissions due to different means of transport (see text for details). Source: Ministero delle Infrastrutture e dei Trasporti (2003).

Mean of transport	**Emissions (gCO_2 km^{-1})**
airplane	150
train	45
car	104-570
taxi	210

Estimating the warming pollution of each type of accommodation is not at all simple. We reasoned in the following approximated way. Knowing the average energy consumption (AC) of a hotel (expressed in kWh $year^{-1}$ m^{-2}), the average per capita cubature of each different housing category (PC, m^3 $person^{-1}$), and assuming that the average height of a room (H) is around 2.7 m, it is possible to estimate the daily energy consumption EC for each participant (measured in kWh $person^{-1}$ day^{-1}) with the formula:

$$EC = (PC \times AC) / (D \times H) \quad (1)$$

where D is the number of days in a year, i.e. $D = 365$ day $year^{-1}$. Unfortunately, the only data for AC we were able to find are not up-to-date (Regione Sicilia 1978). Also, since data for hotels in the second category were not available, we estimated the corresponding EC by averaging the values obtained for the highest and the lowest category. The EC of a participant that is guested in a friends' apartment was estimated as 2 kWh $person^{-1}$ day^{-1}. In the absence of better estimates, we averaged the energetic consumptions of the families of 80 undergraduate students of the Politecnico di Milano in 2005.

To convert the energetic consumption EC to CO_2 emissions one must know how electric energy is produced. To this end we used the coefficients published by Ente Nazionale per l'Energia Elettrica (National Electrical Energy Corporation, ENEL 2005), according to which the production of 1kWh causes the emission of 0.502 CO_2 kilograms. Using the data summarized in Table 2 it is simple to calculate the daily emission of each participant due to housing.

Table 2: Data used to evaluate the CO_2 emissions of each participant due to accommodation (see text for details). The main sources are Regione Sicilia (1978) and Ministère de l'Intérieur et de l'Aménagement du Territoire (1999).

Category	**I**	**II**	**III**	**IV**
AC (kWh $year^{-1}$ m^{-2})	380	N/A	157	–
PC (m^3 $person^{-1}$)	60	N/A	29	–
EC (kWh $person^{-1}$ day^{-1})	23.14	N/A	4.62	2
CO_2 emission ($kgCO_2$ $person^{-1}$ day^{-1})	11.62	6.97	2.32	1

2. CO_2 absorption by trees

2.1 General considerations

Every high-school student knows that primary producers capture CO_2 via photosynthesis and store the carbon atoms into their biomass. It is quite easy to calculate the quantity of CO_2 absorbed by a tree over a time horizon T if one knows the variation in biomass over that same period. Since (a) the ratio of the molecular weight of CO_2 to carbon is 44/12 = 3.67 gCO_2/gC, and (b) the dry biomass of trees is made of carbon for about 50%, the conversion coefficient between biomass and absorbed CO_2 is 1.83 gCO_2 /gDryBiomass. We will call this coefficient the B-to-CO_2 number. The law according to which a tree grows in biomass during its life is well known in silviculture and forest ecology (e.g. Tadaki et al., 1977) and generally takes the form:

$$B(t)=B_\infty[1-\exp(-\alpha t)] \qquad (2)$$

where $B(t)$ is the dry biomass at age t, while B_∞ and α are parameters that are species and location specific, because they strongly depend, among other factors, on climatic conditions and ground fertility. Biologically, B_∞ is the maximum biomass a tree can attain on a hypothetically infinite lifetime, and α is the rate of biomass growth in the earlier life-stages, while the tree is a seedling.

The number of trees (N_{trees}) that can balance the emissions of the participants over a time horizon of T years can thus be evaluated as

$$N_{\mathrm{trees}} = E_{\mathrm{tot}} / B_\infty [1 - \exp(-\alpha T)] \qquad (3)$$

where E_{tot} is the total CO_2 emission, easily obtained by multiplying the daily emission of every attendee by the duration of her/his staying at the meeting and summing up all contributions.

To estimate the number of trees needed to offset the emissions we used data on plant biomass growth for a poplar forest (*Populus* clone I-214) planted in Bagni di Tivoli (Roma). Dividing the age-specific data on tree volume (in m^3/ha), provided by Giordano and Avanzo (1979) and ISAFA (1979), by the actual tree density in their data (278 trees/ha) and multiplying the resulting values by the specific weight of poplar wood (0.445 kg/dm^3, Rumor and Strohmenger 1971), we obtained (Table 3) how the biomass of a single poplar tree increases with age. Multiplying these values by the B-to-CO_2 number we finally calculated (see Figure 2) the quantity of CO_2 that can be absorbed by a tree. A least square fitting of Equation (2) to the presented data gave α = 0.082 year^{-1} and B_∞=1151 kgDryBiomass/tree.

In percent, the emissions due to accommodation were about only 14% of the total, while those due to transport were the great majority (86%). In numbers, 69 attendees used the taxi or the car, 76 used the train and 21 the airplane. If histograms do not sum to the total number of attendees, this is because someone used more than one mean of transport, while the attendees from Viterbo and/or Civitavecchia (the location of the meeting) did not use any. To put in evidence the contribution of each specific means of transport, we show data as a histogram in Figure 3.

Table 3: How a *Populus* tree increases its biomass with age. See text for details.

Age (year)	**Tree volume (m^3/ha)**
0	0
3	168
4	203
5	248
6	291
7	310
8	334
9	360
10	396
11	429
12	455
13	479

3. Results

During the XVI Meeting of the Italian Society of Ecology we asked the participants to fill in a form and to provide us the information needed to evaluate their emissions, as discussed above. The total number of attendees was 400, and 173 of them (43%) participated to our initiative. The total CO_2 emissions of these participants were about 17300 $kgCO_2$ that, according to our calculation, can be redressed over 7 years by planting 19 poplar trees. The monetary cost of installing such a little Kyoto-forest can be estimated (not shown here for brevity) in around 600€.

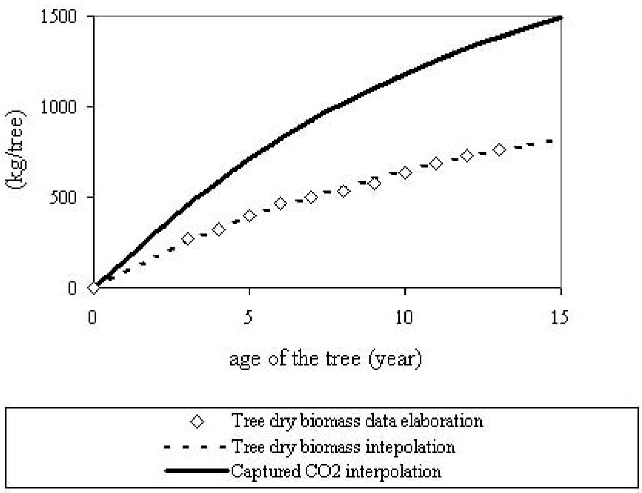


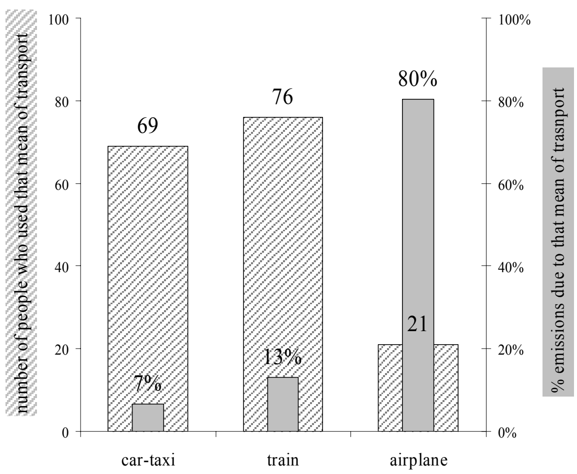
Figure 2

Quantity of CO_2 absorbed by a *Populus* tree during its lifetime.

The first comment is that the use of the airplane was responsible for about 80% of the emissions due to transport. Also, it is interesting to notice that only 21 attendees (12%) used the airplane, thus a little number of participants was responsible for a large warming pollution. If we exclude the emissions due to airplanes, the total impact of the meeting would drop to 5400 $kgCO_2$, the equivalent of 6 trees in 7 years. So, only to compensate the emissions of the attendees that used the airplane, we needed to plant an extra 13 trees. It must be emphasized, though, that the attendees using the airplane are generally International speakers, usually invited for plenary talks, thus largely contributing to the scientific success of the meeting.

From the data provided by the participants we observed that the average number of passengers per car was 3.32, which is fortunately a high coefficient of occupation (we are ecologist, after all!). The average distance driven by taxi was about 2.3 km, by car 460 km, by train 565 km, and by airplane 3800 km. The effect of replacing the use of cars with train on long distances is not very clear. In fact, although the formers have higher impacts than the latter, high coefficients of occupation of the cars can give unexpected outcomes. The emissions of the average participant who answered the questionnaire are about 100 $kgCO_2$/person. Assuming that the participants who filled the form are a representative sample of the global population of the attendees, we can approximately infer that the global impact of the 400 people who participated at the meeting was about 40 tCO_2. This emission can be balanced in 7 years, at the approximate cost of 1400 €, by planting 43 poplar trees.

Figure 3



The percentage of emissions (dark gray, right axis) due to the different means of transport, i.e. from left to right car-taxi, train and airplane, and the number of people who used them (light gray, left axis). See text for details.

Since the average life of a poplar tree is about 13 years, if we leave the plants on site up to their natural death we can expect that the trees will absorb an extra 40% of the CO_2 produced during the meeting. Additionally, in our simplified approach, we omitted the amount of C assimilated by trees that get sequestered into the soil organic matter. Despite it is not easy to quantify, this amount can be substantial, when the plantation occurs on a degraded landscape. Thus, we are confident that our CO_2 emission will be more than well offset by the plantation, with actually, a net beneficial effect on global warming.

4. Conclusion

In this work we described a way to calculate the CO_2 emissions of a scientific meeting and to redress them by reforestation. It is easy to find on the Internet websites with similar purposes, but the methods generally used to perform the calculations are not accessible to the final user. The methodology described here, although very simplified, is in contrast clear, transparent and repeatable.

Future improvements will hopefully include other impacts that have been disregarded in this work, such as those related to the organization of the meeting (e.g., preparatory meetings, gadgets, paper consumption for playbills, abstracts booklet and proceedings) and the food (meals, coffee breaks, social dinner). Further efforts will be aimed at estimating the CO_2 captured by different plant species. In fact, we performed our calculations for a poplar clone just because data on varieties commonly used in silviculture are easily available, but the analysis could be carried out considering autochthonous species which would certainly be preferable for an ecological society to realize a reforestation with.

Suitably modified, the methodology proposed here can be easily extended to assess the impacts of everyday behavior, providing an opportunity to people, not only to scientists, for thinking about the ecological footprint of their actions.

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