Veksø, March 4th, 2002

To
The Danish Committee on Scientific Dishonesty, DCSD.

Regarding
COMPLAINT OVER BJØRN LOMBORG

I have received your letter of 26 February and will express my thanks that you will now begin treating my complaint.

I learned about the existence of the DCSD only on the 20th of February, and since I judged that it would serve the case that I presented a complaint no later than the 21st of February, at the same time as the deadline of application for the position as director of the new institute of environment, my complaint was written in a hurry. Therefore there has slipped in some errors that I wish to correct.

Moreover, I am uncertain how many examples I shall present for there to be sufficient evidence for Lomborg's writings, especially The skeptical Environmentalist, are dishonest and biassed not only in single points, but on the whole all the way through. I have chosen to present one more example in this letter as I criticize the book's chapter 16, " Acid rain and forest death". I will like to emphasize that if the DCSD does not find to be able to draw an unambigous conclusion, you must, rather than reaching an unclear conclusion, inquire and ask for further examples of dishonesty. The amount of potential examples is almost unlimited; what sets the limit is how much time and energy I have for making account.

I enclose photocopies in two duplicates of relevant texts. There is is not copy of all the references I have mentioned in my complaint since I have not been able to procure them in the course of few days. Some references were thus lent from the respective science libraries. I expect to send supplementing copies later.

"The Engineer" has on 1st March published an account of details of my complaint to you. It has happened as follows, the journalist has inquired to the department of the Ministry of Environment claiming right of access to documents and gotten my complaint this way. I have not been able to prevent that.

The letter you have received from Stuart Pimm in New York is as far as I know a preliminary message that he intend to complain. According to what I have heard recently, the complaint itself will be ready in a week's time. Pimm has been notified that you want photocopies of the relevant texts.

Kind regards

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SUPPLEMENT OF 4th MARCH TO COMPLAINT PRESENTED 21st FEBRUARY

THE CHAPTER ON FORESTS, example no. 6

Here, I write that Lomborg uses data comprising the categories ”forest” and “woodland” and say that if only 1% of the trees are left, we are still concerned with “woodland”. This is not correct. FAO’s definition of the term “woodland” is contained in the enclosed copy of the FAO report on forests, where it appears that the canopy must cover at least 5% of the area in order to be “woodland”. However, this does not change the principles of my argumentation.

CONCERNING THE NUMBER OF STARVING PEOPLE IN AFRICA

I included the above-mentioned topic in my complaint because I had the example in fresh memory after a small dispute among readers in the Danish newspaper ***Politiken***. My approach was influenced by the fact that Lomborg’s presentation is based on two sources, of which one was not available at the indicated Internet address. I therefore at first based my criticism on the other source which could be procured, and where it appears that the percentage of starving people in Africa seems to have increased, not declined as Lomborg says. Subsequently I have become aware that the other source does still exist, albeit at a different Internet address than the one indicated. The other source indicates a slight decrease.

When copying the relevant tables I noticed that based on the above-mentioned second source, Lomborg might well have written that the proportion of starving people has developed from 37 % in 1980 to 33 % in 1996. If he had written that, I would not have been justified in criticising him for mixing up the two sets of data. Instead, he has written that the proportion has developed from 38 % in 1970 to 33 % in 1996. The two data examples would give the readers the same impression of a slight decrease, but the difference is that in the last case, two data sets have been combined which ought not to be combined. Even though I maintain the lack of justification in mixing up the two data sets, I must admit that no substantial distortion of the facts has resulted through this act.

However, it appears from FAO’s 1999 report (copy enclosed) that the uncertainty of the figures are estimated at ca. plus/minus 5 %. When the development has moved from 37 % in 1980 to 34 % in 1998, the change is thus inside the interval of uncertainty; the change is not statistically significant. In addition, there is the uncertainty which appars by two very different estimates for 1991, viz. 43 % in the first source and 35 % in the second source. Hence, data are altogether too uncertain to claim any clear tendency. Whether Lomborg on p. 6 asserts that a decrease is concerned is debatable. He uses the words: “...is expected to fall even further”. He thus says indirectly, but not directly, that the trend is decreasing.

Incidentally, I still think that the absolute figures should be given alongside the relative ones. If one wish that the the Africans should improve their situation themselves, the relative figure is important – how many satisfied Africans will there be to help each of the starving. But if the issue is that the developed countries should help the Africans in their distress, then it is important to know the absolute numbers, viz. that in 1970 the number of starving people was just above 100 million, but close to 200 millions in 1998.

However, altogether Lomborg’s treatment of this subject is only lightly biased, and therefore I do not wish to set great store by this example.

THE DECREASING SPERM QUALITY

Professor Skakkebæk has furthermore informed me of the following: The frequency of testicular cancer in Denmark has approximately quadrupled between the 1940s and today. There is evidence of a connection between

the incidence of testicular cancer and the incidence of low sperm quality, and it appears to be a reasonable theory that the two disorders might be expressions of the same underlying cause. For that reason, Skakkebæk tries to make Lomborg include the question of testicular cancer in his text, but Lomborg firmly refuses to do that. This may be seen as an expression of a deliberate lopsidedness in Lomborg – mention of testicular cancer would have meant mention of an example where things are unambiguously developing in the wrong direction, and would also have made the reality of the decline in sperm quality seem more credible. In addition, Skakkebæk informs that a PhD report elaborated at his institute provides no support for the idea that the frequency of ejaculations has changed during the later decades, which speaks further against Lomborg's representation of the case.

In addition, I would like to make a remark on the indications of sperm quality in New York. Fisch et al. (1996) say (p.1012) that some of the other investigations are based on donors to semen banks, and that "sperm donors represent a highly selected and screened group of men". This is used to criticize the investigations based on semen donors. Fisch et al. themselves base their investigation on men who have submitted sperm samples before they had a vasectomy. Why this group of men should be less "highly selected" is difficult to understand. When you look at the presentation on p. 1045 in Fisch & Goluboff (1996), you see that the earlier investigations from New York result in a series of numbers apparently declining in time: 121 – 134 – 101 – 107 – 110 – 79. Then comes their own number of 132, which does not fit into the pattern – perhaps just because their group of persons is "highly selected"? There is a great uncertainty here, as we do not know which differences might exist between differently selected groups of persons.

However, this is not a central point. The essence of my complaint is that Lomborg selectively plays down or omits evidence which speaks against his thesis. Not least the fact that Lomborg knows that Swan ***et al.*** 1997 (photocopy will be submitted later) have carried out a meta-analysis showing that the decline in sperm quality is significant even after variations in ejaculation frequency have been taken into account, but that he still does not mention this.

LOMBORG'S RELATIONSHIP WITH STATISTICS

In my section with this headline, in the lines concerning the extinction of species, I have written about " a figure where the uncertainty is larger than a factor qo". It should have said factor 10.

DID LOMBORG TAKE THE CRITICISM INTO ACCOUNT?

My section bearing this headline deals particularly with the example of the coastal rain forest in Brazil. I would like to ask the members of the Committee to start by reading the section "Check the data" on p. 254-255 in Lomborg's book, and assess whether those readers who do not check the notes are given a fair impression of the case.

REMARK ON THE REFERENCES

To the section with this headline I may add that there may be mentioned several additional examples of references which are central to the assessment of Lomborg's text, but which are no longer available on the Internet.

REVIEW OF LOMBORG'S CHAPTER 16: "ACID RAIN AND FOREST DEATH".

The researchers' current knowledge about the subject

"Forest death" was a controversial issue especially during the 1980es. Some researchers claimed that it was a real and serious problem, while others argued that forest death is no more widespread than it has always been. It is almost self-evident that Lomborg relies on the latter and criticises the first. However, now so much intensive research on the subject has been done with such concrete results that it is possible to give an account covering consensus among the majority of the involved researchers.

We all know that some decades back, extensive forest death occurred in Central Europe, especially in "The black triangle" in the area where the borders of Eastern Germany, Poland, and the Czech Republic meet each other, but also to a more moderate degree in mountain forests in the Black Forest, the Harz and Fichtelgebirge (Northern Bavaria). The actual forest death is attributed to air pollution with SO_2 from nearby sources of pollution.

When SO_2 has remained for some time in the atmosphere, it is oxidized to SO_3, which becomes sulphuric acid, and the nitroxides, NO_x in the air pollution, are likewise oxidized to nitric acid. At the same time, the pollution becomes less concentrated, when it moves further away from the source. The more widespread pollution thus consists of a more diffuse pollution with sulphuric and nitric acid. There is no evidence that these acids affect the foliage of the trees directly, as was the case with SO_2. Instead they acidify the soil, in many cases causing changes in the soil chemistry that have consequences for the root systems of the trees, and thereby, presumably, in the end for the entire trees.

Here, it is of particular importance that the trees need the divalent cations magnesium (Mg) and calcium (Ca). Mg forms part of chlorophyll, and Mg-deficiency therefore leads to a deficiency of chlorophyll. The leaves become yellow. Ca is necessary for the development of the roots, and at Ca deficiency the root system may be insufficiently developed.

When acid rain percolates the forest floor, the natural leaching of Mg and Ca is accelerated. To some degree, this may be counteracted by the natural withering of the soil particles, whereby new Mg and Ca is released, but the withering is far from able to keep up with the leaching in all places. The deficiency in Mg and Ca is not most pronounced at the soil surface, where a continuous re-supply takes place via the foliage, but rather a bit further down in the soil.

The effect of leaching of the soil by acid rain is at first counteracted by the buffer systems of the soil. If we start in the neutral region, then at first the $CaHCO_3$ buffer system comes into function. When this system has been used up, the pH drops below 6.2, and after that the buffer effect takes place through a mechanism where metal ions (Ca, Mg, and others) on the soil colloids are exchanged with acid ions through ion exchange. When this buffer has been used up, i.e. when most Ca and Mg has been washed out, the pH drops below 4.2. Then the soil's content of aluminium (Al) comes into function. Various kinds of Al ions are released into the soil fluid. If the acid is sulphuric acid, undissolved aluminium sulphate is formed, and in that case sulphate is fixed in the soil. In this case, no further leaching will occur, and pH will not sink any further. If on the other hand the acid is nitric acid, the leaching will continue, as aluminium nitrate is soluble. Hence only nitric acid may lower the soil's pH below 4.2. Through the lowering of the pH, more Al ions are gradually dissolved, and they act like poison on the trees' roots. Aluminium is adsorbed to the tips of the fine root hairs, where it inhibits the growth and hence the formation of roots. Of special importance is the ratio between Al and Mg and the ratio between Al and Ca. The higher these ratios, the more difficult will it be for the trees to assimilate enough Mg and Ca. Mg deficiency leads to chlorophyll deficiency, and Ca deficiency causes

insufficient development of the root system, especially in the deeper soil strata. The root system becomes more superficial, and the trees therefore become more vulnerable to weather extremes (storm damage, drought). The general weakening of the trees, their reduced water supply, also make them more vulnerable to attacks by insects and fungi.

Especially conifers are sensitive to Al. Deciduous trees are more vulnerable to H^+.

Together with the acidification, air pollution also implies increased admission of nitrogen. Nitrogen is partly entered as ammonium, and partly as nitrate. Ammonium has aquite similar effect on the roots as aluminium, in the sense that the ammonium/Mg ratio and the ammonium/Ca ratio are important. When the plant roots need to take up nitrogen as fertilizer, and the source of nitrogen is ammonium nitrate (NH_4NO_3), they do so by assimilating NH_3 and leaving behind HNO_3, i.e. nitric acid. Through this mechanism, the soil is further acidified.

The assimilated nitrogen functions as a fertilizer enhancing the growth of the trees. Whether the net effect is a reduction or increase of growth is dependent on the specific area. The latter is the most prevalent situation. But the increased release of nitrogen also causes a greater imbalance between the supplies of N and Mg, and causes problems in the ammonium/Mg ratio. The imbalance between the supplies of N and Mg weakens the tree. Curiously enough, increased growth and weakening of the tree may- thus occur at the same time.

Since alarm was raised about forest death in Germany around 1983, extensive monitoring of the condition of the forest trees has been initiated. The condition of the trees is assessed annually in fixed sample plots distributed over many European countries.

Standardised criteria for the assessment of loss of foliage (thinning of the crown) as well as for yellowing of the needles/foliage (chlorosis) have been elaborated. When “forest death” was most vehemently discussed late in the 1980s, this monitoring had only taken place during so few years (from 1983 onwards) that the long term trends were very uncertain. But the monitoring has continued since then, so that today we have firmer knowledge about the long-term trends.

Lomborg’ references on the subject

One of Lomborg’s references on the subject is an unpublished Danish feature article manuscript. The background is as follows: one of his students, Kenneth Thue Nielsen, had a feature article published in ***Jyllands-Posten***, in which he claimed that “acid rain is a myth”. This gave rise to a countering letter, as 4 researchers belonging to the leading expertise within the field joined in writing a feature article manuscript[1] and sent it to ***Jyllands-Posten***. It was not accepted. Only later it was accepted in a severely shortened version, from which all criticism of the journalists’ role in the case had been purged (incidentally it is a democratic problem that criticism of the press is so rarely published by the press, and it is problematic to let a young student have an entire feature article, while the country’s leading experts are rejected). The rejected manuscript was then put out on the internet instead, from where I have downloaded it and Lomborg did the same. Lomborg refers to it in his notes 1306, 1311, and 1313.

Lomborg further refers to a report from the European Environmental Agency, EEA, in 1998 (Europe’s environment). This report is no longer available on the Internet, which is why I have not been able to procure it immediately.

The most technical of his references is a comprehensive report about a Norwegian acidification experiment, authored by Gunnar Abrahamsen et al[2]. They refer to experiments where small test parcels have been watered with acid water through several years. The parcels are situated on coarse

sandy soil in two places in Southern Norway. Photocopies of a few pages are enclosed. The investigation has serious flaws. Very little Mg and Ca remains in the severely leached, sandy soil already before the start of the experiment. The watering is done with pumped up groundwater containing more Ca and Mg than rainwater. To this water only sulphuric acid is added, not nitric acid. The pH in the soil surface is only 3.5 at the start of the experiment and does not decline at all during the experiment. It was not possible to demonstrate increased amounts of exchangeable Al as a result of the acidification "only small effects on exchangeable Al were measured" (Abrahamsen p. 62). However, this was not to be expected either, as the added sulphuric acid renders Al insoluble, as mentioned above. The exchangeable amount of acid ions on the soil particles did not change at all during the course of the experiment (Abrahamsen table 4.9 p. 63). In short, on the whole the soil chemistry was not altered at all and soluble Al was almost absent. Therefore it is no wonder that no effect whatsoever was seen on the spruce trees in the experiment.

Unfortunately, Abrahamsen et al. make the mistake of concluding on this background that when they in their own experiment were unable to show any effects of watering with water containing added sulphuric acid, then acid rain must be without effect in other cases, too. In support of this view they cite among others a German researcher (Kandler), who claims that forest death in Germany is no worse than it has always been[3,4].

Kandler is a specialist in fungal diseases and presents some photo series showing that already many years ago, spruce trees suffered from those symptoms which are now attributed to acid rain. One of his opponents is the veteran within the field of forest death, B. Ulrich[5]. The conclusion on their dispute may perhaps be that trees always suffered from such symptoms, and when they do, the cause is often fungal diseases, and sometimes climatic conditions (frost, drought). But that does not prevent the frequency of trees showing these symptoms from having increased in recent years, perhaps as the trees have become more sensitive to fungi and drought. In an article published two years later[6], Kandler repeats his arguments, but this time with the addition, supported by photos, that in the Black Forest during the years 1984-86 spruce trees with yellow needles occurred with increased frequency, which was not due to fungus attacks, but could only be explained by Mg deficiency, perhaps caused by drought. One of his opponents (Schulze[7]) writes that in Fichtelgebirge the same problem occurred during the same period, and that in this case the problem had nothing to do with fungus attacks either. Thus, a process towards consensus seems to be ongoing. There is consensus that the trees became green again during the wet years late in the 1980s. Kandler believes that this simply reflects a random change in climate, while his opponent considers the trees to be weakened by acid rain and hence more sensitive to drought than they used to be, and will become yellow again during the next drought period. This dispute can only be clarified through continued observations.

Lomborg is using Abrahamsen and Kandler for support, and thus he relies on those who do not consider acid rain to be a problem.

Other references on the subject

The theory on forest death caused by acid rain is not so weakly founded as the above might indicate. I will now present some references which render a different impression than the one Lomborg offers.

In the rejected feature manuscript, Gundersen et al. write: "Researchers agree that in the longer term the present pollution level will cause problems in the forests ". Lomborg, whom we know has read the text, should have reacted to such an assertion and checked the source. The source is a "conference summary statement", written in unity by 12 researchers, as the conclusion on a large-scale scientific conference on the

subject in 1995[8]. It is enclosed as a copy. The 12 researchers first outline what we do now (1995) know with confidence, and then go on to say what it is reasonable to suspect, and what may be predicted.

What we do know with confidence is for instance that sulphur pollution has caused leaching of "base cations", i.e., Ca and Mg, in the soil, and that the pH of the forest soil in many places in Northern Europe has decreased by 0.5-1.0 pH unit over the last 30-60 years. It is also said that ***this*** has caused diminished extension of the root system of the trees. Several other changes in the soil are mentioned. In other words, the causality betwen air pollution and soil changes is established, and the causality betwen soil changes and changes in the root system of the trees is established too. Thus we know for certain that the pollution has had an effect on the trees. The missing link in the causal chain is the connection between changes in the root system and the observed symptoms above soil, i.e., loss of foliage and yellowing. This part of the story belongs to the category "we suspect that", i.e., there is reason to assume that the leaching of Ca and Mg causes forest damages. Furthermore, it is suspected that the trees have become more sensitive to stress, and that this will lead to problems in combination with an increased frequency of weather extremes (drought, stoms).

So the consensus covers much broader questions than what Lomborg acknowledges.

If Lomborg had skimmed through the conference report, he would have seen that it contains a section on "Forest damages and their causes". It ought to have been interesting reading for him. For example, he might have read a paper containing a review of the international monitoring of forest damages[9]. It is enclosed as a copy. Here, he would have been able to see how the condition of the trees has developed further in time, during the period until 1993, when their condition worsened again (Fig. p. 1224). He could also have read (p. 1225) that "It is evident that the regions of highest damage coincide approximately with those areas of high immissions of sulphur and nitrogen oxides".

Another paper from the same conference volume is likewise enclosed as a copy[10]. Here, one may read that when the trees are fertilized by N from the air pollution, a change happens so that a greater proportion of the growth takes place above soil, and a reduced proportion in the root system beneath the soil surface. So now we know why we are able to measure increased tree growth, while at the same time the trees become more sensitive to drought and wind. Experiments show that addition of ammonium sulphate (the most important component of the aerosol created by the air pollution) causes the roots to concentrate more in the topsoil. It is also explained that shifts in the Al/Ca ratio affect the growth of the roots.

The connection between acidification, aluminium, and reduced root development is apparent in many other papers as well[11].

The most thorough representation of the issue is perhaps a book by the Germans Puhe and Ulrich from 2001[12]. I enclose a copy of some of the most interesting pages. Here, Ulrich has the opportunity to give a comprehensive presentation of the forest death issue, approximately 20 years after he broke through the media wall. The impression is not of a man who is retreating on the subject. On the contrary, the impression is that the documentation of what is going on has become constantly still more solid throughout the 1990s. It is documented that the spruce trees in the Harz now grow more slowly than formerly, and that this has nothing to do with the age of the trees (fig. 5.10 p. 171). Fig. 5.11 gives occasion for a similar conclusion as regards Eastern Bavaria. Fig 5.12 shows that the general development in the entire monitored area of Europe until 1997 was a steady and gradual impairment of the condition of the forests. However, this average image covers major differences between individual tree species.

Fig. 5.13 p. 180 shows that during the later years, especially the deciduous species (beech and oak) have been severely hit. The same appears in fig. 8.8 on p. 439, which shows the conditions in Lower Saxony. Fig. 8.7 shows how the health condition of the trees slowly but steadily worsened between 1984 and 1996 in North Western Germany and Southern Germany. After the wall came down in Eastern Germany the situation has improved much, apparently because brown coal is no longer used as fuel.

The text from p. 190 onwards is about how acid rain changes the soil. It appears that in places with a low degree of soil disintegration (release of low amounts of Ca and Mg ions), the acidification front moves downwards through the soil with a speed of approximtely 2 cm per year. Fig. 6.2 shows how the acidification reached a soil depth of 1 m sometime during the mid-1970s in two localities in Middle Germany. It is clear that a substantial change in soil chemistry has taken place, contrary to what we saw in Abrahamsen's experiment where the soil did not change at all. Thus Abrahamsen's experiments are irrelevant for the situation in Middle Germany.

Fig. 8.11 on p. 452 illustrates how a reduced and more superficial root system, in combination with increased frequency of storms, has caused much greater storm damage in Germany than earlier, and the heavy storm damage of 1999 is not even included. A relationship between changed root development and storm damage is described on p. 195.

Also a paper by E.-D. Schulze from 1989[13] provides a good survey of the question. I enclose a single copy page from this publication. Here, closer details on the relation between Mg deficiency and yellowing of needles are found. In this way, a connection between acid rain-caused changes in the soil (Mg deficiency) and symptoms registered as "Neu-artigen Waldschaden" [new type of forest damages] (yellowing of the spruce needles) has in reality been established. Fig. 5 in the paper (p. 779) illustrates that trees in areas with forest damages have a more superficial root system than trees in healthy areas, and that they take up a major part of their water from the very top soil layers. This must mean that they are more exposed to drought. Fig. 4 on the same page shows some long-term series of pH measurements in the soil, especially a series from Sweden which dates back to 1920. It appears clearly that the crucial change in the soil both in Germany and Sweden occurred during the 1970s, i.e., just before the symptoms of forest death were detected in Germany and other places late in the 1970s. This strongly indicates that the forest death around 1980 really was a new phenomenon, not just a phenomenon which had been there all the time.

This is merely a summary presentation of the existing evidence. Further details may be found in the photocopies. It is hopefully evident that a continuously progressive worsening of the condition of forest trees in Europe is really concerned, and that the connection between acid rain and weakening of the forest trees is much more thoroughly examined than what is apparent in Lomborg's text.

It has been attempted to define a term which may clarify how much acid rain a forest is able to tolerate. The term is "critical load". Fig. 1 in the above-mentioned conference summary statement[14] shows, with the Göteborg area as the example, that the level of critical load is substantially higher than the pre-industrial level – i.e., a certain degree of pollution may be tolereated even over the long term. It is, however, also apparent that the current pollution, even after sulphur pollution has been reduced, is still higher than the critical load. Thus, further acidification of the soil is still taking place, which will sooner or later cause forest damages. Furthermore, the pollution with nitrogen compounds is increasing - not decreasing. The article's fig. 3 on p. 7 shows the areas of Europe where the critical load at present is exceeded. These include Denmark. Schulze (cited above) claims that on good soil in Middle Germany, where forest damages are not seen today, Ca in the soil will be used up in around 100 years and Mg in 800 years. Yet

there are places where the trees are healthy now, but where only 2 years' leaching of Mg would be enough to render them unhealthy, and this may happen if there due to special climatic conditions (dry years) occurs a couple of successive years without withering releasing new Mg to replace the Mg being leached.

It appears on p. 196 in Puhe & Ulrich that experiments where the actual rain on the trees is substituted by "clean rain" without air pollution, causes a substantial improvement of the Ca/Al and the Mg/Al ratios in the soil, and through that an increased development of fine root hairs at all soil depths. On this background it seems reasonable to assume that if the current pollution disappeared, the trees would become more healthy.

Likewise p. 196 reads, with a reference to an analysis from 1999: ". . it could be shown that the role of soil acidification in the new type forest decline cannot be falsified . . ". So it is no longer justifiable to maintain that there is no causality between acidification and forest death.

Lomborg's treatment of the subject

The background given above is necessary in order for us to assess Lomborg's account of the subject acid rain and forest death. His presentation clearly shows a lopsidedness towards the optimistic side, but is the lopsidedness so serious that it is beyond the acceptable?

1) On pp. 178-179, he refers to NAPAP's extensive investigations. One gets the impression that the 500 million dollars spent were by and large wasted because no effects were registered. However, this should be seen in light of the fact that the pollution is less in North America than in Europe. In his review in Scientific American, Thomas Lovejoy says[15]: "It is simply untrue that `there is no case of forest decline in which acidic deposition is known to be a predominant cause.´ Two clear-cut examples are red spruce in the Adirondacks and sugar maple in Pennsylvania." But instead, Lomborg quotes an article in Simon's book and writes that "the vast majority of forests in the U.S. and Canada are not effected by decline." When he gives us the impression that so many dollars have been wasted on throwing light on a non-existing problem, then it is an erroneous and biased representation of the case.

2) On p. 179, he also refers to the fact that in Abrahamsen's experiment no effect of acid rain was seen (his note 1296). This is correct, but it is explained above why the experiments had such a result. In note 1296, you gain the impression that Ulrich's "hypothesis" about the harmful effect of aluminium is unsubstantiated. As it has been demonstrated above, the truth is rather the reverse. Here, Lomborg errs by relying too onesidedly on Abrahamsen; however, this should be regarded as a case of sloppiness rather than deliberate bias.

3) The first section on p. 180 is strongly biased. In itself, the text may be correct, but it is worded in such a way that the reader will believe that forest death is no problem at all.

4) In the following section, Lomborg eradicates the problems in "The Black Triangle" in Central Europe through his use of definitions. He says that the forest death in this area "was due not to acid rain but to local pollution – that smoke directly from the sources of pollution damaged the trees." He refers to note 1306 – Gundersen et al. It must be due to laziness that Lomborg has used such an insignificant reference in order to substantiate this claim, and as the reference is in Danish and even unpublished, hardly any readers have any chance of checking it. What Gundersen et al. say is this: "As for the extreme `forest decline´ in The Black Triangle, direct impacts of air pollution played a major role...". Lomborg has translated this to "smoke", or, in the Danish book [The True State of the World] to "røg" [meaning "smoke"]. But the word smoke means air-borne particles. The factor which damaged the trees was not smoke, but SO_2, which is a gas. Thus Lomborg

renders the impression that the most dramatic forest death in Central Europe had nothing to do with acid rain, which is positively wrong.

5) Further down on p. 180 (bottom left column, top right column, note 1311), he again refers to Gundersen et al. You may compare their text in the middle of the first page with Lomborg's text: "Today we know, however, that this was purely due to a change in the method of calculation". The word "purely" is blatantly wrong in this context, and it is a problem that the readers are not able to check whether the quotation is biased – which it is. Considering that the quotation may not be checked, this must be characterized as gross manipulation.

6) In the next section, Lomborg manipulates the definiton of acid rain. He does indeed start (bottom of p. 178) using a broad definition: "Acid rain has typically been used as a collective term for damage to forests, lakes and buildings believed to be caused by emissions of NO_x or SO_2." Then, when he arrives at the subject of the unquestionable forest death in The Black Triangle, he suddenly narrows down the term acid rain so that it no longer encompasses direct impacts of polluting gases; he makes it look as though the cause was "smoke" (left column, p. 180). And in the right column on p. 180, he starts treating those effects which are seen at a long distance from the source. Here, he once again narrows the definition by writing: ". . pollution does not directly cause damage to the trees (as was assumed by the acid rain theory), but . . it weakens the trees´resistance . . ". So now the acid rain theory has been reduced to say that the trees become damaged by acid rain falling directly on them. If the acid reaches the soil and only then affects the root system, then we are not talking about an effect of acid rain according to Lomborg. He thus continuously narrows the definition at his whim, so that he may avoid those situations where the pollution in fact has an effect. This is conscious manipulation.

7) Then Lomborg – correctly – relates the difficulties of showing that indirect effects, such as increased sensitivity to drought, is a result of acid rain. However, he fails to mention that these difficulties have been overcome to a high degree by now. And the correct impression is particularly lost when he adds: "However, it does seem striking that in comparing the various areas´ pollution with forest death, there is very little or no correlation." Here, one of his references is to Abrahamsen p. 323. Anyone may judge for themselves whether Lomborg's representation of Abrahamsen's text is fair, and whether a correlation on national basis, as Abrahamsen has carried out, is strong enough. If the correlation within Germany shows that 20% of the variation in forest death may be explained by wet deposition of N and S, then this is equal to a correlation of r = 0,45. Considering the widely different soil conditions with widely different buffer capacities in the various parts of Germany, may it then be said that r = 0,45 is "very little correlation"? At an overall European level, there is in fact a correlation between pollution and forest death, as it appears in a reference mentioned above and which Lomborg could have procured[16]. But when Lomborg lets the section in question end by the quoted text, the reader is left with the impression that the indirect effects seem to be very speculative (which they are not), and that there is no truth in any of it all.

8) Then Lomborg cites a report from EEA for saying that no causal relationship may be established between the deposition of acids and the observed losses of foliage. As mentioned I have not got hold of the report and do not know whether the quotation is correct. On the Internet, only a short summary of the report may be found now, and here it says (translated from the Dutch version): "Admittedly the damage on trees does not necessarily per definition have any relationship with acidification, but the long-term effects of acid precipitation on the soil may also play a role". A lack of full consistency between the two versions is seen here. Lomborg's version says that there is no causal relationship, while the summary says

that the possible causal relationship has not been proven. Lomborg should have included the above-mentioned conference summary statement, according to which there is a well-founded suspicion of a causal relationship. He also should have mentioned that the researchers feel convinced of a causal relationship between acidification of the soil and reduced root growth, i.e., that it is certain that the trees are in fact affected.

9) In the next sentence, Lomborg writes that as the SO_2 pollution has become reduced, the foliage loss has kept increasing. This may in turn be explained by the trees becoming continuously older. Such a presentation completely ignores the possibility that the acid effect is accumulated in the soil year by year. I find it hard to believe that the EEA report really ignores this possibility, especially considering that the possibility is mentioned in the summary of the report (cited above). However, without having seen the report in question, I cannot know whether the report is misleading, or whether it is Lomborg who misleads.

10) In the next paragraph, Kandler (”a German scientist”), is referred to, based on Abrahamsen’s mention of him. In the first sentence Kandler is partly correctly quoted, except that Kandler’s photos exclusively concern individual trees and do not illustrate ”the proportion of damaged trees”. But then Lomborg says: ”Foliage loss is in reality simply a non-specific expression that applies to numerous specific, familiar diseases, and the reason why we have started worrying about it is that we have started monitoring this loss.” As reference supporting this assertion, Abrahamsen p. 322 is indicated. But this reference does not contain any justification for such a categorical statement. The words: ”is in reality simply” are very inappropriate, and it must be said that the text is in conflict with current knowledge within the area. Lomborg’s text is strongly misleading in this place.

11) The next paragraph is a kind of conclusion. It reads: ” . . it was probably reasonable to reduce SO_2 emissions from the point of view of health, because the side effect was fewer particles. But acid rain . . . ”. Even if it is not expressed directly, it is clearly said between the lines that S pollution in itself poses no threat to humans or trees. This conclusion is in direct conflict with the consensus among professionals, i.e., that the “critical load” for S pollution has become exceeded in major parts of Europe[17]. As mentioned, Lomborg has seen a reference to this consensus statement, and he ought to have read it. It must be concluded that his failure to take this statement into account is equal to gross sloppiness, and that this sloppiness leads to a conclusion which is both blatantly wrong and grossly irresponsible. I find it unacceptable that a person, who is director of an institute advising the Danish government on environmental issues, may commit such a howler.

12) The chapter’s last paragraph is introduced by: “Unfortunately, the myth lives on in many places . . ” . How can Lomborg express himself like that, when he has read the experts’ statement saying that “Acid rain is not a myth”? Is it really permissible for him to completely reject what the Danish expertise on this area says? No, it is not. He has hardly read any other primary literature in the field than Abrahamsen et al., and on such a weak basis he may not claim to have any overview of the differences of opinion on these issues. On the other hand, the four experts who wrote the feature article manuscript have an overview of the literature on the area which is infinitely greater than Lomborg’s. So Lomborg permits himself to contradict experts who know far more about the subject than he does. When he even on this fragile basis provides the reader with the impression that it is absolutely unnecessary to combat S pollution, then he is a grossly irresponsible ignoramus.

Each of the above-mentioned 12 points may perhaps be regarded as rather innocent, when viewed in isolation. If we now picture a contortion of the text expressed as number of degrees, then we may say that a contortion of the text of 15° per se may perhaps be regarded as rather innocent, but if this is repeated 12 times, then it becomes a contortion of 180°, and then it is definitely not innocent any longer. To stay in the "acidification language": The text is not merely marred by single damages in the presentation, it is percolated by misleading wording and therefore useless in its entirety.

So much about the relationship between acid rain and forest death. Then there is the question of the acidification of lakes. At this point, Lomborg has reduced the lopsidedness of the text slightly compared to the Danish edition. However, his figures on p. 179 regarding the proportion of affected lakes in Scandinavia seem to be a bit on the low side. Lakes where "critical load" is exceeded must include lakes which are not yet damaged, but which will become damaged over the long term if the pollution continues. Therefore it is a bit strange that this apparently only applies to 27% of the lakes in Norway. Of 5,643 lakes in Norway containing trouts, the trout population has disappeared in 820, and reduced in a further 1,069. So in 33% of the trout lakes, demonstrable changes have occurred[18]. Perhaps the explanation of this inconsistency is that the S pollution is now reduced compared to earlier, so that the current pollution only threatens relatively few lakes, while more lakes became damaged while the pollution was still high.

However, the most remarkable feature of the text is that Lomborg does acknowledge that the critical load is still exceeded for a considerable number of the lakes. But this means that they are not able to tolerate the current S pollution. How can he then conclude his chapter by saying that it is unnecessary to limit the S pollution?

Next, there is the question about corrosion of buildings and monuments. I did not check Lomborg's NAPAP source, but Lomborg's report from it can not possibly be absolutely correct. In any case, it is in clear conflict with what is generally known about the subject. For instance, a survey article mentions corrosion experiments with a duration of 4 years[19]. Based on these experiments, equations are provided regarding how the loss of material over 4 years depends on the concentration of SO_2 in the air and the rain's content of acid (H^+). Equations for steel, zink, aluminium, copper, bronze, limestone, and sandstone are provided. For example, the equation for sandstone is:

ML = 29,2 + 6,24 Tow $[SO_2]$ + 480 Rain$[H^+]$. (ML is mass loss in g/m_).

Tow = time of wetness = time fraction below 1.
$[SO_2]$ = konc. of SO_2= of the size order 50 µg/m_.
Rain = precipitation in m/year = a bit below 1.
$[H^+]$ = conc. of H^+= c. 30 mg/l at pH = 4,5.

By using approximate numerical values we get

ML = 29,2 + 300 + 10.000.

In this case, the first term is constant, the second is the corrosion due to SO_2, and the third is the corrosion due to acid. It is seen that if the acid load is reduced by 50%, the corrosion will – all other things being equal – become reduced by 48.4%. On this background it is incomprehensible that Lomborg (p. 179) may cite NAPAP for saying that "Even if acid content was reduced by 50 percent, restoration would only be delayed by 10-15 percent." It must be due to some kind of misunderstanding, or perhaps a scenario where only sulphuric acid and not nitric acid is being reduced.

Lomborg's presentation conflicts with what is said in the above-mentioned review paper, for example "At numerous sites where the SO_2 levels have decreased between the 1987/88 exposure to the 1992/93 exposure, a pronounced decrease has been found of the corrosion rate of especially carbon steel.", "The decreasing trend in SO_2 concentrations has for some materials led to a substantial reduction in deterioration rates", and "Studies of cost of air pollution damage to materials show that the savings may balance a considerable part of the total abatement costs."

Lomborg's description is in total conflict with the general knowledge that antique monuments having lasted for millenia are now almost crumbling in front of our eyes.

Lomborg could have cited from Gundersen et al. that the latest agreement from 1994 on S reduction entails that a cost of 26 billion DM per year saves us damages on buildings equal to 14 billion DM annually, plus the saved damages on irreplaceable cultural values. But he did not want to quote that. On the contrary, he gives us the impression that the S pollution per se does not have any appreciable damaging effects.

My conclusion thus is that the section about acid rain is extremely tendentious, and with a totally misleading conclusion.

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[12] J. Puhe & B. Ulrich (2001): Global climate change and human impacts on forest ecosystems. 592 pp. Ecological studies no. 143. Springer.

[13] Note 33 above.

[14] H. Rohde et al. (1995). See note 34.

[15] Thomas Lovejoy (2002): Biodiversity: Dismissing scientific progress. Scientific American, January, pp. 73-75.

[16] Lorenz (1995), see note 35.

[17] H. Rohde et al. (1995). See note 34.

[18] See p. 366 in K. Fog (1997): Økologi – en grundbog. Data are from B. L. Skjelkvåle (1996): Overvåking av langtransportert forurenset luft og nedbør. Rapport 671/96. Statens forurensningstilsyn, Oslo.

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