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ECONOMIC IMPACTS OF AIR POLLUTION ON CULTURAL HERITAGE*

Report on the workshop of the Network of Experts on Benefits and Economic Instruments prepared by the rapporteur

* This document was submitted on the above date because of processing delays.

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INTRODUCTION

1. The Workshop on Economic Impacts of Air Pollution on Cultural Heritage was held on 6–7 April 2006 in Catania (Italy). It was organized jointly by the Network of Experts on Benefits and Economic Instruments (NEBEI), the International Cooperative Programme on Effects of Air Pollution on Materials, including Historic and Cultural Monuments (ICP Materials), the project Assessment of Air Pollution Effects on Cultural Heritage – Management Strategies (CULT-STRAT) of the European Commission and the Environmental Valuation Laboratory (ENVALAB) of the University of Catania.

2. The workshop was attended by 36 experts from Austria, Canada, the Czech Republic, Estonia, France, Germany, Italy, Norway, Sweden, Switzerland, the United Kingdom and the United States. The attendees represented various fields of expertise, including corrosion and deterioration of materials, air quality and economics.

3. The workshop was chaired by Mr. S. Navrud (Norway) and Mr. V. Kucera (Sweden). Mr. G. Signorello (Italy) opened the workshop on behalf of the hosting organization.

I. OBJECTIVES OF THE WORKSHOP

4. The main objective of the workshop was to present the most recent research on the physical and economic impacts of air pollution on cultural heritage buildings, monuments and artefacts. Results from the workshop might be used as an input to:

(a) The review of the Gothenburg Protocol; and

(b) A revision of the cost-benefit analysis of the European Commission's Clean Air for Europe (CAFE) programme.

II. SUMMARY OF MAJOR DISCUSSION POINTS

A. Impacts of air pollution on cultural heritage – methodologies and policy use

5. The workshop discussed the application of the damage function approach to valuing the economic impact of air pollution on cultural heritage, where a scientific assessment of damage to an estimated stock at risk was followed by economic valuation methods. Participants noted the problems associated with transferring economic estimates obtained in studies in other areas. The need to increase the number of empirical studies in order to facilitate benefit transfer was

recognized, as was the importance of developing better links between exposure-response studies and valuation studies.

6. The workshop also discussed the link between research and policy activities in this field. It expected that the dialogue between economists and experts on materials would help to promote the inclusion of protection of cultural heritage materials in cost-benefit analyses and strengthen policy development.

B. Impacts of air pollution on corrosion and soiling of materials

7. An analysis of pollution and corrosion trends from 1987 onwards for a subset of materials – limestone, zinc and carbon steel – showed considerable variety in the levels of pollution and corrosion effects. There was a substantial decline in sulphur dioxide (SO_2), some decrease in nitrogen oxide (NO_2) and stabilization or a slight increase in ozone. Decreases in corrosion rates varied between materials and sites. There may have been a "memory effect" for calcareous stone materials that had already been exposed to high levels of pollution in earlier environments. Exposure studies under the MULTI-ASSESS project included nitric acid (HNO_3) and particulate matter (PM) to reflect the current pollutant mix, after the considerable reductions in SO_2. Indications that corrosion of some materials might actually be increasing, and that there were big differences between urban and rural sites, meant there was cause for continuing concern.

8. Two sets of dose-response functions for corrosion had been developed using data from ICP Materials that were useful for mapping, calculation of costs and assessment of target levels. The first set, based on data from the original exposure programme, was suitable for high levels of SO_2 pollution, while the second set, based on data from the MULTI-ASSESS project, was suitable for multi-pollutant situations, including the effects of PM and HNO_3. However, the effect of traffic, in particular near main roads, was still only partially covered.

9. Soiling experiments under the MULTI-ASSESS project were used to develop dose-response functions for soiling. Soiling impact was an important effect of particulate air pollution, and it was possible to estimate its economic impact, which was likely to be considerable.

C. Stock at risk and maintenance costs from corrosion and soiling

10. Participants discussed the issue of the cost of more frequent cleaning and maintenance of cultural heritage objects. It was noted that cleaning and repair cycles might not be directly related in their purpose to pollution and weathering cycles and might have varying impacts on

value (i.e. might either improve or spoil appearance). Although cleaning was intended to improve buildings, it might actually harm them. The necessity of cleaning and the costs involved were discussed.

11. Location, material inventories and condition were considered to affect the methods for estimating the stock of cultural heritage at risk for corrosion. Also discussed were soiling and the effects of scale.

12. The current state of the art and the development of methods to map stock at risk at national/city scales were illustrated by a series of stock-at-risk maps. Participants were shown an emerging stock-at-risk map of France based on a geographic information system (GIS), where stock at risk was included based on UNESCO heritage listings and information from tourist guides. They also viewed a city-scale map of Milan with 1,200 monuments plotted.

D. Estimating the social benefits of reducing impacts on cultural heritage

13. Cost-benefit analyses concerning the preservation and restoration of cultural heritage in Europe that were based on contingent valuation studies and choice experiments showed that people were prepared to pay for both use and non-use of heritage. Therefore, benefits to both visitors (users) and non-visitors needed to be captured. The workshop noted the need for more valuation studies specifically aimed at assessing damage to cultural heritage from air pollution.

E. Estimating the economic benefits of reducing impacts on cultural heritage

14. The workshop recognized the difficulty of transferring benefits captured at single monuments to other places. This was due to the differing sizes and heterogeneity of the stocks, as well as the variability in the willingness to pay (WTP). Methods were available to capture this heterogeneity to support benefit transfer estimates. Transfers might be possible if models of population characteristics were used to estimate benefits and then transferred with adjustments to reflect the characteristics of a new area.

15. The potential for benefit transfer from existing studies to value corrosion and soiling of cultural heritage was discussed. It was emphasized that, while cultural heritage was of high merit, its situation was not well modelled by traditional supply-and-demand models. The transfer of benefit estimates from a specific study site to a policy site for which there was little or no data was deemed difficult. Current studies were limited in number and heterogeneous in nature.

16. The workshop took note of several case studies on valuing the benefits of cleaning and WTP to protect cultural heritage.

III. CONCLUSIONS

17. Participants in the workshop agreed on a number of conclusions and needs for future work, which are presented below.

18. The decreasing corrosion trend with regard to many important cultural heritage materials over the last two decades was mainly due to the decreasing level of SO_2. This trend had levelled off in some regions of Europe even though SO_2 concentrations were still decreasing, as other corrosive pollutants had become relatively more important. The new dose-response functions developed for corrosion took into account the effects of PM and HNO_3, in addition to the effects of SO_2.

19. It was noted that estimates of the effects of pollution on the soiling of heritage buildings had been included in the exposure assessment for the first time. Preliminary soiling dose-response functions linking soiling to PM_{10} had been developed.

20. The technical damage functions for cultural heritage were related to air quality policy via "tolerable" corrosion and soiling, based on experiences from restoration and maintenance work. The "tolerable levels" concept could be extended to suggest target levels for air quality. Target levels indicated that materials were sensitive to pollution. It was suggested that cultural heritage be considered in the future assessment of limit values for pollutants.

21. The workshop recognized the importance of determining the stock of cultural heritage in order to estimate the cost of damage and the potential benefit from targeting policy to protect buildings and monuments. It noted the techniques being developed to estimate stock at risk. The simplest approach was to map the risks and identify the materials that could be at risk, without any presumption of knowledge of the cultural heritage in the "at-risk" areas. Those responsible for the cultural heritage in these areas could then determine whether the object (or objects) were likely to be damaged and to what extent.

22. Another approach was to determine the stock of cultural heritage in a given location in some detail, including the materials used. This allowed an estimate of the economic cost of damage to that area. A limitation of this approach was the number of buildings in large areas. This could be resolved by filtering the data to the level of a particular monument/building type or by making some form of generalization.

23. It was concluded that environmental valuation techniques had been successfully applied to value cultural heritage objects, but that there were still very few empirical studies of cultural heritage compared to the number of studies of environmental goods. The studies showed that people had a significant positive average WTP for preservation of cultural heritage.

24. Most of these valuation studies, which covered a wide range of cultural heritage objects, were stated preference studies, including both contingent valuation studies and choice experiments, eliciting individuals' WTP for improvements in the quality of cultural heritage sites. However, the number of studies for each type of object and policy context seemed too small to warrant reliable benefit transfer (or value transfer, as damage estimates could also be transferred). It was concluded that valuation and benefit transfer methods should be used which could model heterogeneity both in cultural heritage sites and in individuals' preferences (and WTP) for these public goods, including the significant proportion of the population that has zero (or even negative) WTP for these goods.

25. The workshop noted that only three of the existing valuation studies could be related to corrosion and soiling from air pollution. None of them was linked directly to endpoints of dose-response functions calculating impacts from air pollution policies.

26. The economic value of cultural heritage was dominated by non-use values. Calculating only the use value to visitors to cultural heritage sites would underestimate the total economic value of these public goods. Stated preference techniques had the potential of estimating both use and non-use values.

27. Most valuation studies valued single cultural heritage sites or small groups of sites, whereas estimates for all sites were needed in order to calculate the social benefits of air pollution policies. The value of a single site could not simply be multiplied by the number of sites affected by air pollution in a given country. As the sites could be substitutes or complements for each other, simple aggregation might over- or underestimate the total social benefits.

28. Individuals' preference for cultural heritage in terms of their WTP should be elicited in the context of cost-benefit analysis, which demonstrated the economic efficiency of air pollution policies. It could be used in combination with corrosion and restoration experts' assessments of tolerable levels of corrosion, and multi-criteria analyses of stakeholder groups' preferences, to support more informed decision-making. The cost-benefit analysis under the European Commission's CAFE programme did not put an economic value on the reduced damages to cultural heritage objects from reduced air pollution, but it noted that impacts on cultural heritage could be of significant value.

29. The workshop reviewed the current knowledge on all steps of the damage function approach from emissions, change in concentrations, dose-response functions and stock at risk to physical impacts in terms of soiling and corrosion and the economic valuation of these impacts. The current knowledge did not seem to be sufficient to provide an order-of-magnitude estimate based on benefit transfer, but it was possible to identify the major needs for further research on including cultural heritage impacts in the cost-benefit analysis of air pollution policies.

IV. NEEDS FOR FURTHER WORK

30. Corrosion rates in urban areas were still considerably higher than those in surrounding rural areas due to the effect of traffic, in particular near main roads. Future efforts should focus on the corrosion effect of PM, nitric acid and other pollutants – for example, those associated with the use of alternative fuels.

31. There was a need for improved estimates of stock at risk at a number of different scales – Europe-wide, regional, city, district and single-building. Many estimates did not include material types or surface areas.

32. It was important to include all of the potential costs of cleaning in cost-benefit assessments of management interventions. Cleaning could, if performed improperly, cause damage to buildings equivalent to many years of corrosion.

33. Estimating the social benefits of air pollution policies included valuing impacts on a stock of cultural heritage sites rather than on individual sites. There was a need for stated preference scenario studies of affected cultural heritage sites on a national and even international scale. Further work was needed on the construction of valuation scenarios by corrosion and economic experts, including illustrations of how and when the appearance of buildings and monuments would change as a result of reduced air pollution.