

THE PROTECTION OF MONUMENTS AGAINST AIR POLLUTION

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I. INTRODUCTION

Since the beginning of the Industrial Revolution, a new hazard, air pollution, has been added to the list of threats to architectural monuments. In many countries, this agent of deterioration has displaced frost, salts, and earthquakes as the principal threat to architecture. To deal effectively with this problem, architectural conservators as well as administrators of agencies with the responsibility to protect monuments must develop strategies that cover all its aspects. Beside purely technical issues, this includes esthetics, economics, politics and possibly even foreign policy matters. For example, to protect the Acropolis of Athens from further air pollution damage, the government of Greece has legislated strict controls on the nature of fuels that can be burned in Athens, and has required the relocation of certain industrial facilities. On the international level, acid rain and its potential effects on buildings continues to be a major diplomatic issue between the United States and Canada.

Consequently, the protection of monuments against air pollution concerns public policy decisions. This implies balancing the benefits to society, in this case the ability to continue to enjoy the monuments, against the costs involved in mitigating the damage of air pollution. This kind of balancing is known in environmental policymaking as risk management. Using the procedure for risk management, several necessary step must be followed:

- o Identification of the damaging pollutants
- o Estimation of the present rate of damage
- o Inventory of monuments at risk
- o Evaluation of options to deal with the problem
- o Implementation of policy through administrative and perhaps legislative measures

The success of a program of remedial action depends upon how thoroughly these tasks are carried out. Lack of essential information or failure to take a comprehensive view of the situation can jeopardize a program undertaken with the best intentions. Therefore it is important to understand what is required in each of the steps in developing a risk management plan.

II. IDENTIFICATION OF AIR POLLUTANTS

The first step is to determine whether or not air pollution is present and is causing the observed deterioration. This task unfortunately has not always been performed, with the result that observers have jumped to the wrong conclusion about the nature of the deterioration. Not all damage to monuments has been caused by air pollution, nor can only one pollutant like acid rain always be assigned the blame. Nevertheless, air pollution has been misidentified as the major cause of damage to several important monuments, among them the Taj Mahal, Cleopatra's Needle, the Statue of Liberty and the Parliament House of Canada (1).

The measurement of air pollution with regard to architectural conservation is a demanding task in itself. Careful consideration must be given to the types of air pollutants that might be found, the relationship between each type of pollutant and the observed damage, and ultimate use of the air pollution data in the program to deal with it (2). As discussed below, for data that may be used as evidence in legal proceedings, the measurements must be made with a high degree of accuracy and precision. However, this high data quality requires a significant investment that may not be justified if the objective is simply to identify qualitatively those pollutants causing damage.

It should be noted that the available equipment and procedures for monitoring air pollutions have been optimized for protection of human health. Thus, they may not always be the most suitable for investigations involving architectural conservation. One possible role for ICOMOS could be to encourage professional societies and equipment makers involved in air pollution monitoring to develop specialized monitors and procedures for architectural conservation.

III. ESTIMATION OF PRESENT RATES OF DAMAGE

Once the pollutants have been correctly measured, their effects must be determined. The rate of damage associated with a given air pollutant can vary greatly depending upon the nature of the building material and its conditions of exposure. For example, granite does not show as much sensitivity to sulfur dioxide as marble. Moreover, the rate of attack of sulfur dioxide on marble depends not only on its composition and physical structure, but also on the amount of the time the stone surface is wet. The relationship between the level of a given air pollutant and the resulting damage to a material is known as a damage function. Unfortunately, very few reliable damage functions are now available.

Research is now underway in a number of countries to obtain data that can be the basis of defensible damage functions for a variety of materials. At the international level, the United

Nations Economic Commission for Europe, the Commission of European Communities and NATO's Committee on the Challenges of Modern Society are all conducting research that can serve as the basis of damage functions. A role for ICOMOS here could be to develop guidance for architectural conservation specialists on the appropriate use of such damage functions.

Another way of estimating the rate of damage is to make comparative measurements over time of the progress of damage on the monument itself. This can be used to establish the rate of damage provided that the level of air pollution remains constant over this time period. However, this assumption can rarely be supported. Over the last few decades, air pollution levels have changed dramatically in many cities. In some countries, where air pollution laws have been put into effect, levels have dropped by an order of magnitude. However, in other parts of the world increasing development has resulted in higher levels of pollution. Thus, measurements of damage on historic buildings must be used with great caution⁽³⁾. Consequently, it is important to have as much documentation as possible on the historic levels as the records permit.

IV INVENTORY OF MONUMENTS

The most appropriate strategy for dealing with air pollution may depend upon the number and types of monuments that are threatened within the affected region. If only a small number are at risk, it may be simpler to apply protective measures directly at the monument site. However, if a large number are at risk, it may be necessary to control the air pollution at the source. Thus, to determine the best approach it is essential to have an accurate inventory of monuments.

Many countries under the inspiration of ICOMOS have compiled or are now compiling national registers of historic buildings. The United Nations Economic Commission for Europe recently reviewed the methodology for assessing the stock at risk⁽⁴⁾, and concluded that such registers may or may not be sufficient depending upon the scope of the information they contain. The most important items of data would include the types of exposed materials and the degree of existing deterioration. A very detailed outline for such a data bank has been proposed by the Ministère de L'Environnement of France⁽⁵⁾. However, the compilation of such an extensive data base may be beyond the capabilities of many countries. A simplified listing that can be assembled rapidly may be the most helpful. ICOMOS may consider establishing a standard format and procedures for compiling inventories.

V EVALUATION OF OPTIONS

With the information collected in the previous tasks it is then possible to make an assessment of the severity of the situation. Such an analysis would estimate the current rate of deterioration of each monument, its present state of damage, and

prognosis for remaining lifetime under current conditions. In this evaluation, it may be useful to employ the medical concept of triage. This consists of grouping the monuments by urgency of remedial action into three categories: those that need action immediately, those for which action can wait because the rate of damage is not as great, and the third category which are those monuments that are so damaged that protective measures would be of no practical help.

The concept of triage reflects the limitations of time, personnel and resources. The choice of buildings for remedial action has often been made in a random way. For various reasons, a particular building is selected for immediate action even though it may not be suffering as badly as others that are not receiving attention. The purpose of triage is to impose a comprehensive look at the situation and to set priorities so that the greatest overall number of monuments can be protected.

The options for remedial action include applying some protective measures to the monument itself. This has been the usual response in the past. Unfortunately, the application of protective coatings has not proven effective in the past and may contribute to the damage⁽⁶⁾. A more drastic measure would be replacement with more durable materials. The original architectural details may be preserved indoors where they can be sheltered from air pollution exposure. This option has been pursued for a few critical monuments such as the Erechtheion and the Cologne Cathedral but would not be feasible for a large number of monuments.

A third option would shift the focus away from the individual monument and instead would seek to reduce the threat to all monuments through reducing the air pollution at the source. Unlike the first two options, which concern only the monument itself, and how the architectural conservator responds to its deterioration, this options involves additional parties in government and in the industrial sector who may not view the protection of monuments as the highest priority. To use this option successfully, it is essential to have a well-substantiated case.

The control of air pollution also involves a range of administrative options, which vary from country to country. Where a single source or only a few sources create the air pollution problem, the appropriate government authority may take action to impose controls. Lacking such an authority, it may still be possible for those responsible for monument protection to bring the polluter into court under civil law if damage can be clearly proven. It is essential in this situation to have properly prepared evidence. All scientific data will be thoroughly scrutinized for possible inaccuracies that render them invalid.

However, when a large class of polluters is involved it would probably be necessary to enact legislation to apply controls uniformly. Finally, when the source of the pollution lies

outside the nation's borders, the problem would have to be resolved by diplomatic means.

It should be noted that there is very little known about the legal aspects of air pollution law as it applies to matters other than human health. Some countries like the United States have proposed air pollution standards for the protection of building materials. However, these have not been enforced. Moreover, the technical basis for these standards is not clear, given the lack of damage function information mentioned above. Also, the types of civil or criminal law that could apply vary considerably from one jurisdiction to another. Thus, it would be very useful if ICOMOS were to prepare a compilation of laws and environmental standards that apply to the protection of monuments in different countries. This could serve as the first step in the international harmonization of environmental regulations for the protection of monuments.

The final option is to do nothing. While this may be justified for objects in museums where the environment is controlled, it cannot be relied upon for architectural conservation. Monuments exposed to hazardous conditions will continue to deteriorate. Thus postponing action is in itself an irreversible decision.

Given this set of options, a comprehensive strategy for protection of monuments against air pollution can be prepared. Depending upon the evaluation of the situation, more than one option may be utilized. For those monuments most urgently requiring protection, the most important architectural details may be removed and stored indoors temporarily, while measures to control air pollution at the source are pursued.

VII. IMPLEMENTATION OF POLICIES

It can be seen that a comprehensive strategy involves technical, economic and political considerations. Some actions can be undertaken at the initiative of the architectural conservation professionals. Others such as the establishment of air pollution monitoring networks require cooperation with other organizations. The enactment of legislation involves convincing the public as well as the affected special interests that such actions are necessary. Consequently, implementation of a program, aside from technical and economic considerations, must also take into account coordination with other organizations and the necessity for public information.

VIII. CONCLUSIONS

The protection of monuments from air pollution demands a comprehensive and well-prepared strategy. Hasty action may result in further damage if the wrong treatments are applied, or if the monuments that most urgently need remedial action are not given highest priority. Calls for immediate action to control air pollution can result in public opposition if a carefully documented case is not prepared.

The essential steps in preparing a strategy consist of careful data gathering and analysis in order to evaluate the severity of the threat of air pollution to monuments. The pollutants must be identified and measured, the current rate of attack must be determined, and the number of monuments at risk must be established. Only after a clear picture of the situation is obtained, is it possible to develop an effective strategy.

Although research in the technical aspects of the problem is now being carried out by a number of agencies at the national or international level, there is still much that ICOMOS could do to assist administrators and architectural conservators in developing and implementing programs to protect monuments from air pollution. These actions include:

1. Developing recommendations for appropriate air pollution monitors for architectural conservation.
2. Preparing guidelines for using damage functions to estimate damage to monuments.
3. Establishing a common format and procedures for compiling inventories of monuments at risk.
4. Preparing an international compilation of laws, regulations and standards concerning the protection of monuments against air pollution.

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Development of an effective policy to manage the risks to monuments involves several steps. First, the pollutants must be identified and measured. Second, the present rate of damage must be estimated. Third, there must be an inventory of the monuments at risk. Fourth, the options for dealing with the problem must be evaluated. Finally, the program must be implemented.

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La Protection des Monuments contre la Pollution Atmosphérique

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Depuis le commencement de la Révolution Industrielle, un nouvel hasard, la pollution atmosphérique, a été ajouté à la liste des menaces aux monuments. En beaucoup de pays, elle a déplacé la gelée, le sel et le séisme comme la menace principale à l'architecture. Afin de traiter efficacement cette problème, les conservateurs architecturaux et les administrateurs chargés avec la responsabilité de préserver l'architecture doivent développer les stratégies complètes. Ce comprend non seulement les éléments techniques mais aussi les aspects esthétiques, économiques, politiques et peut-être diplomatiques.

Le développement d'une politique efficace de diriger les risques aux monuments a plusieurs aspects. Premier, il faut identifier et mesurer les polluants atmosphériques. Deuxième, le taux de la détérioration courante doit être estimé. Troisième, un inventaire des monuments à risque doit être compilé. Quatrième, les options de résoudre le problème doit être évalué. Finalement, le programme doit être exécuté.

Bien que la recherche dans les aspects techniques marche bien maintenant plusieurs agences nationales et internationales, il y a toujours plus que l'ICOMOS peut faire d'assister les conservateurs architecturaux et les administrateurs dans le développement et l'implémentation des programmes à protéger les monuments contre la pollution atmosphérique. Ces actions y compris:

1. Développer des recommandations pour les instruments à mesurer la pollution atmosphérique.
2. Préparer les règles pour l'application des fonctions aux dommages à estimer la détérioration des monuments.
3. Développer un format commun pour compiler les inventaires de monuments-à-risque.
4. Préparer une compilation internationale des lois, des règlements et des normes concernant la protection des monuments contre la pollution atmosphérique.