

## Relevance Of Acid Rain

The climate change reckoning looms. As scientists try to discern what the Earth's changing weather patterns mean for our future, Rachel Rothschild seeks to understand the current scientific and political debates surrounding the environment through the history of another global environmental threat: acid rain. The identification of acid rain in the 1960s changed scientific and popular understanding of fossil fuel pollution's potential to cause regional—and even global—environmental harms. It showed scientists that the problem of fossil fuel pollution was one that crossed borders—it could travel across vast stretches of the earth's atmosphere to impact ecosystems around the world. This unprecedented transnational reach prompted governments, for the first time, to confront the need to cooperate on pollution policies, transforming environmental science and diplomacy. Studies of acid rain and other pollutants brought about a reimagining of how to investigate the natural world as a complete entity, and the responses of policy makers, scientists, and the public set the stage for how societies have approached other prominent environmental dangers on a global scale, most notably climate change. Grounded in archival research spanning eight countries and five languages, as well as interviews with leading scientists from both government and industry, *Poisonous Skies* is the first book to examine the history of acid rain in an international context. By delving deep into our environmental past, Rothschild hopes to inform its future, showing us how much is at stake for the natural world as well as what we risk—and have already risked—by not acting.

Representing the Proceedings of the International Speciality Conference "Acid Rain Research; Do we have enough answers?", this book provides a valuable conclusion to the coordinated research on acidification in the Netherlands from 1985 to 1994. The book focuses on atmospheric deposition, effects of acid deposition on forest ecosystems in the Netherlands, and future acidification research. Special attention is given to: trace gases; ammonia; and particle deposition; and the overall assessment of deposition loads to ecosystems and soils is also discussed. This volume will be invaluable to environmental scientists, ecologists, and those involved in atmospheric science/pollution. Provides a basic account of the acid rain story and covers the social and historical background to the effects of emissions on health and the environment. It provides a wide-ranging but integrated account of this issue which has been of environmental concern for several decades and, now that control strategies have been enacted in Europe and North America, the author gives consideration to the time-scale for recovery of an acid-damaged ecosystem and the alternatives available.

Discusses the problem of acid rain, its causes, how it spreads, and its devastating effects on the environment. Also examines possible solutions to the problem.

The Watt Committee on Energy became active in of the effects on buildings, for instance. Proposals the study of Acid Rain during 1982. Perhaps the for action should therefore concentrate on measures only aspect of the subject that has become more that promise a real improvement as a result of certain during the subsequent five years is that the expenditure. expression 'Acid Rain' is used loosely in public The Watt Committee's study of this subject has been in two phases. The first dealt with the nature debate for a complex of industrial and environmental phenomena. Among these, Acid Rain in the of the problem, and culminated in the publication straightforward meaning of the words-rain and of Watt Committee Report No. 14 in 1984. That perhaps snow having a significantly high level of Report was divided into four sections, each of acidity-is of only limited importance. To represent which was prepared by a sub-group of the working this perspective,

therefore, the Watt Committee Ex group: they dealt respectively with the fate of air borne pollution, vegetation and soils, fresh water ecutive decided that the study leading to the present Report should be entitled 'Air Pollution, Acid Rain and remedial strategy. In the second phase, these and the Environment'. sub-groups have brought their sections up-to-date The Watt Committee's interest in Acid Rain and a fifth sub-group was appointed to study arises from the fact that, among its causes, the buildings and non-living materials.

T. C. Hutchinson The NATO Advanced Research Workshop detailed in this volume was held in Toronto, Canada, in 1985. The purpose of the Workshop was to provide a "state of the art" report on our knowledge of the sensitivities and responses of forests, wetlands and crops to airborne pollutants. Approximately 40 scientific experts from nine countries participated. Most participants were actively involved in research concerning the effects of air pollutants on natural or agro-ecosystems. These pollutants included acidic deposition, heavy metal particulates, sulphur dioxide, ozone, nitrogen oxides, acid fogs and mixtures of these. Also invited were experts on various types of ecosystem stresses, physiological mechanisms pertinent to acid deposition, and other areas that were felt by the director to be of direct relevance, including: effects of ethylene on vegetation, the physiology of drought in trees, the nature and role of plant cuticles as barriers to acid rain penetration, the use of dendrochronological techniques in reconstructing the time of onset and the subsequent progression of growth declines, the ability of soils to naturally generate acidity, the role of Sphagnum moss in natural peat land acidity, the use of lichens as indicators of changing air quality, and the magnitude of natural emissions of reduced sulphur gases from tropical rainforests and temperate deciduous forests. The Workshop included a series of invited presentations and subsequent group discussions. These presentations were designed to allow syntheses of our present knowledge as well as detailed questioning and discussion.

A book that explains in clear and vivid language both acid rain and global ecology. It presents many solutions.

This collection of essays by noted academicians, lawyers, energy agency administrators, and research analysts focuses on the political and legal aspects of the acid rain debate, the policy options for resolving the controversy, and the international dimensions of acid rain control. The contributors highlight concerns drawn primarily from the developing study of acid rain in political science, economics, public administration, and policy analysis--concerns that are the focal point of the public debate over the nature, impact, and cost of acid rain and the mitigation of its effects. The book complements the impressive body of research from the natural sciences and responds to the need for applied study to help resolve the current policy stalemate on this critical environmental issue. The Acid Rain Debate features a comprehensive annotated bibliography on acid rain and relevant social science research.

This book traces centuries of human use and abuse of forest ecosystems by discussing past decades of intense burning, grazing, and timber cutting that added to the natural acidification of the soil. Air pollutants and acids generated by

industrial activities worldwide are also considered. Many forests in Europe and North America now receive as much as 30 times more acidity than they would if rain or snow were falling through a pristine atmosphere; ozone levels in many rural areas of Europe and North America are now regularly in the range known to damage trees. The book is organized into six sections, an introduction and bibliography of cited references. Major topic areas discussed include: (1) signs of forest destruction worldwide; (2) pathways of pollution that in most cases are traced back to sulfur and nitrogen oxides emitted during the burning of fossil fuels; (3) economic and ecological reality of forest destruction; (4) controlling emissions through requirements for effective technology; (5) international cooperation as an essential factor in controlling a wholesale continental pollution trade; and (6) the emerging realization of the potential economic and ecological consequences of acid rain and air pollution. (BC)

Acid Rain and Environmental Degradation is a succinct yet comprehensive survey of emission trading - a significant research and policy field of increasing importance for both Europe and the USA. Against the background of environmental policy instruments in general, Dr Klaassen presents a state-of-the-art survey of both the theory and actual applications of tradable permits. This survey also analyses international theory and experience. Later chapters examine the European acid rain issue and discuss how it can be addressed by means of tradable permits with particular relevance to sulphur emissions. Acid Rain and Environmental Degradation responds to current European policy discussions to apply emission trading on a continental scale. Because of its unique blend of theory and practice, this volume not only sets the tone for future discussions in Europe on transboundary pollution control, but also offers something for the academic economist, the environmentalist and the policymaker.

Acid Rain Overview and Abstracts Nova Publishers

This book looks at the sources and composition of the atmosphere and rainfall, with particular attention on acidifying components and those that affect ecosystems. It further widens the subject to look at trace metals. It includes papers on the impact of deposition on soils and forests and the recovery of the natural environment. Work on critical loads makes a contribution to understanding the degree to which deposition must be reduced to limit its impact.

From reviews of the first edition: "Covers a wide range of issues with balance and clarity. . . . I can recommend the book highly as an intermediate-level source of information and insight into the international aspects of the acid rain problem."—J. F. Hornig, *Ambio* "A masterful analysis of the policy problems raised by acid rain in the U.S. and Canada . . . detailed, objective, understandable, and compelling. Weaving substantive and institutional factors into their analysis, the authors skillfully portray the controversy's multifaceted nature."—Tracy Dobson, *American Journal of International Law* "[A] thorough, well-balanced analysis . . . [that] could serve as a model for analysis of complex policy issues."—Choice

“Reveals the interface between science, technology, and public policy as being the co-extensive network it really is. . . . Timely and welcomed.”—John de la Mothe, Canadian Public Policy/Analyse de Politiques

The environmental impacts of acid rain: on human health, on buildings and materials, on forests, freshwaters, crops and biodiversity and on global warming have been well-documented. Less is known about the extent and economic costs of these impacts. This book describes the first major implementation of an integrated scientific and economic assessment of the consequences of acid rain. It provides an extensive data review and examines how this unique approach to assessment modelling can be used to calculate an acidification cost per unit of pollutant in monetary terms. Part One focuses on the methodological issues of scientific measurement of acidification, dose-response relationships and economic approaches to acidification control. Part Two looks at the environmental impacts and economic consequences of acidification. Affected environmental media and human health are investigated in separate chapters, each including both scientific and economic analyses. Part Three provides a summary of the findings and makes recommendations for further application of these types of results to policy actions.

This volume contains papers presented at a NATO Advanced Research Institute, sponsored by their Eco-Sciences Panel, on "The effects of acid precipitation on vegetation and soils," held at Toronto, Canada from May 22-26, 1978. The organizing expenses and greater part of the expenses of the speakers and chairmen were provided by N.A.T.O. The scientific programme was planned by T. C. Hutchinson together with an international planning committee of G. Abrahamsen (Norway), G. Likens (U.S.A.), F.E. Last (U.K.), C.O. Tamm (Sweden) and B. Ulrich (W. Germany). Many of the dimensions of the 'acid rain' problem are common to countries of northern Europe and North America. The developing awareness over the past ten years of the international nature of the acid rain phenomenon has led to studies documenting damaging effects on susceptible freshwater bodies. Large areas of the Canadian Pre-Cambrian Shield, with its extension into the United States, and the granitic areas of southern Norway and Sweden contain lakes which are in the process of acidification. The biological resources of these affected areas are of considerable national concern. However, while clearly damaging effects of acidification on freshwater systems have been well documented, the impact of acid precipitation on terrestrial systems has not been so well understood.

The Handbook of Environment and Waste Management, Volume 1, Air and Water Pollution Control, is a comprehensive compilation of topics that are at the forefront of many technical advances and practices in air and water pollution control. These include air pollution control, water pollution control, water treatment, wastewater treatment, industrial waste treatment and small scale wastewater treatment. Internationally recognized authorities in the field of environment and waste management contribute chapters in their areas of expertise. This handbook is an essential source of reference for professionals and researchers in the

areas of air, water, and waste management, and as a text for advanced undergraduate and graduate courses in these fields. 'Acid rain' is a broad term used to describe several ways that acids fall out of the atmosphere. A more precise term is acid deposition, which has two parts: wet and dry. Wet deposition refers to acidic rain, fog, and snow. As this acidic water flows over and through the ground, it affects a variety of plants and animals. The strength of the effects depends on many factors, including how acidic the water is, the chemistry and buffering capacity of the soils involved, and the types of fish, trees, and other living things that rely on the water. Dry deposition refers to acidic gases and particles. About half of the acidity in the atmosphere falls back to earth through dry deposition. The wind blows these acidic particles and gases onto buildings, cars, homes, and trees. Dry deposited gases and particles can also be washed from trees and other surfaces by rainstorms. When that happens, the runoff water adds those acids to the acid rain, making the combination more acidic than the falling rain alone. Prevailing winds blow the compounds that cause both wet and dry acid deposition across state and national borders, and sometimes over hundreds of miles. This new book combines an excellent background article with over 900 abstracts and book citations. Easy access is provided by title, author, and subject indexes.

This volume, *Proceedings of the Conference ACID RAIN: Economic Assessment*, is meant to present the areas of agreement which economists have established and the uncertainties which they have discovered in their attempts to use the methodology of economics to better understand the nature of the acid rain issue. Scientific articles about acid rain initially appeared in 1972. The public turned its attention to the issue in the mid-1970s. In April 1979, the first acid rain bill was introduced in the Senate, authored by New York's Senator Daniel P. Moynihan. The bill sought to establish a federal research program dedicated to filling the gaps in understanding of the phenomena of long-range transport of air pollutants and their environmental, health and economic impacts. The bill was passed into law in 1980. Since then, tens of bills have been proposed to control emissions of SO<sub>2</sub> and NO<sub>x</sub>, thought to be the precursors of acid rain. And yet, in contrast with the pattern set by the majority of environmental issues, where legislation followed very quickly on the heels of public anxiety and involvement, by July 1985 not a single federal acid rain control bill had been passed.

Originally published in 1994 this volume includes contributions from environmental scientists, consultants and research workers. The incidence and effects of the phenomenon of acid rain in the late 1970s, 80s and early 1990s, as well as certain remedies, are discussed at length. The roles of vehicles and power stations are examined in detail and legal aspects of curbing acid rain are considered.

What is loosely described as acid rain is not a new phenomenon. The burning of coal and other fossil fuels must have always resulted in the production of sulphur dioxide, and, where the combustion temperatures are high, of oxides of nitrogen. These may be present in various stages of oxidation and are often referred to as simply SO<sub>x</sub> and NO<sub>x</sub>. The Clean Air Act 1956 with its limitations on the burning of raw coal in urban areas has virtually eliminated acid rain in British cities but has not directly reduced the SO<sub>x</sub> emissions. It is only during the last decade or so that Acid Rain has become a topic of discussion vying with

nuclear energy in its emotive power. Initially attention was mainly concerned with the alleged effect of these gases and the acids formed therefrom on lakes and rivers in Scandinavia. This concern was soon followed by reports of serious damage to, for instance, the Black Forest, and, more locally, to lakes in the Galloway area and damage in other parts of Scotland. In the case of these and many other examples, suggestions, still to be verified, have been made about the probable origin of the pollutants."

A detailed analysis of acidification effects on forest soil, rhizosphere and plant life and on the processes connecting them such as nutrient uptake and mineral cycling. Presents findings from the Solling project, an important long-term study on acid rain results in Germany's Black Forest, as well as other European forests which have experienced severe acid rain damage as a means of evaluating and predicting similar harm to U.S. forests.

Describes the causes of acid rain, its harmful effects, and efforts being made to solve this environmental problem.

This study describes the origins of acid rain, how it is formed, the ecological and human effects, and prevention methods. It also examines debates within the scientific community as a basis for evaluating policy decisions. A comprehensive review of pollution control techniques questions which technologies are currently available, their future availability, or whether they are merely theoretical. The authors frame the economic and political context for making decisions about acid rain control policy and offer valuable insights about the underlying dynamics of the environmental policymaking process for the near future.

The report examines the extent of environmental damage in the Community and in certain other European countries that may be attributable to acid pollutant emissions within Member States. The study assesses the evidence for possible causal effects and considers the physical, chemical and biological processes which have been suggested as damage mechanisms. Concern in Europe has grown in the past few years as a result of observed damage to forests found principally in central and southern Germany, and also because of the loss of fish populations in the lakes of parts of south west Norway and Sweden. More recently, a few lakes, rivers and streams in Scotland, England and Wales, with geological and upper river catchments similar in character to those areas of Scandinavia referred to, have also reported absence or death of fish. Acid precipitation is considered a possible contributory cause. Loss of needles from pine trees has also been found in other areas of the Community. Less well appreciated is the existence of damage to building materials, caused by short range acid pollutant effects and the possibility under certain conditions that yields of some crops and vegetables are affected by the dry deposition of acid pollutants and their derivative products. Historically most attention has focused on SO<sub>2</sub>, and its oxidised 'wet' form, sulphuric acid. Overall emissions of SO<sub>2</sub> in the Community have declined in the last ten years and this trend may well continue.

Acid rain is a serious international environmental problem. Scandinavian forests have suffered especially severe damage, and have been the focus of considerable research on the causes and impacts of atmospheric pollution. This book presents the results of long-term studies on acid rain in Norwegian forests. This research examined soil chemistry and biology; the impacts of acid rain on tree growth and nutrition; and its influence on ground vegetation, fungi, and seedling germination and development. Long-Term Experiments with Acid Rain in Norwegian Forest Ecosystems is a lasting contribution to the literature on acid precipitation, and will be of interest to researchers in ecology, air pollution, forestry and environmental chemistry.

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