urban environmental management

planning for pollution control

AN ORIGINAL TEXT WITH INTEGRATED READINGS

BRIAN J. L. BERRY

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BRIAN J. L. BERRY
University of Chicago

FRANK E. HORTON
University of Iowa

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preface

The realization that a companion volume to *Geographic Perspectives on Urban Systems* was both needed and timely emerged soon after that book had seen the light of day. In *Geographic Perspectives* we dealt with urban geography from the highly circumscribed social-scientific view of that field, at the very time that the "new environmentalism" was gaining strength as a national movement and a disciplinary perspective, placing further pressures on the field to become increasingly policy oriented. Several books appeared in rapid succession, beginning to probe the physical geography of the city and problems of environmental pollution. But none took the next step of exploiting the discipline's particular concerns with location, spatial relationships and the mutual interdependencies of man and nature, its comprehension of the complexity of ecological explanations, and its skill at spatial analysis and interdisciplinary synthesis. We felt there was a need and an opportunity.

Should we write a totally new volume, or, consistent with *Geographic Perspectives*, draw together the best of the writings of others into an integrated synthesis? We chose the latter path and acknowledge our total debt to the fifty authors who were willing to allow us to blend their contributions into a single text. The Guide to the Readings (pp. xiii–xv) and an introductory footnote to each chapter indicate whose work is included and where it is incorporated. Whereas we selected and edited for flow, balance, and consistency, we have attempted to retain the core of each author's contribution in his own style and sequence.

A number of people have been of great help to us in our task. In particular, we want to acknowledge our debt to John S. Adams, Donald C. Dahmann, James S. Gardner, Charles P. Kaplan, Marvin W. Mikesell, and M. Gordon Wolman. In addition, we would like to thank the Environmental Studies Division of the

Environmental Protection Agency and its director, Peter House, for support and assistance. Project R-801419, "Land Use Forms and the Environment," currently being undertaken under a contract between EPA and The University of Chicago, has provided a variety of insights and raised a whole series of questions about the base level of understanding required for such research that we have tried to address in this book, as well as tables that help fill some of the gaps in the previous literature. The full report of the research project will be published at the same time as this book in the Department of Geography Research Series, The University of Chicago.

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guide to the readings

This book is a text with integrated readings. Selections from a variety of studies have been edited and, with the permission of their authors and editors, combined into a single manuscript. The materials included in each chapter are listed below. Numbers in parentheses are the pages of this book on which selections begin. In addition, use is made throughout the book of the reports of the Council on Environmental Quality: *Environmental Quality, 1970; Environmental Quality, 1971; Environmental Quality, 1972.* Washington, D.C.: U.S. Government Printing Office.

Materials are quoted in the Introduction from:

Elizabeth H. Haskell, *Quality of the Urban Environment: The Federal Role.* Washington, D.C.: The Urban Institute, Working Paper 102–106, May 1970. (2)

David Lowenthal, Ian Burton, Richard Cooley, and Marvin Mikesell, "Report of the AAG Task Force on Environmental Quality," *The Professional Geographer*, Vol. 25 (1973), 39–47. (5)

Chapter 2 includes selections from:

Lewis W. Moncrief, "The Cultural Basis for our Environmental Crisis," *Science*, Vol. 170 (October 30, 1970), pp. 509–512. (9)

Marshall I. Goldman, "The Convergence of Environmental Disruption," *Science*, Vol. 170 (October 2, 1970), pp. 37–42. (11)

Leo Marx, "American Institutions and Ecological Ideals," *Science*, Vol. 170 (November 27, 1970), pp. 945–952. (12)

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Robert W. Kates, "The Perception of Storm Hazards on the Shores of Megalopolis," in

David Lowenthal, *Environmental Perception and Behavior*, Department of Geography Research Paper No. 109, University of Chicago, 1967. (20)

Much of Chapter 3 is drawn from:

Helmut E. Landsberg, "Man-made Climatic Changes," *Science*, Vol. 170 (December 18, 1970), pp. 1265–1268. (33)

Peter D. Tyson, "Urban Climatology: A Problem of Environmental Studies." Johannesburg: Witwatersrand University Press, 1970. (39)

James T. Peterson, *The Climate of Cities: A Survey of Recent Literature*. Durham, N.C.: National Air Pollution Control Administration, 1969. (40)

Luna B. Leopold, *Hydrology for Urban Land Planning—A Guidebook on the Hydrologic Effects of Urban Land Use*. Washington D.C.: U.S. Government Printing Office, 1968 (Geological Survey Circular 554). (63)

Selections are included in Chapter 4 from:

Donald H. Pack, "Meteorology of Air Pollution," *Science*, Vol. 164 (November 27, 1964), pp. 1119–1127. (86)

George B. Morgan, Guntis Ozolins, and Elbert C. Taylor, "Air Pollution Surveillance Systems," *Science*, Vol. 170 (October 16, 1970), pp. 289–295. (96)

Andris Auliciems and Ian Burton, *Perception and Awareness of Air Pollution in Toronto*, Working Paper Series No. 13, Natural Hazard Research Series, University of Toronto, 1970. (99)

Andris Auliciems, Ian Burton, John Hewings, Myra Schiff, and Chris Taylor, "The Public Use of Scientific Information on the Quality of the Environment: The Case of the Ontario Air Pollution Index," paper presented to the International Geographical Congress, Montreal, 1972. (108)

Chapter 5 materials are included from:

Ian Burton, Douglas Billingsley, Mark Blacksell, and Geoffrey Wall, "A Case Study of Successful Pollution Control Legislation in the United Kingdom," paper presented to the International Geographical Congress, Montreal, 1972. (124)

Kenneth R. Woodcock, *A Model for Regional Air Pollution Control Cost/Benefit Analysis*, TRW Systems Group, McLean, Virginia 22101 (prepared under Contract PH 22–68–60, U.S. Environmental Protection Agency). The report can be obtained from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Va. 22151 (accession number PB 202 353). (128)

Chapter 6 draws from:

Nancy B. Hultquist, "Water Pollution as an Aspect of Dynamic Urbanism," Technical Report No. 4, Institute of Urban and Regional Research, University of Iowa, Iowa City, Iowa, 1971. (169)

M. Gordon Wolman, "The Nation's Rivers," *Science*, Vol. 174 (November 1971), pp. 905–918. (173)

Selections in Chapter 7 are integrated from:

Federal Water Quality Control Administration, *Delaware Estuary Comprehensive Study*, Preliminary Report and Findings, Philadelphia: FWQCA, July 1966. (204)

Walter E. Westman, "Some Basic Issues in Water Control Legislation," *American Scientist*, Vol. 60 (November-December 1972), pp. 767–773. (228)

A. Myrick Freeman III and Robert H. Haveman, "Residual Charges for Pollution Control: A Policy Evaluation," *Science*, Vol. 177 (July 1972), pp. 322–329. (237)

Chapter 8 relies upon:

James F. Johnson, *Renovated Waste Water*. Department of Geography Research Paper No. 135, University of Chicago, 1971, pp. 3–23 and 160–166. (247)

Materials are included in Chapter 9 from:

John R. Sheaffer with Berndt von Boehm and James E. Hackett, *Refuse Disposal Needs and Practices in Northeastern Illinois.* Chicago, Ill.: Northeastern Illinois Planning Commission, 1965.

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Martin Wachs and Joseph Schofer, *A Systems Analyst View of Noise and Urban Planning,* Discussion Paper Series No. 14, Center for Urban Studies, University of Illinois at Chicago Circle, 1970.

Materials reprinted in Chapter 11 are drawn from:

S. Ishikawa, M.D., P. H. Bowden, M.D., V. Fischer, M.D., and J. P. Wyatt, M.D., "The 'Emphysema Profile' in Two Midwestern Cities in North America," *Archives of Environmental Health,* Vol. 18 (1969), pp. 660–666.

Lester B. Lave, "Does Air Pollution Shorten Lives?" Paper prepared for the Committee on Urban Economics Summer Conference, University of Chicago, September 10–11, 1970.

Richard J. Hickey, David E. Boyce, Evelyn B. Harner, and Richard C. Clelland, "Ecological Statistical Studies Concerning Environmental Pollution and Chronic Disease," *IEEE Transactions on Geoscience Electronics,* Vol. GE8 (October 1970), pp. 186–202.

Selections are included in Chapter 12 from:

Richard N. L. Andrews, "Three Fronts of Federal Environmental Policy," *Journal of the American Institute of Planners,* Vol. 37 (July 1971), pp. 258–266.

Merrill Eisenbud, "Environmental Protection in the City of New York," *Science,* Vol. 170 (November 13, 1970), pp. 706–712.

contents

CHAPTER 1

introduction

Perhaps the most important idea to emerge in recent decades with respect to man's use and abuse of his environment is the realization that man lives in a virtually closed resource system, "spaceship earth"—a natural environment with essentially fixed dimensions in terms of mass-energy and assimilative-regenerative capacity. Whatever has been and will be produced, consumed, and ultimately discarded within this resource system is still here and will continue to be, in one form or another. The question is whether the size and regenerative capacity of the natural environment are large and responsive enough to allow sustained economic growth and population expansion in cities and effluent accumulations around them without seriously impinging on health and other demands in the short run, and on growth itself in the long run. There is clear evidence in major metropolitan regions that the answer is a resounding no; externalities, particularly negative effects, grow increasingly pervasive as population expands and economic growth is left to unregulated market forces.

This presents clear challenges to the traditional economic theory of resource use and allocation, which was built on the presumption that virtually everything of value is suitable for private ownership with little or no spillover to other persons, households, or firms when the private

Materials are quoted in the introduction from:
Elizabeth H. Haskell, *Quality of the Urban Environment: The Federal Role.* Washington, D.C.: The Urban Institute, Working Paper 102–106, May 1970. Begins on page 2.

David Lowenthal, Ian Burton, Richard Cooley, and Marvin Mikesell, "Report of the AAG Task Force on Environmental Quality," *The Professional Geographer*, Vol. 25 (1973), 39–47. Begins on page 5.

property is put to use by its owner. The competitive market was visualized as a mechanism through which mutual gains could be maximized by individual negotiations and choices. But it is now clear that the pure private-property concept applies satisfactorily to a rapidly narrowing range of natural resources and economic activities. Common property resources, for which it is impossible to assign private property rights, loom ever larger in decisions and choice because it is exactly in such resources—air, watercourses and oceans, landscapes, complex ecosystems—that overuse and accumulating spillovers are threatening the viability of the system as a whole. It is exactly in such cases that lack of a proper pricing mechanism produces misallocations.

In the market economy, prices play a major and valuable role in the allocation of resources to the uses that will be of highest value. On the other hand, degradable environmental resources—the commons, our community resources—are now outside the scope of the market system. Many strategies for direct control of pollution at its many sources or for imposing residuals charges on those who discharge effluents into the environment are now being applied, experimented with, or proposed. Residuals charges, for example, are designed to raise the costs of discharging harmful wastes to the environment, to lead to the curbing of those discharges, and ultimately to reduce the damages they cause, thus in theory extending the corrective powers of the market to the commons.

But since our understanding of complex environmental systems is in a very early stage of development, our ability to design effective control strategies that do not do more damage than the problems they are supposed to correct is limited indeed. We simply know very little about what works and what does not. This book therefore will review some of what we know about the impact of urbanization on environment, the nature and consequences of environmental pollution, and the range of control, policing, and pricing strategies available to urban policymakers. We believe that many of these issues are fundamentally geographical, involving man's relation to nature and problems of spatial allocation and misallocation, and so we approach the problem as geographers, extending our previous work on the social and economic geography of cities to an explicit consideration of the physical interface.

We know that, physically, cities can be regarded as organisms with their own special metabolism. This special metabolism has two origins: *structurally*, it has heat-holding capacities without parallel in the natural environment; *functionally*, it concentrates and consumes unprecedented amounts of energy (fuel, food) in small areas. According to Abel Wolman the daily input-output energy ratios per 1,000,000 urban inhabitants in a developed country are roughly of the dimensions described in Table 1.1.

TABLE 1.1

Metabolism of a city of one million

Input (fuel)		*Output (waste)*	
Water	625,000 tons	Sewage	500,000 tons
Food	2,000 tons	Solid wastes	2,000 tons
Fuel:		Particles	150 tons
coal	3,000 tons	Sulfur dioxide	150 tons
oil	2,800 tons	Nitrogen oxides	100 tons
gas	2,700 tons	Carbon monoxide	450 tons
motor	1,000 tons		

SOURCE: Abel Wolman, "The Metabolism of Cities," *Scientific American*, vol. 213, no. 3 (September 1965), p. 180.

As a consequence of daily metabolic activity of this magnitude, and of the accumulation of the outputs of residuals, urban America becomes increasingly dirty, noisy, poisoned, paved, crowded, monotonous, and stripped of its greenery, wetlands, and wildlife. This beleaguered condition is a matter of growing importance to public policy, for as the quality of the environment deteriorates, so does the quality of life. Deteriorated air, water, and land restrict

desired human uses of the environment for recreational, agricultural, domestic, and industrial purposes. Health, social, and economic problems result, for man is a creature of the biosphere, the air/water/land capsule which supports life on earth. While these conditions affect all parts of the nation to some degree, they are primarily urban problems, generated and suffered most in the intensely used urban environment.

It is easy to become an alarmist about the growing magnitude of the environmental crisis and its likely results. Every major river system, the Great Lakes, even coastal waters are polluted by growing wastes from homes, industry, agriculture, mineral extraction, power plants, and watercraft. Municipal sewage returns are now about 5,300 billion gallons a year, and each year over 13,000 billion gallons of waste water is discharged by manufacturing industry. Patterns of pollution match urban/industrial configurations, with the most intense problems occurring in the North Atlantic and Great Lakes states. Close behind are the water-quality problems of the Ohio region and the Upper Mississippi, California, South Atlantic Gulf, and Texas Gulf regions. With pollution, the price of water goes up, additional waste treatment is necessary, and recreation and fish and wildlife habitats diminish.

Similarly, to some degree every community over 50,000 has an air pollution problem, and over 43 million Americans live in those larger cities that have "major" air pollution problems. Most of the gaseous wastes are generated while converting fossil fuels into energy in cars, homes, power plants, buildings, and factories. Burning solid wastes creates air pollutants. Acids, phenols, odors, and heat also contribute to the damaging of human health and safety and the destruction of property and plant life.

To continue the sad litany, garbage, rubbish and other solid wastes—over 360 million tons a year—are generated by household, commercial, and industrial activities in and around urban areas. That amounts to more than ten pounds each day for every man, woman, and child in the United States. The collection and disposal of these wastes not only tax the environment but on the average rank third in municipal budget expenditures. Economical land disposal sites are nearly exhausted around many large cities, and nearly all present disposal practices result in noxious odors, are unsightly, and pollute air and water, often presenting health and safety hazards. Pesticides and fertilizers permeate the soils, and radioactive wastes are a threat to land quality. Five hundred new chemicals are added each year to the 500,000 to 600,000 compounds already on the market. Many of these come to rest in the environment with unknown environmental effects.

As daily urban activity runs its course, cities jangle with transport, construction, industrial, and other noises of modern technology, causing physiological and psychological illness. Street and airport noises often exceed levels that under continual exposure produce hearing loss. Meanwhile, the growth of urban areas means that about one and one-half million acres of open land every year are built up for suburban housing, industrial sites, commercial enterprises, and other urban uses—about 50 percent more than a decade ago. Highways use much of this land. Today, America's 3,600,000 square miles of land surface are covered with 3,700,000 miles of streets and roads, or more than one mile of street for every square mile of land. In downtown Los Angeles two-thirds of the land is devoted to parking lots and streets. There are few surviving greens, greenbelts, or wedges in American cities.

As more land is paved, trees are cut, and wetlands are drained, the natural flow of water from sky to land to sea and back again is altered. Rains and melting snow that once were absorbed by soil and vegetation, replenishing supplies, now increasingly run off; floods and droughts increase while groundwater supplies diminish. At the same time swamps and marshes are often filled

in and built on, destroying temporary storage areas. Then storm sewers must be built to artificially channel waters out to sea or to the river, and new water supplies must be sought to compensate for the loss of natural supplies.

Some scientists fear that cumulative human impacts of these kinds on natural systems may trigger disasters that could dwarf the current health, economic, and social problems that have been the focus of postwar urban policy. Science and technology wield more power than ever before to manipulate natural processes, but science still has very little understanding of the effects of man's actions on the thin band of air, water, and soil which supports life on earth. A large measure of guesswork and extrapolation, therefore, is involved in today's predictions—which foresee consequences ranging from major earthquakes, which might result from excessive stress on fault lines and in earthquake zones, to altered wind patterns and atmospheric content that would change the world's climate and vegetation. For example, some scientists believe global temperature may be decreasing, because the sun's rays are blocked by particles in the air. A serious change could cause another ice age. Still others believe that the earth's temperature is warming because of increased carbon dioxide in the atmosphere—an increase of about 14 percent over the past 100 years. Carbon dioxide, the theory goes, captures and holds the sun's energy on the earth's surface, like heat in a greenhouse. A significant warming of the continent could cause the ice cap to melt, flooding coastal cities. In any case, with the added waste heat from power plants, water temperatures may rise significantly over the next few years, which ecologists fear may change whole aquatic life patterns. It is also thought that chemical poisoning or lead pollution of the oceans may destory the plankton essential to photosynthesis which produces much of the world's oxygen supply.

Taken together, water, air, trees, and open land perform many basic functions for the human community: they supply water, moderate climatic extremes, prevent erosion and floods, provide food and shelter, fuel and fun, as well as disperse wastes, noise, and dust. But there are limits to changes that can safely be absorbed. If man destroys bacteria involved in the nitrogen cycle, from which every organism builds its proteins, life on earth will cease. The same is true for the cycles of oxygen, sulfur, and carbon. The balances of prey and predator are also important to man, because a broken link in natural food chains might seriously affect his own food supplies.

Exactly when the destruction of natural systems becomes irreversible is still unknown. It appears to be different for each natural system and the elements of each system. The delayed reaction of ecological changes further complicates this natural phenomenon. The full effects of present changes on the natural world may not materialize for generations. Once they occur, however, it may well be too late for repairs, even with vast amounts of money, technology, and determination.

Apprehensions of environmental disaster of major dimensions go back more than a century to George Perkins Marsh's book *Man and Nature*. But few took his warnings seriously. Since the 1960s, however, complacency has given way to alarm as perceptions of environmental deterioration have increased. A new environmental movement has emerged, and with it a new personality: the ecoactivist. As a consequence of the resulting pressure, environmental quality has become a central issue in national policy. The far-reaching Environmental Policy Act of 1969, for example, established the Council on Environmental Quality and instructed all Federal agencies to include an impact statement as part of future reports or recommendations on actions significantly affecting the quality of the human environment. Section 102(2) (C) defines the impact statement as follows:

> SEC. 102. The Congress authorizes and directs that, to the fullest extent possible: (1) the polices, regulations, and public laws of the United States shall be