ers of the *Annals.* A few words of welcome are in order, however, for our two distinguished commentators who hail from geography's kindred disciplines.

Dr. Steve Rayner is Senior Program Manager for Global Environmental Management Studies and leader of the Climate Change Research Group at Pacific Northwest Laboratories of Battelle in Washington, D. C. He is also a member of the Steering Committee for the *International Assessment of Climate Change and the Social Sciences* that Battelle is preparing in collaboration with the Human Dimensions Program of the International Social Science Council. Dr. Rayner received his doctorate in Anthropology from University College London in 1979. Subsequently, he served as Deputy Director of the Global Environmental Studies Center at Oak Ridge National Laboratory where he was responsible for research in policy, energy, and human systems. Dr. Rayner played a key role in several DOE Reports submitted to the United States Congress namely "A Compendium of Options for Government Policy to Encourage Private Sector Responses to Potential Climate Change" and "Limiting Net Greenhouse Gas Emissions in the United States." His current work focuses on institutional issues associated with global environmental decision making, sustainable development, and policy implementation as well as with global risk analysis and land-use change. He is coauthor of *Energy Policies and the Greenhouse Effect,* Volume 2, and a new book on economic development entitled *Making Markets.*

Dr. Thomas Malone is the Director of the Sigma Xi Center at Research Triangle Park in North Carolina. He is past president of Sigma Xi, the American Geophysical Union, and the American Meteorological Society. He is a fellow of the American Society of Arts and Sciences and served as Foreign Secretary of the National Academy of Sciences (1978–1982). Dr. Malone is a recent recipient of the American Association for the Advancement of Science Award for International Scientific Cooperation in recognition of "his exemplary and ceaseless efforts to promote, organize, and lead international and interdisciplinary programs." A case in point is his central role in the volume *International Networks for Addressing Issues of Global Change* published in 1993 by the Sigma Xi Center. The Forum essays by Dr. Malone as well as Dr. Rayner and Professor Wescoat nicely extend our conversations on *ET,* and for these they have my sincerest thanks.

In launching this inaugural Forum, I have here to perform two final tasks—the one is to thank our several authors for meeting my deadlines with good cheer; the other is to offer some hints on next year's Forum, but alas I must leave these to your *geographical imaginations.*

Summation

The Earth as Transformed by Human Action in Retrospect

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The Earth as Transformed by Human Action (*ET*) is a monumental volume by objective measures, whatever its subjective merits: a weighty tome (seven pounds, 720 pages) addressing a weightier topic, a study of three centuries of global environmental change that itself consumed seven years from planning to publication; a tour of a vast field through

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which it took six editors to shepherd a flock of almost a hundred distinguished contributors.

The "Earth Transformed" symposium and the volume that emerged from it were inspired by the recognition that global environmental change and its human dimensions had begun to emerge as major worldwide concerns. The rationale for the effort lay in the proposition that to understand the significance of current human-induced change in the biosphere requires a baseline from which to measure and assess it. Such a baseline—a stocktaking of the long-term impacts and trajectories of human-induced and natural change in the same systems—could now be constructed through the synthesis of existing research.

The volume drew for inspiration on the example of two earlier works: George Perkins Marsh's *Man and Nature; Or, Physical Geography as Modified by Human Action* (1864) and *Man's Role in Changing the Face of the Earth,* edited by William L. Thomas, Jr. (1956). Each had summed up the state of knowledge, at the time of its publication, regarding human impact on the environment. We sought a similar synthesis of a field that has expanded and diversified enormously since 1956. We could draw more heavily on the knowledge accumulated on change in material and energy flows to supplement Marsh's and *Man's Role*'s emphasis on land-surface alteration. We could also much more readily than our predecessors offer results in quantitative form.

Toward this end, the *Earth Transformed* volume was meant principally to take inventory of the major human impacts on the global environment over the past three hundred years as a reference point for assessing contemporary change: its main goal was documentation of the magnitudes and trajectories of change and of the size of the human input compared to natural forces and states. Its secondary goals were to examine some of the major changes in human society that have accompanied and, perhaps, driven the changes in the environment, and to illustrate, through regional case studies, variations in environmental change from the global aggregates and the interactions of the different changes in particular settings. Finally, the volume sought to explore briefly the major perspectives of contemporary social science that have been brought to bear on environmental transformation.

A project steering committee, assisted by a science advisory committee, drew the first outline of the volume from 1983 to 1986. It identified the major topics requiring treatment and commissioned papers addressing them, many from multiple authors or research teams; it also raised from multiple sources the approximately $200,000 required to make the volume a reality. Draft chapters were circulated in advance, then presented and discussed at a week-long symposium held at Clark University in October, 1987. Not only the contributors, but a number of invited commentators took part. The papers were subsequently revised under the guidance of the volume editors and several new ones were commissioned to fill gaps that had become apparent.

The volume contains an introductory overview and synthesis and four main sets of chapters. The first examines global changes over the past three centuries in several major aspects of human society relevant to environmental transformation: population, technology, institutions and social organization, trade, urbanization, and awareness of human impact. The second and largest section begins with a long-term assessment of natural change in the biosphere. It then offers eighteen chapters in five sets dealing with the last 300 years of human impact on the major states and flows of the globe: land transformation, forests, soils, sediment flows, and the coastal zone; water flows and water quality; the marine environment, the atmosphere, and the climate; terrestrial fauna and flora and marine animals; and flows of carbon, sulfur, nitrogen and phosphorus, trace pollutants, and ionizing radiations. The third section offers studies of historical and contemporary human impact on the environment in a dozen regions of the world, selected to represent a diversity of physical and socioeconomic environments: the Huang-Huai-Hai Plain, Amazonia, Borneo and the Malay Peninsula, Caucasia, the East African Highlands, the Russian Plain, the American Great Plains, the Basin of Mexico, Nigeria, Sweden, the Hudson-Raritan Basin, and Switzerland. The volume concludes with three chapters addressing the contributions that different perspectives in social science could make to the understanding of human-induced environmental transformation.

The global and regional assessments offered a solid foundation for a number of generalizations. Human alteration of the globe has been

enormous, now rivaling or exceeding in rate and in magnitude the work of natural processes. Most of it has been quite recent in human history, concentrated disproportionately in the twentieth century and indeed in the latter part of it. Human-induced change has grown in variety and complexity as much as in degree and rate, contributing to the increasing emergence of unforeseen and initially little-understood impacts. Despite the overall growth and acceleration of change, some human impacts have lessened in recent decades. The regional patterns and trajectories vary, sometimes widely, from the global ones; distinctive patterns of agricultural, industrial, and advanced industrial regional environmental impact are evident. Of the candidate human causes of change, such familiar variables as population, technological capacity, and affluence/poverty appear most closely correlated with environmental change at the global level. Within most regions, however, the apparent driving forces are not so uniform, and these associations are weaker though still apparent. Within regions and in particular periods, such sources of environmental change as state policy, institutional and economic structures, and beliefs and attitudes are much more in evidence.

Events since the conception of the volume have borne out the steering committee's confidence that the effort would be a timely one. By the time the volume appeared, global change had become a major scientific and public concern worldwide. Signs of that concern are now as ubiquitous as they are varied: the 1992 UN (or Rio) Conference on Environment and Development and the international agreements and initiatives to which it has given rise; the research agendas of the International Geosphere-Biosphere Programme, the Intergovernmental Panel on Climate Change, and the Human Dimensions of Global Environmental Change Programme; the currency in the media as well as the scientific journals of such terms as global warming, the ozone hole, biodiversity, deforestation, desertification, acid rain, and sustainability; some electoral successes by Green parties and the far more widespread "greening" of existing ones and of their electorates; the revelation of massive environmental degradation in the former East Bloc; the diffusion of environmental curricula in undergraduate institutions and K–12 education; and the founding of such journals as *Global Environmental Change* (edited by a geographer).

The reception of the volume has also justified the belief that such a work would make a useful contribution; reviewers have been enthusiastic and sales gratifying. The book did not, as one pessimistic contributor told us it would, sink like a stone. It sold well in hardcover and became available in paperback about a year after initial release. It has to our knowledge been adopted as a textbook for a number of upper-level courses in global change both nationally and abroad. It also serves as the basis for a more popularly written synthesis soon to be released by Cambridge University Press.

Even a volume whose publisher has allotted it more than half a million words cannot say everything. At one time the steering committee toyed with the idea of a double volume, the second to document in similar detail three centuries of changes in human society, but abandoned it for several reasons, including the expense and demands of the symposium and volume in hand. Always lying outside the goals of the effort were systematic assessments of the social impacts of environmental change and prescriptions for societal responses. Aside from some of the things that reviewers would have had us do differently, we have some regrets of our own. Missing, somewhat unaccountably, from the topics given global assessments were stocks of mineral and energy resources—classic concerns of the conservationist literature—and the distribution of pathogens. Virtually missing from the social science perspectives deployed were those of resource and environmental economics, a lacuna that no doubt puzzles many readers and puzzles us in retrospect. The chapters on social changes are less systematic than those on environmental change itself, and the links between the two are left largely implicit. The case studies, though reflecting the variety of regional experiences of transformation, also reflect a wide variety of approaches and, though suggestive, do not permit rigorous comparisons regarding the human drivers of change.

To link social changes to environmental transformations would, of course, require theory as well as data. As Robert Sack in the final section of the volume argues—and as the section itself demonstrates—human-environment

theory remains an area of profound and indeed fundamental disagreement. The argument is only confirmed by the response to these chapters both at the symposium and later by reviewers; to criticize the section for incoherence is to shoot the messenger rather than the culprit. The social sciences are in disagreement over fundamentals and yet they offer concepts, interpretations, and theories of human-environment relations that cannot be ignored in an assessment of the state of knowledge, even though none of them can be unequivocally endorsed.

The volume has already begun to suffer the predictable fate of any attempt to sum up the state of knowledge in a lively research field. It requires some correction in details not only because further environmental changes have occurred since it went to press, but because changes in the period that it covered have been reinterpreted in light of new evidence. According to current thinking—itself, of course, open to future correction—various chapters, reflecting the best judgment available at the end of the 1980s, probably somewhat exaggerate the role of land-cover change in carbon releases, the extent of Amazonian deforestation in the 1980s, the temperature impact of a CO_2 equivalent doubling, and the global area of desertification, and underrate the role of albedo change in global climate and past releases of ionizing radiation; as another mark of its time the book contains the then-obligatory and now discredited quotation from the nineteenth-century American Chief Seattle, which in a new edition would need to be properly ascribed to the American film scriptwriter who actually penned it ca. 1970. Because of the rigidity of the large-volume format, it seems unlikely that comparable efforts at stocktaking and assessment in the future will usefully employ it. The creation of a companion electronic atlas capable of routine updating was discussed informally at the symposium. For all of the volume's own differences from its predecessors, successors to it are likely to resemble it in format much less than it resembles *Man and Nature* and *Man's Role*.

One lesson of the long process by which the volume took shape is that of the strength and role of geography in the environmental field. The project was eminently inter- and multidisciplinary, as attested by its joint sponsorship by the International Institute of Applied Systems Analysis (Laxenburg, Austria), the World Resources Institute (Washington, D.C.), and the Graduate School of Geography, Clark University. Geographers, nonetheless, ranked first among equals, furnishing three of six editors and many of the authors. Of the some twenty disciplines represented by the participants, geographers proved disproportionately well qualified to write some of the global survey chapters as well as some of the regional case studies. As a geographer-led interdisciplinary undertaking and one of many geography-led efforts, it also speaks to a longstanding difference about how best to strengthen our discipline, whether to emphasize the uniqueness of our approach or the commonality of questions that we and others pursue. In the collaborative assessment of earth transformation, geographers have the opportunity not only to capitalize upon their longstanding interest in nature-society relationships, but to strengthen the discipline through a network of shared scientific interests.

At the same time, the volume indicates the usefulness to a wider audience of research and synthesis done on a scale at which contemporary social scientists and geographers on the whole rarely work. While modest in scale relative to much current research in the earth sciences, *ET*, in geographical context, is big science, in content and conclusions, and in time, cost, and participation. It is arguable that in recent decades geographers' attention to local particularity and detail has overwhelmed their equally longstanding concern with the empirical assessment of the big picture; the reception of *ET* suggests that there is something to be gained by redressing the balance. Similarly, it is arguable that in the organization of our research we are too restrained in our reach, too modest in our grasp, too solitary in our undertakings, too limited in our mutual assistance. Again there is much to be gained from embracing larger, albeit more costly enterprises, for success in them can over time enlarge the resource pool for all scales of research and publication.

The work also shows the usefulness of an approach that is too rare in modern academe: edited volumes that have been genuinely edited according to a coherent plan. It is a rare review of a multi-authored collection that does not fault it for some degree of diffuseness and incoherence and suggest that a more rigorous

plan of organization would have made it a more useful book; a frequent review that observes that the whole is no more valuable than some of the parts. In the case of *ET,* the reviewers' suggestions, by and large, would have made it more rather than less diffuse. The excellent recent volumes on global environmental change by such geographers as Goudie (1981), Simmons (1989), and Mannion (1991) testify that the single-authored synthesis, if based on a deep knowledge of the literature, still has a role to play, and to trade its advantages for those obtained by exploiting the expertise of many individuals requires a strong editorial hand. If such a hand is applied, however, the result can be very well worth the effort.

Between the publication of *Man and Nature* and *Man's Role,* 92 years passed, and between *Man's Role* and *The Earth Transformed,* there was a gap of 34 years. The gap between *ET* and its digitized successor is likely to be even less, for both the supply of knowledge and the demand for it are growing rapidly. The great international research enterprise designed to understand how the earth works will supply, if all goes well, untold additional observations of the earth, new models that link the present disparate realms of land, air, water, and people, and novel transnational institutions of study and policy. At the same time, the phenomenal challenge posed by the doubling of world population and the quadrupling of consumption within the lifetime of today's children will demand the very best of science, understanding, and collective action if humankind is to navigate safely the extraordinary passage ahead. For geographers, for whom the human use of the earth is a central question, it is not too early to use the occasion of this reflection on *ET* to ask of ourselves and our species: beyond modification, beyond transformation, what ought to be the human use of the earth?

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Evaluation

Social Solidarities and Environmental Separations

Steve Rayner

Battelle, Pacific Northwest Laboratories[1]

The Earth as Transformed by Human Action (*ET*) is a truly monumental work. The papers assembled here represent a comprehensive historical and spatial mapping of significant anthropogenic changes in the appearance of our world over the past 300 years. Measurable changes, quantitative and qualitative, in population, natural resource extraction,

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