ECOLOGICAL RESTORATION: A GLOBAL CHALLENGE

Ecological restoration projects seek to recover the natural functioning of degraded ecosystems, most often areas disturbed by human large scale projects such as agriculture developments, road building, mining and urban sprawl. While scientists focus on the ecological basis of habitat repair, practitioners, governmental and non-governmental organizations, and local people, tend to worry about social, economic, cultural and political aspects. The value of ecological restoration is discussed here with examples including tropical forests in Vietnam and Australia, degraded environments in China as a paradigm of global issues, the restoration of wetlands and the coastal zone and how to proceed with urban developments. The author also uniquely assesses how ecological restoration can be used against the impacts of climate change. In addition to strategies for extending ecological restoration on a global scale, it provides useful ideas and tools for the everyday work of practitioners, professionals, researchers and students.

FRANCISCO A. COMÍN is an ecologist with background experience on ecosystem analysis and development of management tools. He has been Professor of Ecology at University of Barcelona (Spain) for twenty-five years and visiting professor of CINVESTAV-IPN (Mérida, Yucatan, Mexico) for fifteen years. Books published include X. Rodo & F. A. Comín (2003), Global Climate. Current Research and Uncertainties in the Climate System; F. A. Comín & T. Northcote (1990), Saline Lakes. Developments in Hydrobiology 59; F. A. Comín, J. A. Herrera, J. Ramírez (2000). Limnology and Aquatic Birds. Monitoring, Modelling and Management Univ. Autónoma del Yucatán Publ.. He has been performing research and practical work on ecological restoration for twenty years. His aim in his work is to integrate scientific, technical, economic and social aspects of ecological restoration. Topics in the frontiers between different sciences are a special subject of interest, as is shown in this book. He is member of SER International, Intecol and RIACRE.
This book is dedicated to previous scientists and restoration practitioners who inspired our ideas and to the future generations, in the hope that they will use our planet wisely and will extend the practice of ecological restoration on a global scale.
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Foreword

The time for complacency and “business as usual” with regard to the management of our home, planet Earth, is in the past. We are now entering a period in which massive action must be taken to halt and reverse damage to the environment. For the last several millennia we humans have expanded our geographic reach and accelerated our uses of the environment and its resources. The effects of this on the biosphere are well documented and have been thoroughly discussed. The second half of the nineteenth century bore witness to a shift in our thinking as a species, as the appreciation of nature and wild places became points of public discussion. The early twentieth century saw the development of the concepts of conservation and resource management, while the second half saw the rise of modern environmentalism. These concepts focus primarily on halting environmental damage and the sustainable use of natural resources. The idea of repairing environmental damage, or ecological restoration, and its associated scientific discipline, restoration ecology, developed concurrently with modern environmentalism, but were until recently less well known.

While environmental exploitation has benefited relatively few throughout history, the collapse of colonialism following World War II and the increasing pressure on governments to foster economic development for the masses has accelerated the utilization of the Earth’s finite resources. What became clear before the close of the twentieth century, however, was that the unbridled use of the planet’s resources would not bring prosperity to the poor, but rather would ultimately harm everyone. Thus, the idea of sustainability gained traction within the global political community, culminating in the World Commission on Environment and Development’s 1989 definition of sustainability: “[to meet] the needs of the present without compromising the ability of future generations to meet their own needs.”

Unfortunately, not everyone yet understands the seriousness of our situation as a species and the affects of our actions on the planet and our fellow inhabitants. The Bush administration’s decision to prevent the United States from full participation in
international agreements such as the Kyoto Protocol and the Convention on Biological Diversity put the global environment at higher risk and illustrates how old ideas die hard. Ironically, it is failed economic policies in the first decade of the twenty-first century that now provide us with a critical opportunity for change. The global meltdown in 2008 may take social scientists years or even decades to understand, but what is clear is that the world will never be the same.

*Ecological Restoration: A Global Challenge* could not come at a better time. Massive change is on its way and ideas like sustainability and ecological restoration are poised for increased prominence. For twenty years, the Society for Ecological Restoration International and its members have worked to develop the techniques, philosophy and science behind environmental repair and rehabilitation. Now it is time to move beyond the limited conservation actions of the past and put this knowledge to work at the planetary scale. Ecological restoration is not a utopian idea: it is a powerful tool, and if implemented on a large scale, it could change the planet for the better by transforming the way humans relate to it and to each other. Ecological restoration can help protect biodiversity, mitigate climate change, sequester carbon, reunite indigenous peoples with their landscapes and cultures, and restore a healthy relationship between people and nature. Ecological restoration also complements other allied efforts such as rare species conservation, natural landscaping, reconciliation ecology, organic agriculture, the restoration of natural capital, environmental justice and the elimination of armed conflict. If implemented properly, it can help alleviate poverty and assist in the equitable sharing of resources among the Earth’s inhabitants.

Around the world, local communities are picking up their shovels and restoring degraded ecosystems, in many cases, with little or no funding. These Herculean efforts point to an increasing public awareness that restoring “green infrastructure” is the most efficient and desirable way to secure goods and services derived from nature. In many cases, these are irreplaceable and their economic value is immeasurable: how can we replace the environment’s role in protecting us from droughts, floods, and storms or in providing water and air purification or supporting agriculture and fisheries? What is needed now is more funding and political commitment to ecological restoration at the local, national and international level. In my mind, there is an urgency to get to work and there is a tremendous amount to do. This book provides the background and stimulus to do just that.

*George D. Gann*

*Chair*

Preface

The state of the environment at the end of the twentieth century was diagnosed as rather negative (Starke, 2000). Evidence of the direct relationship between greenhouse gas emissions caused by human activity and global warming of the Earth’s atmosphere was proven (IPCC, 2007), and the loss of habitats was still very high. At the same time, never before had there been so much interest in improving the conservation of natural resources and the state of the environment, from governmental and non-governmental entities, from individuals and global-scale associations. It seemed that the world was becoming focused on changing the paradigm in the relationship between human beings and nature, and that the principles of caution and nature conservation were to be integrated into development planning. A new kind of human-nature relationship, embodying conservation and a rational use of the ecosystem, had become necessary, as well as a new form of socioeconomic development which integrated this rational use of the ecosystem and involved local populations.

However, the twenty-first century has hardly begun to consider these experiences or this diagnosis (MEA, 2005; WorldWatch Organization, 2009). Far from it, human demand for resources and natural services has long exceeded the Earth’s capacity to provide them (Ewing et al., 2008). The globalization of terrorism, war and the countless cases of financial, political and social irresponsibility, on all scales from global to local, have maximized the separation of the factors regulating economic development and human well-being in general, and are still clearly contributing to the degradation of natural systems. The increase in human migrations, in the international traffic of exploited human beings, in the gap between urban and rural worlds, is not independent of environmental degradation and the loss of habitats and natural resources. The confirmation of the connection between atmospheric global warming and environment-degrading human activities, together with the forecast of the impact of climate change on the ecosystem, should make us adopt measures for mitigation and adaptation to these phenomena quickly.
There is a growing interest in this direction. Environment-improving campaigns are being developed by small local groups and by whole governments, with many diverse interests, from species conservation to the purchase of land and its sustainable management from strict nature protection to improvements in people’s social and economic status. However, the general state of the world does not seem to improve, but worsen. Although the number and extension of protected areas increase, at regional and global scale, natural habitats are still being lost, and changes in land use are identified as the cause for 50 percent of the greenhouse gas emissions in the world (World Watch, 2009). Sustainability has become a concept difficult to put into practice, although there are significant small-scale cases proving that it is achievable (Gulf et al., 2006; Munasinghe, 2009).

Under these circumstances, the restoration of degraded ecosystems stands out as an imperative activity in order to improve the state of the Earth. It is not enough to conserve or protect, it is necessary to restore, and to do so on a global scale, since degradation also happens on a global scale. Such is the inspiration and main thesis of this book. It is not possible to imagine now the final form and state of the planet that will be attained through global ecological restoration. However, the concept is beginning to develop. More and more scientists are contributing their ideas along these lines, and more practitioners their experience. There are increasingly more organizations participating in restoration projects, and agencies contributing material goods or finance for this activity (Clewell and Aronson, 2008).

Nevertheless, practice is currently more advanced than theory, despite the fact that the last decade has seen a proliferation of publications on restoration ecology and ecological restoration. The scientific journal Restoration Ecology, sponsored by the Society for Ecological Restoration International, has published scientific research works on restoration ecology for nearly twenty years. Since 1981, the journal Ecological Restoration (formerly Restoration & Management Notes), has published a relevant combination of practical articles, restoration experiences, and scientific information. The journal Ecological Management & Restoration has been similarly publishing since 2000, focusing on the Australian continent. Many other journals have published articles on restoration in the last decade. Both small-scale experiments on ecological restoration and large-scale practical applications offer excellent opportunities for two complementary aspects of scientific and social progress: extending knowledge and gaining practical experience.

Moreover, a growing number of books, as well as other types of documents, are beginning to form a formal corpus on restoration ecology. A group of these books is promoted by the Society for Ecological Restoration International (available at Island Press); each deals with a specific topic or type of ecosystem. Others are well-structured, general books (e.g., Perrow and Davy, 2002; Mitsch and Jorgensen, 2003; Van Andel and Aronson, 2006). These books constitute an excellent
collection which shows the significant quality attained by ecological restoration projects and its contribution to the progress of ecology. However, ecological restoration includes, as does ecology, important social and economic aspects which confer a wider dimension than that of restoration ecology. These aspects are considered in all these publications, which markedly demonstrates how ecological restoration juxtaposes various approaches and integrates different disciplines.

Thus, this volume aims at conveying two main ideas: (i) the above-mentioned need to develop ecological restoration practices on a global scale in order to improve the state of our world, and (ii) the need for global-scale ecological restoration to positively integrate and contribute to socioeconomic development. For the first idea to be efficiently disseminated it is necessary to base ecological restoration practices on the foundations proved by experts and scientists, whose advice is to develop restoration actions at ecosystem-scale, that is, at the scale of the functional relations among the components of an ecologic system (SER International Science & Policy Working Group, 2004; Clewell et al., 2005). Consequently, it is not so much a matter of achieving the establishment of a predetermined physical or biological structure, as a matter of re-initiating adequate functional relations (e.g., geomorphological and biogeochemical processes, the renewal of key biological populations) and allowing ecosystems to develop within the framework of general environmental conditions. It is important that research work and restoration practices take into account the dynamic, changing character of the ecosystems. Otherwise, there is a risk of considering fixed, invariable structures, either physical or biological, as the aim of restoration, whereas they are something alien to natural ecosystems and to ecological restoration aims, and tend to restrict the ecosystems’ self-organization capacity and their potential for adaptation to changing environmental and climatic conditions.

The second idea stems from the common experience acquired with the implementation of restoration projects. Social and economic factors are as important as scientific and technical factors, or maybe more, and need to be integrated into restoration projects (Comin et al., 2005). Neglecting these aspects may lead to the failure of a restoration project. This extends to ethical considerations that are included in restoration practices; these are beginning to be formalized by scientists, as well as by practitioners and philosophers interested in these issues.

In this sense, ecological restoration can become a global tool for cooperation and development in situations of war and hostility between groups. Without losing any scientific-technical rigor or expert basis, restoration projects can be agglutinants of interests that motivate and strengthen relations between groups of persons and entities and also between governmental organizations, be their interests boundary-oriented or based on peaceful coexistence and mutual respect. The capacity of ecological restoration to integrate scientific-technical, economic and social concerns offers opportunities for the betterment of the human condition.
Consideration of all these issues motivated the content structure of this book. Thus, the contents are grouped in two main parts. The first part includes more generic content, related to the challenges faced in this century by humankind, the uncertainties concerning the carbon cycle as the engine for change in our ecosystem the Earth, and the mitigation of carbon emissions to the atmosphere made possible through ecological restoration. The second part includes global-scope restoration discussions, either related to key ecosystems of the world, or to specific cases which could constitute examples to be developed on a global scale.

This book neither is, nor pretends to be, an exhaustive treatise on ecological restoration techniques. As was mentioned above, there are already many books and manuals on the restoration of specific types of ecosystems. This book collects together the most usual ideas and practices of ecological restoration, considering both the practicalities and the design and implementation of the projects, and tries to further the expansion of ecological restoration to the whole world, contributing its scientific-technical rigor, its practical experience, and its ability to assist with socioeconomic development and cooperation. In summary, this book’s purpose is to further the aim of ecological restoration to leave the Earth at the end of the twenty-first century in a better state than at the beginning of the century.

References

Preface


Acknowledgements

A book of this nature owes much to the authors’ efforts. Their commitment and dedication must be acknowledged here, for they have contributed their wide perspective and sound experience to the contents of this book. The authors’ varied geographical origins, together with their internationalization, are another token of this book’s global character. We also would like to express our recognition to Mª Paz Errea for her dedicated revision of the graphical materials, to Susana Artieda for her sound reviewing of the text edition, and to Mercedes Garcia for her efficient assistance during the process of editing the book. We wish to acknowledge Cambridge University Press, for their encouraging reception of this book, Dominic Lewis in special for his great professionalism, and the positive vision of the Publications Department of the Consejo Superior de Investigaciones Científicas (CSIC), which made this joint publication possible.

Francisco A. Comín
## Abbreviations

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<tbody>
<tr>
<td>ARRA</td>
<td>Alexander River Restoration Administration</td>
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<td>ARRP</td>
<td>Alexander River Restoration Project</td>
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<td>BAU</td>
<td>business as usual</td>
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<td>BD</td>
<td>buffer discount</td>
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<tr>
<td>BMZ</td>
<td>German Federal Ministry for Economic Cooperation and Development</td>
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<td>CBD</td>
<td>Convention on Biological Diversity</td>
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<tr>
<td>CDM</td>
<td>Clean Development Mechanism</td>
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<td>CER</td>
<td>Certified Emission Reduction</td>
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<td>CERN</td>
<td>Chinese Ecosystem Research Network</td>
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<td>CFERN</td>
<td>China Forest Ecosystem Research Network</td>
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<td>CNSCN</td>
<td>China Network of Soil Conservation Monitoring</td>
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<td>COP</td>
<td>United Nations Climate Change Conference</td>
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<td>CREP</td>
<td>Conservation Reserve Enhancement Program</td>
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<td>CSIRO</td>
<td>Commonwealth Scientific and Industrial Research Organisation (of Australia)</td>
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<tr>
<td>CSR</td>
<td>corporate social responsibility</td>
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<tr>
<td>ENSO</td>
<td>El Niño Southern Oscillation</td>
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<tr>
<td>ER$_{\text{net}}$</td>
<td>net emission reduction</td>
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<td>ER$_{\text{project}}$</td>
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<td>other project emission</td>
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<td>ET</td>
<td>Emission Trading</td>
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<td>EU ETS</td>
<td>European Emission Trading Scheme</td>
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<td>FAO</td>
<td>Food and Agricultural Organization</td>
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<tr>
<td>FAPAR</td>
<td>fraction of photosynthetically absorbed active radiation</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>CGP</td>
<td>Grain for Green Program</td>
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List of Abbreviations

GHG greenhouse gas
GIS Geographic Information System
GOALS Global Ocean-Atmosphere-Land System
GPP gross primary production
GTOS Global Terrestrial Observing System
GUMBO Global Unified Metamodel of the Biosphere
HIV-AIDS Human Immunodeficiency Virus-Acquired Immunodeficiency Syndrome
IAP Institute of Atmospheric Physics
ICZM integrated coastal zone management
ILTER International Long Term Ecological Research Network
IPCC Intergovernmental Panel for Climate Change
IRF International River Foundation
IUCN International Union for Nature Conservation
JI Joint Implementation
L leakage
LAI leaf area index
LASG Laboratory of Atmospheric Sciences and Geophysical Fluid Dynamics
LBRP Lake Bam Restoration Project
LCA Louisiana Coastal Area
LPJ Lund-Potsdam-Jena (dynamic global vegetation model)
LULUCF Land-Use, Land-Use Change and Forestry
MEA Millenium Ecosystem Assessment
MOM Missouri-Ohio-Mississippi (river basin)
NBP net biome productivity
NDVI normalized difference vegetation index
NFPP Natural Forest Protection Program
NGO non governmental organization
NEP net ecosystem production
NPP net primary production
ODA Official Development Assistance
ORCHIDEE Organizing Carbon and Hydrology in Dynamic Ecosystems (terrestrial biosphere model)
PFT plant functional type
Ra autotrophic respiration
RE restored Earth
REDD reduced emissions from deforestation and degradation
REW relative extractable water (in soil)
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<td>heterotrophic respiration</td>
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<tr>
<td>RIEMS</td>
<td>Regional Integrated Environmental Model System</td>
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<td>RUE</td>
<td>radiation use efficiency</td>
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<tr>
<td>SDM</td>
<td>structurally dynamic model</td>
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<tr>
<td>SER(I)</td>
<td>Society for Ecological Restoration International</td>
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<tr>
<td>TER</td>
<td>total ecosystem respiration</td>
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<td>TGDP</td>
<td>Three Gorges Dam Project</td>
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<td>TGR</td>
<td>Three Gorge Reservoir</td>
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<td>TOPEX</td>
<td>Topography Experiment for Ocean Circulation</td>
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<td>VCS</td>
<td>Voluntary Carbon Standard</td>
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<td>VOC</td>
<td>volatile organic compound</td>
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<td>UNCCD</td>
<td>United Nations Convention to Combat Desertification</td>
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<td>United Nations Environmental Program</td>
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<td>United Nations Framework Convention on Climate Change</td>
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<td>World Wildlife Fund</td>
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