Transdisciplinary Challenges in Landscape Ecology and Restoration Ecology

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Transdisciplinary Challenges in Landscape Ecology and Restoration Ecology - An Anthology

with Forewords by E. Laszlo and M. Antrop and Epilogue by E. Allen

by

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Springer

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I dedicate this book to
my dear wife Ziona,
whose love and devotion, patience
and encouragement have been
the strongest pillars of my life and work
for 55 years.

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I acknowledge with gratitude the kind help of Dr Yohay Carmel, Prof. Emeritus Arthur S. Lieberman and Sonia Danziger during the composition of this anthology. My warmest thanks are also extended to Ms Ria Kanters, the publishing assistant of Springer and the editors of the Landscape Series Prof. Henri Decamps, Gunther and Baerbel Tress. I appreciate especially the encouragement I enjoyed throughout, and the readiness of Dr. Gunther and Baerbel Tress to help me in completing this book. I acknowledge gratefully the forewords contributed by Prof. E Laszlo and by M. Antrop, and the epilogue by E. Allen.

I am grateful to all those many scholars and students, landscape and restoration scientists, ecologists and geographers, planners and conservationists, whose interest in my work was a source of inspiration and pride for me. I also thank the publishers of the journals and books, for granting me permission to republish my studies in chapters 1–13.

FOREWORD BY THE SERIES EDITORS

With the Springer Landscape Series we want to provide a much-needed forum for dealing with the complexity of landscape types that occur, and are studied, globally. It is crucial that the series highlights the richness of this diversity – both in the landscapes themselves and in the approaches used in their study. Moreover, while the multiplicity of relevant academic disciplines and approaches is characteristic of landscape research, we also aim to provide a place where the synthesis and integration of different knowledge cultures is common practice.

Transdisciplinary Challenges for Landscape Ecology and Restoration Ecology is the seventh volume of the series. It is an anthology of global and Mediterranean issues that assembles the author's work of over 40 years of publications in the field of landscape ecology and restoration ecology. Professor Zev Naveh dedicated his work to the study of landscapes around the world and has been one of the pioneers in introducing holistic concepts into landscape studies demanding collaboration across disciplinary boundaries. The fourteen chapters in this book give unique evidence of the various stages of development and progress in landscape ecology and restoration ecology, which were and are influenced by the author until now. The anthology illustrates the increasing importance of landscape ecology in coping with societal and ecological challenges. It is the author's restless attempt to offer landscapes as a conceptual basis to approach recent environmental, social and economic challenges and problems in our world, understood as the Total Human Ecosystem. The chapters propose an academic development in the study of landscapes, which ultimately will lead to a holistic landscape science, including natural sciences, social sciences, humanities and the arts.

We are proud to publish this anthology in our series and recommend the book to students and all academics interested in understanding the development and need for landscape science. The anthology is an impressing record of landscape ecology and restoration ecology and will be an important source of inspiration for the current and future generation of academics involved in the study of landscapes.

Toulouse and Aberdeen, January 2006
Henri Décamps
Bärbel Tress
Gunther Tress

PREFACE

by Marc Antrop

When Zev Naveh asked me to write a foreword to his anthology, I felt honoured and glad. Honoured because it proved me that he appreciated the many discussions we used to have; he as an ecologist and I as a geographer, who met each other in the field of landscape ecology. I was also glad that he was able to finalize his idea of an anthology which he had been thinking about for a long time. In my opinion it is an important work. Many people know – as citations prove – Naveh from the book *Landscape Ecology – Theory and Applications* which he published with Arthur Lieberman for the first time in 1984. At present it continues to be a milestone in the revival of landscape ecology in the second half of the 20th century. Many things have changed since then though. Not only the landscape, but the whole of the environment and society have changed drastically. Adhering to his own holistic approach to the landscape as part of the Total Human Ecosystem (THE), Naveh broadened his work accordingly. He has become even more convinced of the importance of holistic landscape research and its application in societal matters. As such, he has become a promoter of transdisciplinary discipline with the landscape as an integrating concept, important for the future ecological, socio-economical and cultural development. He has stressed this in many publications and many enthusiastic lectures all over the world. It is this personal transition towards transdisciplinary landscape studies in a more global context Naveh has wanted to express clearly in this anthology. Using a selection of previous work, put in a logical order and completed with new comments and a recapitulation. Not looking back, but stressing the important issues and also pointing to the future and the enormous responsibility scientists have in what he calls the revolution of sustainability. This makes this anthology special and a valuable narrative as well.

Naveh started as a vegetation scientist working in Mediterranean areas. The first part of this book deals with his experiences there. Rapidly, he broadened his 'perceptual and conceptual "looking glass" from ecosystems to landscapes', as he writes in the introduction. He became a landscape ecologist focussing on conservation and restoration ecology. As a geographer I was struck by the similarities between Naveh's perception and conception of Mediterranean landscapes and the ones of the first geographers describing these landscapes such as Vidal de la Blache and Philippson. As a young geographer, I also started my career in the Mediterranean and I am convinced that my holistic perspective on landscape was mainly forged by these landscapes too. The great variation of the natural

conditions and the ancient history of human use of the land resulted in landscapes where the "interaction between natural processes and human activities", as defined in the recent European Landscape Convention, is obvious. Mediterranean landscapes are also severely threatened by mismanagement and I agree with Naveh that there is little optimism for the future. New transdisciplinary approaches based on sound landscape ecological principles are urgently needed here, but, as Naveh points out, landscape ecologists still play a minor role in decision making. Consequently, landscape ecologists cannot be pure scientists, but they have to transmit and explain their work in a broader sense, to educate decision makers, to make the general public aware of the severe problems and possible solutions.

The second part of the book consists of a selection of theoretical, methodological and practical issues in a global perspective. Here Naveh focuses on his Total Human Ecosystem (THE) and its implementation in a transdisciplinary landscape science in the perspective of sustainable development. In his introductory comments, he stresses the applicability of this theoretical paradigm and the selected papers offer practical examples. Even when familiar with the selected publications, I found it very worthwhile re-reading them after reading Naveh's comments on the subject. Clearly, this anthology is not just a collection of previous work, but a reflection of a scholar on his past work looking at it with greater wisdom and concern for the future development. This second part deals as much with spiritualism, culture, socio-economics as ecology. Their integration forms the basis for "the transdisciplinary process for the overall improvement in the quality of living creatures and their environment", Naveh writes. Also, the focus is no longer on natural and pastoral landscapes, but is broadened to all kind of landscapes, also to what Naveh calls the techno-landscapes. It becomes clear that he sees landscapes as the tangible meeting points of nature and mind in the context of a holistic THE. When he uses the term 'landscape ecology' it has a much broader meaning than just a kind of ecology or a specific discipline. He speaks of a transdisciplinary landscape science; biology-ecology and culture always go hand in hand when it comes to diversity, conservation and restoration. The real significance of ecological research is given by its contribution within the THE as part of the Grand Synthesis of Laszlo, who inspired Naveh a lot.

The third part of the book consists of one chapter devoted on this gradual transformation of landscape ecology and restoration ecology into transdisciplinary approach of sciences to holistic landscape studies with applications in management, planning, conservation and restoration. It is an extensive recapitulation of Naveh's thinking and evolution through his career, and also a new step in consolidating his thoughts on a universal philosophical theory by Laszlo. It is certainly not an end, but as Naveh puts it hopefully a new cornerstone in the further development of a unified transdisciplinary landscape science.

The anthology combines the theoretical and methodological development of landscape ecology and the personal narrative of an eminent scientist and scholar in his attempt to make his science more useful and meaningful for mankind. For me, his message to the scientific community is clearly stated in Chapter 10: *scientists will*

have to integrate scientific knowledge with ecological wisdom and ecological ethics, helping us to learn from past experience, comprehending the present and envisaging the future of our cultural landscapes. It reminds me also to one of his famous quotations in one of his challenging lectures for young PhD students in landscape ecology: "The things that count, can not be counted."

Marc Antrop
University of Ghent,
Belgium
January 2006

FOREWORD

by Ervin Laszlo

It is a genuine pleasure and distinct privilege to write this introductory note to Zev Naveh's comprehensive summary of his life-work, an opus of truly epoch-making dimensions and significance.

Writing this Preface is a personal pleasure, because it is seldom that a theoretician can discover that his ideas have fallen on fertile grounds not only on the level of theory, but also on the level of practice – or, as a first step, as practice-oriented applied theory. This, however, is what I have found in Naveh's writings. I am delighted that his THE (Total Human Ecosystem) model not only uses the holistic thinking I have long championed as a general framework, but finds use for such specific theoretical concepts as my general-evolution theoretical model of bifurcation-based sequential evolution, and even more remarkably, for the Integral Theory of Everything I have outlined recently, rooted in the concept of a universal information field, the Akashic or A-field.

Writing this Preface is even more importantly a privilege, and also a moral and intellectual duty, for the importance of Naveh's work is not limited to the choice of theoretical model. It is not an exaggeration to claim that Naveh's contribution to scientific advance in the field of landscape ecology, and beyond that to the grasp of the interrelated processes that frame our life on this planet, are entirely fundamental. Naveh brings to the domain of ecology a systemic understanding that, to – an outsider surprisingly – has been lacking in this field of inquiry, although it is reputed to be generally systemically oriented. He points out that the study and management, and conservation and restoration of landscapes in every part of the world require a holistic approach, transcending the frontiers of the natural sciences into the social sciences, and even the humanities and the arts. This is a fundamental insight, and a radical innovation for the dominant paradigm in ecology.

Naveh discusses the urgent need for a transdisciplinary shift in both theory and practice in all environmental fields, especially in landscape ecology, restoration ecology, and landscape studies in general. This shift is the essence of the urgently needed environmental revolution that could lead to a post-industrial symbiosis of humans and nature, as expressed in the interaction of humans and landscapes. In the essays that comprise this volume, the warrant for and the practical utility of this transdisciplinary shift is convincingly demonstrated through the use of concepts developed in the systems sciences, in cybernetics and complexity theory, and through the general evolutionary and integrated worldview conceptions elaborated by the present writer.

As Naveh shows – and as it is also widely recognized – most ecologies in the world are presently on a degenerative path. They need not only to be maintained in their current state, but restored to a more balanced, healthy condition. In this regard, Naveh notes, consideration needs to be given to the restoration not only of vegetation

patterns, but of all the processes that ensure a sustainably healthy and attractive landscape. This calls for a holistic approach that encompasses the maintenance and restoration of the homeorhetic flow-equilibrium between biodiversity and ecological and human cultural heterogeneity in regard to the patterns of human land-use. Ultimately, the requirement is for a holistic land-use policy. This, alas, is still far from reality, in the scientific as well as in the political domain. Yet Naveh's point, that the true role of ecology in an integrated socio-economic, ecological and cultural development is to lead to an overall improvement in the quality of living creatures and the environment, is good common sense.

The point this volume makes is one that few people outside the technical disciplinary domain of ecology may be acquainted with. It is that the reductionist and mechanistic worldview in science and society has left a deep and unwelcome mark on the paradigm that dominates work in the field of landscape ecology. This has to be overcome, for it encourages a false separation of human social and cultural activity from the biological processes that hallmark the environment in which that activity takes place. The most insidious consequence of this separation is the often voiced view that environmental problems are problems of nature and not of society, and thus they concern biologists, chemists, and landscape engineers and not politicians, business managers, and civil society. This view ignores the multiple strands of interaction between society and the environment that makes it not just misleading, but factually false, to speak of nature as a system of biological organisms without considering the human beings and their cultures and technologies that interact with the system.

The view that society and nature are distinct and separate is a logical but pernicious consequence of the dynamics that drive society progressively further from integration with the rhythms and processes of nature. As other living species, our distant forebears were well integrated into their natural environment. This level of integration was progressively impaired in the course of evolution. Around 40 million years ago the family of primates split off from the then existing species of mammals, and about 9.2 million years ago the primate family split into two groups, of which one, the pongids, stayed with the arboreal life, and several others (such as *Gigantopithecus* and *Sivapithecus*) later became extinct. The group of pongids evolved into the modern apes: chimpanzees, gorillas, orangutans, and gibbons. Out of this family evolved a subgroup of terrestrially based bipedalists: the hominids.

About 2.5 million years ago, the early hominid *Australopithecines* split into different branches. Many became later extinct (for example, *boisei* and *robustus),* and the surviving branch evolved into *habilis* and *erectus,* and ultimately into *sapiens.* Some 40 000 years ago, sapients appeared in Europe, probably co-inhabiting the continent with *Homo neanderthalis.* The latter disappeared around 30 000 years ago, and since then *Homo sapiens sapiens* has been the sole survivor of the hominid branch.

With *Homo sapiens sapiens,* integration with the environment became entrusted to culture rather to genes: human evolution shifted from the biological to the sociocultural domain. For the past thirty to fifty thousand years it has been

the sociocultural organization of groups of individuals that has mutated rather than their gene pool. A series of sociocultural mutations led to the increasing detachment of the processes and dynamics of the societies formed by humans from their ecologies. This detachment culminated with the appearance of modern industrial societies. At this point human societies appeared, and still appear, as systems with *in sui generis* laws and processes. The environment is relegated mainly to the role of source and sink: to the role of supplier of natural resources and habitable space, and sink of wastes.

Industrial societies possess a dynamic that is out of sync with the natural rhythms of their environment, but they are not, for all that, separate systems. Society and the environment are properly viewed as systems with a dynamic of their own, but not as systems of such autonomy that their modeling can ignore the fact that they are elements in a larger common system. Naveh is correct in insisting that landscapes must be regarded as organic parts of the Total Human Ecosystem Gestalt; as meeting points between dynamic processes of nature and the workings of human mind and culture.

The links of industrial societies to the biosphere have intensified, and in many areas transformed into relations of critical dependence. Human societies have always depended on clean air, water, fertile soils, and the availability of sufficient quantities and qualities of air and biological produce, but industrial societies are critically dependent on a vast range of minerals and energy sources in addition. This has prompted some social scientists to include the environment in their modeling of the pertinent flows and processes; for example, economics is now viewing nature as a subsystem of the economy. This indicates that the separation of the natural and the human domains is being narrowed, but it also shows that the new conceptualizations are still inadequate. It is more correct to speak of the economy (and indeed, of human society as a whole) as a subsystem of nature, rather than of nature as a subsystem of the economy.

The total dynamics of the human/cultural/technological/biological system – the socio-biosphere, or in Naveh's terminology, the Total Human Ecosystem – constitutes the basis of our life. Recovering our integration with it, and restoring its damaged integrity is a precondition of our continued survival. We should be grateful to courageous and insightful ecologists such as Zev Naveh for pointing to the fallacy of the fragmented reductionist approach, and insisting that, both in the interest of scientific accuracy and of our life and future, applying the holistic paradigm of complex, interacting and information-imbued systems is of urgent and crucial importance.

If any reader may still entertain any doubt about the scientific validity and practical utility of the holistic approach in landscape ecology, he or she has only to read this volume. It marks a milestone in the vital advance of integrated evolutionary systems thinking in the empirical sciences.

Ervin Laszlo
Tuscany, Italy
January 2006

IN MEMORIAM OF FRANCESCO DI CASTRI (1930–2005)

Just before the final submission of this anthology to Springer, the sad news reached me that Prof. Francesco Di Castri died. As I stated in the introduction to Chapter 1, I had the great fortune to be invited by him to participate in an international symposium on the comparison of Mediterranean climate types in Chile and California at Valdivia in 1971, conducted under his brilliant leadership. Since then we created warm personal contacts. He was without doubt the most influential ecologist who had deep roots in the Mediterranean and I regarded him highly as a fine human and great scientist and concerned ecologist. I would therefore not like to close this book without devoting a few sentences to his memory.

UNESCO, in which he played a leading role, has devoted in their website a full account of his numerous contributions as an eminent scientist, deeply involved in environmental issues from the local to the global levels, summarized here as follows: "UNESCO is saddened to announce the death of Francesco di Castri, eminent ecologist, first director of the MAB Program (1971–1984), later Coordinator of UNESCO environmental Programs. Francesco di Castri played a creative and leading role in many international activities on the environment, at both non-governmental and governmental levels. He was a four–language polyglot, estimated by those in government and those in science, in North and South, East and West, a prolific writer. Authoring and coauthoring some 700 scientific and popular articles, monographs and book chapters. He was a noble, complex and highly erudite signor in the tradition of his native city (Venice), a skilled and subtle debater, with a fine sense of irony and metaphor, an exceptional motivator of those around him, a man of imagination and foresight, of courage and rigour. He left his mark. He will be missed and remembered by many."

Among his numerous achievements, probably the most significant and of lasting relevance were his contributions as the founding director of the Division of Ecological Sciences of UNESCO when he shaped and directed what came to be considered one of UNESCO's principal contributions in promoting international cooperation on environmental issues within the framework of the MAB program. Together with Michael Battise he nurtured and developed the Biosphere Reserve concept. He furthered its worldwide implementation as the transdisciplinary basis, bridging the natural and social sciences for the rational use and conservation of resources of the biosphere, and for the improvement of the relationships between man and the environment. In the same vein, he initiated also the World Cultural Heritage Convention, what became one of the most successful legal instruments for the conservation of the world-wide natural and cultural heritage. What I most admired was his realistic, but at the same time optimistic forward-looking view of ecology (as well as landscape ecology) as sciences, rich in opportunities, instilling

hope, rather than despair, and rejecting dogma and rhetoric, instead of action and involvement. We were specially pleased and honoured when Francesco responded readily to contribute a short and very positive introduction to the Spanish edition of the Naveh- Lieberman Springer book on landscape ecology in 2001. I could not think of anybody else who could serve as such a fine model for a Mediterranean ecologist as Francesco di Castri.

INTRODUCTION – A REVIEW OF THE CHAPTERS CONTENT WITH SOME AUTOBIOGRAPHICAL COMMENTS

The author

1. A SHORT PERSONAL INTRODUCTION

I was born in 1919 in Amsterdam, and grew up in Germany. Escaping the Nazi regime, I immigrated in 1935 to Israel (then Palestine) together with other members of the Zionist Pathfinder youth movement to a Kibbutz (collective settlement) in the Jezreel Valley. In 1938 we founded our own Kibbutz "Mazuba" in the foothills of the Western Galilee. Here, among other jobs, I helped to

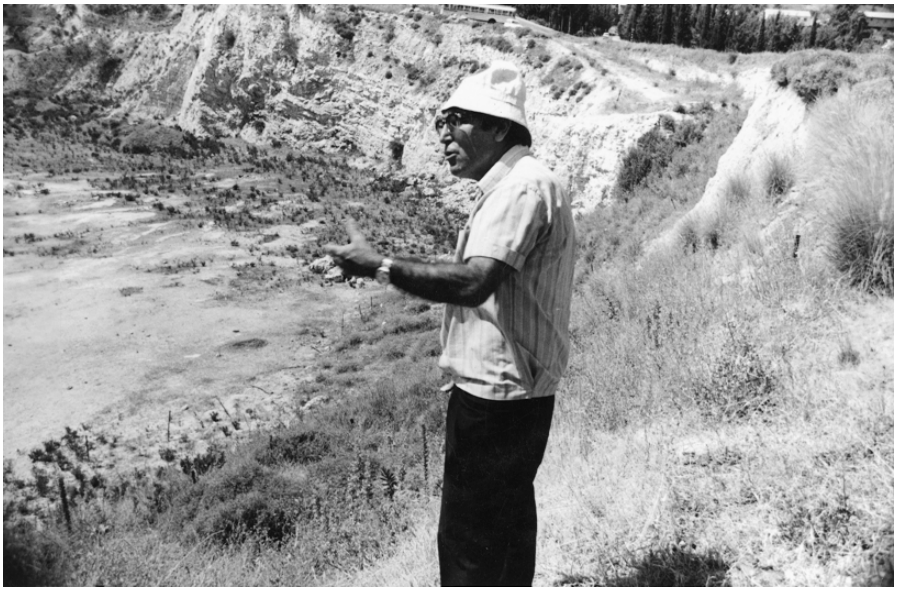
reclaim the rocky slopes for cultivation by uprooting the dense shrub cover, removing the rock outcrops and using these for the construction of terraces, similar to those built already more than 5000 years ago by the Israelite tribes, settling in the hills of the Galilee. My main occupation was to work as shepherd of goats and sheep and finally as cattle herder and breeder for milk and meat production. This marked the beginning of my attachment to the rocky Mediterranean hill and mountain landscape, and its rich natural and cultural assets, resulting from a very long human history of coevolution with these landscapes and their utilization for better or worse. To these Mediterranean landscapes I have devoted most of my professional and scientific career, first as a pasture research scientist after I received a M Sc degree in Agronomy from the Hebrew University, Jerusalem in 1950, at the Governmental Experimental Station, and from 1965 at the Lowdermilk Faculty of Agricultural Engineering of the Technion, the Israel Institute of

The author with pasture specialists from the Israel Soil Conservation Authority (ISCA) inspecting the striking natural regeneration of perennial grasses after temporary removal of shrub competition by controlled burning, chiefly. Note in the background Carob trees, protected from fire. Mazuba 1950, Photo, courtesy I.S.C.A.

The author shows to Tanzania government officials promising grass/legume mixtures for fodder of stall-fed cattle and for soil protection in the coffee plantations of Chagga farmers on Mt. Kilimanjaro, tested in experimental plots, 1964. Photo courtesy Lyamungu Coffee Research Station.

Technology, Haifa as a teacher and researcher in ecology, landscape ecology and restoration ecology. The closely interwoven natural and cultural patterns and processes of these landscapes were among the major topics of my study. However, after learning more about other landscapes all over the world, I realized that this is true for all human-used and modified landscapes and therefore their study and management, conservation and restoration require a holistic approach and integrative methods, transcending the frontiers of the natural sciences into the social sciences, the humanities and the arts. Since my retirement in 1987 as Professor Emeritus, I regard my main scientific mission, to make landscape and restoration ecologists aware of the need for a problem-solving oriented trans-disciplinary landscape science, contributing to the transformation from the industrial to the post-industrial information-rich society, and to my great satisfaction these efforts are not in vain. This anthology is part of my effort in fulfilling this mission.

The following is an overview of the contents of each chapter, interwoven with autobiographical background.



The author shows to his students the result of limestone quarry reclamation with limestone tolerant and drought resistant shrubs and perennial grasses. (In the background, steep unreclaimed slopes). “Nesher” cement factory 1973.

Measuring height of drought resistant fodder shrub for multi-beneficial afforestation, replacing Pinus halepensis in experimental plots at Achihud forest, near Acre, 1974.

2. INTRODUCTION TO CHAPTERS

In view of the complex and closely interwoven ecological, socio-economic, political and cultural crisis facing human society during the present transitional period from the industrial to the post-industrial global information age, there is an urgent need for a transdisciplinary shift, both in theory and in practice in all scientific environmental fields. This is especially true for landscape ecology and restoration ecology and landscape studies in general. Capitalizing on more than 40 years of ecological research and inquiry, this anthology responds to this need by presenting a cross section of major studies and essays in Mediterranean and global landscape issues. Since these studies are found in widely dispersed scientific publications, in professional journals and books or as invited lectures in international meetings, they are not easily accessible for landscape ecologists and restorationists and for all those interested in holistic landscape studies in the broadest sense. I decided therefore to present these as a joint collection in the Springer (formerly Kluwer) Landscape Series, the most suitable channel for this purpose.

Covering a broad range of theoretical and practical landscape issues from holistic and transdisciplinary perspectives, this anthology complements and updates the second edition of our book by Arthur S. Lieberman of Cornell University and myself on theoretical and practical aspects of landscape planning and management, conservation and restoration and landscape studies (Naveh and Lieberman 1994). Its first edition appeared in 1984 as the first English textbook on landscape ecology. Spanish and Chinese translations of the second edition were published in 2000. In this book we introduced a holistic conception of landscapes, based on insights gained in advanced systems science, cybernetics and complexity, which emphasized the need for transdisciplinary approaches to landscape research, education and action. Since that publication, holistic landscape ecology has made great strides (Naveh 2000), and transdisciplinary orientations in environmental and landscape studies are gradually gaining a strong foothold.

Here is the proper place to gratefully recognize that Springer was the first scientific publisher to open the gate for the nascent science of landscape ecology in the English-speaking world with our landscape ecology book, followed later by the publication of many more valuable landscape studies. Therefore it gives me great satisfaction that now, 20 years later, after Springer's fusion with Kluwer, it has taken it upon himself to continue Kluwer's Landscape Series so that I could return to my first publication's "home base". I do this in the hope that this volume will reach not only landscape and restoration ecologists but the steadily growing circle of scientists, academics and professionals, as well as students, who deal with landscape research and practice.

The chapters within this anthology are subdivided into a Mediterranean part and a global part and each are arranged in chronological order by date of their publication. Among the great number of investigations in Israel and other Mediterranean countries on vegetation and landscapes, I have included those which are also most relevant on a global scale. One of these studies reaches far back into the early history and evolution of human cultural landscapes, modified in the Pleistocene with the

help of fire. Others address some of the most crucial issues for the present and future of our open and built-up landscapes, revealing the need for a transdisciplinary systems approach to dynamic planning, conservation and restoration management of Mediterranean multifunctional landscapes. In the second global part, this chronological order reflects progress towards the consolidation of theoretical and practical foundations of a transdisciplinary orientation in landscape ecology (LE) and restoration ecology (RE). These culminate in an updated, specially written chapter, which synthesizes these studies.

CHAPTER 1 – MEDITERRANEAN ECOSYSTEMS AND VEGETATION TYPES IN CALIFORNIA AND ISRAEL (*Ecology* 48: 445–459, 1967)

This comparison between ecosystems and vegetation of California and Israel, as well as other studies, I could conduct in California as Visiting Research Fellow at the School of Forestry of the University of California, Berkeley from 1958 to 1960, thanks to a grant by the National Academy of Sciences, National Research Council (N.A.S – N.R.C.). I was very fortunate to gain this prestigious fellowship at the early stage of my professional carrier. It enabled me to travel and to stay for two years with my wife and two young children, and to take advantage of this distinguished place of teaching and scholarship. I gratefully acknowledge the support and encouragement I enjoyed throughout all these ecological studies from the School of Forestry and especially from my sponsor and gracious host, Prof. H.H. Biswell. I will discuss in more detail how much I learned from my close contact with Prof. Biswell in the context of fire ecology studies of Chapter 3. His assistant, Prof. A.M. Schultz, carried out some exciting and groundbreaking ecosystem research in the Northern California's Pigmy forest and in Alaska. For many years he taught a unique course on transdisciplinary "ecosystemology" and some of the brightest and most open-minded students from different faculties on the campus flocked to his lectures for an experience that was very different from any other classes they had attended on campus. Much later, when I had the delight of inviting him to the Technion as a guest lecturer, his course on ecosytemology greatly inspired my graduate students and all others attending these lectures.

We became close friends and it was thanks to him that I learned much about the exciting shift that American ecology was undergoing at this time, towards a quantitative vegetation science and towards systems ecology, and about the scientists driving these developments.

I was also very fortunate to make close acquaintance of several outstanding scientists at the campus of U.C. Berkeley and to experience their work and teaching. Among these was Prof. H. Jenny, the ecologically minded prominent soil scientist, Prof. H.G. Backer and Prof. G.L. Stebbins, distinguished geneticists and evolutionairies, and last but not least Prof. K. Sauer, the great cultural geographer, who can be regarded as the first American holistic landscape ecologist. He was the first to draw my attention to the resemblances between the history of fire and its pre-agricultural human uses in the Mediterranean and in California, to which I will refer in Chapter 7. Through visits at Berkeley's famous anthropological museum and library I also learned much about the

pre-European California Native American land use. All these scientists and scholars opened new vistas for me and had great influence on my work and thinking.

The same holds true for the far-sighted holistic ecologist Frank Egler, whom I met for the first time (and several times later on) at his famous Eaton Forest estate in Connecticut on the way back to the East Coast before returning home to Israel. I adopted his "Total Human Ecosystem" (THE) concept, integrating humans with their total environment, by which humans are treated as co-evolutionary partners at a higher ecological hierarchic level above the natural ecosystem. At the University of Georgia at Athens, Georgia, where I presented a guest lecture on my work in California, I made the acquaintance of Prof. E.P. Odum, the "father" of ecosystem ecology. Although I did not agree with his rather deterministic succession to climax paradigm, his personality and his holistic ecosystem concept made a great impression on me. I introduced his important innovative textbook on the fundamentals of ecology in Israel, and used it extensively while teaching ecology courses at the Tel Aviv University. These were the first ecology courses ever conducted in Israel which enabled students specializing in botany or in zoology to participate jointly. I used Odum's ecosystem concept as the common ecological foundation, bridging the then existing gaps in the ecological education between botanists and zoologists. Later on at the Technion, selected chapters of the third edition of his book (Odum 1971) became obligatory reading for my agricultural and environmental engineering and architecture graduate students. At Brooklyn College, I met Prof. R.H. Whittaker and realized that I was dealing with a giant in vegetation ecology.

In conclusion, these two years in the U.S.A. were formative for me as a young ecologist at the beginning of his professional career and I am most grateful to the N.A.S – N.R.C. for affording me this unique opportunity.

In Chapter 1, I examined both Mediterranean-climate type regions in through integrative comparisons of climatic, topographic, edaphic and botanical features, as well as other landscape characteristics with special attention to the impact of human land uses. About ten years later this was followed by a comprehensive comparison of Mediterranean-climate type ecosystems in Chile and California, conducted under the leadership of Prof. F. Di Castri, whose results were first presented at an international symposium at Valdivia, Chile in 1971, together with a comprehensive collection of lectures on the origin and structure of Mediterranean-type ecosystems (Di Castri and Mooney 1973). I had the great fortune to participate in these groundbreaking discussions and to create warm personal contacts with Prof. Francesco di Castri, who became the most prominent and influentional Mediterranean ecologist. This conference opened the way for closer interactions between ecologists dealing with the comparison of such Mediterranean-type ecosystems and landscapes on all continents and lead to the formation of "ISOMED", the International Society for the Study of Mediterranean Ecology, of which I had the honour to be a distinguished member.

I concluded that in order to conduct an overall landscape comparison, climate alone is insufficient to ensure a resemblance in the structure and physiognomy of vegetation if edaphic and biotic factors are divergent, even if their human uses and reaction to burning are rather similar. For example, this is the case of the grazed and browsed

marquis and garigue shrub vegetation of *Quercus* and *Pistacia* on Terra Rossa and Rendzina soils in Israel and in other Mediterranean countries, as opposed to the chamise (*Adenostoma*) chaparral on very poor non-calcic, lithosols in California.

However, I found the closest overall resemblance between the oak savannas of Central Coastal California, between Santa Barbara and Carmel Valley, dominated by *Quercus douglasii* H.&A. and by *Quercus itaburensis* (Decne) Boiss in the Lower Galilee. I defined such landscapes as *ecologically equivalent*, indicating that resemblance in climatic conditions correlates to parent rock, topography and land use. In these, even great part of the herbaceous vegetation is taxonomically synonymous and some of the dominating woody plants are ecological and taxonomical "vicariants". That means they have close physiognomic features in both Mediterranean-climate type regions. I assumed that the most successful invaders and colonizers from the Mediterranean, such as *Avena, Bromus, Erodium* and *Medicago* were pre-adapted to the combined agro-pastoral Spanish land use, which the latter introduced to California from similar field-grasslands. In fact, according to Stebbins (personal communication 1959) on the few calcareous soils of this region in California, the replacement of indigenous plants by Mediterranean invaders was greatest.

It is of interest to note that by using more advanced statistical methods for the climatic comparison between California and Israel, my young colleague, Y. Carmel, who replaced me as teacher and researcher of ecology at the Technion, and with whom I co-authored a study on the evolution of Mt. Carmel cultural landscapes (see Chapter 7), reached similar conclusions, 30 years later. He found also the closest climatic resemblance existing between the Mediterranean Zone in northern Israel and the Central Coastal Region and choose the Carmel Valley, dominated by *Q. Douglasii,* as his main study area in California, which was also one of my chief study areas.

CHAPTER 2 – Naveh Z. and R.H. Whittaker (1979). STRUCTURAL AND FLORISTIC DIVERSITY OF SHRUBLANDS AND WOODLANDS IN NORTHERN ISRAEL AND OTHER MEDITERRANEAN AREAS (Vegetatio 4:171–190.)

This study was carried out in collaboration with Prof. R.H. Whittaker whom I met again at Cornell University. Since our first encounter he had founded the most advanced school of quantitative vegetation science in North America. I had the opportunity to get closer acquainted with his work and especially with his innovative, quantitative approach to biological diversity. I was very fortunate to gain his collaboration for a joint study of structural and floristic diversity in Israel and other Mediterranean areas. We applied the method that Whittaker himself had developed, used also for his precious studies in other mediterranean climate regions in California, Chile, Australia and South Africa.

As part of the first Mediterranean biodiversity study (and one of the first studies, supported by the Israel–USA Research Foundation), we also included some of the results of these studies, as well as of my research in Northern California. We also developed the system of using stratified vegetation cover and richness as parameters

for structural diversity. Despite of the great importance of these parameters for determining the ecological niche diversity for understory plants and for birds, it is largely neglected in biodiversity studies. Our investigation of vascular plant diversity in Israel was combined with a study of animal species diversity lead by Prof. M. Warburg.

Our Israeli study provided convincing proof that richness and diversity of herbaceous species was dependent on the kind and intensity of defoliation pressures in shrublands and on grazing intensities in open Tabor oak woodlands. Biodiversity was highest under moderate grazing during the main winter rain growth season. This was later on corroborated by the findings of Noy-Meir and Kaplan (1991) on a much larger scale. In addition, we found that diversity increased along a declining moisture gradient, with highest woody and herb species richness in open *Pistacia lentiscus* shrubland on the xeric borders of the Mediterranean climate zone on Mt. Gilboa (described already in the Bible as a dry place, "lacking dew and rain"). Here we found shrubs and herbs with one of the highest alpha diversity in the world. Mt. Gilboa also ranked highest in animal species diversity. As mentioned in Chapter 5, the ecotype of *P. lentiscus* on Mt. Gilboa proved itself as the most drought resistant of all those we tested in Northern Israel, and we can assume that this is true not only for *P. lentiscus* in Israel, but also for all other sclerophyll shrubs throughout the Mediterranean.

Comparing the diversity of the different Mediterranean climate types, we clearly distinguished between the much older Gondwanan heath-like plant communities in Australia and South Africa, and the younger Pleistocene Californian chaparral and woodlands, the Chilean matorral and the Old World Mediterranean shrublands and woodlands. The former are well adapted to very old, nutrient-poor soils, which are lacking in annual species, but are extremely rich in woody species. In this context we also discussed the evolutionary implications of the increasing duration of human disturbances in California, Chile and the Mediterranean, mentioned also in Chapters 2 and 7.

CHAPTER 3 – FIRE IN THE MEDITERRANEAN – A LANDSCAPES ECOLOGICAL PERSPECTIVE. In: Goldammer, J. F., Jenkins M. J. (Eds) Fire in Ecosystems Dynamics. Proceedings of the Third International Symposium in Freiburg, FRG, May 1989. SPB Academic Publishing, the Hague, the Netherlands, pp. 1–20.

This chapter is based on the outcomes of our fire ecology research until 1975. I had commenced this research already in 1951, as part of my studies on brush range improvement of mixed Marquis shrub communities in the Western Galilee, while working as pasture and range research scientist at the Neve Yaar Governmental Experimental Station. It served at the same time also as a part of my PhD thesis at the Hebrew University, Jerusalem.

In this study I followed the example of California, using controlled, prescribed burning of the brush canopy as a favourable seedbed for perennial grasses in the ashes, but simultaneously also saving the scattered *Quercus calliprinus* oaks and *Ceratonia siliqua* carob trees from the fire. The object was to create a more or less

stable and productive perennial grass – tree savanna. However, we tried in vain to prevent the vigorous resprouting of the shrub canopy by applying brush killers 2–4D and 2–4–5T from airplanes or by selective spot spraying of the resprouting of undesirable woody plants in the first years after the fire. This was one of the first applications of herbicides in Israel and as mentioned below I did not have at that time any misgivings about herbicides spraying.

In addition to my smaller-scale intensive experimental areas, the large-scale controlled burning, reseeding and spraying trials were carried out on the non-tillable rocky shrub hill pastures of Kibbutz (collective settlement) Mazuba in close cooperation with the Soil Conservation Department of the Ministry of Agriculture and "Chim Avir", the first commercial company in Israel, spraying herbicides by airplanes. As a former member of Kibbutz Mazuba, in charge of the cattle herd, I was well acquainted with these shrublands and used the Kibbutz as my "home base" for these studies. At the same time I could also study the effect of widespread wildfires in adjacent marquis shrubland on the post-fire regeneration of the herbaceous and woody vegetation grazed by cattle and goats under traditional grazing regimes.

However, in spite of the successful establishment and early high production of some of the reseeded grasses, and especially *Oryzopsis (Piptatherum) milicea* and *Phalaris tuberosa*, these highly palatable grasses were very sensitive to heavy grazing in the spring and were soon crowded out by the vigorously regenerating shrubs. Therefore, the long range results were disappointing, both from a practical, economic and ecological point of view. However, this taught me a valuable lesson: you cannot fight nature by futile attempts to turn such resilient shrub communities into grass pastures. In my thesis in 1958, I still cited recent studies which claimed that 2–4D and 2–4–5T had no detrimental effects on cattle. When I found out about the detrimental effects of these herbicides, I became one of the strongest opponents of the use of these herbicides. Our landscape ecological and restoration studies, carried out since 1965 at the Faculty of Agricultural Engineering of the Technion, also convinced me that the evergreen sclerophyllous shrub, *Pistacia lentiscus* which we previously attempted to eliminate as a low-palatable and heavy competitor for grasses and trees was a most valuable soil protector and builder, with high photosynthetic and water efficiency. Combining low palatability with high drought resistance and limestone tolerance, this vigorously resprouting after fire and cutting, deep-rooted shrub maximizes its overall survival potentials. Therefore, we also used it as a bio-engineering and ecological model plant for rehabilitation and slope stabilization (Yogev and Naveh 1986) and other restoration studies (Naveh 1988) (See also Chapters 4 and 6).

Thanks to these earlier studies, I became aware of the significance of fire in the Mediterranean uplands – and fire ecology studies both in the Western Galilee and on Mt. Carmel became an important part of my research programme.

Here is the proper place to mention how much I was inspired in my fire ecological studies in Israel by Prof. Biswell's fire ecology research in California. His untiring efforts to introduce controlled burning to prevent destructive hot wildfires, and at the same time to show its beneficial effects on wildlife and browsing game in forests and shrublands and in nature reserves and parks, faced fierce opposition by most of his

colleagues of the School of Forestry. He even was not allowed to use the University's experimental forest for his studies and had to carry out his experiments on privately owned forest land in Northern California. This turned out to be a unique opportunity to prove how right he was: one of the most destructive wildfires, raging in the Ponderosa pine forests of Northern California could be stopped right on the border of the forest in which Biswell had cleaned the entire brush understory by controlled burning. Thus, in spite of all obstacles he finally made his point on a much larger scale and in a real situation, and not in experimental plots of the University forest which he could never have simulated on experimental plots at the University forest. He showed convincingly that the "Smoky Bear" syndrome could be replaced by more efficient ways to prevent hot and uncontrollable wildfires, namely by the judicious application of fire and fuel management, especially in national Parks and Reserves. He served for me as an example to present a similar message in Israel and in the Mediterranean Basin to replace the wholesale condemnation of fire in Mediterranean uplands by a more rational approach, realizing that controlled and prescribed fire has advantages.

In this International Symposium on Fire in Ecosystem Dynamics at Freiburg I discussed the role of fire from a landscape ecological perspective, emphasizing the most relevant aspects for the study and application of fire as a tool in integrated and dynamic conservation management for Mediterranean uplands.

This chapter also summarizes our studies on the effect of burning on soil fertility and stability, showing that fire serves as an important link in the recycling of nutrients to the soil. In the first years after the fire, this has striking effects on the herbaceous fire followers, and especially on the rise in dry matter and seed production of grasses. If this was also the case in the Late Pleistocene, it could have had far-reaching implications for the role of fire in the domestication of grasses, such as *Triticum dicoccoides* and *Hordeum spontaneum* (see Chapter 7). In the following years also deeper-rooted woody plants could take advantage of this.

Like in the earlier studies in the Western Galilee we similarly could not detect on Mt. Carmel any evidence of run-off or soil erosion, after hot wildfires in dense Marquis and mixed oak and pine forests. However, this does not mean that under heavy grazing or other post-fire disturbances, such as the removal of dead wood, no erosion could occur. Indeed the greatest damage can be inflicted upon the vegetation and soil by goat and cattle grazing in the first winter and spring after fire. I therefore warned against jumping into too sweeping general conclusions on the effect of fire from single, short-term studies and superficial observations. I further pointed out that the study of fire should be treated in a holistic way as part of multifactorial landscape functions. In such a function, a clear distinction has to be made between controlling landscape state factors, such as land use, soil parent material, relief, climatic fluxes and organisms, and their depending post-fire variables, such as soil, vegetation, human-made artefacts.

I hypothesized that these fire-swept Mediterranean upland landscapes could be considered perturbation dependent dissipative structures, maintained and stabilized only by permanent energy/matter and entropy exchange with the environment. I illustrated this with the help of Prigogine's dissipative function under different fire perturbation

regimes. The determination of optimum fire perturbation regimes requires systematic long-term studies on all landscape scales. In such optimum regimes, intervals between fires should neither be too frequent nor occurring with too long intervals, so that the capacity of constant self-organization and stabilization can be maintained for the conservation and enhancement of biological diversity and other desirable functions. For this purpose, new directions in research and land management are necessary, which aim not only at the suppression of destructive wildfires, but also at the beneficial application of fire and fuel management. To my great satisfaction the results of these studies could serve as guidelines for the extensive fire ecology research, following two wildfires on Mt. Carmel and included prescribed burning in pine forests.

This chapter is the first in this anthology reflecting the broadening of my perceptional and conceptional scientific "looking glass" from ecosystems to landscapes. This paradigm shift towards landscape ecology was influenced to a great deal by my visits to Central Europe, where I became acquainted with LE and created personal, long-lasting warm contacts with some of its outstanding representatives in Germany and the Netherlands. Their broad holistic approach and impressive, problem-solving oriented research enriched my thinking and inspired the future direction of my work. Among these distinguished landscape ecologists were Prof. Wolfgang Haber from the Technical University of Muenchen in Weihenstephan, Prof. Karl-Friedrich Schreiber from the University of Muenster. I was introduced to them by their former teacher and mentor, Prof. H. Ellenberg, my gracious and impressive host at the University of Goettingen. He was the most influential plant ecologist of Central Europe, broadening its scope by initiating integrated ecosystems studies, and especially the Solling project as one of the most comprehensive multidisciplinary International Biological Program in Europe. As reflected in Naveh and Lieberman (1994), his ecosystem concept inspired the distinction between natural biosphere and artificial technosphere ecosystems and landscapes. Also in the Netherlands I made the acquaintance of two of the leading landscape ecologists, Prof. Edie Van der Maarel from the University of Nijmegen and Prof. Isaac Zonneveld from the important ITC institute in Enschede, who was chosen the first president of the International Association of Landscape Ecology (IALE), founded in 1984. These developments paved the way for our first edition of the above-mentioned textbook on LE, published in 1984 by Springer, containing also a detailed description of the development of LE in Central Europe (Naveh and Lieberman 1994). My collaborator in this book and dear friend, Prof. Arthur Lieberman from Cornell University also introduced me to the emergence of this science in North American as a most important and active branch of IALE.

CHAPTER 4 – FROM BIODIVERSITY TO ECODIVERSITY: A LANDSCAPE–ECOLOGICAL APPROACH TO CONSERVATION AND RESTORATION (*Restoration Ecology* 2:180–189, 1994)

My first paper in my first newly founded journal "Restoration Ecology" – I attempted to present RE in the framework of a holistic landscape conception of whole landscape restoration. I considered such restoration as part of the urgently needed

environmental revolution, which should lead to a post-industrial symbiosis of humans and nature, as expressed through human–landscape interaction. This conception was the outcome of more than 20 years research and its application in practical restoration and biological protection projects on denuded slopes and roadsides. This included the rehabilitation of an abandoned limestone quarry (the very first carried out in any semi-arid Mediterranean country (see also Chapter 9)). The first inspiration for such a landscape restoration concept I gained in my above-mentioned visit to Germany, and especially from the impressive, large scale, whole landscape restoration work, carried out along the Mosel and the Ruhr rivers, and from the open coal mine rehabilitation in the greatest industrial center of Germany in the Ruhr district. This was carried out in the 1960s as a major effort to improve the quality of life and to prevent many of the highly qualified professional labourers and engineers immigrating to more attractive regions, especially to the rapidly developing industrial areas in Bavaria.

I was also very fortunate to have the opportunity of later learning from the experience and expertise of restoration research and practice in many other countries and conditions where I enjoyed the kind hospitality of my guides. Here I can mention only very briefly some of these. Thus, for instance, I gained much inspiration for our restoration research, and for what I introduced as "vegetation engineering" to Israel, from the closer acquaintance with such grand bio-engineering projects along the Brenner Pass highway and from similar, smaller-scale work in the Swiss and Austrian Alps.

I benefited very much from my personal contacts with Prof. A.D. Bradshaw from the University of Liverpool. He was one of the first ecologists to devote himself to the foundation of a practical restoration science and its application to the reclamation of industrial dereliction and abandoned copper mines. He published together with M.J. Chadwick the first groundbreaking book on restoration (Bradshaw and Chadwick 1980).

Spending part of my sabbatical year, 1978, in Australia and presenting a series of guest lectures, in which I introduced LE which at that time was not known in any English-speaking country, I also learned much about the Australian restoration work. My excellent guide was C.V. Malcolm from the Agricultural Department of South-West Australia at Perth, one of the first ecological experts, choosing restoration not only as a profession, but also as a mission. Thanks to him. I had the opportunity to see much of the reclamation work of the salt affected Yarrah Eucalyptus forest slopes in the Wheat Belt in South Western Australia, and the use of halophytic *Atriplex* species as pasture shrubs, wherever the degradation had reached the point of no return. Among those shrubs from Australia, I tested in Israel, the limestone tolerant *A. nummularia* was the most promising, palatable and productive fodder shrub. It competed successfully under heavy goat grazing pressure with *Sarcopoterium spinosa*, dominating the dwarfshrub "Batha" communities in poor calcareous Rendzina soils and re-invading these reclaimed sites.

In the USA I had the great fortune to create close and lasting ties with Prof. Edith B. Allen, who invited me to an excellent symposium on advanced restoration research in arid and semi-arid land (Allen 1988). Prof. Allen is a leading restoration ecologist in