DESERT DEVELOPMENT

The GeoJournal Library

Series Editor: WOLF TIETZE

Editorial Board

John E. Bardach, Honolulu
Pierre Biays, Lille
Asit Biswas, Oxford
Bruce Currey, Bedford Park
J. Demek, Brno
Yehuda Gradus, Beer-Sheva
Arild Holt-Jensen, Bergen
Huang Ping-wei, Beijing
Johannes Karte, Bonn
P. M. Kelly, Norwich
C. Kergomard, Lille
C. Gregory Knight, University Park
M. P. Lapping, Guelph

W. Lauer, Bonn
Lee Shu-tan, Nanjing
Richard F. Logan, Los Angeles
Walther Manshard, Freiburg i. Br.
German Müller, Heidelberg
Paul Müller, Saarbrücken
Hiroshi Sasaki, Tsukuba
Akira Suwa, Tokyo
Jörn Thiede, Kiel
H. Th. Verstappen, Enschede
E. M. Yates, London
M. M. Yoshino, Tsukuba
Alexander Zaporozec, Madison

Desert Development

Man and Technology in Sparselands

Edited by

Yehuda Gradus

Ben-Gurion University of the Negev, Beer-Sheva, Israel

Publication of this work was made possible thanks to the generous financial support of The Blaustein International Center for Desert Studies, Sede Boqer, Ben-Gurion University of the Negev, Israel

D. Reidel Publishing Company

A MEMBER OF THE KLUWER ACADEMIC PUBLISHERS GROUP

Dordrecht / Boston / Lancaster / Tokyo

Library of Congress Cataloging in Publication Data

Main entry under title:

Desert development.

(GeoJournal library)

Bibliography: p.

Includes index.

1. Desertification—Addresses, essays, lectures.
2. Arid regions agriculture—Addresses, essays, lectures.
3. Dessert resources development—Addresses, essays, lectures. I. Gradus, Y., 1942– II. Series
GB611.D394 1985 333.7'3 85–14229

ISBN-13: 978-94-010-8882-4

e-ISBN-13: 978-94-009-5396-3

DOI: 10.1007/978-94-009-5396-3

Published by D. Reidel Publishing Company

P.O. Box 17, 3300 AA Dordrecht, Holland

Sold and distributed in the U.S.A. and Canada

by Kluwer Academic Publishers,

190 Old Derby Street, Hingham, MA 02043, U.S.A.

In all other countries, sold and distributed

by Kluwer Academic Publishers Group,

P.O. Box 322, 3300 AH Dordrecht, Holland

All Rights Reserved

© 1985 by D. Reidel Publishing Company, Dordrecht, Holland

Softcover reprint of the hardcover 1st edition 1985

No part of the material protected by this copyright notice may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, recording or by any information storage and retrieval system, without written permission from the copyright owner.

**I will make a way in the wilderness
and rivers in the desert.**

Isaiah 43:19

TABLE OF CONTENTS

Acknowledgements	ix
Preface	xi
I: VIEWPOINTS	1
DAVID H. K. AMIRAN / Arid Zone Development: An Appraisal towards the End of the Twentieth Century	3
MICHAEL J. WATTS / Social Theory Environmental Degradation	14
RICHARD E. LONSDALE / The Political Burden of Spareseland Development: Some International Consistencies	33
II: THE BUILT ENVIRONMENT	39
YEHUDA GRADUS and ELIAHU STERN / From Preconceived to Responsive Planning: Cases of Settlement Design in Arid Environments	41
BARUCH GIVONI and LISA ORLICK / Planning for Comfort in Hot Dry Climatic Regions	60
YAIR ETZION / Desert Architecture – The Architecture of the Extremes	81
III: PROVISION OF SERVICES IN SPARSELANDS	103
ELIAHU STERN / The Provision of Public Transit Services in the Arid Environment	105
JONATHAN D. MAYER / Health Services in Sparsely Settled Areas	118
AVINOAM MEIR / Delivering Essential Public Services to Arid Zone Nomads	132
SHABTAY DOVER and YITZHAK KHAYUTMAN / High Technology Alternatives for Educational Systems in Sparsely Settled Zones: The Case of the Israeli Desert	150
IV: HIGH TECHNOLOGY IN DESERT AREAS	165
AMOS RICHMOND / Desert Agriculture – Past and Future	167
HAIM TSOAR and YEHUDA ZOHAR / Desert Dune Sand and Its Potential for Modern Agricultural Development	184
CHARLES F. HUTCHINSON / Remote Sensing for Arid Zone Development	201
ILAN SALOMON and ERAN RAZIN / Potential Impacts of Tele- communications on the Economic Activities in Sparsely Populated Regions	218

V: ECONOMIC POTENTIAL AND DEVELOPMENT	233
STUART GABRIEL, MOSHE JUSTMAN, and AMNON LEVY / <i>The Development of Sparsely Populated Arid Regions: An Integrative Analysis with Application to the Negev</i>	235
EITHAN HOCHMAN, GIDEAN VITKON, RICHARD E. JUST, and DAVID ZILBERMAN / <i>The Dynamics of Agricultural Development in Sparsely Populated Areas: The Case of the Arava</i>	256
SHAUL KRAKOVER / <i>Development of Tourism Resort Areas in Arid Regions</i>	271
VI: TOWARDS THE FUTURE	285
JOEL SCHECHTER / <i>New Frontiers in Desert Research</i>	287
About the Authors	310
Index	315

ACKNOWLEDGEMENTS

I would like to express my thanks to a number of people who have been particularly helpful with information, guidance, and suggestions in the preparation of this book.

I would especially like to thank Ms. Chaya Galai of the Humphrey Center of Ben-Gurion University of the Negev for her invaluable editorial assistance. Her careful reading and editing of the papers have improved their quality and readability. I must also thank Sonya Oren for typing successive drafts. A special word of thanks is due Sharona Lazar and Neta Peer who took on the job of drafting maps with vigor and precision. Thanks also to the staff of the photography laboratories of Ben-Gurion University of the Negev, Beer-Sheva, Israel for their help.

Special mention goes to Shira Leibowitz for her editorial suggestions, revisions of the Preface, and ideas about the structure of the book.

Generous support was also supplied by the Blaustein International Center for Desert Studies and the Jacob Blaustein Institute for Desert Research at Sede Boquer, under the auspices of Ben-Gurion University of the Negev.

Thanks are also due to D. Reidel Publ. Co., Dordrecht, the Netherlands, who supported the project from the beginning, and especially to Drs. Michiel C. ten Raa of this company.

Professor Wolf Tietze, the editor of *GeoJournal* must be thanked for encouraging this project.

My appreciation is extended to the numerous experts who refereed the articles and were so generous with their time.

I want to thank the *Geographical Research Forum*, edited by Eliahu Stern and Avinoam Meir of the Geography Department of the Ben-Gurion University of the Negev for permission to reprint Richard Lonsdale's paper, 'The Political Burden of Sparseland', which appeared in the September 1983 issue, No. 6, pp. 72-77.

A special thanks to my wife, Dorit, without whose help, encouragement and companionship none of this would have seen the light of day.

Though each of the above people has contributed to the book, I alone must be held responsible for any remaining shortcomings.

Beer-Sheva 1985

YEHUDA GRADUS

PREFACE

The fact that approximately one-third of the world's land mass is arid desert may be congenial for the camel and the cactus, but not for people. Nevertheless, well over half a billion people, or 15% of the world's population live in arid desert areas.

If the world's population were distributed evenly over the land surface, we would expect to find about 30% of the population inhabiting arid desert areas. Does the fact that 'only' 15% of the world's population live in an arid desert environment reflect the harshness of the environment? Or is it a testimony to the adaptability and ingenuity of mankind? Do we view the glass as half-full? Or half-empty? The contributors to *Desert Development: Man and Technology in Sparselands* adopt the position that the cup is half-full and, in fact, could be filled much more. Indeed, many arid desert zones do thrive with life, and given appropriate technological development, such areas could support even greater populations. While the dire Malthusian prediction that rapid world population growth exceeds the carrying capacity of existent resource systems has gained popularity (typified by the 1972 Club of Rome book, *Limits to Growth*), there is a growing body of serious work which rejects such pessimistic 'depletion' models, in favor of models which are mildly optimistic. The latter approach, which is found in the essays in this book, views the desert environment as capable of supporting larger human populations due to the accumulation of human knowledge which enables mankind to utilize and exploit new resources. In this book, the reader will find a wide range of essays detailing the ways in which technology can continue to release the potential of arid desert lands for viable settlement.

We make no pretense of being exhaustive, but rather focus on a number of technologies which we believe, if suitably utilized, will enable sparsely populated arid zones to improve their built environments, service provision, and economic development. In contrast to books on desert development which tend to focus on water provision, flora and fauna, or mineral potential, our collection is anthropocentric, concentrating on man and the technologies that enable him to live in the desert. With this man-environment interaction in mind, we have organized the research topics into five distinct sections.

The first section introduces three points-of-view from which to approach arid zone research. The second section examines the built environment. The third section deals with the provision of services in sparsely populated arid (and non-arid) areas. The fourth section discusses specific examples of the application of high technology to arid desert zone problems. Finally, the fifth section explores avenues of potential economic development. The concluding essay suggests future directions of arid zone research and technology.

The first chapter, 'Arid Zone Development: An Appraisal Towards the End of the Twentieth Century', by David H. K. Amiran is an analysis of desert life in developing

nations as it pertains to the needs and expectations of well-to-do populations. The risks of arid zone habitation, both environmental and economic, are expected to limit population increase to the educated and competent, who will settle arid desert areas in a modern oasis pattern. In contrast, Michael J. Watts, in his 'Social Theory and Environmental Degradation', focuses on arid deserts in developing nations. He has a deep respect for the nomad/peasant technologist whose complex decision-making, experimentation, agronomic knowledge, inventiveness and adaptability have ensured a relatively successful system over the past millennia. Watts questions the near-hysterical warnings during the past decades about dangers of desertification and is skeptical of such generalities. He calls on us to abandon the anti-nomad bias of much scientific writing today, and in a myriad of examples shows that we have a great deal to learn from the expertise of farmers and herders in coping with the vicissitudes of arid ecosystems. He emphasizes the social referents in environmental processes and the pivotal role of the political and economic micro-climate. Whereas Amiran grounds his viewpoint in examples mainly from the Israeli experience, Watts concentrates on the Sudano-Sahelian West African desert. Both authors are optimistic about technology enabling man to cope with desert conditions: for Amiran it is current and future technologies which increase our understanding; for Watts it is past and present methods.

Richard E. Lonsdale introduces a third viewpoint in 'The Political Burden of Sparseland Development: Some International Consistencies'. While the focus of his attention is not arid or desert lands per se, he touches on one facet of such areas: their sparse population. Not all sparselands are deserts, but most deserts are sparselands; and Lonsdale probes the factors which often lead to sparselands becoming 'wards of the state'. Lonsdale's essay is included because it indicates the generic quality of problems and policy associated with development of arid zones. His analysis, attributing the dependency of sparselands on outside forces to the exploitation of natural resources, misguided settlement patterns, and unrealistic service demands, contrasts somewhat with the previous more optimistic viewpoints. Nevertheless, Lonsdale envisages the long-term viability of sparselands if realistic goals are set. Lonsdale's viewpoint highlights topics covered in the two sections following his paper, 'The Political Burden of Sparselands Development'.

The essays in section two focus on the different levels of interaction between man and the built environment. Yehuda Gradus and Eliahu Stern, in 'From Preconceived to Responsive Planning: Cases of Settlement Design in Arid Environments', discuss the specific problems arising from planning regions and urban and neighborhood environments in a desert setting. Their article is based on examples from the Negev desert planning experience where problems associated with applications of preconceived and inappropriate models for (a) a regional settlement system; (b) a specific city (Beer-Sheva); and (c) a nomadic Bedouin town, eventually led planners to develop a more responsive process for erecting built environments. Gradus and Stern discuss planning on the macro level. In the following essay, 'Planning for Comfort in Hot Dry Climatic Regions', Baruch Givoni and Lisa Orlick discuss environmental planning on the micro level. The theoretical issues in micro-planning

which a designer – architect, engineer or planner must consider when adapting the built form to the desert environment are applied to a hypothetical desert dweller whose comfort needs must be satisfied if desert inhabitation is to succeed. These papers stress that responsive planning with feedback processes are crucial in the desert environment. The next essay, ‘Desert Architecture – the Architecture of the Extremes’, by Yair Etzion, which draws on examples from the Negev, discusses the problem of working with preconceived notions of architecture. Etzion narrows our focus down to the micro built environment of the individual dwelling unit. The economic and technical problems of providing thermal comfort in a desert environment are highlighted.

Once the settlement needs have been examined, service needs of the population are treated. Section three, ‘Provision of Services in Sparselands’, contains discussions of specific services – transportation, health and education. Eliahu Stern presents the interrelationships between the arid spatial conditions, the transit demand patterns and the transit supply requirements. His chapter, ‘The Provision of Public Transit Services in the Arid Environment’, also examines the required service standards in the sparsely populated arid areas which will later be used as guidelines for developing regional transit systems. In dealing with ‘Health Services in Sparsely Settled Areas’, Jonathan D. Mayer examines the allocation of health service resources to sparsely settled areas. Mayer maintains that the specific characteristic of aridity and desert environments has a negligible impact on health problems compared to the impact of the sparse and dispersed settlement pattern, which severely impinges upon the provision of health services. The latter factor is examined in the light of allocation of resources between primary care facilities (e.g. hospitals) versus investments in public health improvement schemes. In sparsely settled areas (and consequently in arid lands) benefits accruing from health and sanitation investments are greater than those for other types of health service expenditures. Mayer’s paper deals with a wide range of examples from Africa, the Middle East and the United States. Next, in ‘Delivering Essential Public Services to Arid Zone Nomads’, Avinoam Meir focuses on a specific case of desert population, that of the Negev Bedouin, and examines the problems involved in providing health and educational services to a dispersed and mobile nomadic populace, whose values as well as physical environment are sometimes hostile to service provision. Lastly, Shabtay Dover and Yitzhak Khayutman discuss ‘High Technology Alternatives for Educational Systems in Sparsely Settled Zones: The Case of the Israeli Desert’. Application of electronics technology in the field of education is examined as one means, among others, to overcome the distance handicaps in sparsely populated areas. This chapter broaches the subject of high technology, which will be discussed in greater detail in section four.

The next four chapters contain a spectrum of examples of high-technology applications to desert, arid zone, and sparseland problems. In order to put present high technology efforts into historical perspective, we open with Amos Richmond’s our analysis of ancient methods of harnessing desert conditions into fruitful productivity. In ‘Desert Agriculture – Past and Future’, Richmond indicates how the basic philo-

sophy of desert farmers thousands of years ago can be adapted into present and future biotechnologies in arid zones. This and the next essay both indicate how perception of the desert may change from that of a wasteland to an area of food production and even in some areas food production for export. An in-depth study of one facet of desert agriculture is provided by Haim Tsoar and Yehuda Zohar who discuss the 'Desert Sand Dune and Its Potential for Modern Agricultural Development'. They point out that certain soil conditions, usually considered disadvantageous to vegetation, can be advantageous in arid lands. By applying an integrative high technology approach which takes into account such factors as soil, sand, water and atmospheric conditions, crop selection and market timing productivity can be impressively increased. The following essays focus on high technology applications for non-agricultural endeavours in arid zones. Charles F. Hutchinson discusses the advantages of 'Remote Sensing for Arid Zone Development', in the assessment of land use and resources. Information gathering and monitoring is an often neglected stage, and for large expanses of arid zones, remote sensing combined with some ground sampling in a multi-stage approach can be pivotally important and economically necessary. Another application of high technology is examined by Ilan Salomon and Eran Razin in 'Potential Impacts of Telecommunication on the Economic Activities in Sparsely Populated Regions'. The Israeli examples studied by them are not primarily arid zone case studies, but the implications for similarly dispersed arid zone settlements are important in demonstrating the opportunities (for the development of sparsely populated areas) made possible by telecommunications industries.

The first chapter of section five provides a conceptual framework for evaluation of economic development of sparsely populated regions. The subsequent two chapters detail the dynamics of two economic sectors: agriculture and tourism.

In 'The Development of Sparsely Populated Arid Regions: An Integrative Analysis with Application to the Negev', Stuart Gabriel, Moshe Justman, and Amnon Levy outline an integrative framework for analysis of development of sparsely populated arid zones. The development model underlying this analysis makes explicit the intimate relationship between the structure of growth in population in arid areas with the availability of both industrial employment opportunities and housing options. The authors of this essay also evaluate recent development trends in Israel's arid Negev region, which includes about a dozen new towns. The factors which determined the relative success of about half of the towns, and the reasons for the relative stagnation of the others are discussed. The authors close by making explicit policy suggestions which flow from their analysis of economic development of sparsely populated arid regions throughout the world.

While the aforementioned authors study non-agriculturally based desert settlements, Eithan Hochman, Gideon Vitkon, Richard Just, and David Zilberman tackle the problem of 'The Dynamics of Agricultural Development in Sparsely Populated Areas: The Case of the Arava'. In their essay, they characterize the main elements of optimization problems associated with such regions, and use the settlement of the

Arava desert region of Israel to demonstrate the stages they suggest all successful desert settlements go through leading to economic take-off and eventual saturation. They attribute the relative success of sparsely settled regions to the dynamic optimization framework which necessitates some risk-taking.

Another sector for economic development is closely examined by Shaul Krakover in his essay 'Development of Tourism Resort Areas in Arid Regions', the last in section five. His assessment considers the desert's (1) unique physical conditions; (2) limited accessibility; (3) poor infra-structure; and (4) limited and untrained endogenous manpower. On the basis of these considerations, the author presents a developmental stage model in which he portrays the changing conditions required for the development of a resort area in desert environments. He examines his multi-stage model in light of the actual development of the Dead Sea resort area in the Israeli Negev.

In the final essay by Joel Schechter entitled 'New Frontiers in Desert Research', future directions for research are described. After summarizing the major sources and resources in the world for food and mineral production, Schechter presents an argument for expanded and more intensive utilization of arid desert areas. He then discusses various avenues of research and development which hold promise for desert zone development. Several research endeavours are described and evaluated and suggestions made for some novel, high-risk directions which depart from conventional research policy. Examples of his wide-ranging discussion include the development of plastic materials for irrigation, mulches, wind-breakers, and other desert uses; suggestions for new social-legal mechanisms for balancing water rights; and genetic engineering for desert livestock husbandry. Rather than emphasizing one area in particular, Schechter stresses the importance of research and development of new technologies in order to expand the possibilities embedded in desert areas.

All the essays, with the exception of the third, by Richard Lonsdale, have been specially commissioned for this book. Many chapters draw from the Israeli experience of arid desert developments. It was felt that Israel provided conditions which emulate a gigantic 'living laboratory' for desert research, development, and applications. Though compact, Israel contains many gradations of arid desert areas. Furthermore, data gathering in Israel is made easier due to the number of desert-oriented research and information collection institutions. In addition, on-going research has been and continues to be monitored, with a plentiful supply of researchers, technical staff, and observers. Since two-thirds of Israel's area is desert, and that area contains only ten percent of the population, problems of both deserts and sparselands can easily be studied *in situ*.

In contrast to those fatalists who see the world being depleted of resources, we have presented what we believe is a hopeful picture of man vis-à-vis natural resources. These essays view positively *man's* intervention in nature, and the authors demonstrate man's ingenuity in using his knowledge to harness nature. We trust that

some of the ideas and technologies discussed in *Desert Development: Man and Technology in Sparselands* will encourage further research and development in the world's sparsely populated arid environments.

*Department of Geography and the Blaustein
International Centre for Desert Studies
Ben-Gurion University
of the Negev, Israel*

YEHUDA GRADUS