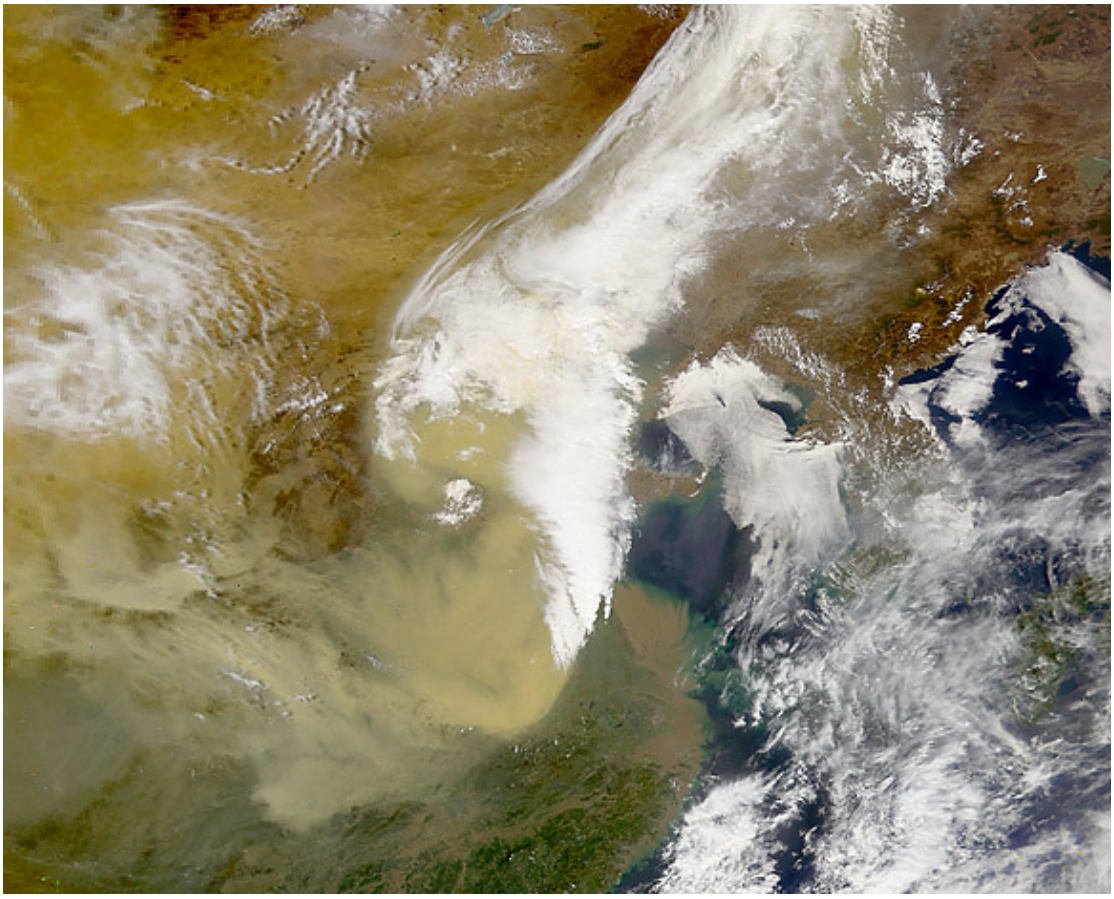
GLOBAL ALARM:
DUST AND SANDSTORMS
FROM THE WORLD'S DRYLANDS



UNITED NATIONS

Front cover photograph:

"These SeaWiFS images show the development of a large dust storm in China and its interaction with a meteorological system that carried the dust far out into the Pacific Ocean. In the first image, from April 16, 1998, the bright yellowish-brown cloud near the coast is the center of the storm, being pushed by a frontal system. In the subsequent images from April 20-24, the atmospheric circulation around a low-pressure system entrains the dust from the storm and carries it over the North Pacific Ocean. On April 25, dust from this event reached the West Coast of North America."

Acknowledgements:

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http://eosdata.gsfc.nasa.gov/CAMPAIGN_DOCS/OCDST/asian_dust.html

Additional copies of this publication are available upon written request from the Asia RCU of the UNCCD, United Nations Building, Rajadamnern Avenue, Bangkok 10200, Thailand.

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Yang Youlin
Bangkok

Victor R. Squires
Adelaide

Lu Qi
Beijing

Bangkok, August 2001

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PREFACE

INTRODUCTION

After the devastating dust storms that swept across Northern China in 2000, there was much interest in examining and analyzing experiences with dust storm mitigation, prevention, forecasting and control. There was a need to document the nature, extent, causal factors associated with the severe sand and dust storms experienced in China itself and which threatened the lives and livelihoods of millions of people. Due to the long-range transport of sediments impacting the neighbouring countries, especially those downwind of the source, there was much interest in getting international cooperation so that the collective wisdom of experts from many countries could be distilled in this monograph.

What emerged from the writings collected here was that desertification - land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities, is the result of processes that are complex and variable. Desertification is characterized by a cycle of natural and socio-economic causes and effects.

Sand and dust storms are both a symptom and cause of desertification. They are often an early warning that things are going wrong. Once they progress from slight to serious and severe categories they contribute to the spread of desertification through the transport and deposition of sediments that can destroy crops, habitation and infrastructure and render areas uninhabitable.

Combating sand and dust storms demands political, social, biological, economic, educational and engineering approaches as well as the physical effort that has dominated efforts in the past.

Past policy in many countries has been shown to exacerbate the problem and efforts are now being made to reverse past mistakes and set things in train to develop and maintain more sustainable land-use. Lessons learned from the big disasters in North America during the so-called Dust Bowl era of the 1930s and the more recent adoption of participatory approaches in many other countries, may well see a reversal of the recent trends toward more frequent and more severe dust storms, that not only affect local communities but are impinging and impacting on peoples in urban centres. Apart from the inconvenience and the disruption to transport and communications, there is also the increased risk of health-related problems (respiratory diseases, etc).

There are enormous costs in terms of direct damage to life and property but also in terms of income foregone. Development of robust and sophisticated tools to enable economic analysis of the real costs of dust storms is a high priority. Decision-makers need to know, based on cost-benefit analysis, how to respond to the perceived threats.

A number of decision-making problems arise as we try to balance the costs of early action against delayed or no action. One way to deal with this problem of uncertainty is to adopt the precautionary principle *"when there are threats of serious or irreversible damage, lack of full scientific uncertainty should not be used as a reason for postponing such measures."* Clearly there is need for more research into the economic aspects including a robust methodology for assessing *"damage cost"* and more work needs to be done on the important questions of monitoring, prediction and forecasting of dust storms.

Because the impact is on people, the human tragedy needs to fully understood. Drylands occupy half of the world's land surface. They are home to about 1 billion people and therefore warrant a lot of attention from national governments and from the broader international community. From the point of view of the UN family of agencies there are many cross cutting issues involved: food security, poverty alleviation, health and welfare and sustainable development. The recognition that the world's drylands are regions under threat has now taken hold. Many countries are signatories to the UN Convention to Combat Desertification (UNCCD) and many have prepared their National Action Plans. Efforts to arrest and reverse land degradation will have a beneficial effect on the mitigation of dust storms and improve the welfare of the people.

This publication aims at providing the reader with analysis of the factors contributing to dust and sandstorms and provides, via the various detailed case studies, examples of how the menace can be brought under control through a series of measures, ranging from mechanical interventions and bio-remediation to policy change and legislative back up.

SCOPE AND CONTENT

The collection of essays and case studies presented here have been selected to meet the following objectives:

1. To identify more precisely the physics and mechanics of dust storms and the entrainment and transport of sediments.
2. To present reviews of success stories from various countries and regions to demonstrate that measures can be effective in mitigating the effects of dust-related events and to counter the threat of severe and disastrous sand and dust storms.
3. To draw lessons from the experiences gained in designing strategies and programmes for sustainable land-use in the worst affected regions, where climatic and human-induced factors combine to promote frequent and severe dust storm events.

THE BOOK HAS SEVERAL MAJOR THEMES

Human-induced change is by far the most significant factor in the alarming increase in some regions in the scourge of dust storms. Past policies on land-use and the promotion of farming systems that were unsustainable were the root cause of most disasters. Climatic factors, including some evidence of global climate change, make the task of mitigation and prevention more difficult. Distinguishing natural causes from human intervention as factors in accelerated wind erosion is a major task for scientists and land managers.

The challenge for policy makers is to put in place instruments that will reinforce the beneficial aspects of land-use change, assist the reversal of past errors and generally assist the welfare of the people.

THE BOOK IS ORGANIZED INTO SIX PARTS

In *Part I*, the physics, mechanics and processes of dust and sandstorms are examined. *Part II* analyses the experiences in North America (Canada and the US) during and after the Dust Bowl era of the 1930s and also looks at the current situation as weather patterns favourable to dust storm activity return from time to time. *Part III* contrasts the situation on two continents, Australia and Africa, and compares the response to the spread of desertification in each. *Part IV* focuses on the several case studies from Asia and gives insights into the serious and possibly irreversible consequences of large-scale implementation of policies and land-use practices that were fatally flawed. *Part V* zeroes in on China's experiences and particularly analyses several calamitous dust storms that wreaked havoc over vast areas of China and beyond. Detailed case studies are provided of the legacy of destruction in one sub-region where a combination of a harsh and unforgiving environment came into collision with an inflexible set of policy decisions that have proven to be misguided and unsustainable. Finally, *Part VI* looks at the important question of how to forecast, mitigate and prevent dust storms. The role of monitoring and modeling is considered here.

Yang Youlin — *Bangkok*
Victor R. Squires — *Adelaide*
Lu Qi — *Beijing*

Bangkok, August 2001

FOREWORD

Drylands, the focus of the articles in this volume, cover about 43% of the world's land surface. They are characterized by low and variable rainfall and, on many of them, heavy pressure from human impacts. It is for this very reason that the UNCCD was framed and why over 170 countries are signatories to the Convention. The work of the UNCCD is to counter the problems outlined here and to arrest the spread of desertification.

One of the manifestations of desertification that is commonly experienced in the cities and towns of dryland countries is the visitation by dust and sandstorms. Often these dust-related phenomena are the trigger for government action as citizens of the cities and towns pressure their governments to act.

Sand and dust storms are natural events that occur widely around the world, especially in the subtropical latitudes and dry Savannah's. They are most common in the mid-latitude drylands. However, the major dust storms occur where anthropogenic land disturbance occurs in drylands under conditions of severe drought. Major storms occur when prolonged drought causes the soil surface to lose moisture and there are strong winds.

Land management, or lack of it, is also a contributing factor in most cases of dust-related events. Anthropogenic changes in land cover can be reversed by attention to re-vegetation and other remedial measures. The evidence from the work reported in this volume is that frequency and severity of dust storms can be reduced to almost negligible proportions through attention to proper management practices.

The fact that most of the articles in this volume are from Chinese scientists is particularly appropriate, since China is one of the countries severely plagued by desertification. With up to 58% of the country's land area being classified as arid or semi-arid, nearly one-third of China's land suffers from the effects of desertification.

The effects of desertification in China are mainly in the form of encroachment on arable land, destruction of forest ecosystems, and worsening sandstorms that blow across large areas of the northern and western regions. The damage that desertification causes in China each year is estimated to amount to USD 6.5 billion, which accounts for 16% of the overall damage of worldwide desertification.

Desertification occurs primarily in the form of encroachment on arable land but rangelands are also under threat. For instance, in China since the 1950s, expanding deserts have taken a toll of nearly 0.7 million hectares of cultivated land, 2.35 million hectares of rangeland, and 6.4 million hectares of forests, woodlands, and shrublands. At present, as many as 2.6 million km² of land in China is already desertified; each year an estimated 3,000 km² of land turns into deserts, compared to an annual expansion rate of 1,560 km² in the 1970s and 2,100 km² in the 1980s. A considerable number of villages have been lost to expanding deserts. It is estimated that some 24,000 villages, 1,400 kilometres of railway lines, 30,000 kilometres of highways, and 50,000 kilometres of canals and waterways are subject to constant threats of desertification

Dust-laden blasts have buried villages before blowing into cities and suffocating urban residents. While incremental ecological destruction leads, inevitably, to desertification, the pace of desertification has been accelerating due to rapid population growth and unsustainable human activities such as excessive land conversion, overgrazing, over-logging, and irrational utilization of water resources.

The good news, however, is that measures can be taken as the case studies from China, Australia, the USA, and elsewhere demonstrate.

The mission of the CCD is precisely to assist governments to reverse trends of land degradation in those countries where desertification is a problem. The lessons learned from the experiences collected in this volume are therefore greatly welcomed by the Secretariat of the CCD. It is my hope that the outcome following the publication of this volume will benefit not only dryland inhabitants but be of value to dryland administrators and policy makers everywhere.

Hama Arba Diallo
Executive Secretary
UNCCD

MESSAGE FROM THE EXECUTIVE SECRETARY ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC (ESCAP)

One of the manifestations of desertification in the world's drylands is the increased frequency and severity of dust storms. This is especially so in North East Asia where populations are receiving frequent reminders of the problem being encountered. Dust is often transported over great distances (thousands of kilometres) and expresses itself in ways that are highly visible.

Asia is a vast region, home to more than half of the world's population and one of the world's regions most adversely affected by desertification. Here, the full interplay of human-induced environmental change and the often harsh and unpredictable climate is being experienced. No region has such a delicate balance between the number of people and the capacity to have food security. No region has undergone such upheaval, social and economic, in the past century.

Dust is both a symptom of serious land degradation, and also a problem in its own right. The economic costs to infrastructure, transport communications and to human health are significant. Yet the human tragedy of crops and animals sacrificed, homes damaged and lives lost bring home the true nature and extent of the problem.

The measures needed to forecast the likelihood of damaging dust related events, the setting up of monitoring systems and mitigating their effects are an urgent priority for governments throughout the drylands. This is especially so when it is noted that the people most affected by sand-dust storms are the rural poor.

ESCAP's mission is to respond to such environmental threats. ESCAP as the hosting agency of Asia Regional Coordinating Unit of the UNCCD has a special interest in the problems outlined in this publication. Since many of the problems involved are transnational in their nature and geographic spread it is important that international cooperation is promoted to effect solutions, to coordinate research and share information.

The lessons to be learned from experiences in several contrasting geographic regions of the world should be especially valuable in framing the action plans of the various countries in Asia and the Pacific. The opportunity presented by the compilation of this publication is therefore welcomed by ESCAP.

Dr. Kim Hak-Su
Executive Secretary

MESSAGE FROM THE EXECUTIVE DIRECTOR
UNITED NATIONS ENVIRONMENT PROGRAMME (UNEP)

The processes of land degradation are complex and variable, a cycle of natural and socioeconomic cause and effect. Deforestation, degraded rangelands, exhausted cultivated fields, salinized irrigated land, depleted groundwater resources, all have terrible consequences for many poverty-stricken people living in the drylands. With little or no capital or decision-making control over their resources and with scant political support, many have had few available options but to mine their resources or to migrate during times of stress.

Land degradation is about people. People cause and suffer from it. Unsustainable land management practices caused by either inadequate techniques or increasing population pressure will enhance degradation of land especially in susceptible drylands. Around 40% of the land surface are drylands and thus prone to the land degradation process. About 65% of all arable land has lost some of its biological and physical functions.

UNEP, being one of two United Nations agencies headquartered in Africa, has witnessed the consequences first hand. Environmental refugees, who flee the miserable conditions created by the vicious cycle of unfertile land, droughts, decreasing production and subsequent over-use of land, are the first victims of desertification. More than 40% of Africa's population lives in the susceptible drylands. Equivalent numbers account for Asia and South America. Desertification affects the lives of one-sixth of the world's population.

This volume in particular deals with a scourge of many dryland regions – *devastating dust storms.* These are both a symptom and a cause of further desertification. Dust storms affect the ecological and economic foundation of whole regions and are in turn affected by climatic changes, weather patterns, policy decisions and individual actions at the grassroots level.

The lessons learned from the experiences in Africa, Asia, particularly China and North America demonstrate that there are ways and means of mitigating the worst impact of the recurrent dust storms. Governments and individuals in North America have invested billions of dollars to minimize loss of productive agricultural lands after the *"Dust Bowl"* of the 1930s. How can the poorest citizens of the poorest countries be expected to sustain themselves without similar investments? How can they respond to mounting pressures of population growth, land degradation and migration without losing their livelihood and human dignity?

UNEP from the very beginning, has been closely associated with the UN Convention to Combat Desertification which focuses attention to the needs of the people in the drylands, and aims to ensure that they receive the support they need to maintain sustainable livelihoods on their lands. Part of this support must be to assist with education of the local people (officials and land users alike) about sustainable management of arid and semi-arid lands, soil conservation and about inter generational equity. To this end, UNEP will continue to provide the necessary support to the Convention and affected governments, within the means at its disposal.

It is equally essential to enlist the support of the wider international community to accelerate the pace and magnitude of action. It is our sincere hope that readers to this volume will be encouraged to learn more from the experience of others and that policy makers will be heartened by the knowledge that concrete achievements and a more sustainable and secure future for the inhabitants of the world's drylands can be replicated – many times over.

Dr. Klaus Topfer
Executive Director