

SCOPE 28

**Environmental Consequences  
of Nuclear War**

Volume II

**Ecological and Agricultural Effects**

## **Executive Committee of SCOPE**

*President:* Professor R. O. Slatyer, Department of Environmental Biology, Australian National University, PO Box 475, Canberra ACT 2601, Australia.

*Past-President:* Professor G. F. White, Institute of Behavioural Science, University of Colorado, Colorado 80309, USA.

*Vice-President:* Professor G. A. Zavarzin, Institute of Microbiology, USSR Academy of Sciences, Prosojusnaja 71, 11731 Moscow, USSR.

*Secretary-General:* Professor J. W. M. La Rivière, International Institute for Hydraulic and Environmental Engineering, Oude Delft 95, PO Box 3015, 2601 DA Delft, The Netherlands.

*Treasurer:* Sir Frederick Warner, FRS, 11 Spring Chase, Brightlingsea, Essex CO7 0JR, UK.

## **Members**

Dr M. A. Ayyad, Botany Department, Faculty of Sciences, University of Alexandria, Moharran Bay, Alexandria, Egypt.

Professor M. J. Kostrowicki, Institute of Geography, Polish Academy of Sciences, Warsaw, Poland.

Professor S. Krisnaswamy, School of Biological Sciences, Madurai Kamaraj University, Madurai 625 021, India.

Professor T. Rosswall, Department of Microbiology, Swedish University of Agricultural Sciences, S-75007 Uppsala, Sweden.

Professor Yasuo Shimazu, Department of Earth Sciences, Faculty of Science, Nagoya University, Furo-cho, Chikusa, Nagoya, Aichi 464, Japan.

## **Editor-in-Chief**

Professor R. E. Munn, IIASA, Schlossplatzl, A-23651, Laxenburg, Austria.

SCOPE 28

# Environmental Consequences of Nuclear War

Volume II

## Ecological and Agricultural Effects

**Mark A. Harwell and Thomas C. Hutchinson**

*with*

**Wendell P. Cropper, Jr, Christine C. Harwell, and Herbert D. Grover**

*Additional Contributions by:*

L. C. Bliss, J. A. Clark, J. K. Detling, A. C. Freeman, J. P. Grime,  
J. D. Hanson, M. Havas, R. Herrera, A. Keast, G. J. Kelly, J. R. Kelly,  
P. M. Kelly, N. K. Lukyanov, J. McKenna, S. J. McNaughton, K. Meema,  
R. L. Myers, T. Ohkita, S. Pacenka, D. Pimentel, V. M. Ponomarev,  
J. Porter, S. J. Risch, M. J. Salinger, Y. Shimazu, T. Sinclair,  
D. Sisler, R. B. Stewart, Y. M. Svirezhev, P. B. Tinker, Z. Uchijima,  
M. H. Unsworth, T. Urabe, J. Vandermeer, M. Verstraete, D. W. H. Walton,  
G. F. White, R. C. Worrest, E. Zubrow

*Published on behalf of the  
Scientific Committee on Problems of the Environment (SCOPE)  
of the  
International Council of Scientific Unions (ICSU)  
by*

**JOHN WILEY & SONS**

**Chichester · New York · Brisbane · Toronto · Singapore**

Copyright © 1985 by the  
Scientific Committee on Problems of the Environment (SCOPE)

Reprinted October 1986

Reprinted July 1987

All rights reserved

No part of this book may be reproduced by any means, or  
transmitted, or translated into a machine language  
without the written permission of the copyright holder.

*British Library Cataloguing in Publication Data*

Harwell, Mark A.

Environmental consequences of nuclear war.—  
(SCOPE; 28)

Vol. 2 : Ecological, agricultural and human effects

1. Nuclear warfare—Environmental aspects

I. Title II. Hutchinson, Thomas C.

III. International Council of Scientific Unions

*Scientific Committee on Problems of the Environment*

IV. International Council of Scientific Unions

574.5 QH545.N83

ISBN 0 471 90898 3

*Library of Congress Cataloging in Publication Data*

Harwell, Mark A.

Environmental consequences of nuclear war.

(SCOPE; 28)

Includes index.

Contents: —V. 2. Ecological, agricultural,  
and human effects.

1. Nuclear warfare—Environmental aspects—

Addresses, essays, lectures. I. Hutchinson, Thomas C.

II. International Council of Scientific Unions.

Scientific Committee on Problems of the Environment.

III. Title. IV. Series: SCOPE (Series); 28.

U263.H37 1985 574.5'222 85-20114

ISBN 0 471 90898 3 (v. 2)

Printed and bound in Great Britain

- SCOPE 1: Global Environmental Monitoring 1971, 68pp (out of print)
- SCOPE 2: Man-Made Lakes as Modified Ecosystems, 1972, 76pp
- SCOPE 3: Global Environmental Monitoring Systems (GEMS): Action Plan for Phase 1, 1973, 132pp
- SCOPE 4: Environmental Sciences in Developing Countries, 1974, 72pp  
Environment and Development, proceedings of SCOPE/UNEP Symposium on Environmental Sciences in Developing Countries, Nairobi, February 11-23, 1974, 418pp.
- SCOPE 5: Environmental Impact Assessment: Principles and Procedures, Second Edition, 1979, 208pp
- SCOPE 6: Environmental Pollutants: Selected Analytical Methods, 1975, 277pp (available from Butterworth & Co. (Publishers) Ltd, Sevenoakes, Kent, England)
- SCOPE 7: Nitrogen, Phosphorus, and Sulphur: Global Cycles, 1975, 192pp (available from Dr Thomas Rosswall, Swedish Natural Science Research Council, Stockholm, Sweden)
- SCOPE 8: Risk Assessment of Environmental Hazard, 1978, 132pp
- SCOPE 9: Simulation Modelling of Environmental Problems, 1978, 128pp
- SCOPE 10: Environmental Issues, 1977, 242pp
- SCOPE 11: Shelter Provision in Developing Countries, 1978, 112pp
- SCOPE 12: Principles of Ecotoxicology, 1978, 372pp
- SCOPE 13: The Global Carbon Cycle, 1979, 491pp
- SCOPE 14: Saharan Dust: Mobilization, Transport, Deposition, 1979, 320pp
- SCOPE 15: Environmental Risk Assessment, 1980, 176pp
- SCOPE 16: Carbon Cycle Modelling, 1981, 404pp
- SCOPE 17: Some Perspectives of the Major Biogeochemical Cycles, 1981, 175pp
- SCOPE 18: The Role of Fire in Northern Circumpolar Ecosystems, 1983, 344pp
- SCOPE 19: The Global Biogeochemical Sulphur Cycle, 1983, 495pp
- SCOPE 20: Methods for Assessing the Effects of Chemicals on Reproductive Functions, 1983, 568pp



- SCOPE 21: The Major Biogeochemical Cycles and Their Interactions, 1983, 554pp
- SCOPE 22: Effects of Pollutants at the Ecosystem Level, 1984, 443pp
- SCOPE 23: The Role of Terrestrial Vegetation in the Global Carbon Cycle: Measurement by Remote Sensing, 1984, 272pp
- SCOPE 24: Noise Pollution, 1986
- SCOPE 25: Appraisal of Tests to Predict the Environmental Behaviour of Chemicals, 1985, 400pp
- SCOPE 26: Methods for Estimating Risks of Chemical Injury: Human and Non-human Biota, 1985, 712pp
- SCOPE 27: Climate Impact Assessment: Studies of the Interaction of Climate and Society, 1985, 649pp
- SCOPE 28: Environmental Consequences of Nuclear War  
Volume I Physical, 1985, 342pp  
Volume II Ecological and Agricultural Effects, 1985, 523pp

Funds to meet SCOPE expenses are provided by contributions from SCOPE National Committees, an annual subvention from ICSU (and through ICSU, from UNESCO), an annual subvention from the French Ministère de l'Environnement et du Cadre de Vie, contracts with UN Bodies, particularly UNEP, and grants from Foundations and industrial enterprises.

**International Council of Scientific Unions (ICSU)**  
**Scientific Committee on Problems of the Environment (SCOPE)**

SCOPE is one of a number of committees established by a non-governmental group of scientific organizations, the International Council of Scientific Unions (ICSU). The membership of ICSU includes representatives from 68 National Academies of Science, 18 International Unions, and 12 other bodies called Scientific Associates. To cover multidisciplinary activities which include the interests of several unions, ICSU has established 10 scientific committees, of which SCOPE is one. Currently, representatives of 34 member countries and 15 Unions and Scientific Committees participate in the work of SCOPE, which directs particular attention to the needs of developing countries. SCOPE was established in 1969 in response to the environmental concerns emerging at that time; ICSU recognized that many of these concerns required scientific inputs spanning several disciplines and ICSU Unions. SCOPE's first task was to prepare a report on Global Environmental Monitoring (SCOPE 1, 1971) for the UN Stockholm Conference on the Human Environment.

The mandate of SCOPE is to assemble, review, and assess the information available on human-induced environmental changes and the effects of these changes on humans; to assess and evaluate the methodologies of measurement of environmental parameters; to provide an intelligence service on current research; and by the recruitment of the best available scientific information and constructive thinking to establish itself as a corpus of informed advice for the benefit of centres of fundamental research and of organizations and agencies operationally engaged in studies of the environment.

SCOPE is governed by a General Assembly, which meets every three years. Between such meetings its activities are directed by the Executive Committee.

R. E. Munn  
Editor-in-Chief  
SCOPE Publications

Executive Secretary: V. Plocq

Secretariat: 51 Bld de Montmorency  
75016 PARIS



The editors wish to thank the following organizations for giving permission to reproduce copyright material:

Figure 1.3. Reproduced from C. Raunkier, *The Life Forms of Plants and Statistical Plant Geography*, 1934, by permission of Oxford University Press.

Figures 1.4, 1.5. Reproduced from J. Levitt, *Responses of Plants to Environmental Stresses*, 1972, by permission of Academic Press.

Figure 1.8. Reproduced from M. G. R. Cannell and L. J. Sheppard, *Forestry*, **55**, 137–153, 1982, by permission of Oxford University Press.

Figure 1.9. Reproduced from C. Glerum, *Can. J. Plant Science*, **53**, 881–889, 1973, by permission of the Agricultural Institute of Canada.

Figures 1.10, 1.11, Tables 1.6, 1.7. Reproduced from P. H. Li and A. Sakai, *Plant Cold Hardiness and Freezing Stress, Volume 2*, 1982, by permission of Academic Press.

Figure 1.15, Table 3.4. Reproduced from M. A. Harwell, *Nuclear Winter: The Human and Environmental Consequences of Nuclear War*, by permission of Springer-Verlag, New York.

Figure 1.18. Reproduced from D. B. Carter and J. R. Mather, *Publications in Climatology*, **19**(4), 305–395, 1966, by permission of C. W. Thornthwaite Associates.

Figure 1.19a. Reproduced from H. Leith, *Human Ecology*, **1**, 303–332, 1973, by permission of Plenum Publishing Corporation.

Figure 1.22. Reproduced from R. H. Whittaker, *Communities and Ecosystems*, 2nd edition, 1975, by permission of Macmillan Publishing Company.

Figure 3.3, 3.7, Table 3.12. Reprinted with permission from F. W. Whicker and V. Shultz, *Radioecology: Nuclear Energy and the Environment, Vol. 1*, 1982. Copyright CRC Press, Inc., Boca Raton, FL.

Figure 3.5. Reproduced from *Health Physics* Vol. 23, p. 519–527 by permission of the Health Physics Society.

Table 1.5. Reproduced from J. Levitt, *Responses of Plants to Environmental Stresses, Vol 1*, 2nd edn., 1980, by permission of Academic Press.

Tables 1.8, 1.9. Reproduced from T. C. Hutchinson, *Journal of Ecology*, **55**, 291–299, 1967, by permission of Blackwell Scientific Publications Limited.

Table 1.13. Reproduced from E. P. Odum, *Science*, **164**, 1969, by permission of the American Association for the Advancement of Science. Copyright 1969 by the AAAS.

Table 1.16. Reproduced from V. Stoy, *Physiol. Plant. Suppl.*, **IV**, 1–25, 1965, by permission of Physiologia Plantarum.