

Environmental Indicators

Robert H. Armon • Osmo Hänninen
Editors

Environmental Indicators

 Springer

Editors

Robert H. Armon
Civil and Environmental Engineering
Israel Institute of Technology Technion
Haifa, Israel

Osmo Hänninen
Department of Physiology
Institute of Biomedicine
University of Eastern Finland
Kuopio, Finland

ISBN 978-94-017-9498-5

ISBN 978-94-017-9499-2 (eBook)

DOI 10.1007/978-94-017-9499-2

Springer Dordrecht Heidelberg New York London

Library of Congress Control Number: 2014954799

© Springer Science+Business Media Dordrecht 2015

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed. Exempted from this legal reservation are brief excerpts in connection with reviews or scholarly analysis or material supplied specifically for the purpose of being entered and executed on a computer system, for exclusive use by the purchaser of the work. Duplication of this publication or parts thereof is permitted only under the provisions of the Copyright Law of the Publisher's location, in its current version, and permission for use must always be obtained from Springer. Permissions for use may be obtained through RightsLink at the Copyright Clearance Center. Violations are liable to prosecution under the respective Copyright Law.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

While the advice and information in this book are believed to be true and accurate at the date of publication, neither the authors nor the editors nor the publisher can accept any legal responsibility for any errors or omissions that may be made. The publisher makes no warranty, express or implied, with respect to the material contained herein.

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

An indicator is like a lighthouse, if we don't pay attention we'll end up crashing on the rocks.

To my current grandchildren Yahli, Ivri and Ori and to those to be born in a cleaner world! And also in the memory of my best friends, my late parents Dorothea and Theodor.

Preface

While on sabbatical leave at Kuopio University, Finland, and being involved with the organization called ISEI (International Society of Environmental Indicators), I reached the conclusion that a concentrated effort articulated in a book on various environmental indicators does not exist on the global bookshelf, and this is the time to put one together!

Following discussions with my ISEI colleague Prof. Em. Osmo Hänninen from Finland, a veteran and highly active member of our organization (ISEI), an outlook list was composed, which was intended to be covered later by various international authors (known as experts in their field). Now, in retrospect, we should say that it was not an easy task, as we had to decide which subjects to cover and which to leave for alternative future opportunities. When the subject list had been consolidated, it was communicated to various international scientists, and, following their approval, the book “assemblage” was on its way. I do recall today that in a phone conversation with Dr. Paul Roos (Editorial Director of Environmental Sciences, Springer Dordrecht), besides expressing his interest, he told me that he thought the proposed project a very ambitious one, basically meaning that our venture would not be an easy task. . . . As scientists, we are never hindered by difficulties, but rather the contrary is true: they make our work more challenging, and therefore, we attacked the task seriously and stubbornly.

Indeed, after more than a year’s work, the present book represents the efforts of 80 authors, expressed in 15 subjects and 58 chapters on a large variety of environmental issues, starting from thermodynamics and ending in health issues! The subjects that are covered were selected based on European and US environmental databases, as the important issues that raise critical environmental concerns had been emphasized along the years by these leading entities.

We are happy to bring this compilation to the reader involved in environmental issues, as well as to those who wish to use it as the first textbook on environmental indicators as such. We as well as our academic colleagues always touch upon the indicator issue in our courses, although merely as related to our own specific professional field. The present book is the first effort to present the most

important indicators together and consolidate a unifying line between the various subjects. We hope that this volume achieves this task well and can be used by many thousands of scientists involved in environmental research.

Haifa

April 2014



Prof. Robert H. Armon, Faculty of Civil and Environmental Engineering, Technion (Israel Institute of Technology), Department of Environmental, Water and Agricultural Engineering, Haifa 32000, Israel. Board Member of IWA Specialist Group-HRWM (Health-Related Water Microbiology).

Kuopio

April 2014



Prof. Em. Osmo Hänninen, Chair of the International Multidisciplinary Biomonitoring Commission of IUBS (International Union of Biological Sciences), Department of Physiology, Institute of Biomedicine, University of Eastern Finland, P.O.B. 1627, FI-70211 Kuopio, Finland.

Acknowledgement

We would like to thank Ms. Liz Yudim for her help with English style editing of each book chapter. To Technion (Israel Institute of Technology) for financial support and the vast references data base (SciFinder) that allowed reading of hundreds of published articles to be used in the consolidation of the chapters. And finally to Dr. Paul Roos (Editorial Director, Environmental Sciences, Springer) and to Ms. Betty van Herk and Ms. Judith Terpos for their help in bringing this volume to production.

And finally to all authors that contributed to this book with their intellectual knowledge, effort and time.

Contents

Introduction	xxv
The International Society of Environmental Indicators: Historical Overview	xxix
Part I Environmental Thermodynamics	
1 Non-renewable Resources as Indicator of Thermodynamic Changes in Environment	3
Wenjie Liao and Reinout Heijungs	
2 Photon Dissipation Rates as an Indicator of Ecosystem Health	15
Karo Michaelian	
Part II Climate Change	
3 Environmental Indicators of Climate Change: Phenological Aspects	39
Anders Pape Møller	
4 Carbon Footprint – An Environmental Sustainability Indicator of Large Scale CO₂ Sequestration	51
Dragoljub Bilanovic	
5 Urban Heat Islands	67
Keiko Masumoto	
6 Tsunami	77
Robert H. Armon	

Part III Conservation

7 Species Extinction Indicators 91
 Robert H. Armon

8 Indicators of Pollinator Decline and Pollen Limitation 103
 Yuval Sapir, Achik Dorchin, and Yael Mandelik

9 Coral Bleaching 117
 Jeremiah G. Plass-Johnson, Ulisse Cardini, Nanne van Hoytema,
 Elisa Bayraktarov, Ingo Burghardt,
 Malik S. Naumann, and Christian Wild

10 Invasive Alien Species and Their Indicators 147
 Robert H. Armon and Argyro Zenetos

Part IV Environmental Degradation

11 Marine Eutrophication 177
 Christian Jessen, Vanessa N. Bednarz, Laura Rix,
 Mirta Teichberg, and Christian Wild

Part V Environmatics

**12 Framework for Analyzing Environmental Indicators
 Measurements Acquired by Wireless Distributed Sensory
 Network – Air Pollution Showcase 207**
 Barak Fishbain

**13 Environment Benefits Quantification Through
 Statistical Indicators 225**
 Giani Gradinaru

Part VI Intensive Farming

14 Environmental Indicators of Dryland 239
 Martin Wiesmeier

**15 Pesticide Drift: Seeking Reliable Environmental Indicators
 of Exposure Assessment 251**
 Christos A. Damalas

Part VII Land Degradation

**16 Environmental Indicators of Land Cover, Land Use,
 and Landscape Change 265**
 Gerald J. Niemi, Lucinda B. Johnson, and Robert W. Howe

17	Desertification and Desertification Indicators Classification (DPSIR)	277
	Robert H. Armon	
Part VIII Soil		
18	Soil Conservation	293
	Paolo Giandon	
19	Soil Erosion	307
	Paolo Giandon	
20	Soil Salination Indicators	319
	Zhi-Qing Lin and Gary S. Bañuelos	
21	Soil Contamination by Diffuse Inputs	331
	Paolo Giandon	
22	Markers, Indicators of Soil Pollution	343
	Monica Butnariu	
23	Landsnail for Ecotoxicological Assessment of Chemicals and Soil Contamination – Ecotoxicological Assessment of Chemicals and Contaminated Soils Using the Terrestrial Snail, <i>Helix aspersa</i>, at Various Stage of Its Life Cycle: A Review	365
	Annette de Vaufleury	
Part IX Land Use		
24	Land Use Changes and Landscape Degradation in Central and Eastern Europe in the Last Decades: Epigeic Invertebrates as Bioindicators of Landscape Changes	395
	Jaroslav Boháč and Zuzana Jahnova	
25	Environmental Indicators of Biological Urbanization	421
	Anders Pape Møller	
Part X Environmental Pollution		
26	Environmental Impact of the Coal Industry and Resource Equivalency Method for Environmental Damage with Ecological Indicators	435
	Jaroslav Boháč and Josh Lipton	
27	Environmental Quality Assessment: Geoenvironmental Indices	461
	Sergey Monakhov, Olga Esina, Galina Monakhova, and Vitaly Tatarnikov	

28 Nonpoint Source Pollution: Assessment and Management of Environmental Quality According to Geoenvironmental Indices 479
 Sergey Monakhov, Olga Esina,
 Galina Monakhova, and Vitaly Tatarnikov

29 Point Source Pollution Indicators 495
 Robert H. Armon and Janetta Starosvetsky

30 Noise Pollution Indicators 501
 Arnaud Can

31 Snow Samples as Markers of Air Pollution in Mass Spectrometry Analysis 515
 Albert T. Lebedev, Dmitry M. Mazur, Olga V. Polyakova,
 and Osmo Hänninen

Part XI Water Pollution

32 Marine Pollution-Environmental Indicators in Marine Meiofauna from Brazil 545
 Patrícia Pinheiro Beck Eichler,
 Beatriz Beck Eichler, and Helenice Vital

33 Environmental Impacts of Reservoirs 561
 Gordana Dević

Part XII Water Biological Pollution

34 Bacteriological Indications of Human Activities in the Ecosystems 579
 Elias Hakalehto

35 Indicators of Waterborne Viruses 613
 Robert H. Armon

36 Algal Bloom Indicators 633
 Robert H. Armon and Janetta Starosvetsky

37 Biological Indicators of Water Quality: The Role of Fish and Macroinvertebrates as Indicators of Water Quality 643
 Eugenia López-López and Jacinto Elías Sedeño-Díaz

38 Histopathological Indicators in Fish for Assessing Environmental Stress 663
 Ricardo Arturo Ruiz-Picos, Jacinto Elías Sedeño-Díaz,
 and Eugenia López-López

39 Risk Management During Effluent Application for Irrigation 677
 Gideon Oron, Laura Alcalde-Sanz, Leonid Gillerman,
 Yossi Manor, Amos Bick, and Miquel Salgot

40 Molecular Bioindicators of Pollution in Fish 695
 Nancy D. Denslow and Tara Sabo-Attwood

Part XIII Water Chemical Pollution

41 Ocean Acidification and Related Indicators 723
 Friedrich W. Meyer, Ulisse Cardini, and Christian Wild

**42 Mercury in Fish: History, Sources, Pathways, Effects,
 and Indicator Usage 743**
 Edward J. Zillioux

**43 The Chronic POEDCs Ecotoxicological Impact: An Aquatic
 Environmental Indicator of Surface and Groundwater 767**
 Uri Zoller

**44 Bioaccumulation and Long-Term Monitoring
 in Freshwater Ecosystems – Knowledge Gained
 from 20 Years of Zebra Mussel Analysis by the German
 Environmental Specimen Bank 781**
 Martin Paulus, Diana Teubner, Heinz Rüdél, and Roland Klein

**45 Viability and Reliability of Dense Membranes in Removing
 Trace Organic Contaminants for Wastewater Reclamation
 and Purification: Pros and Cons, Mechanisms, and Trends 805**
 Shirra Gur-Reznik and Carlos G. Dosoretz

Part XIV Air Pollution

46 Indoor Air Quality Indicators 827
 Dimosthenis A. Sarigiannis

Part XV Environmental Health

47 Environmental Burden of Diseases 845
 Otto Hänninen

48 Textile Toxicants in Environmental and Human Health 859
 Kaisa Klemola

49 Biological Indicators of Ionizing Radiation in Nature 871
 Anders Pape Møller and Timothy Alexander Mousseau

50 Health-Related Indicators of Outdoor Air Quality 883
 Paul T.J. Scheepers

51 Health Implications of Combustion Engine Exhaust 899
 Paul T.J. Scheepers

52 Health-Related Indicators of Indoor Air Quality 925
Paul T.J. Scheepers and Stef van Hout

53 Human Biological Monitoring and Public Health 945
Paul T.J. Scheepers

54 Chemicals Disaster Management and Public Health 967
Paul T.J. Scheepers

**55 On the Relationships Between Health Outcome
and Urban Air Quality 995**
David Broday

**56 Electromagnetic Radiation – Environmental Indicators
in Our Surroundings 1011**
Yael Stein, Osmo Hänninen, Paavo Huttunen,
Mikko Ahonen, and Reijo Ekman

57 Electromagnetic Radiation and Health: Human Indicators 1025
Yael Stein, Osmo Hänninen, Paavo Huttunen,
Mikko Ahonen, and Reijo Ekman

**58 Molds and Radon, Indoors Problems
as Indicated by Diseases 1047**
Heikki Elonheimo, Osmo Hänninen, and Robert H. Armon

Index 1061

Contributors

Mikko Ahonen School of Information Sciences, University of Tampere, Tampere, Finland

Laura Alcalde-Sanz Water Resources Unit, Institute for Environment and Sustainability, Joint Research Centre, Ispra, VA, Italy

Robert H. Armon Faculty of Civil and Environmental Engineering, Technion (Israel Institute of Technology), Haifa, Israel

Gary S. Bañuelos San Joaquin Valley Agricultural Sciences Center, Agricultural Research Service, United States Department of Agriculture, Parlier, CA, USA

Elisa Bayraktarov Coral Reef Ecology Group (CORE), Leibniz Center for Tropical Marine Ecology (ZMT), Bremen, Germany

Vanessa N. Bednarz Coral Reef Ecology Group (CORE), Leibniz Center for Tropical Marine Ecology (ZMT), Bremen, Germany

Amos Bick Bick Associates, Ganey Tikva, Israel

Dragoljub Bilanovic Center for Environmental, Earth, and Space Studies, Bemidji State University, Bemidji, MN, USA

Jaroslav Boháč Faculty of Agriculture, University of South Bohemia in České Budějovice, České Budějovice, Czech Republic

David Broday Faculty of Civil and Environmental Engineering, The Division of Environmental, Water and Agricultural Engineering, Technion Center of Excellence in Exposure Science and Environmental Health, Technion (Israel Institute of Technology), Haifa, Israel

Ingo Burghardt Coral Reef Ecology Group (CORE), Leibniz Center for Tropical Marine Ecology (ZMT), Bremen, Germany

Monica Butnariu Chemistry and Vegetal Biochemistry, Banat's University of Agricultural Sciences and Veterinary Medicine "Regele Mihai I al României" from Timisoara, Timisoara, Timis, Romania

Arnaud Can Centre de Nantes, LUNAM Université, IFSTTAR, AME, LAE, Bouguenais cedex, France

Ulisse Cardini Coral Reef Ecology Group (CORE), Leibniz Center for Tropical Marine Ecology (ZMT), Bremen, Germany

Christos A. Damalas Department of Agricultural Development, Democritus University of Thrace, Orestiada, Greece

Nancy D. Denslow Department of Physiological Sciences, University of Florida, Gainesville, FL, USA

Center for Environmental and Human Toxicology, University of Florida, Gainesville, FL, USA

Annette de Vaufléury Department Chrono-Environment, UMR 6249, University of Franche-Comté-CNRS, Besançon cedex, France

IUT Besançon-Vesoul, Department HSE, University of Franche-Comté, Vaivre et Montoille, France

Gordana Dević Department of Chemistry, IChTM, University of Belgrade, Belgrade, Serbia

Achik Dorchin Department of Zoology, Zoological Museum (TAUZM), Tel Aviv University, Tel Aviv, Israel

Carlos G. Dosoretz Division of Environmental, Water and Agricultural Engineering, Faculty of Civil and Environmental Engineering, Technion-Israel Institute of Technology, Haifa, Israel

Beatriz Beck Eichler Instituto Oceanográfico da Universidade de São Paulo (IOUSP), São Paulo, Brazil

Patrícia Pinheiro Beck Eichler Programa de Pós Graduação em Geofísica e Geodinâmica (PPGG), Laboratório de Geologia e Geofísica Marinha e Monitoramento Ambiental, Centro de Ciências Exatas e da Terra da, Universidade Federal do Rio Grande do Norte (GGEMMA, CCET, UFRN), Natal, RN, Brazil

Reijo Ekman Radio and EMC Laboratory, Degree Program in Electronics, ICT and Life Sciences, Turku University of Applied Sciences, Turku, Finland

Heikki Elonheimo Director, Excellent Element Oy (limited Company), Jyväskylä, Finland

Olga Esina Federal State Budgetary Institution (FSBI), "Caspian Marine Scientific Research Center" (KasPMNIZ), Astrakhan, Russia

Barak Fishbain Technion Enviromatics Lab, Department of Environmental, Water and Agricultural Engineering, Faculty of Civil & Environmental Engineering, Technion – Israel Institute of Technology, Haifa, Israel

Paolo Giandon Soil Monitoring and Remediation Unit, ARPAV – Environmental Protection Agency of Veneto Region, Veneto, Italy

Leonid Gillerman Environment Water Resources, J. Blaustein Institute for Desert Research, Ben-Gurion University of the Negev, Kiryat Sde-Boker, Israel

Giani Gradinaru Statistics and Econometrics Department, Bucharest Academy of Economic Studies (ASE), Bucharest, Romania

Shirra Gur-Reznik Division of Environmental, Water and Agricultural Engineering, Faculty of Civil and Environmental Engineering, Technion-Israel Institute of Technology, Haifa, Israel

Elias Hakalehto Department of Environmental Sciences, University of Eastern Finland, Kuopio, Finland

Otto Hänninen National Institute for Health and Welfare, THL Env. Health, Kuopio, Finland

Osmo Hänninen Department of Physiology, Institute of Biomedicine, University of Eastern Finland, Kuopio, Finland

Reinout Heijungs Institute of Environmental Sciences, Leiden University, Leiden, The Netherlands

Department of Econometrics and Operations Research, VU University Amsterdam, Amsterdam, The Netherlands

Robert W. Howe Department of Natural and Applied Sciences, Cofrin Center for Biodiversity, University of Wisconsin-Green Bay, Green Bay, WI, USA

Paavo Huttunen Department of Electrical and Information Engineering, Laboratory of Optoelectronics and Measurement Technology, University of Oulu, Oulu, Finland

Zuzana Jahnova Faculty of Agriculture, University of South Bohemia in České Budějovice, České Budějovice, Czech Republic

Christian Jessen Coral Reef Ecology Group (CORE), Leibniz Center for Tropical Marine Ecology (ZMT), Bremen, Germany

Lucinda B. Johnson Center for Water and the Environment Natural Resources Research Institute, University of Minnesota, Duluth, MN, USA

Roland Klein Department of Geography/Geosciences – Biogeography, Trier University, Trier, Germany

Kaisa Klemola Kuopio Academy of Design, Savonia University of Applied Sciences, Kuopio, Finland

Albert T. Lebedev Organic Chemistry Department, M.V. Lomonosov Moscow State University, Moscow, Russia

Wenjie Liao INRA/Agrocampus Ouest, UMR1069, Soil, Agro and hydroSystem, Rennes, France

Zhi-Qing Lin Environmental Sciences Program, Southern Illinois University, Edwardsville, IL, USA

Josh Lipton Faculty of Agriculture, University of South Bohemia in České Budějovice, České Budějovice, Czech Republic

Stratus Consulting, Boulder, CO, USA

Eugenia López-López Laboratorio de Bioconservación y Manejo, Escuela Nacional de Ciencias Biológicas, Instituto Politécnico Nacional, Ciudad de México, Mexico

Yael Mandelik Department of Entomology, The Hebrew University of Jerusalem, Rehovot, Israel

Yossi Manor Central Virological Laboratory, Sheba Medical Centre, Tel-HaShomer, Israel

Keiko Masumoto Urban Environment Group, Osaka City Institute of Public Health and Environmental Sciences, Tennoji-ku, Osaka, Japan

Dmitry M. Mazur Organic Chemistry Department, M.V. Lomonosov Moscow State University, Moscow, Russia

Friedrich W. Meyer Ecophysiology Group, Leibniz Center for Tropical Marine Ecology (ZMT), Bremen, Germany

Karo Michaelian Departamento de Física Experimental, Instituto de Física, UNAM, Cto. de la Investigación Científica, Ciudad Universitaria, México D.F., México

Anders Pape Møller Laboratoire d'Ecologie, Systématique et Evolution, CNRS UMR 8079, Université Paris-Sud, Orsay Cedex, France

Sergey Monakhov Federal State Budgetary Institution (FSBI), "Caspian Marine Scientific Research Center" (Kaspmniz), Astrakhan, Russia

Galina Monakhova Federal State Budgetary Institution (FSBI), "Caspian Marine Scientific Research Center" (Kaspmniz), Astrakhan, Russia

Timothy Alexander Mousseau Department of Biological Sciences, University of South Carolina, Columbia, SC, USA

Malik S. Naumann Coral Reef Ecology Group (CORE), Leibniz Center for Tropical Marine Ecology (ZMT), Bremen, Germany

Gerald J. Niemi Center for Water and the Environment Natural Resources Research Institute, University of Minnesota, Duluth, MN, USA

Gideon Oron Environment Water Resources, J. Blaustein Institute for Desert Research, Ben-Gurion University of the Negev, Kiryat Sde-Boker, Israel

Martin Paulus Department of Geography/Geosciences – Biogeography, Trier University, Trier, Germany

Jeremiah G. Plass-Johnson Coral Reef Ecology Group (CORE), Leibniz Center for Tropical Marine Ecology (ZMT), Bremen, Germany

Olga V. Polyakova Organic Chemistry Department, M.V. Lomonosov Moscow State University, Moscow, Russia

Laura Rix Coral Reef Ecology Group (CORE), Leibniz Center for Tropical Marine Ecology (ZMT), Bremen, Germany

Heinz Rüdell Department Environmental Specimen Bank and Elemental Analysis, Fraunhofer Institute for Molecular Biology and Applied Ecology (Fraunhofer IME), Schmallenberg, Germany

Ricardo Arturo Ruiz-Picos Laboratorio de Bioconservación y Manejo, Escuela Nacional de Ciencias Biológicas, Instituto Politécnico Nacional, Ciudad de México, Mexico

Tara Sabo-Attwood Environmental and Global Health, University of Florida, Gainesville, FL, USA

Center for Environmental and Human Toxicology, University of Florida, Gainesville, FL, USA

Miquel Salgot Facultat de Farmacia, Universidad de Barcelona, Barcelona, Spain

Yuval Sapir The Botanical Garden, Department of Molecular Biology and Ecology of Plants, Tel Aviv University, Tel Aviv, Israel

Dimosthenis A. Sarigiannis Environmental Engineering Laboratory, Department of Chemical Engineering, Aristotle University of Thessaloniki, Thessaloniki, Greece

Paul T.J. Scheepers Department for Health Evidence, Radboud University Medical Centre, Nijmegen, The Netherlands

Jacinto Elías Sedeño-Díaz Coordinación Politécnica para la Sustentabilidad, Instituto Politécnico Nacional, Ciudad de México, Mexico

Janetta Starosvetsky Faculty of Civil and Environmental Engineering, Technion (Israel Institute of Technology), Haifa, Israel

Yael Stein Department of Anesthesiology and Critical Care Medicine, Hebrew University – Hadassah Medical Center, Jerusalem, Israel

Vitaly Tatarnikov Federal State Budgetary Institution (FSBI), “Caspian Marine Scientific Research Center” (Kaspmniz), Astrakhan, Russia

Mirta Teichberg Coral Reef Ecology Group (CORE), Leibniz Center for Tropical Marine Ecology (ZMT), Bremen, Germany

Diana Teubner Department of Geography/Geosciences – Biogeography, Trier University, Trier, Germany

Stef van Hout Department for Health Evidence, Radboud University Medical Centre, Nijmegen, The Netherlands

Nanne van Hoytema Coral Reef Ecology Group (CORE), Leibniz Center for Tropical Marine Ecology (ZMT), Bremen, Germany

Helenice Vital Programa de Pós Graduação em Geofísica e Geodinâmica (PPGG), Laboratório de Geologia e Geofísica Marinha e Monitoramento Ambiental, Centro de Ciências Exatas e da Terra da, Universidade Federal do Rio Grande do Norte (GGEMMA, CCET, UFRN), Natal, RN, Brazil

Martin Wiesmeier Lehrstuhl für Bodenkunde, Wissenschaftszentrum Weihenstephan, Technische Universität München, Freising-Weihenstephan, Germany

Christian Wild Coral Reef Ecology Group (CORE), Leibniz Center for Tropical Marine Ecology (ZMT), Bremen, Germany

Argyro Zenetos Institute of Marine Biological Resources and Inland Waters, Hellenic Centre for Marine Research (HCMR), Anavissos, Hellas, Greece

Edward J. Zillioux Co-founder, ISEI, Environmental Indicators Foundation, LLC, Fort Pierce, FL, USA

Uri Zoller Faculty of Natural Sciences, Haifa University-Oranim, Kiryat Tivon, Israel

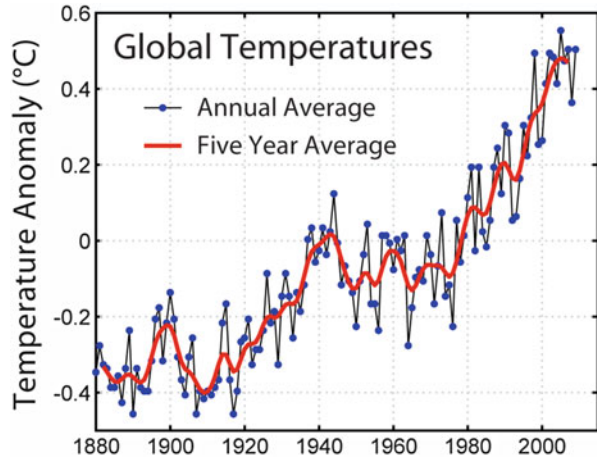
Introduction

Perhaps the finest analogy to the role of indicators can be found in the physician's preliminary examination of a patient. Any respectful physician will start his or her diagnosis of a patient with simple and fast tests that are easy to perform, e.g., temperature, blood pressure, physical contact to detect pain, etc., and only later will apply the more sophisticated tests, such as CT, MRI, or the simpler X-ray radiography, in order to reach a final diagnosis. We should bear in mind this analogy when handling environmental indicators.

Environmental indicators are simple events that let us know what is happening in different surrounding environments. Because of its complexity, environmental measurement should be performed using a less expensive and cumbersome approach involving a large variety of indicators. For example, to measure the presence of a pathogen in potable water in order to ensure the safety of a water supply, a large battery of expensive materials and methods are required that in some cases are useless and in others practically and economically almost impossible to accomplish! In most cases, those pathogens are found in low numbers, therefore requiring a concentration step, which will increase the economic burden (especially since thousands of such tests are required annually) to the extent of leading to economic bankruptcy! On the other hand, for health people, what is the epidemiological significance of one viral/bacterial particle in 1,000 L? Consequently, the indicator system makes our lives easier and is a matter of choice, both economically and scientifically. Below, we present two historical examples of "classical indicators" and their introduction and use.

Historically, microbiological indicators of the sanitary quality of water were introduced at the end of the nineteenth century. In 1880, Von Fritsch described *Klebsiella pneumonia* and *Klebsiella rhinoscleromatis* as characteristic human fecal bacteria, and in 1885 Percy and Grace Frankland introduced the first routine bacteriological examination of London's water, using Robert Koch's solid gelatin media for bacterial enumeration. The same Frankland, in 1891, came up with the idea that sewage microorganisms should be characterized in order to give warning of a potential sanitary hazard. In 1885, Escherich described *Bacillus coli*

Fig. 1 An example of an environmental indicator: Trend in global temperature anomalies of the last 150 years as an indicator of climate change (Source: National Aeronautics and Space Administration, Goddard Institute for Space Studies (http://data.giss.nasa.gov/gistemp/graphs_v3/); Hansen et al. 2006)



(now called *Escherichia coli* in his memory) as a typical bacterium originating from the feces of breast-fed infants. Then, starting at the beginning of the last century (1900 and on), *Bacillus coli* was used as an indicator in the UK of potential water contamination with fecal material. To make a long story short, specific human fecal bacteria became the standard indicators of potable water safety! Together with the introduction of chlorination, waterborne diseases were significantly reduced worldwide. Today, those bacteria are used as the common indicators of water pollution, in spite of their many drawbacks.

Another example of an important indicator, which marked the way to apprehending climate change, is the temperature rise over time as an indicator of global warming (Fig. 1)! Temperature measurements are easy to perform and have been conducted for more than 100 years. Therefore, using their anomalies frequency as an indicator, it can be concluded that there is an essential shift in global temperatures.

Both examples show the use of simple, fast, and cost-effective parameters that have a real potential to indicate with a certain percentage of accuracy that our environment is polluted or is facing a problem!

This book presents many such indicators covering a large area of environmental issues that affect the human population globally. It is our pleasure to bring to the attentive environmentalist reader a large panel of indicators that are in use, or whose potential as such is proposed, to achieve a more livable and cleaner planet (Maher 2011).

The editors would like to thank all contributors and the Springer publishing house, especially Dr. Paul Roos for his support and encouragement and Ms. Betty van Herk for her editorial support. We would like to thank the authors' families for their equability and for understanding the value of our contribution, in spite of long hours and days in the office.

References

- Hansen J, Sato M, Ruedy R, Lo K, et al (2006) Global temperature change. *Proc Natl Acad Sci* 103:14288–14293
- Maher B (2011) *The new rules: a funny look at how everybody but me has their head up their ass. New rule: oil companies must stop with the advertisements implying they're friends of the environment. 'At Exxon Mobil, we care about a thriving wildlife.' Please – the only thing an oil executive has in common with a seagull is they'd both steal French fries from a baby.* Blue Rider Press

The International Society of Environmental Indicators: Historical Overview

The International Society of Environmental Indicators (ISEI) is an international network of scholars who support and promote the development and use of biological, chemical and physical environmental indicators in environmental assessments and environmental management. Environmental indicators are critical components of monitoring efforts worldwide, and because many environmental indicators are relatively inexpensive to monitor, ISEI makes efforts to work with scientists in developing countries to enable them to better integrate environmental indicators in their environmental assessment and monitoring efforts. This overview describes its formation and development.




The ISEI traces its origin to a series of sessions on bioindicators, or biomarkers, organized by myself and Jim Newman at the Annual International Conference on Contaminated Soils, Sediments and Water held at the University of Massachusetts, Amherst in 2002–2005. Abstracts from the inaugural session are available at: http://scholarworks.umass.edu/cgi/viewcontent.cgi?article=1001&context=soils_conf_abstracts. In 2003, we published a paper on *Bioindicators – Essential tools for realistic site assessment and remediation cost control* in the March/April issue of The Association for Environmental Health & Sciences (AEHS) magazine, *Soil Sediment & Water*. It was in Amherst during this period when several new journals were being launched by Amherst Scientific Publishers, an affiliate of AEHS. I was having lunch with Paul Kostecki, the co-founder of AEHS, and suggested that there was a need for a journal on environmental bioindicators and that AEHS should consider adding such a journal to their portfolio. Paul responded with, “Why don’t you do it?” This was not something I had contemplated before and it took a couple weeks to get used to the idea. I contacted Jim Newman to see if he would be interested in partnering with me on the venture and found him to be enthusiastic. I then called a contact at Taylor & Francis Group, LLC (T&F). A short time later, Jim and I were invited to meet with the publishing staff of T&F at their corporate offices in Philadelphia. We were advised that the chances of such a journal being a success would be greatly enhanced if we were to form a scientific society to support it.

The first meeting of the new International Society of Environmental Bioindicators was held in concert with the Thirteenth International Conference on Environmental Bioindicators of the International Union of Biological Scientists (IUBS), International Commission on Bioindicators at the Vila Porthemaka Praha, Czech Republic, 6–10 June 2005. The formation of the new society was proposed and agreed to by the participants. (The name of the new society was formally changed to the International Society of Environmental Indicators [ISEI] in 2009 to reflect the broader scope of the interests of its members.)

The inaugural issue of a new international journal, *Environmental Bioindicators*, was published by T&F in the first quarter of 2006 in print and online (ISSN 1555–5275, and 1555–5267, respectively). The print version of the journal continued to be published quarterly through October–December 2009. A brief history of the changes and milestones in the structure of the journal and in the development of the society was reported in an editorial at the completion of its first 4 years of publication (Zillioux EJ, 2009, *Environmental Bioindicators* [EBI] to *Environmental Indicators* [EI] and other Developments: the evolution of a journal. Vol. 4, pp. 283–285). Beginning with volume 5 in 2010, *Environmental Indicators* became a stand-alone on-line open-access journal. Complete contents of all issues of both print and subsequent on-line volumes are accessible at www.environmentalindicators.net.

Following the Prague conference, the ISEBI and subsequent ISEI Conferences continued on an annual basis from 2005 through 2011. At the 2011 conference it was decided to hold future conferences on a biennial basis. The first biennial conference was held in 2013 and the next is planned for 2015. All ISEI conferences are listed with details on Table 1; in addition, a related and linked conference, held in Moscow in 2013, is also listed.

Table 1 Conferences sponsored by ISEI, 2005–2015

Conference	Theme	Location & sponsoring institute
	21st International Conference on Environmental Indicators 9th ISEI International Conference 2–5 August 2015	Windsor, Canada – University of Windsor and the Agriculture and Agri-Food Canada
	20th International Conference on Environmental Indicators 8th ISEI International Conference 16–19 September 2013	Trier, Germany – Trier University
	An ISEI-Related and Linked Conference 4–6 February 2013	Moscow, Russian Federation – Moscow State University

(continued)

(continued)

	19th International Conference on Environmental Indicators	Environmental Indicators with a Global View	Haifa, Israel – <i>Technion-Israel Institute of Technology</i>
	7th ISEI Annual Meeting		
	11–14 September 2011		
	18th International Conference on Environmental Indicators	Polar & Marine Environmental Changes and Pollutants & Other Anthropogenic Impacts	Hefei, China – University of Science and Technology of China
	6th ISEI Annual Meeting		
	13–16 September 2010		
	17th International Conference on Environmental Indicators	Global Indicators	Moscow, Russian Federation – Moscow State University
	5th ISEI Annual Meeting		
	18–20 May 2009		
	16th International Conference on Environmental Indicators	Management Metrics	Orlando, Florida, USA – Environmental Indicators Foundation, LLC
	4th ISEI Annual Meeting		
	11–14 November 2008		
	15th International Conference on Environmental Indicators	Bioindicators for Environmental Management	Hong Kong, SAR, China – City University of Hong Kong
	3rd ISEI Annual Meeting		
	7–9 June 2007		
	14th International Conference on Environmental Indicators	Indicators of Performance and Trends	Linthicum Heights, Maryland – Maritime Institute
	2nd ISEI Annual Meeting		
	24–26 April 2006		
	13th International Conference on Environmental Indicators	Large-scale Biomonitoring	Prague, Czech Republic – University of South Bohemia
	1st ISEI Annual Meeting		
	6–10 June 2005		

ISEI is governed by an elected Board currently headed by: President: Diane Henshel, Ph.D., Indiana University, Bloomington, IN, USA, dhenshel@indiana.edu, and Vice President: Zhi-Qing (ZQ) Lin, Ph.D., Southern Illinois University, Edwardsville, IL, USA, zhlin@siue.edu. Other Officials of the Society include: Secretary: Nancy Denslow, Ph.D., University of Florida, Gainesville, FL, USA, ndenslow@ufl.edu; Editor-in-Chief: Nicholas V.C. Ralston, Ph.D., University of North Dakota, Grand Forks, ND, USA, nralston@undeerc.org; Treasurer: Edward Zillioux, Ph.D., Environmental Indicators Foundation LLC, Fort Pierce, FL, USA, zillioux@bioindicators.org; and Board Members: Robert Armon, Ph.D., Technion, Haifa, Israel; Jill Jenkins, Ph.D., Geological Survey, Lafayette, LA, USA; Roland Klein, Ph.D., Trier University, Trier, Germany; James Newman, Ph.D., Normandeau Associates, Inc., Gainesville, FL, USA; and Carla Ralston, Ph.D., University of North Dakota, Grand Forks, ND, USA.

The ISEI journal and society website is in the process of being upgraded to make it more efficient to use and easier to access and to submit papers. The Board is currently conducting a Membership Drive to strengthen the vitality of ISEI and to carry forward the critical mission of this society:

Mission Statement and Objective

The International Society of Environmental Indicators (ISEI) and its journal, *Environmental Indicators* (JEI), seeks to explore the scientific bases and uses of indicators (biological, chemical, physical) and biomarkers as they relate directly to specific measurable effects in ecological and human populations from environmental exposures. Emphasis is placed on the application of molecular to landscape level indicators as tools to help in understanding the probability that the presence of a contaminant(s) or other disturbances in the ambient environment that may produce an adverse effect in exposed receptors or populations, the degree of harm that may be indicated, and the integration of these data to characterize environmental health. Environmental indicators range from molecular and genetic indicators to landscape-level indicators reflecting the conditions of the human and ecological environments.

It is the objective of the Society to provide an empirically-derived foundation in the use of indicators to help define environmental health and requisite protection or restoration needs, and from which responsible action, including informed and cost-effective regulatory endpoints, can be developed.

The ISEI membership application (which is also available on the Society website: <http://www.environmentalindicators.net/>) is attached for the convenience of prospective renewal and new membership applicants. Please copy the application and follow submittal instructions. Thank you.

Acknowledgements Thanks are due to Drs. Diane Henshel, Nicholas Ralston, and Zhi-Qing (ZQ) Lin for their reviews and helpful suggestions which have substantially improved this chapter.

Fort Pierce, FL, USA

Edward J. Zillioux

2014–2015 ISEI Membership Application

International Society of Environmental Indicators (ISEI) <http://www.environmentalindicators.net>.

Year of Renewal or New Member Application: _____

(Memberships are accepted on a calendar-year basis only; dues include subscription to the on-line journal, free manuscript submissions, and conference registration fee discount)

Please check category and amount paid:

Renewal New

Regular Membership: US\$100.00 per year

Charter Membership: US\$80.00 per year

Special Membership Rate for Developing Countries*: US\$40.00 per year

* “Developing Countries” are those categorized as “Low-Income,” “Lower-Middle-Income,” and “Upper-Middle-Income” by the World Bank; see <http://go.worldbank.org/D7SN0B8YU0>

Special Membership Rate for Students: US\$15.00 per year (a valid student ID required)

Payment Options:

Credit card: Please select: MasterCard Visa Discover American Express

Name on Card: _____

Card Number: _____ Expiration date: _____

Security Code: (3-digit number on back of MC, V, D card; 4-digit on front of Amer. Exp.) _____

Amount (USD): \$ _____

Signature: _____ Date: _____

PayPal: Payments for membership can be processed through PayPal. **Option 1:** Interested individuals who have a PayPal account can send payments to

zillioux@bioindicators.org. **Option 2:** Interested Individuals who do not have a PayPal account, should send an email to **zillioux@bioindicators.org** requesting payment through PayPal. I will forward your request and PayPal will contact you and ask for your credit card information. Your card information is protected by PayPal.

Check or money order: Make payable to “Environmental Indicators Foundation, LLC” in US funds. Send to ISEI, 207 Orange Avenue, Ste. G, Fort Pierce, Florida, 34950, USA

Member Information:

Name: _____

Affiliation: _____

Title/Position: _____

Address: _____

City: _____ State/Province: _____ Zip/Country Code: _____

Country: _____ E-mail: _____

Print and complete this form and mail to: Edward J. Zillioux, Treasurer and ISEI Business Manager, 207 Orange Avenue, Ste. G, Fort Pierce, FL 34950, USA, or send a scanned copy by email to: **zillioux@bioindicators.org**.