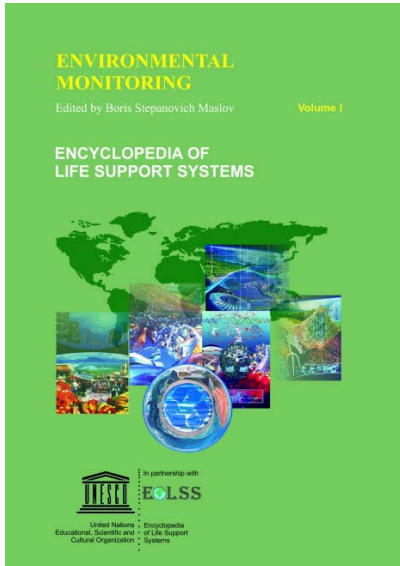


CONTENTS

ENVIRONMENTAL MONITORING



Environmental Monitoring - Volume 1

No. of Pages: 587

ISBN: 978-1-905839-75-9 (eBook)

ISBN: 978-1-84826-975-0 (Print Volume)

Environmental Monitoring - Volume 2

No. of Pages: 339

ISBN: 978-1-905839-76-6 (eBook)

ISBN: 978-1-84826-976-7 (Print Volume)

For more information of e-book and Print Volume(s) order, please [click here](#)

Or [contact : colssunesco@gmail.com](mailto:colssunesco@gmail.com)

CONTENTS

VOLUME I

Monitoring of the Environment as a Whole **1**

Isoken T. Aighewi, *Department of Soil Science, University of Benin, Benin City, Nigeria.*

Ema Oladiran Ekundayo, *Department of Soil Science, University of Benin, Benin City, Nigeria.*

1. Introduction
 - 1.1. Definition of Environmental Pollution Monitoring
 - 1.2. Scope of Environmental Pollution Monitoring
2. Objectives and Purpose of Environmental Pollution Monitoring
3. A Public Health Perspective of Environmental Pollution Monitoring
4. Levels of Environmental Quality Monitoring Programs
5. Design of Single, Multimedia and Special Purpose Environmental Monitoring Programs
 - 5.1. Land Quality
 - 5.2. Air Quality
 - 5.3. Water Quality
 - 5.4. The Use of Organisms in Chemical Monitoring and Criteria for Organism Selection
6. Issues in Environmental Planning
 - 6.1. Implementation of Environmental Quality Monitoring Programs
 - 6.2. Legal and Technological Aspects

Priority Parameters: Abiotic and Biotic Components **21**

Joseph I. Muoghalu, *Obafemi Awolowo University, Ile-Ife, Nigeria*

1. Introduction
2. Priority Abiotic Factors
 - 2.1. Temperature
 - 2.2. Moisture
 - 2.3. Light
 - 2.4. Soil
 - 2.5. Fire
 - 2.6. Pollutants
3. Priority Biotic Factors
 - 3.1. Living Organisms
 - 3.2. Biotic Interaction

Background State of the Biosphere **39**

Miah M. Adel, *University of Arkansas at Pine Bluff, USA*

Syed A. Hasnath, *Department of Geology, Boston University, USA*

1. Introduction
2. Natural Hazards
 - 2.1. Extraterrestrial Origin
 - 2.1.1. Stellar Outbursts
 - 2.1.2. Asteroids
 - 2.1.3. Meteoroids
 - 2.1.4. Solar Radiation Storms
 - 2.1.5. Radio Blackouts
 - 2.1.6. Geomagnetic Storms
 - 2.2. Terrestrial Origin
 - 2.2.1. Geologic Origin
 - 2.2.1.1. Volcanoes
 - 2.2.1.2. Earthquakes

- 2.2.1.3. Landslides
- 2.2.1.4. Avalanche
- 2.2.1.5. Tsunamis
- 2.2.2. Weather and Climatic Origin
 - 2.2.2.1. Floods
 - 2.2.2.2. Droughts
 - 2.2.2.3. El Niño and La Nina
 - 2.2.2.4. Tornados and Tropical Storms
 - 2.2.2.5. Lightning
 - 2.2.2.6. Blizzard
- 2.2.3. Biologic Origin
 - 2.2.3.1. Bacteria
 - 2.2.3.2. Viruses
 - 2.2.3.3. Insect- and Rodent-borne Diseases
 - 2.2.3.4. Death Causes
- 3. Anthropogenic Activities
 - 3.1. Biomass Burning
 - 3.2. Greenhouse Gases and Global Warming
 - 3.3. Incineration of Chemical Weapons
 - 3.3.1. Predicted Toxins in the Exhaust Gas
 - 3.3.1.1. Oxides of Sulfur
 - 3.3.1.2. Oxides of Nitrogen
 - 3.3.1.3. Ozone
 - 3.3.1.4. Phosphorous
 - 3.3.1.5. Oxides of Carbon
 - 3.3.1.6. Organic Aerosols and the Environmental Impact
 - 3.3.1.7. Dioxins
 - 3.3.1.8. Heavy Metals
 - 3.3.1.9. Effects of Acid Rains on Soils, Surface Water, Aquatic Environment, and Others
 - 3.3.1.10. Impact of Chemicals on Trees, Plants, and Crops and Animals
 - 3.4. Construction of Dams and Diversion of Water
 - 3.4.1. Missouri-Mississippi Basin
 - 3.4.2. Aral Sea Basin
 - 3.4.3. Bengal Basin
 - 3.4.4. Oil and Gas Explorations
 - 3.4.5. Fires
 - 3.4.6. Earthquake Induced by Human Actions
 - 3.4.7. Nuclear-Chemical-Biological Weapons
 - 3.4.8. Wars
- 4. Conclusion

- 1. Introduction
 - 1.1. Bioindicator
 - 1.2. Sentinels
 - 1.3. Keystone Species
 - 1.4. Endangered Species
 - 1.5. Bioindication sensu lato
 - 1.5.1. Biomarkers sensu strictu
 - 1.5.2. Morphological Indicators
 - 1.5.3. Behavioral Stress Responses
 - 1.5.4. Life-history and Higher Level Responses
- 2. Applications of Indicator Species in Biomonitoring
 - 2.1. Biotic Indices and Rapid Bioassessment
 - 2.1.1. Saprobic Index

- 2.1.2. The Trent Biotic Index (TBI) and Modifications
- 2.1.3. Chandlers Biotic Score (CBS)
- 2.1.4. Biological Monitoring Working Party (BMWP)-score
- 2.1.5. Belgian Biotic Index (BBI)
- 2.1.6. Chutter's Biotic Index
- 2.1.7. Floristic Quality Index (FQI)
- 2.1.8. Index of Air Purity (IAP)
- 2.1.9. Chironomid Indices
- 2.1.10. Oligochaeta Indices
- 2.2. Online Biomonitoring
- 3. Alternative Biomonitoring Methods
 - 3.1. Community Approach
 - 3.1.1. Diversity Indices
 - 3.1.2. Similarity indices/Community Comparison Indices (CCI)
 - 3.1.3. Multimetric Indices
 - 3.1.4. Non-taxonomic Biomonitoring Approaches
- 4. Aquatic Bioindicators
 - 4.1. Bacteria and Algae
 - 4.2. Bryophyta
 - 4.3. Aquatic Vascular Plants
 - 4.4. Protozoa
 - 4.5. Macroinvertebrates
 - 4.6. Fish
- 5. Terrestrial Bioindicators
 - 5.1. Lichens and Bryophytes
 - 5.2. Protozoa
 - 5.3. Arthropoda
- 6. Examples of Biomonitoring
 - 6.1. Freshwater Acidification
 - 6.2. South Florida Landscape/Seascape Restoration
- 7. Evaluation and Future Directions
 - 7.1. Biological Indices
 - 7.2. Online Biomonitoring
 - 7.3. Integrated Biomonitoring Concepts
 - 7.3.1. Standardization
 - 7.3.2. Triad Approach in Freshwater Biomonitoring
 - 7.3.3. Environmental Indicator Systems for Ecosystem Health
- 8. Integrated Biomonitoring of Freshwater Ecosystems

Remote Sensing (Satellite) System Technologies

124

Michael A. Okoye, *Earth Satellite Corporation, Rockville Maryland, USA*

Greg T. Koeln, *Earth Satellite Corporation, Rockville Maryland, USA*

- 1. Introduction
- 2. Basics of Satellite Remote Sensing
 - 2.1. How Remote Sensing Works
 - 2.2. Satellite Remote Sensing Types
 - 2.2.1. Panchromatic Imaging Systems
 - 2.2.2. Multispectral imaging systems
 - 2.2.3. Hyperspectral Imaging Systems
 - 2.2.4. Radar or Microwave Imaging System
 - 2.3. Advantages of Satellite Remote Sensing
 - 2.3.1. Synoptic View
 - 2.3.2. Globally Available Global Data
 - 2.3.3. Dynamic and Up-to-Date Data
 - 2.3.4. Many Views of the Same Situation
 - 2.3.5. Digital and Computer Compatible

- 2.3.6. Fast, Accurate, and Inexpensive
- 2.4. Limitations of Satellite Remote Sensing
 - 2.4.1. The Mechanism of Data Acquisition
 - 2.4.2. Cloud Cover and Other Limiting Factors
 - 2.4.3. Systems Limitations
 - 2.4.4. Socioeconomic Limitations
- 3. The Remote Sensing Application Process
 - 3.1. Introduction
 - 3.2. Establishing Your Need for Satellite Imagery
 - 3.3. Considering Sources of Existing Spatial Data
 - 3.4. Selecting Satellite Sensor and Suitable Imagery
 - 3.4.1. Introduction
 - 3.4.2. Sensor and Imagery Types
 - 3.4.3. Spatial Resolution
 - 3.4.4. Spectral Resolution
 - 3.4.5. Temporal Resolution or Revisit Cycle of the Satellite
 - 3.4.6. Scene Size and Sensor's Swath Width
 - 3.5. Image Processing Considerations

Geophysical Monitoring Technologies

143

Aniekan Edet, *University of Calabar, Nigeria*

- 1. Introduction
- 2. Gravity Method
 - 2.1. Physical Basis
 - 2.2. Interpretation Methods
- 3. Magnetic Method
 - 3.1. Basic Concepts and Instrumentation
 - 3.1.1. Magnetic Properties of Rocks
 - 3.1.2. Magnetic Instruments
 - 3.2. Field Surveys and Interpretation
- 4. Seismic Method
 - 4.1. Basic Concepts
 - 4.2. Seismic Surveys
 - 4.2.1. Seismic Refraction Survey
 - 4.2.2. Seismic Reflection Survey
- 5. Electrical Resistivity Method
 - 5.1. General
 - 5.2. Techniques
- 6. Spontaneous (Self) Potential (SP) Method
 - 6.1. Origin of SP
 - 6.2. Measurement of SP
- 7. Induced Polarization (IP) Method
 - 7.1. Origin of IP
 - 7.2. Measurement of IP
- 8. Electromagnetic (EM) Method
 - 8.1. Types of EM Systems
 - 8.2. Principles and Interpretation Methods
 - 8.2.1. Principles
 - 8.2.2. Interpretation Methods
- 9. Ground Penetrating Radar
 - 9.1. Principles of Operations
 - 9.2. Data Acquisition, Processing, and Interpretation

Laboratory-Based Analytical Technologies

167

John L. Daniels, *University of North Carolina, Charlotte, North Carolina, USA*

Sunyoung Bae, *University of North Carolina, Charlotte, North Carolina, USA*

1. Introduction
 - 1.1. Laboratory-Based versus Field-Based Technologies
 - 1.2. Hazardous Waste
2. Analysis of Trace Organic Contaminants by Chromatography
 - 2.1. Gas Chromatography (GC)
 - 2.1.1. Qualitative GC Analysis
 - 2.1.2. Quantitative GC Analysis
 - 2.1.3. Principles of Operation
 - 2.1.4. Instrumentation
 - 2.1.5. Sample Preparation
 - 2.2. High Performance Liquid Chromatography (HPLC)
 - 2.2.1. Principles of Operation
 - 2.2.2. Instrumentation
 - 2.2.3. Sample Preparation
3. Analysis of Trace Metals by Atomic Spectrometry
 - 3.1. Atomic Absorption Spectrometry (AAS)
 - 3.1.1. Principles of Operation—Flame Atomic Absorption Spectrometry (FAAS)
 - 3.1.2. Principles of Operation—Graphite Furnace Atomic Absorption Spectrometry (GFAAS)
 - 3.2. Atomic Emission Spectrometry (AES)
 - 3.2.1. Principles of Operation—Flame Atomic Emission Spectrometry (FAES)
 - 3.2.2. Principles of Operation—Inductively Coupled Plasma (ICP)
 - 3.3. X-Ray Fluorescence Spectrometry
 - 3.4. Sample Preparation, Matrices, and Detection Limits
 - 3.4.1. FAAS, GFAAS, FAES
 - 3.4.2. ICP, ICP-MS
 - 3.4.3. X-ray Fluorescence
4. Analysis of Trace Organic and Metallic Contaminants by Mass Spectrometry (MS)
 - 4.1. Gas Chromatography-Mass Spectrometry (GC-MS)
 - 4.2. Liquid Chromatography-Mass Spectrometry (LC-MS)
 - 4.3. ICP-MS
5. Future Trends and Directions

Priority Parameters and Their Measurements

195

Constance M. Brown-Mitic, *University of Arizona, Tucson, Arizona, USA*

Roger Bales, *University of Arizona, Tucson, Arizona, USA*

Samuel K. Kaharabata, *Agriculture and Agri-Food, Ottawa, Ontario, Canada*

1. Introduction
2. Parameters that Reflect Air Quality
 - 2.1. Carbon Monoxide
 - 2.2. Nitrogen Dioxide
 - 2.3. Sulfur Dioxide
 - 2.4. Tropospheric Ozone
 - 2.5. Particulate Matter
 - 2.6. Measurement Networks
3. Parameters that Reflect Ecosystem Dynamics
 - 3.1. Carbon Dioxide
 - 3.1.1. Trends and Estimates
 - 3.1.2. Monitoring CO₂
 - 3.2. Methane
 - 3.2.1. Trends and Estimates
 - 3.2.2. Monitoring Methane
 - 3.3. Nitrous Oxide
 - 3.3.1. Trends and Estimates
 - 3.3.2. Monitoring Nitrous Oxide

- 3.4. Methods of Measurement
 - 3.4.1. Global-Scale Observations
 - 3.4.2. Indirect Budget Methods
 - 3.4.3. Mass Balance Methods
 - 3.4.4. Flask Sampling
 - 3.4.5. Chamber or Enclosure Methods
 - 3.4.6. Micrometeorological Methods
 - 3.4.7. Atmospheric Tracer Method
- 3.5. Radiation and Boundary Layer Properties
- 4. Conclusion

Transboundary Air Pollution

217

Franco Di-Giovanni, *Airzone One Ltd., 222 Matheson Boulevard East, Mississauga Ontario, Canada*
 Philip Fellin, *Airzone One Ltd., 222 Matheson Boulevard East, Mississauga Ontario, Canada*

- 1. Introduction
- 2. Background on the Atmosphere and Dynamics
 - 2.1. Vertical Structure of the Earth's Atmosphere
 - 2.2. Horizontal Structure of the Earth's Atmosphere
 - 2.3. Pollutant Deposition
- 3. Smog
 - 3.1. Introduction
 - 3.2. Emissions and Transport
 - 3.3. Investigation Methods
 - 3.4. Reduction Actions
- 4. Acid Deposition
 - 4.1. Introduction
 - 4.2. Emissions and Transport
 - 4.3. Investigative Methods
 - 4.4. Reduction Actions
- 5. Particulate Matter
 - 5.1. Introduction
 - 5.2. Emission and Transport
 - 5.3. Investigation Methods
 - 5.4. Reduction Actions
- 6. Mercury
 - 6.1. Introduction
 - 6.2. Emissions and Transport
 - 6.3. Investigation Methods
 - 6.4. Reduction Actions
- 7. Haze
 - 7.1. Introduction
 - 7.2. Emissions and Transport
 - 7.3. Investigative Methods
 - 7.4. Reduction Actions
- 8. Persistent Organic Pollutants
 - 8.1. Introduction
 - 8.2. Emissions and Transport
 - 8.3. Investigation Methods
 - 8.4. Reduction Actions

Noise Level Monitoring

247

Khanindra Pathak, *Indian Institute of Technology, Kharagpur, India*

- 1. Introduction
- 2. Effects of Noise

- 2.1. Effects on Performance
- 3. Noise Monitoring
- 4. Basic Concepts of Acoustics
 - 4.1. Sound Power
 - 4.2. Scale of Measuring Acoustic Variables
 - 4.3. Combined Effects of Sound
 - 4.4. Frequency Weighting
 - 4.5. Directional Characteristics of Sound Sources
 - 4.6. Sound Field
- 5. Present Status of Noise Awareness
- 6. Techniques of Industrial Noise Monitoring
 - 6.1. Noise Measurement
 - 6.2. Noise-Measuring Instruments
 - 6.3. Index for Noise Estimation
 - 6.3.1. Sound Pressure Level, L_p
 - 6.3.2. Equivalent Sound Level, L_{eq}
 - 6.3.3. Percentile Exceeded Sound Level, L_x
 - 6.3.4. Day-Night Sound Level, L_{DN}
 - 6.3.5. Community Noise Equivalent Level (CNEL)
 - 6.3.6. Day Average Sound Level, L_D
 - 6.3.7. Noise Exposure Level, L_{AEX}
 - 6.4. Errors in Noise Measurements
- 7. Noise Assessment Models
 - 7.1. Concentration of Sources
 - 7.2. Division of Noise Sources
 - 7.2.1. Incoherent
 - 7.2.2. Coherent
 - 7.3. Industrial Noise Assessment and Prediction
 - 7.3.1. Sound Output of Processes and Plants
 - 7.3.2. Presence of Other Sources
 - 7.4. Attenuation of Noise Level
 - 7.4.1. Attenuation by Spreading
 - 7.4.2. Influence of Ground Surfaces
 - 7.4.3. Absorption by Air
 - 7.4.4. Attenuation by Barrier
 - 7.4.5. Other Attenuation
 - 7.5. Meteorological Conditions
 - 7.5.1. Viscosity
 - 7.5.2. Humidity
 - 7.5.3. Rain and Fog
 - 7.5.4. Temperature
 - 7.5.5. Wind
 - 7.5.6. Turbulence
- 8. Calculation of Noise Levels Near Industrial Complexes
 - 8.1. Plant Sound Power Method
 - 8.2. Calculation of L_{eq} for Mobile Plant
 - 8.2.1. Mobile Plants within a Small Area
 - 8.2.2. Mobile Plants on Regular Routes
 - 8.2.3. Road Traffic Noise
 - 8.3. Summation of Sound Levels
- 9. Noise Level Monitoring for Prediction
 - 9.1. Source Characterization Model
 - 9.2. Theory of the Equivalent Acoustic Center (EAC)
- 10. The Development of Source Characterization Model
- 11. Conclusion

Priority Parameters for Monitoring of Freshwater and Marine Systems, and Their Measurement**318**Luke J. Twomey, *Institute of Marine Sciences, University of North Carolina at Chapel Hill, USA.*M.F. Piehler, *Institute of Marine Sciences, University of North Carolina at Chapel Hill, USA.*H.W. Paerl, *Institute of Marine Sciences, University of North Carolina at Chapel Hill, USA.*

1. Introduction
2. Salinity and Conductivity
3. Light
4. Dissolved Oxygen
5. Temperature
6. pH
7. Nutrients
8. Phytoplankton
9. Zooplankton
10. Aquatic Pathogens
11. Fish and Other Large Organisms

Freshwater Observation Systems, Networks, and Existing Databases**339**Lisa Martinenghi, *Studio d'ingegneria Martinenghi SA, Cureglia, Switzerland*Fedo Zamboni, *University of Applied Sciences of Southern Switzerland, Canobbio, Switzerland*

1. Introduction
2. Methods for Monitoring of Rivers and Streams
 - 2.1. Hydraulic Measurements
 - 2.2. Physical-Chemical Measurements
 - 2.3. Biological Measurements
3. Methods for Monitoring of Lakes
 - 3.1. Hydraulic Measurements
 - 3.2. Physical Measurements
 - 3.3. Thermal Budget
 - 3.4. Chemical Measurements
 - 3.5. Chemical Budget
 - 3.6. Biological Measurements
 - 3.7. Sedimentation and Study of Floor Sediments
4. National and International Programs for Water Control
 - 4.1. Annual Programs for the Monthly Monitoring of Physical, Chemical, and Biological Parameters
 - 4.2. Commissions and Programs for the Study and Protection of Freshwater
5. Data Processing and Databases

Marine and Brackish Water Observation Systems, Networks and Existing Databases**360**Khadiga G. Adham, *Zoology Department, Faculty of Science, University of Alexandria, Egypt*

1. Introduction
2. Fundamentals of Observing Systems of Seas and Oceans
 - 2.1. Background Approach (Agenda 21 Chapter 17)
 - 2.2. Conceptions of a Functional Observation System
 - 2.2.1. A Sustainable System
 - 2.2.2. An Operational System
 - 2.2.3. An Integrated System
3. Incentives for a Sustained, Operational and Integrated Observation System
 - 3.1. Detecting and forecasting oceanic components of climate variability
 - 3.2. Facilitating safe and efficient marine operations
 - 3.3. Ensuring National Security and Global Environmental Well-Being
 - 3.4. Managing Living Resources for Sustainable Use
 - 3.5. Preserving Healthy and Restoring Degraded Marine Ecosystems

- 3.6. Mitigating Natural Hazards
- 3.7. Ensuring Public Health
- 4. Observation of Seas and Oceans
 - 4.1. Technical Topics of Ocean Observation systems
 - 4.1.1. Operational Ocean Instrumentation, Measurement, and Data/Information Dissemination Systems
 - 4.1.2. Automated Ocean/ Atmosphere Observations from Volunteer Observing Ships
 - 4.1.3. Polarimetric Infrared Imaging
 - 4.1.4. High-Speed Tethered Shipboard Upper-Ocean Profiling System
 - 4.1.5. High Resolution Hyperspectral System for Rapid Coastal Marine Geophysical Data Acquisition and Processing
 - 4.1.6. Hydrographic Data Acquisition and Data Processing
 - 4.1.7. Ship Motion Measurement System Utilizing a GPS/ IMU System
 - 4.2. Some Examples of Worldwide Observation Networks
 - 4.2.1. OHP (Ocean Hemisphere Network Project– http://eri-ndc.eri.utokyo.ac.jp/index_e.html)
 - 4.2.1.1. Background
 - 4.2.1.2. Observation System of the Ocean Hemisphere Network
 - 4.2.1.3. Data Management and Analysis
 - 4.2.1.4. Observation Stations of the Ocean Hemisphere Network
 - 4.2.1.5. Examples of observation facility
 - 4.2.2. TCOON (Texas Coastal Ocean Observation Network)
 - 4.2.3. RONMAC (Water Level Observation Network for Latin America)
 - 4.2.4. MedGLOSS (Mediterranean regional subsystem of the Global Sea Level Observing System—Monitoring Network System for Systematic Sea-Level Measurements in the Mediterranean and Black Seas – UNESCO – CIESM)
- 5. Major Intergovernmental Actors and Pilot Projects of the Observation System
 - 5.1. Academy of Natural Sciences
 - 5.2. ACCE (Atlantic Circulation and Climate Experiment–WOCE)
 - 5.3. ARGO (Array for Real-time Geostrophic Oceanography)
 - 5.4. BALTEX (Baltic Sea Experiment)
 - 5.5. BATS (Bermuda Atlantic Time-series Study)
 - 5.6. CBOS (Chesapeake Bay Observing System)
 - 5.7. CENR (Committee on Environment and Natural Resources) of the National Science and Technology Council)
 - 5.8. CIESM (International Commission for the Scientific Exploration of the Mediterranean Sea)
 - 5.9. COFS (Coastal Ocean Forecast System)
 - 5.10. CORE (Consortium for Oceanographic Research and Education)
 - 5.11. CORIE (Consortium for Oceanographic Research and Education)
 - 5.12. FAGS (Federation of Astronomical and Geophysical Data Analysis Services)
 - 5.13. GLOBEC (Global Ocean Ecosystem Dynamics)
 - 5.14. GoMOOS (Gulf of Maine Ocean Observing System)
 - 5.15. GOOS (Global Ocean Observing System)
 - 5.16. GPS (US Global Positioning System)
 - 5.17. IAG (International Association of Geodesy)
 - 5.18. IAG Unification of global Vertical Datums
 - 5.19. IAPSO (International Association for the Physical Sciences of the Ocean)
 - 5.20. ICES (International Council for the Exploration of the Sea)
 - 5.21. ICSU (International Council of Scientific Unions)
 - 5.22. IERS (International Earth Rotation Service)
 - 5.23. IGBP (International Geosphere-Biosphere Programme)
 - 5.24. IGN (Institut Geographique National – France)
 - 5.25. IGS (International GPS Service for Geodynamics)
 - 5.26. IOC (Intergovernmental Oceanographic Commission –UNESCO)
 - 5.27. IUGG (International Union of Geodesy and Geophysics)
 - 5.28. JGOFS (Joint Global Ocean Flux Study)
 - 5.29. LEO-15 (Long-term Ecosystem Observatory at 15-meter depth)
 - 5.30. LOICZ (Land-Ocean Interactions in the Coastal Zone)
 - 5.31. LTER (Long Term Ecological Research – in Land/Ocean Margin Ecosystems –NSF)

- 5.32. MBNMS (Monterey Bay National Marine Sanctuary)
- 5.33. National Marine Sanctuary Monitoring Programs – (NOAA)
- 5.34. NERRS (National Estuarine Research Reserves – NOAA)
- 5.35. NEP (National Estuary Program – and associated monitoring activities– EPA)
- 5.36. NOAA (National Oceanic and Atmospheric Administration)
- 5.37. PORTS (Physical Oceanographic Real-Time System)
- 5.38. SABSOON (South Atlantic Bight Synoptic Offshore Observational Network)
- 5.39. SCOR (Scientific Committee on Oceanic Research)
- 5.40. UNH Sea Grant (University of New Hampshire Sea Grant)
- 5.41. USGS (US Geological Survey)
- 5.42. WOCE (World Ocean Circulation Experiment)
- 6. Existing Databases and Major Data Management Systems
 - 6.1. Australian Museum
 - 6.2. BioLink software
 - 6.3. BRIDGE (Ocean Sciences Education Teacher Resource Center)
 - 6.4. Bringing the Ocean to the K-12 Classroom Using a Coastal Ocean Observation Laboratory and a National Estuarine Research Reserve
 - 6.5. California Academy of Sciences
 - 6.6. CoML (Census of Marine Life)
 - 6.7. CISNet (Coastal Intensive Site Network, NOAA/EPA/NASA)
 - 6.8. COAST:PILOT (Consortium for Oceanographic Activities for Students and Teachers: Putting Interactive Learning on Target)
 - 6.9. DODS (Distributed Oceanographic Data System)
 - 6.10. EASy (Environmental Analysis System)
 - 6.11. EOS (Earth Observing System – NASA)
 - 6.12. EOSDIS (Earth Observing System Data Information System – NASA)
 - 6.13. Enhancing K-12 Science Education via Satellite-Televised Interactive Technologies
 - 6.14. ERMS (The European Register of Marine Species)
 - 6.15. FishBase (A Global Information System on Fishes)
 - 6.16. GCOS (Global Climate Observing System)
 - 6.17. GIS (Geographic Information System)
 - 6.18. GLOUP (Global Undersea Pressure)
 - 6.19. GODAE (Global Ocean Data Assimilation Experiments –WOCE)
 - 6.20. Hexacorallians of the World
 - 6.21. IODE (International Oceanographic Data & Information Exchange – UNESCO)
 - 6.22. JASON Project: Descending the Ocean Ladder Providing Context for Continuous Student Access to Ocean Science Research – NOPP
 - 6.23. Joint Data and Information Management Plan of GOOS, GTOS, and GCOS– Described in GOOS Publication no. 42, The GOOS 1998, IOC, Paris, 168 pp.
 - 6.24. MarLIN (Marine Life Information Network)
 - 6.25. MEL (Master Environmental Library – Department of Defense)
 - 6.26. Metadata requirements of the Federal Geographic Data
 - 6.27. National Marine Sanctuary Monitoring Programs – NOAA
 - 6.28. NAVOCEANO (Naval Oceanographic Office) – suite of ocean data and products
 - 6.29. NEP (National Estuary Program – EPA)
 - 6.30. NERRS (National Estuarine Research Reserves) Activities
 - 6.31. NODC (National Oceanographic Data Center – NOAA/NESDIS)
 - 6.32. NOPP (National Oceanographic Partnership Program)
 - 6.33. NURP (National Undersea Research Program – NOAA)
 - 6.34. OBIS (The Ocean Biogeographical Information System)
 - 6.35. PSMSL (Permanent Service for Mean Sea Level)
 - 6.36. STORET system – EPA
 - 6.37. TAO (Tropical Atmosphere Ocean project– US Dept of Commerce / NOAA / OAR / ERL / PMEL / TAO)
 - 6.38. TIEMPO (The Tiempo Climate Cyberlibrary)
 - 6.39. Tsunami Information (An interactive, on-line, tsunami-information resource)
 - 6.40. URMO (UNESCO-IOC/– Register of Marine Organisms)
 - 6.41. VODHub (Virtual Ocean Data Hub– NOPP)

Index 407

About EOLSS 411

VOLUME II

Deposition of Pollutants and Their Impacts on Fisheries 1
 B.B. Jana, *University of Kalyani, West Bengal, India*

1. Introduction
2. Pollutants
 - 2.1. Sources and Types of Pollutants
3. The Aquatic Ecosystem
 - 3.1. Assimilative Capacity
4. Fate of Aquatic Pollutants
 - 4.1. Pollutant Deposition in Sediments
 - 4.1.1. Microbial Transformation
5. Biotransformation of Pollutants
 - 5.1. Bioconcentration
 - 5.2. Bioaccumulation
 - 5.3. Biomagnification
6. Impacts of Different Pollutants on Fisheries
 - 6.1. Inorganic Pollutants
 - 6.1.1. Mercury
 - 6.1.2. Cadmium
 - 6.1.3. Zinc
 - 6.1.4. Copper
 - 6.1.5. Lead
 - 6.1.6. Other Heavy Metals
 - 6.1.7. Mixture of Toxicants
 - 6.1.8. Mechanism of Heavy Metal Toxicity
 - 6.1.9. Other Inorganic Toxicants
 - 6.1.10. Chlorine
 - 6.1.11. Aluminum
 - 6.1.12. Relative Accumulation from Food and Water
 - 6.1.13. Acid Rain and Subsequent Effects
 - 6.1.14. Toxicity to Fish
 - 6.2. Organic Pollutants
 - 6.2.1. Persistent Organic Pollutants
 - 6.2.2. Chlorinated Hydrocarbons
 - 6.2.3. Polychlorinated Biphenyls (PCBs)
 - 6.2.4. Polycyclic Aromatic Hydrocarbons (PAHs)
 - 6.2.5. Chlorobenzene
 - 6.2.6. Cyclodienes
 - 6.2.7. Polyaromatic Hydrocarbons
 - 6.2.8. Nonpersistent Organic Pollutants: Herbicides
 - 6.3. Key Issues of Fisheries Unsustainability
 - 6.3.1. Sewage-Fed Fisheries
 - 6.3.2. Nutrient Enrichment Syndrome
 - 6.3.3. Bioaccumulation of Bloom Toxin
 - 6.3.4. Intensive Aquaculture Systems: Salmonids
 - 6.3.5. Intensive Aquaculture Systems: Shrimp Farming
 - 6.3.6. Soil and Groundwater Salinization
 - 6.3.7. Ichthyoeutrophication
 - 6.3.8. Nitrogen Excretion
 - 6.3.9. Ammonia

- 6.3.10. Water Quality Deterioration at Harvest
- 6.3.11. Destruction of Mangroves
- 6.3.12. Aquachemicals
- 6.3.13. Antibacterials
- 6.3.14. Antibiotics
- 6.3.15. Insecticides
- 6.3.16. Algicides
- 6.3.17. Parasiticides and Fungicides
- 6.3.18. Hormone Residues
- 6.3.19. Persistence of Drug Residues in the Environment
- 6.3.20. Drug Residues in Bottom Sediments
- 6.3.21. Residues in Cultured Animals
- 6.3.22. Residues in Nontarget Species
- 6.3.23. Drug Resistance
- 6.3.24. Resistance in Gut Microflora
- 7. Environmental Impact Assessment
 - 7.1. Determination of Toxicity
 - 7.1.1. Shapes of Toxicity Curves
 - 7.1.2. Application Factor
 - 7.2. Biomonitoring
 - 7.2.1. Microbial Biomass Indicator
 - 7.3. Clinical Indicators
 - 7.4. Genotoxic Effects
- 8. Reclamation Strategies
 - 8.1. Crop Rotation
 - 8.2. Probiotics
 - 8.3. Eco-Friendly Feed Quality
 - 8.4. Withdrawal Period
 - 8.5. Mathematical Models
- 9. Conclusions

Pollution of Littoral Zone and Bottom Sediment

66

B.B. Jana, *University of Kalyani, West Bengal, India*

- 1. Introduction
- 2. Freshwater Resources
- 3. The Aquatic Ecosystem
 - 3.1. Food Chain and Food Web
 - 3.2. Biological Decomposition
 - 3.3. Bottom Sediment
 - 3.4. The Role of Benthic Animals
- 4. The Homeostasis Syndrome
 - 4.1. Buffer Capacity
- 5. Concept of Aquatic Pollution
 - 5.1. Sources and Complexities
- 6. Organic Pollution
 - 6.1. Synthetic Organic Compounds
 - 6.1.1. Persistent Organic Pollutants (POPs)
 - 6.1.2. Polychlorinated Biphenyls (PCBs)
 - 6.1.3. Pesticides
 - 6.1.4. DDT (Dichlorodiphenyltrichloroethane)
 - 6.1.5. Herbicides
 - 6.1.6. Chlorinated Hydrocarbons
 - 6.1.7. Nonpersistent Organic Pollutants
 - 6.2. Hydrocarbons
 - 6.3. Environmental Recycling of Organic Pollutants
 - 6.4. Partitioning of Organic Pollutants

- 6.5. Role of Sediment Organic Carbon
- 7. Eutrophication
 - 7.1. Eutrophication Models
- 8. Inorganic Pollutants
 - 8.1. Nitrate Pollution
 - 8.2. Thiocyanate Contamination
- 9. Toxic Chemicals of Natural Origin
- 10. Metal Pollution
 - 10.1. Sources of Heavy Metal Pollution
 - 10.2. Heavy Metals in Bottom Sediments
 - 10.2.1. Seasonal and Spatial Variation
 - 10.3. Cadmium
 - 10.3.1. Cadmium Distribution in Aquatic Biota
 - 10.3.2. Complexation
 - 10.3.3. Bottom Sediment
 - 10.3.4. Whole-Lake Experiment
 - 10.4. Mercury
 - 10.4.1. Level of Mercury
 - 10.4.2. Transformation in Bottom Sediments
 - 10.5. Arsenic
 - 10.6. Lead
 - 10.7. Nickel
 - 10.8. Chromium
 - 10.9. Cesium
 - 10.10. Other Metals
 - 10.10.1. Copper
 - 10.10.2. Aluminum
- 11. Acidification
- 12. Thermal Pollution
- 13. Water Quality Assessment
- 14. Sustainable Management
 - 14.1. Ecological Engineering Approach
 - 14.2. The Living Machines
 - 14.3. Biomanipulation
 - 14.4. Environmentally Sound Technologies
- 15. Conclusions

Lake and River Sediment Monitoring

120

Rudolf Reuther, *Environmental Assessments, Herrsching/Ammersee Germany*

- 1. Introduction
- 2. Monitoring Programs
 - 2.1. Objectives
 - 2.2. Substrate Characteristics and Processes
 - 2.2.1. Physical Factors
 - 2.2.2. Chemical Processes
 - 2.2.3. Biological Processes
 - 2.3. Methods and Performance
 - 2.3.1. Sampling and Equipment
 - 2.3.2. Sampling Strategies
 - 2.3.3. Sampling Time and Site
 - 2.3.4. Laboratory and Field Studies
- 3. Monitoring Results
 - 3.1. Data Treatment, Analysis, and Presentation
 - 3.2. Data Evaluation
- 4. Sediment Quality
 - 4.1. Sediment Quality Criteria (SQC)

- 4.2. Promising Approaches
 - 4.2.1. Sediment Quality Triad (SQT)
 - 4.2.2. Toxicity Identification Evaluation (TIE)

Soil Contamination Monitoring

148

C. Marjorie Aelion, *University of South Carolina, Columbia, SC, USA*

1. Introduction
2. Properties of Soil Contaminants
3. Soil and Vapor Sampling for Soil Contamination Monitoring
 - 3.1. Soil Solid Phase Sampling
 - 3.2. Soil Vapor Phase Sampling
4. Chemical Soil Contamination Monitoring Techniques
 - 4.1. Chromatography
 - 4.2. Spectroscopy and Spectrometry
 - 4.3. Radiochemical Techniques
 - 4.4. Isotopic Composition
 - 4.5. Hand-Held Meters and Field Kits
5. Geophysical Soil Contamination Monitoring Techniques
 - 5.1. Dielectric Constant and Electrical Conductivity
 - 5.2. Laser-Induced Fluorescence (LIF) Excitation-Emission Matrix (EEM)
 - 5.3. Electromagnetic Induction (EMI)
 - 5.4. Radiometry
 - 5.5. In-Situ Gamma Spectroscopy
6. Biological Soil Contamination Monitoring Techniques
 - 6.1. Organisms and Tissue-Level Biomarkers
 - 6.2. Chemical Biomarkers
 - 6.3. Enzyme-Based Biomarkers
 - 6.4. Immunoassays
7. Need for Innovative Soil Contamination Monitoring Techniques

Groundwater Monitoring

175

Naresh Singhal, *University of Auckland, New Zealand*

Rajika Samaranyake, *University of Auckland, New Zealand*

Hettiarachchige Dayananda Gunasekera, *University of Auckland, New Zealand*

Jahangir Islam, *University of Auckland, New Zealand*

1. Philosophy and Purpose of Groundwater Investigations
2. Health and Safety Considerations
3. Groundwater Monitoring Networks
 - 3.1. Monitoring System Design
 - 3.1.1. Designs for Selected Hydrogeologic Settings
4. Monitoring Wells
 - 4.1. Drilling Methods
 - 4.1.1. Selection Procedure
 - 4.2. Monitoring Well Design
 - 4.2.1. Well Casing
 - 4.2.2. Screens and Filter Packs
 - 4.2.3. Surface Protection
 - 4.3. Monitoring Well Development
 - 4.4. Monitoring Well Maintenance and Rehabilitation
5. Acquisition and Interpretation of Groundwater Data
 - 5.1. Water-Level Acquisition
 - 5.1.1. Manual Measurement Methods
 - 5.1.2. Methods of Continuous Measurement
 - 5.2. Sampling for Groundwater Quality

- 5.2.1. Sampling Frequency
- 5.3. Analysis and Interpretation of Groundwater Data
 - 5.3.1. Analysis and Interpretation of Water Level Data
 - 5.3.2. Analysis of Data for Groundwater Quality

Desertification and Vegetation Monitoring

200

Joseph I. Muoghalu, *Obafemi Awolowo University, Ile-Ife, Nigeria*

1. Introduction
 - 1.1. Desertification
 - 1.2. Vegetation Degradation and Destruction
2. Causes of Desertification and Vegetation Degradation and Destruction
 - 2.1. Natural Causes
 - 2.1.1. Drought
 - 2.1.2. Herbivory by Wild Animals
 - 2.2. Human Causes
 - 2.2.1. Vegetation Cover Degradation and Regeneration
3. Monitoring: Indicators of Desertification and Vegetation Destruction
 - 3.1. Degradation of Vegetation Cover
 - 3.2. Overgrazing due to an Increase in Livestock Population
 - 3.3. Overcultivation
 - 3.4. Fuelwood Collection and Vegetation Exploitation
 - 3.5. Groundwater Status, Alkalinization, and Salinization
 - 3.6. Urbanization
 - 3.7. Sand Drift and Sand Encrustation
4. Conclusion

Contaminated Site Characterization and Monitoring

212

T. Cassia de Brito Galvao, *Universidade Federal de Minas Gerais, Belo Horizonte, MG, Brazil*

John L. Daniels, *University of North Carolina, Charlotte, NC, USA*

Hilary I. Inyang, *University of North Carolina, Charlotte, NC, USA*

1. Introduction
2. Site Characterization and Monitoring Protocol
 - 2.1. Site Characterization Objectives
 - 2.2. Logistical Support
 - 2.3. Constraints
 - 2.4. Soil Sampling Protocol
 - 2.4.1. Statistical Sampling Requirements
 - 2.4.2. Variables to Monitor
 - 2.4.3. Data Collection Methods
 - 2.4.4. Methods of Analysis/Identification of Alternatives
 - 2.4.5. Sample Handling, Preservation, Transportation, and Storage
 - 2.5. Site Investigation and Monitoring Parameters
 - 2.6. Data Management
 - 2.7. Screening of Alternatives/Feasibility Studies
 - 2.8. Quality Assurance/Quality Control
 - 2.9. Health and Safety
3. Assessment Monitoring
 - 3.1. Indirect Methods
 - 3.2. Direct Methods
4. Performance/Postclosure Monitoring
 - 4.1. Bioremediation/In Situ Remedial Treatment and Containment Monitoring
5. Current Technologies and Future Trends
6. Conclusions

Evolution of Geographic Information and Visualization Systems

240

Ann K. Deakin, *State University of New York College at Fredonia, USA*

1. Introduction
2. Geographic Information and Visualization Systems
 - 2.1. What are Geographic Information Systems (GIS)?
 - 2.2. What is a Visualization System Relative to GIS?
3. Factors Spurring the Evolution of Geographic Information and Visualization Systems
 - 3.1. The Growth of Geographic Information Systems
 - 3.1.1. GIS in Canada
 - 3.1.2. GIS in the United States
 - 3.1.3. GIS in the United Kingdom
 - 3.1.4. GIS, the United Nations, and the Impact of Satellite Data
 - 3.1.5. The Evolution of GIS and its Computing Environment
 - 3.2. The Development of Visualization Systems
 - 3.2.1. Visualization Systems and Geospatial Data
 - 3.2.2. Representation of Geospatial Data in Geovisualization Environments
 - 3.2.3. Visualization-Computation Integration for Geovisualization Environments
 - 3.2.4. Interfaces for Geovisualization Environments
 - 3.2.5. Cognition and Usability in Geovisualization Environments
4. The Role of Access and Geographic Information and Visualization Systems
 - 4.1. The Accessibility of Geographic Information Systems
 - 4.2. Accessing Visualization Systems through GIS
5. The State of the Art in Geographic Information and Visualization Systems
 - 5.1. Present Trends in Geographic Information Systems
 - 5.2. Present Trends in Visualization Systems
 - 5.2.1. Representation of Geospatial Data
6. Conclusion

Statistical Analysis and Quality Assurance of Monitoring Data

263

Iris Yeung, *City University of Hong Kong, Kowloon, Hong Kong*

1. Introduction
2. Statistical Analysis
 - 2.1. Seasonal Kendall Test and Slope Estimator
 - 2.1.1. Seasonal Kendall Test
 - 2.1.2. Seasonal Kendall Slope Estimator
 - 2.2. Time Series Models
 - 2.2.1. ARIMA model
 - 2.2.2. Transfer Function Model
 - 2.2.3. Intervention Model
 - 2.3. Multivariate Analysis
 - 2.3.1. Principal Components Analysis
 - 2.3.2. Factor Analysis
 - 2.3.3. Discriminant Analysis
 - 2.3.4. Cluster Analysis
 - 2.3.5. Multidimensional Scaling
3. Quality Assurance
 - 3.1. Quality Assurance in Field Sampling
 - 3.2. Quality Assurance in Laboratory Analysis
 - 3.3. Shewhart Control Charts
4. Computer Programs

Geostatistical Analysis of Monitoring Data

293

Mark Dowdall, *Norwegian Radiation Protection Authority, Environmental Protection Unit, Polar*

Environmental centre, Tromso, Norway

John O’Dea, Institute of Technology, Ballinode, Sligo, Ireland

1. Introduction
2. Regionalized Variables
3. The Semi-Variogram
4. Theoretical Semi-Variogram Models
5. Semi-Variogram Modeling for Environmental Data
6. Kriging
7. Kriging Process Parameters
8. Cross-Validation
9. Sampling Plans for Geostatistical Estimation
10. Application of Geostatistics: Considerations
11. Conclusions

Applications of Geographic Information Systems

314

Christopher Misati Ondieki, Kenyatta University, Kenya

Shadrack Kiana Murimi, Kenyatta University, Kenya

1. Introduction
 - 1.1. Definition and Scope
 - 1.2. Concept
 - 1.3. Role
2. GIS Data Format
 - 2.1. Vector Format
 - 2.2. Raster Format
 - 2.3. Database and Sources
3. Functionality of GIS
 - 3.1. Data Input
 - 3.1.1. Keyboard
 - 3.1.2. Manual Digitizing
 - 3.1.3. Scanning
 - 3.1.4. Import of Existing Digital Files
 - 3.2. Data Storage and Retrieval
 - 3.3. Data Manipulation and Analysis
 - 3.4. Data Output and Reporting
4. GIS Software and Data Capture
 - 4.1. GIS Software
 - 4.1.1. ArcInfo
 - 4.1.2. ArcView
 - 4.2. Selection and Benefits
 - 4.2.1. Geo-Spatial Data
 - 4.2.2. Geographic Features
 - 4.2.3. Referencing Systems and Map Projections
 - 4.3. GIS Software Development
 - 4.3.1. Trends
 - 4.3.2. Perspectives
5. GIS Applications
 - 5.1. General
 - 5.2. Environmental Planning and Management
 - 5.3. Hydrology and Water Resources
 - 5.4. Urban Planning and Socioeconomics
 - 5.5. Urban Growth Modeling
6. Limitations and Opportunities for GIS Systems
 - 6.1. Limitations
 - 6.2. Opportunities for GIS Improvements
 - 6.3. GIS Vendors

7. Conclusions

Use of Monitoring Data in Human/Ecological Exposure Assessment 341

Joanna Burger, *Rutgers University, Environmental and Occupation Health Sciences Institute, and Consortium for Risk Evaluation with Stakeholder Participation, Piscataway, New Jersey, USA*
 Michael Gochfeld, *Robert Wood Johnson Medical School and Consortium for Risk Evaluation with Stakeholder Participation, Piscataway, New Jersey, USA*

1. Introduction
 - 1.1. Research Data vs. Monitoring
 - 1.2. Short-Term Monitoring
 - 1.3. Compliance Monitoring
2. Types of Data Available
 - 2.1. Sources of Monitoring Data
 - 2.2. Continuous vs. Discrete Input Variables
 - 2.3. Uncertainty in Monitoring Data
3. Weight of Evidence and the Precautionary Principle
 - 3.1. Weight of Evidence
 - 3.2. Precautionary Principle
 - 3.3. Hypothesis Generation
4. Concept of Exposure Assessment (EA)
 - 4.1. Who Performs an Exposure Assessment
 - 4.2. Biological Markers in Exposure Assessment
 - 4.3. Probabilistic vs. Deterministic Exposure Assessments
5. Structure of Exposure Assessment
 - 5.1. Timing of Exposure
 - 5.2. Environmental Transport and Transformation
 - 5.3. Pathways of Exposure
 - 5.4. Vulnerability and Susceptibility
 - 5.5. Bioavailability and Absorption
 - 5.6. Sources of Data in Exposure Assessment
6. Ecological Exposure Assessment (EEA)
 - 6.1. Environmental Media and Pathways
 - 6.2. Uses of Exposure Data
7. Human Health Exposure Assessment (HEA)
 - 7.1. Human Health Monitoring Databases
 - 7.1.1. The National Center for Health Statistics
 - 7.1.2. National Human Exposure Assessment Survey
 - 7.1.3. Environmental Quality Databases
 - 7.1.4. Biomonitoring Databases
 - 7.1.5. Industrial Ecology Monitoring and Exposure
 - 7.1.6. Industrial Hygiene Monitoring
8. Case Study: Monitoring and Methylmercury Exposure
 - 8.1. Methylmercury in Aquatic Food Chains
 - 8.2. Methylmercury and Human Exposure
 - 8.3. Using Biomonitoring Data on Fish for HEA
9. Conclusions

Monitoring of Fresh and Brackish Water Resources 364

David Banks, *Holymoor Consultancy, Chesterfield, UK*

1. Introduction
2. What is Monitoring ?
3. The History of Monitoring
4. Why Monitor ?
5. The Importance of Background Conditions

- 6. Conceptual Models
 - 6.1. The Importance of Conceptual Models to Monitoring Design
- 7. The Practicalities of Monitoring
 - 7.1. Monitoring Frequency
 - 7.2. Measurement and Sampling Techniques
 - 7.2.1. Surface Waters
 - 7.2.2. Soil Moisture / Unsaturated Zone
 - 7.2.3. Groundwater
 - 7.2.4. Choice of Method
 - 7.2.5. Water Quality
- 8. Which Parameters should be Measured ?
- 9. Analysis
 - 9.1. Quality Assurance
- 10. Interpretation of Data
- 11. Integrated Monitoring
 - 11.1. Integrated Catchment Monitoring
 - 11.2. Ecotoxicological Monitoring

Index **401**

About EOLSS **405**