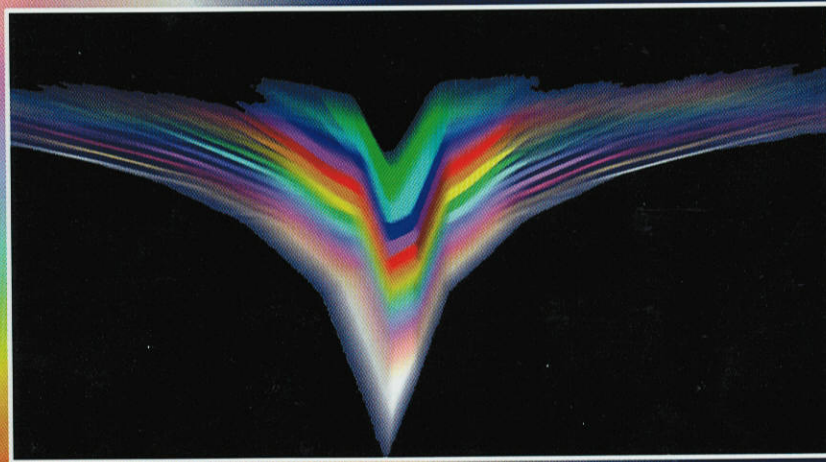


**Development and Application of
Computer Techniques
to Environmental
Studies VIII**



**G. Ibarra-Berastegi
C.A. Brebbia
P. Zannetti**
Editors

WITPRESS



DEVELOPMENT AND APPLICATION OF COMPUTER TECHNIQUES TO ENVIRONMENTAL STUDIES VIII

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KEYNOTE ADDRESS

Richard A. ...
University of ...

Abstract

This paper reviews environmental information available on the Internet. It discusses the challenges of environmental information, including the need for better data, better models, better tools, and better reports. The paper also discusses the need for better data, better models, better tools, and better reports. The paper also discusses the need for better data, better models, better tools, and better reports.

Introduction and overview

The Internet revolution is clearly destined to completely transform the way we work, communicate, shop, eat, travel, and live. It is a revolution that is already here, and the vision of participating and producing the change. Not only scientists, but also engineers, and science fiction writers will find change coming, even though the rate of change is likely to be slower than predicted. A paradigm shift is at the dawn of the computer revolution. For example, in the late 1980s, IBM employees were already communicating with an internal e-mail system and using binary "attachments."

The revolution has, of course, affected the environment. In the last few years, we have experienced an exponential expansion of material available through the Web. The full implications of this trend are still unclear. We wonder, for example, about the future role of traditional scientific publishing, since it is becoming common practice for authors to post preliminary or final articles directly on their Web sites, in addition to (or in substitution of) formal publication in peer-reviewed journals.

The proliferation of environmental information on the Web has been astounding. We have already reached the point where it has become impossible for an individual to keep track of all the new material. I just ran a search at yahoo.com with the keyword "environment" and got 14,000 sites! Also, 120,884 Web sites were found in a search of the complete Lycos Web catalog using "environmental sciences." Hence, the need to use more and

Environmental data, software, information, and resources on the Internet — a review

P. Zannetti
Exponent, Inc.
Menlo Park, California

Abstract

This paper presents a review of environmental information available on the Internet. This includes data, measurements, statistics, databases, software, simulation models, articles, reviews, and technical reports. The paper also analyses current trends and provides a perspective on future developments expected in the next few decades.

1 Introduction and overview

The "Internet Revolution" is clearly destined to completely transform the way we work, communicate, shop, sell, interact, and live. I found it amazing that nobody really had the vision of anticipating and predicting this change. Neither scientists, nor "futurologists," nor science fiction writers saw this change coming, even though the roots of this evolution could be detected, *a posteriori* of course, at the dawn of the computer revolution. For example, in the late 1970s IBM employees worldwide were already communicating with an internal e-mail system and using binary "attachments."

This revolution has, of course, affected the environmental sciences community. In the last few years, we have experienced an exponential expansion of material available through the Web. The full implications of this trend are still unclear. We wonder, for example, about the future role of traditional scientific publishing, since it is becoming common practice, for authors, to post preliminary or final articles directly on their Web sites, in addition to (or in substitution of) formal publication in peer-review literature.

The proliferation of environmental information on the Web has been astonishing. We have already reached the point where it has become impossible for an individual to keep track of all the new material. I just ran a search at yahoo.com with the keyword "environment" and got 13,906 sites! Also, 120,684 Web sites were found in a search of the complete Lycos Web catalog using "environmental sciences." Hence, the needs to use more and

more intelligent Web search engines. More importantly, the need for specialists in different environmental disciplines to share their findings and provide the rest of the environmental community with useful, specialized information and lists of Web pointers, frequently updated.

2 Categories of Web sites

This paper does not attempt to provide a comprehensive list, but a review of trends and issues on available environmental information on the Web. I am taking the risk of providing a "classification" of Web pages, even though Internet-based materials change so rapidly that this cataloging effort may become obsolete very quickly:

1. Government/Agency sites
2. Sites of environmental departments/groups at universities, institutes, national laboratories, etc.
3. Sites of environmental groups at industrial companies (e.g., electric utilities, automobile manufacturers, oil industry, etc.)
4. Environmental consulting sites describing capabilities and services provided by consulting groups
5. Publishing sites
6. Sites dedicated to environmental activism (e.g., the so-called "green" organizations) and counter-activism (e.g., sites sponsored by industrial groups to provide views in opposition of what they label as "environmental extremism")
7. Individual or semi-individual sites, often providing information on special topics
8. Other sites, including "weird or unusual" sites

Most important among the environmental Web pages today are the government sites, at least in the United States. The US Environmental Protection Agency site (www.epa.gov) is incredibly rich in information, including descriptions of laws and regulations, national programs, downloadable publications and reports, and available software and data. In addition to this national site maintained by the EPA, each state has its own sites, often extremely rich, such as California – a state that has always been at the forefront for new environmental regulations and trends. For air quality important California Web pages are, for example: www.arb.ca.gov for the state, www.aqmd.gov for the Los Angeles region, and www.baaqmd.gov for the San Francisco region. They all provide extensive information on local programs and studies, regulatory support, data, software, and reports.

Virtually all universities and major research laboratories throughout the world have an environmental department with its own Web site. For example:

- **The Atmospheric Chemistry Program (ACP)** is a Global Change Research program sponsored by the Environmental Sciences Division of the US Department of Energy (DOE).
– <http://gonzalo.er.anl.gov/ACP>

- **International** oriented information modeling. IC tributes group workshops, c water hydro problems rel
– www.mini

- **Oak Ridge** Division (ES
– www.esd

- **Cooperative** (CIRES) is d plines of the
– <http://cires>

- **Department** Gurion Univ
– www.bg

- **EnviroCom** laboratory de tion phenom
– www.env

- **Pacific Nor** environment has made sig and technol sources, fac challenging pollution pr
– www.pnl

- **Institute of** University, I
– <http://bss>

- **Canadian C** stimulate th changes in h
– <http://c2>

- **Central Pol**
– <http://en>

As far as the mental activities, environmental reg industrial groups : mental sciences.

Here are a few

- **International Ground Water Modeling Center** is an internationally oriented information, education, and research center for ground-water modeling. IGWMC advises on ground-water modeling problems, distributes ground-water modeling software, organizes short courses and workshops, conducts research in practical, applied areas of ground-water hydrology and modeling, and provides technical assistance on problems related to ground-water modeling.
 - www.mines.edu/research/igwmc
- **Oak Ridge National Laboratory (ORNL) Environmental Sciences Division (ESD)**.
 - www.esd.ornl.gov
- **Cooperative Institute for Research in Environmental Sciences (CIRES)** is devoted to research and teaching in the wide-ranging disciplines of the environmental sciences.
 - <http://cires.colorado.edu>
- **Department of Geological and Environmental Sciences** at Ben Gurion University of the Negev.
 - www.bgu.ac.il/geol
- **EnviroComp** is an Internet-based international institute and software laboratory dedicated to the study of environmental sciences and pollution phenomena.
 - www.envirocomp.org
- **Pacific Northwest National Laboratory** is one of America's premier environmental research organizations. Since 1965, Pacific Northwest has made significant contributions to the field of environmental science and technology. Today, the Laboratory is applying its unique resources, facilities, and expertise to solve some of the nation's most challenging environmental problems, such as global climate change, pollution prevention, and cleanup.
 - www.pnl.gov/main/sectors/environment.html
- **Institute of Environmental and Natural Sciences** at Lancaster University, Lancaster, United Kingdom.
 - <http://bssv01.lancs.ac.uk/bs/home.html>
- **Canadian Centre for Pollution Prevention (C2P2)** was founded to stimulate the adoption of pollution prevention approaches to influence changes in behavior.
 - <http://c2p2.sarnia.com>
- **Central Pollution Control Board, Delhi**.
 - <http://envfor.nic.in/cpcb>

As far as the industry is concerned, each group is involved in environmental activities, at least to achieve and maintain compliance with environmental regulations and perform community relations. However, many industrial groups also perform research and development studies in environmental sciences.

Here are a few sites of major industrial groups:

- General Motors
 - www.generalmotors.com/company/community_involvement/environment/index.htm
- Chevron
 - www.chevron.com/environment/frame.html
- Monsanto
 - www.monsanto.com/monsanto/about/sustain_97/default.htm
- AT&T
 - www.att.com/ehs
- Intel
 - www.intel.com/intel/other/ehs/index.htm
- Pacific Gas & Electric
 - www.pgecorp.com/news/environment/index.html
- McDonald's
 - www.mcdonalds.com/community/environ/index.html
- Coca-Cola
 - www.thecoca-colacompany.com/environment/index.html

Many consulting companies specialize in providing their clients with environmental support, e.g., to assist in achieving compliance with existing laws and regulations. Here are a few examples of consulting sites:

- ENSR
 - www.ensr.com
- Bechtel
 - www.bechtel.com/services/environ.html
- SAIC
 - www.saic.com/business/solutions/environ
- Exponent
 - www.exponent.com/services/environmental.htm

All major publishers produce books, journals, and reports on environmental topics. For example:

- Elsevier
 - www.elsevier.com/inca/tree/?key=SSAG
- Wiley
 - www.wiley.com/products/subject/environment
- WIT Press
 - www.witpress.com/envindex.html

and, for electronic books in environmental sciences:

- EnviroComp
 - www.envirocomp.org

Another group of "counter-activists" (better ones). For

- The Sierra Club
 - www.sierraclub.org
- Greenpeace
 - www.greenpeace.org

On the other hand, the claims of the

- IEA
 - www.iea.org
- Joint Center for Global Change Studies
 - www.jointcenter.org

One interesting 'individual' site is for more person, a specific technical modeling, <http://www.pmhp.org/pmhp/inter>

Finally, all anybody, with a site for little or total freedom, beneficial. However, of environmental liberation of world culture. Sometimes

3 Environment

In addition to the list Web sites, Examples of s

3.1 Laws and

- US - Environmental Protection Agency
 - www.epa.gov
- Environmental legal resources
 - www.environmental.org

Another group of sites is dedicated to environmental "activism" or "counter-activism" (perhaps these labels are inappropriate but I cannot find better ones). For example, well-known organizations of environmentalists are

- The Sierra Club
 - www.sierraclub.com
- GreenPeace
 - www.greenpeace.org

On the other side, one can find Web pages aimed at countering some of the claims of the environmentalists, such as:

- IEA
 - www.iea.org.uk/index.html
- Joint Center
 - www.aei.brookings.org

One interesting aspect of the Internet revolution is the creation of 'individual' sites. These are Web pages created and maintained by one or more person, and covering specific niches. They may provide useful links on a specific technical subject or focus on a particular issue (e.g., ecological modeling, <http://rudjer.irb.hr/~legovic>; environmental activism, www.gn.apc.org/pmhp/internet/index.htm).

Finally, all types of 'weird or unusual' sites can be found, since virtually anybody, with or without a clear message, can create an "environmental" Web site for little or no cost. In a way, the Internet revolution has been based on total freedom, with a little touch of anarchy that, so far, has probably been beneficial. However, for a person like myself, who has worked on the subject of environmental sciences for three decades, it is often sad to witness the proliferation of weird people and groups who have chosen the "environment" as a cult. Sometimes I feel like an astronomer surrounded by astrologists.

3 Environmental topics on the Web

In addition to the categorization by sites presented, an effort can be made to list Web sites (or sections of Web sites) based on specific technical topics. Examples of such are provided.

3.1 Laws and Regulations

- US - Laws and regulations are a major tool in protecting the environment.
 - www.epa.gov/epahome/rules.html
- Environmental Law Net - The Internet offers reliable primary source legal resources which are indispensable to environmental lawyers and compliance managers. This site delivers those resources through a uniquely functional and efficient format, which allows us to make informed decisions, while saving time and money. Some of the most

useful resources provided on this site are typically not available in law firm libraries or through expensive proprietary networks. This site also delivers valuable original content and special features designed to make the Internet more informative, easy, and enjoyable to use.

- www.EnvironmentalLawNet.com

3.2 Environmental Models and Software

- EPA Models

- www.epa.gov/epahome/models.htm

- Atmospheric Sciences Modeling Division, part of NOAA's Air Resources Laboratory, contains information about atmospheric models.

- www.epa.gov/asmdner1

- Center for Exposure Assessment Modeling (CEAM) provides predictive exposure assessment models for aquatic, terrestrial, and multimedia pathways for organic chemicals and metals.

- www.epa.gov/epa_ceam/wwwhtml/ceamhome.htm

- Center for Subsurface Modeling Support (CSMoS) a source for publicly available ground water and vadose zone modeling software and services.

- www.epa.gov/ada/csmos.html

- Support Center for Regulatory Air Models (SCRAM) a source of information on atmospheric dispersion (air quality) models that support regulatory programs required by the Clean Air Act.

- www.epa.gov/ttn/scram

- Vehicle & Engine Emission Modeling Software a source for vehicle and engine emission software, including MOBILE5, MOBILE6, PART5, non-road, and fuel models.

- www.epa.gov/OMSWWW/models.htm

- CALPUFF Modeling System is a multi-layer, multi-species non-steady-state puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollutant transport, transformation, and removal. CALPUFF can be applied on scales of tens of meters to hundreds of kilometers. It includes algorithms for sub-grid scale effects (i.e., terrain impingement), as well as, longer-range effects (i.e., pollutant removal due to wet scavenging and dry deposition, chemical transformation, and visibility effects of particulate matter concentrations).

- www.epa.gov/ttn/scram/t29.htm#calpuff

- Environmental Modelling Centre was established as a part of the Environmental and Resource Studies at Trent University.

- www.trentu.ca/academic/aminss/envmodel

- Environmental Software/Scientific Software Group, an internationally known software and publications company established in 1984, has a long tradition of excellence in providing the most advanced and comprehensive environmental software and publications available today.

- www.scisoftware.com

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3.3 Environmental Data

- EPA Data
 - www.epa.gov/epahome/Data.html
- Envirofacts a national information system that provides a single point of access to data extracted from seven major EPA databases.
 - www.epa.gov/enviro/index_java.html
- San Francisco Bay wind patterns
 - <http://sfports.wr.usgs.gov/wind>
- Hazardous Substance Release/Health Effects Database, HazDat is the Agency for Toxic Substances and Disease Registry's (ATSDR) hazardous substance release/health effects database and is the scientific and administrative database developed to provide access to information on the release of hazardous substances from Superfund sites or from emergency events and on the effects of hazardous substances on the health of human populations.
 - www.atsdr.cdc.gov/hazdat.html
- Weather Data
 - www.nws.noaa.gov
- AIRNOW website, operated by the US EPA, goals are: 1) provide real-time air pollution data in an understandable, visual format, 2) provide information about the public health and environmental effects of air pollution, and 3) provide the public with information about ways in which they can protect their health, and actions they can take to reduce pollution. This Web site currently focuses on ground-level ozone (smog). Future plans for this site are to expand the geographic coverage of the current ozone maps and to include other pollutants. The Ozone Mapping project is part of the EPA's environmental monitoring for public access and community tracking (EMPACT) initiative – a new approach to providing timely environmental information to communities.
 - www.epa.gov/airnow
- California Data Exchange Center (CDEC) installs, maintains, and operates an extensive hydrologic data collection network including automatic snow reporting gages for the Cooperative Snow Surveys Program and precipitation and river stage sensors for flood forecasting. CDEC provides a centralized location to store and process real-time hydrologic information gathered by various cooperators throughout the State. CDEC disseminates this information to cooperators, the public, private agencies, and news media.
 - <http://cdec.water.ca.gov>
- Minimal Risk Levels (MRLs) for hazardous substances were developed as an initial response to the mandate. Following discussions with scientists within the Department of Health and Human Services (HHS) and the EPA, ATSDR chose to adopt a practice similar to that of the EPA's Reference Dose (RfD) and Reference Concentration (RfC) for

deriving substance-specific health guidance levels for non-neoplastic endpoints. An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure. ATSDR health assessors and other responders to identify contaminants and potential health effects that may be of concern at hazardous waste sites use these substance-specific estimates, which are intended to serve as screening levels. It is important to note that MRLs are not intended to define clean up or action levels for ATSDR or other agencies.

– www.atsdr.cdc.gov/mrls.html

- Industrial Pollution Projection System - NIPR, short for New Ideas in Pollution Regulation, is targeted at people and organizations interested in public policy issues relating to the cost-effective control of pollution. The World Bank's Economics of Industrial Pollution Control research team – a part of the World Bank's Research Program, maintains this site.
– www.worldbank.org/nipr/ipps
- National Environmental Satellite, Data, and Information Service (NESDIS)
– <http://ns.noaa.gov/NESDIS>
- Persistent Organic Pollutants (POPs) are chemical substances that persist in the environment, bioaccumulate through the food web, and pose a risk of causing adverse effects to human health and the environment. With the evidence of long-range transport of these substances to regions where they have never been used or produced and the consequent threats they pose to the environment of the whole globe, the international community has now, at several occasions called for urgent global actions to reduce and eliminate releases of these chemicals.
– <http://irptc.unep.ch/pops/>
- Pollution management provides access to information on the Bank's ongoing work. This emphasizes integrated environmental management, rather than just pollution control using a broad mix of incentives and pressures to achieve sustainable environmental improvements.
– <http://wbln0018.worldbank.org/essd/essd.nsf/Docs/PPAH>
- TERRENE Institute fully searchable database of nonpoint source prevention and control projects including projects conducted or compiled by the organizations listed here.
– www.terrene.org/database.htm
- Toxics Release Inventory (TRI), published by the US EPA, is a valuable source of information regarding toxic chemicals that are being used, manufactured, treated, transported, or released into the environment. Two rules, Section 313 of the Emergency Planning and Community Right-To-Know Act (EPCRA) and Section 6607 of the Pollution Prevention Act (PPA), mandate that a publicly accessible toxic chemical database be developed and maintained by the US EPA. This database contains information concerning waste management

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activities and the release of toxic chemicals by facilities that manufacture, process, or otherwise use said materials. Using this information, citizens, businesses, and governments can work together to protect the quality of their land, air, and water.

- www.epa.gov/opptintr/tri/

- National Geophysical Data Center (NGDC) is the national repository for geophysical data, providing a wide range of science data services and information. NGDC provides long-term stewardship for and access to geophysical data, compiles new, well-documented databases from many sources, and offers value-added data services to researchers and the general public. NGDC acquires and exchanges global data through the World Data Center system and other international programs.

- www.ngdc.noaa.gov

- Environmental Data Resources, Inc. ("EDR") is the nation's leading provider of environmental information. It offers current and historical environmental risk management information, industry publications and market research, newsletters, a daily business news service, training workshops, and state-of-the-art online services including interactive mapping.

- www.edrnet.com

- National Data Buoy Center (NDBC) the premier source of buoy-measured environmental, meteorological, and oceanographic data.

- <http://seaboard.ndbc.noaa.gov>

- Environmental Data Services (ENDS) provides accurate information on the environment, for anybody with a professional interest in environmental affairs. Focusing primarily on the UK/Europe.

- www.ends.co.uk/jobs

- CEDAR Databases and Resources, site of the Central European Environmental Data Request Facility (CEDAR) Computer Network for Exchanging Environmental Information. In 1991, the Austrian Ministry for the Environment selected the International Society for Environmental Protection (ISEP) to administer CEDAR. CEDAR provides computing and Internet work facilities to support international data exchange with the Central and Eastern European environmental community. In 1992, CEDAR began to work with the United Nations Environmental Programme's INFOTERRA Network, UNEP's global information exchange program. Designated as the INFOTERRA Internet node and Regional Service Centre for Central and Eastern Europe, CEDAR is working with the Austrian National Focal Point (NFP) at the Austrian Federal Environmental Agency and other regional and global NFPs to support environmental information dissemination.

- www.cedar.univie.ac.at/data

- The environmental data catalogue (UDK) provides an overview of the data collected and stored by Austrian authorities and institutions. WWW-UDK is a tool to fulfill the requirements of the Austrian Environmental Information Act (UIG 1993).

– <http://udk.ubavie.gv.at>

- The Environmental Protection Agency (EPA) has assessed major EPA databases to characterize their overall quality and applicability for non-programmatic and secondary uses (i.e., evaluating the local state of the environment, identifying pollution sources and hot spots, promoting environmental education, and tracking corporate accountability). The assessment process resulted in descriptions of each of the major databases that include information on coverage, spatial characteristics, temporal characteristics, consistency within the data system, ability to link to other systems, accuracy, limitations, access, and documentation.
 - www.epa.gov/ceisweb1/ceishome/quality.html

3.4 Global Issues (also www.envirocomp.org/html/publish/GlobalWarming/GWreport-text.pdf)

- Carbon Dioxide Information Analysis Center (CDIAC) includes the World Data Center for atmospheric trace gases. It is the primary global-change data and information analysis center of the US Department of Energy (DOE). More than just an archive of datasets and publications, CDIAC has, since its inception in 1982, enhanced the value of its holdings through intensive quality assurance, documentation, and integration. Opposite to many traditional data centers that are discipline-based (e.g., meteorology or oceanography), CDIAC's scope includes potentially anything and everything that would be of value to users concerned with the greenhouse effect and global climate change. This includes concentrations of carbon dioxide and other radiatively active gases in the atmosphere; the role of the terrestrial biosphere and the oceans in the biogeochemical cycles of greenhouse gases; emissions of carbon dioxide to the atmosphere; long-term climate trends; the effects of elevated carbon dioxide on vegetation; and the vulnerability of coastal areas to rising sea level.

– <http://cdiac.esd.ornl.gov>

- US National Aeronautics & Space Administration offers many sites for specific technical topics. We mention just a few here.

– Globally averaged atmospheric temperatures

* http://science.nasa.gov/newhome/essd/essd_strat_temp.htm

– Measuring the temperature of earth from space

* http://science.nasa.gov/newhome/headlines/notebook/essd13aug98_1.htm

– Temperature trends

* http://science.nasa.gov/newhome/headlines/essd12jan99_1.htm

– Global climate change briefing book congressional research service

* www.cnre.org/nle/clim-7/ebgcctop.html

– Greenhouse gases, climate change and energy

* www.eia.doe.gov/oiaf/1605/ggccebro/chapter1.html

- NSF global change research programs support research and related activities that advance fundamental understanding of dynamic physical,

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biological, and socioeconomic systems as well as interactions among those systems.

– www.nsf.gov/geo/egch

• Global Environmental Management Initiative

– <http://gemi.org>

• The Climate Change Research Center (CCRC) is devoted to the retrieval and interpretation of global change records that document climate (response and forcing), biogeochemical cycling, atmospheric chemistry, unique atmospheric phenomena (e.g., extreme events, volcanic events, biomass burning) and the influence of human activities on our environment. The Center is developing a series of records from atmospherically teleconnected high latitude (e.g., Antarctica, Greenland and Canadian Arctic) and low to middle latitude sites (e.g., Asia and North America).

– www.grg.sr.unh.edu/ccrc/main.html

• Environmental Reviews contain a narrative section, a map showing the country's location, and a profile section listing pertinent country, economic, energy, and emissions data. The narrative provides information on general environmental conditions in the country, official energy policy, energy taxes and subsidies, environmental and efficiency programs, environmental export opportunities, and energy use and carbon emissions trends. The profile section includes important sectoral and efficiency indicators, as well as information on energy production and consumption.

– www.eia.doe.gov/emeu/env

4 Lists of environmental resources on the Web

There are very useful sites that provide lists of Internet resources in different topics. For example:

• Environmental Issues

– www.envirocomp.org/html/otherwebs/bowers/envhome.htm

• Atmospheric Sciences

– www.envirocomp.org/html/otherwebs/apm/index.htm

• Ecological Modeling

– <http://rudjer.irb.hr/~legovic>

• Hydrogeology, Hydrology, and Environmental Sciences

– www.us.net/adept/links.html

• Environmental Web Sites

– www.cerr.ucla.edu/othersites.htm

• Environmental Activism

– www.gn.apc.org/pmhp/internet/index.htm

5 Conclusions

The Internet revolution is one of the most exciting events in our lifetime. In particular, environmental scientists are achieving high benefits through data and software availability, improved communications, and instant information availability. Future developments are expected to be astonishing, with an exponential growth of Web-based environmental activities. Environmental scientists should not miss this great opportunity of professional growth. This change also represents a great opportunity for scientists in less-developed countries who, through the Internet, can now obtain access to a large body of information that, just a few years ago, would have been unachievable even to their colleagues working at the most technologically advanced facilities.

6 Electronic copy

To get an electronic copy of this paper with automatic Internet links, the reader can contact the author at zannetti@exponent.com.