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EPA's Report on the Environment

2007
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EPA's 2007 Report on the Environment: Science Report

NOTICE

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Office of Research and Development
U.S. Environmental Protection Agency
Washington, DC

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EPA's 2007 REPORT ON THE ENVIRONMENT: SCIENCE REPORT

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1. INTRODUCTION

To accomplish its mission, the U.S. Environmental Protection Agency (EPA) must pay close attention to trends in the condition of the nation's air, water, and land, and related or associated trends in human health and ecological systems. Compiling relevant, scientifically sound data on the status and trends of the nation's environment provides valuable input for developing EPA's strategic outlook and priorities and allows EPA and the public to assess whether the Agency is succeeding in its overall mission to protect human health and the environment.

EPA embarked on a bold initiative in 2001 to assemble, for the first time, the most reliable available indicators of national environmental conditions and their trends over time that are important to its mission. EPA initially presented this information in its *Draft Report on the Environment (ROE) Technical Document*, released in 2003. Since then, EPA has revised, updated, and refined the ROE in response to scientific developments, as well as feedback from EPA's Scientific Advisory Board (SAB) and stakeholders. *EPA's 2007 Report on the Environment: Science Report* presents the results of this work.

EPA's 2007 ROE Science Report (SR) compiles in one place, the most reliable indicators currently available that help to answer the questions that EPA believes are of critical importance to its mission and to the national interest. All of the indicators were screened and peer-reviewed to meet exacting standards for accuracy, representativeness, and reliability. This 2007 ROE SR presents trends wherever adequate data are currently available, and it establishes some reliable national baselines where trend data are not yet available. Equally important, the report identifies key limitations of these indicators and gaps where reliable indicators do not yet exist. Data limitations are noted to provide the reader with information about the quality or extent of the data presented that may affect the way in which they are used. Generally, such limitations cause uncertainty in drawing conclusions about actual conditions in the environment. Data gaps are noted to identify areas or aspects of the environment in which little or no measurement is done. This report does not propose actions to reduce data limitations or fill gaps, nor does it analyze the costs and benefits of doing so.

Written for environmental professionals, the *ROE Science Report* provides the scientific basis for two other components of EPA's ROE project:

- A web-enabled version, the *e-ROE*, that provides access to the details of the methodology, databases, references, and sources of additional information behind the indicators that form the basis for the *ROE Science Report*
- *EPA Report on the Environment: Highlights of National Trends 2007*, which highlights the most important content of the *Science Report* for the general public.

The indicators presented in this report are supported by data gathered from different federal and state agencies and non-government organizations using a variety of methods. EPA is committed to releasing periodic updates of the ROE so that information on environmental condition and trends can be provided on a long-term basis within EPA and to external scientists and interested members of the public.

Organization of This Report

This report consists of five chapters: Air, Water, Land, Human Health, and Ecological Condition. The Air, Water, and Land chapters (Chapters 2, 3, and 4) focus on trends in air, water, and land media, and their effects on human health and ecological systems. The Human Health and Ecological Condition chapters (Chapters 5 and 6) follow with information on overall trends in human health and ecological

1 systems. These latter two chapters address questions that are intrinsically affected by multiple factors
2 across media, as described below.

3 For each of these five chapters, EPA identified a set of priority questions (see below) that it considers to
4 be most important and relevant to the Agency's mission to protect the environment and human health.
5 The report is organized around these questions. The response to each of the questions has three
6 components:

- 7 • An introduction that describes the scope of the question (see below) and provides relevant
8 background information.
- 9 • A set of indicators that answer (or more often partially answer) the question.
- 10 • A discussion of (1) the "answer" that the indicators collectively provide to the question; and
11 (2) the most critical indicator gaps, limitations, and challenges that prevent the question from
12 being fully answered.

13 The document concludes with Chapter 7, *Afterword*, which discusses the next steps for improving
14 indicators and summarizes the challenges to answering the questions and synthesizing and integrating
15 information across indicators. Appendix A lists acronyms and provides a glossary of terms that have
16 particular definitions within this document or whose definitions are not commonly available. Appendix B
17 describes the process used to develop the *2007 ROE Science Report*. Appendix C compares indicators
18 used in the 2003 Draft ROE Technical Document with those in this 2007 version.

19 **ROE Questions**

20 As described above, the ROE is organized around 26 priority questions that EPA considers to be
21 important and relevant to its mission. EPA developed these questions in 2002 and refined them in 2004 in
22 a series of workshops involving specialists from across the Agency. These are questions that EPA
23 believes *should* be answered with confidence if it is to be adequately informed about important
24 environmental trends. They are not necessarily, however, questions that EPA *can* fully answer at present
25 based on available data.

26 The questions in the Air, Water, and Land chapters examine trends in the condition, quality, and/or extent
27 of environmental media (e.g., outdoor air, fresh surface waters) and trends in stressors to those media
28 (e.g., pollutant emissions, chemicals used on land). These questions also address trends in human health
29 and ecological systems *that are expected to be clearly linked to the foregoing media-related trends*. For
30 example, downward trends in the acidity of lakes and streams in certain geologically sensitive regions of
31 the country are expected to be clearly linked to declining acid deposition, and some types of damage to
32 leaves in forest plants can be clearly attributed to ozone exposure. Therefore, these types of effects
33 indicators are presented in these media-specific chapters of this document.

34 The questions in the chapters on Human Health and Ecological Systems, on the other hand, do not
35 explicitly ask about particular effects arising from particular media. At the national or regional scales
36 covered in this report, most trends in human health or in the condition of ecological systems cannot be
37 definitively linked to trends in particular stressors arising from particular media, such as air pollutant
38 emissions or concentrations of contaminants in food or drinking water, because many factors, some
39 having nothing to do with pollutants or particular media, affect the trends in these indicators. For
40 example, the Human Health chapter includes a question about trends in human disease and conditions for
41 which environmental pollutants may be a risk factor, and the Ecological Condition chapter includes
42 questions about trends in biological diversity and critical physical and chemical attributes of ecological
43 systems. Environmental pollutants are known to influence these types of trends, but trends in these health

1 or ecological outcomes cannot be attributed with any confidence to *particular* pollutants or other causes..
2 Nevertheless, EPA believes that it is important to ask questions about such trends and to maintain
3 surveillance of related indicators in order to identify emerging issues that may need additional research or
4 investigation.

5 Each chapter is organized into sections, one for each ROE question. Each section begins by discussing the
6 range of issues related to that question that are particularly important to EPA's mission. This includes not
7 only EPA's regulatory responsibilities, but also areas where the Agency conducts or sponsors research,
8 exerts policy leadership, provides information to the public, or shares an interest in human health and the
9 environment with its federal, state, and tribal partners. It is important to note that the ROE does not cover
10 other important environmental issues, such as natural resource management, land management, or the
11 control of communicable diseases, that are more closely related to the missions of other government
12 agencies.

13 **ROE Indicators**

14 Environmental conditions can be represented in many ways. For particular issues or particular locations,
15 many reports conduct an integrated assessment by gathering and weighing the strengths and weaknesses
16 of all the relevant information available. This integrated approach is not feasible for the ROE because it
17 covers so many different topics across the entire nation. Instead, the ROE relies on an indicator approach.

18 To maintain a high level of scientific integrity and consistency among the indicators used in the ROE,
19 EPA established an explicit definition and six criteria that all ROE indicators must meet (see Box 1-1).
20 The criteria are based in part on EPA's Information Quality Guidelines
21 (<http://www.epa.gov/quality/informationguidelines/>), which cover important information that EPA
22 provides to the public. Together, the six criteria are intended to ensure that all indicators in the ROE are
23 useful to EPA and the public, and that they are objective, transparent, and based on high-quality,
24 comparable, and representative data across space and time. The ROE emphasizes indicators that can be
25 tracked over time; therefore, one-time studies are not included unless they serve as baselines for future
26 trends.

27 Indicators, whether they represent baseline conditions or trends, involve uncertainties. While statistical
28 analyses have been or could be done on some of the indicators in this report, such analyses require
29 considerably more complex indicator development and peer review. Due to time and resource limitations,
30 EPA determined that this 2007 edition of the ROE Science Report would not include statistical analysis
31 of uncertainty and trends; however, the Agency recognizes that this is an important issue and does plan to
32 quantify uncertainty in indicators in the next edition of the ROE.

33 The ROE indicator definition intentionally excludes some categories of indicators. For example, ROE
34 indicators include measures of pollutant emissions, but not measures of corresponding causal factors such
35 as energy generation or agricultural production. Also excluded are economic indicators such as the value
36 of land or natural resources and the cost of health care or pollution control, or efficiency factors such as
37 pollutant emissions per vehicle mile traveled. Because ROE indicators focus on actual physical
38 measurements, administrative indicators such as permits issued, regulations promulgated, and
39 enforcement actions also are excluded. Indicators based on results predicted by environmental fate and
40 transport models or risks to people or ecological systems also are excluded, because they are not based on
41 actual measurements. Indicators based on emissions factor are necessary exceptions, because most
42 emissions cannot be measured directly.

Box 1-1. Indicator Definition and Criteria.

Indicator Definition: For EPA's *Report on the Environment*, an indicator is a numerical value derived from actual measurements of a pressure, state or ambient condition, exposure, or human health or ecological condition over a specified geographic domain, whose trends over time represent or draw attention to underlying trends in the condition of the environment.

Indicator Criteria:

- The indicator is useful. It answers (or makes an important contribution to answering) a question in the ROE.
- The indicator is objective. It is developed and presented in an accurate, clear, complete, and unbiased manner.
- The indicator is transparent and reproducible. The specific data used and the specific assumptions, analytic methods, and statistical procedures employed are clearly stated.
- The underlying data are characterized by sound collection methodologies, data management systems to protect its integrity, and quality assurance procedures.
- Data are available to describe changes or trends and the latest available data are timely.
- The data are comparable across time and space, and representative of the target population. Trends depicted in this indicator accurately represent the underlying trends in the target population.

1
2 Selection of the indicators for this 2007 ROE Science Report was conducted internally at EPA, based on
3 indicators suggested by EPA's Program and Regional Offices, and by other federal agencies, state
4 agencies, and non-governmental organizations. As the first step, EPA developed a list of 93 proposed
5 indicators. This included indicators from the 2003 Draft ROE that EPA judged to be relevant and
6 consistent with the ROE 2007 indicator definition and criteria as well as many new indicators (see
7 Appendix C for a list). All proposed indicators were evaluated via an independent public peer review
8 process (see <http://cfpub.epa.gov/eroe/index.cfm?fuseaction=main.peerReview>
9 on the peer review). Of the proposed indicators, 86 were ultimately selected for inclusion in the ROE.
10 Appendix B provides more information on the indicator development process.

11 Each indicator consists of graphics or tables and explanatory text. All indicators present the most recent
12 relevant, quality-assured data available when this report went to press. EPA intends to update these
13 indicators in the e-ROE as new data become available. The baselines and reference levels for most
14 indicators follow the underlying sources. Thorough documentation of the indicator data sources can be
15 found at <http://cfpub.epa.gov/eroe>. For ease of use in both the print and e-versions, each indicator was
16 developed to stand alone, with sufficient information for the reader to understand its scope, origin, and
17 data sources. As a result, some redundancies of text exist in the hardcopy version of the document.

18 Some indicators are used to answer more than one ROE question. In all but one case, these indicators are
19 presented where they are first used to answer a question and referenced when they are used to answer a
20 subsequent question. For example, the Blood Cotinine indicator is first used to answer a question in the
21 Air chapter and then another question in the Health chapter. This indicator is presented in the Air chapter;
22 the Health chapter refers the reader to the Air chapter for details. Tables listing indicators and their page

1 numbers are provided as navigation aids at the end of this Introduction (Table 1-1), in the introduction to
2 each chapter, and in the introduction to each question.
3

4 More than half the indicators and supporting data derive from sources other than EPA, including other
5 federal agencies, state agencies, and non-government organizations. These external sources also maintain
6 many environmental datasets that are valuable for other purposes and offer potential for development of
7 future ROE indicators (see Box 1-2).
8

9 **Box 1-2. The Role of Other Important Environmental Datasets**

10 Many important environmental datasets are not included in this report because the data do not yet meet
11 the ROE indicator criteria. For example, since 1971, the Centers for Disease Control (CDC), EPA, and
12 the Council of State and Territorial Epidemiologists have maintained a surveillance system for collecting
13 and periodically reporting data on occurrences and causes of waterborne-disease outbreaks (WBDOs).
14 State, territorial, and local public health agencies have the primary responsibility for detecting and
15 investigating WBDOs, and these agencies voluntarily report WBDOs to the CDC and EPA. These
16 surveillance activities are useful in characterizing the epidemiology of WBDOs, identifying changing
17 trends in the etiologic agents that caused WBDOs, and determining why the outbreaks occurred. The data
18 are also useful for identifying major deficiencies in providing safe drinking water. The number and
19 etiology of WBDOs are reported annually. Results to date range from a high of 53 outbreaks in 1980 to a
20 low of 8 outbreaks in 2002, with 207 WBDOs and 433,947 illnesses reported in the most recent 12-year
21 period. Because of the differences in investigating outbreaks, differences in reporting patterns from state
22 to state, and underreporting, the actual number of WBDOs nationwide is unknown. In addition, outbreaks
23 represent only a portion of waterborne illness associated with drinking water exposure. Due to these
24 limitations, the data from this passive surveillance system do not currently meet the indicator criteria for
25 the ROE. EPA continues to work with CDC and other federal, state, and private organizations on
26 important programs such as this one, so that they may meet the indicator criteria and be used in future
27 editions of *EPA's Report on the Environment*.
28

29
30 The topics of air, water, land, human health, and ecological condition under which the indicators are
31 presented are all interconnected. For example, changes in one medium affect other media, human health
32 depends on environmental condition, and environmental condition is affected by human factors. At the
33 indicator level, the interconnections are complex and multi-factorial. In reality, humans and ecological
34 systems are exposed to multiple pollutants from multiple sources; large spatial and temporal variations in
35 environmental exposures exist; and numerous non-environmental factors may also contribute to an
36 outcome. The ROE recognizes these complexities, and will continue to work in future versions of the
37 ROE and the e-ROE to look for ways to better link and integrate indicators across questions and chapters.
38

39 **Regional Indicators**

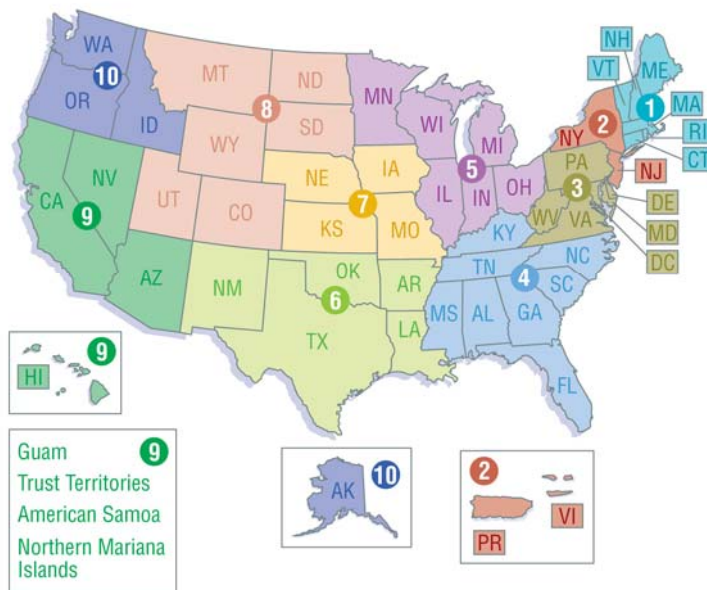
40 The ROE focuses on trends within the United States, even though the indicators may be impacted by
41 sources outside U.S. borders. National-level indicators (indicators for which nationally consistent data are
42 available) are the focus of this report. However, highly aggregated national data may mask important
43 variations that take place at finer scales. Therefore, the ROE takes two preliminary steps to demonstrate
44 how relevant indicators might be identified, developed, and presented at finer geographic scales.

- 45 • National data are broken out by EPA Regions for 23 indicators where the data are sufficiently
46 representative at that geographic scale. EPA Regions follow state borders, and do not reflect
47 natural boundaries based on physiography, climate, or biota. Rather than adopt
48 regionalization schemes based on natural boundaries that would be unique to each individual

1 indicator, EPA chose to adopt a consistent approach for all 23 indicators based on EPA
2 Regions. To aid readers who are unfamiliar with EPA Regional boundaries, the ten EPA
3 Regions are delineated in Exhibit 1-1, and also depicted in icons on each indicator graphic
4 that displays regional data.

- 5 • Ten Regional Indicators (indicators that cover an EPA Region or substantial parts of one or
6 more EPA Regions) were selected to demonstrate how such indicators can answer part of an
7 ROE question that is unique to a particular region, or could eventually be expanded to answer
8 an ROE question at the national level. All Regional Indicators were required to satisfy the
9 ROE indicator definition and criteria. EPA hopes that these Regional Indicators will serve as
10 useful models, and that lessons learned from them will help the Agency identify and present a
11 more robust set of indicators that answer ROE questions at multiple scales in the future.
12 However, it is important to note that these Regional Indicators are presented as *examples*
13 *only*— they do not represent an exclusive set of indicators needed to answer the ROE
14 questions at a regional scale, and they may or may not scale up to National Indicators. EPA
15 may or may not include these indicators in future versions of the ROE.

Exhibit 1-1. The EPA Regions



16 Changes from 2003 Draft ROE

17 As mentioned earlier, EPA released the first edition of ROE as a draft report in 2003 (see
18 <http://www.epa.gov/indicators/roe/html/tsd/index.htm>). A number of changes, designed to increase the
19 clarity, consistency, and usefulness of the report, have been incorporated into this 2007 edition in
20 response to comments on the 2003 draft. The major changes comprise:

- 21 • **Indicators** – As a result of revisions to the indicator definition and criteria, there have been
22 several changes to the 2003 indicators, including combining some indicators and deleting others.
23 Additionally, as mentioned earlier, some new indicators have been added that were not available
24 for the 2003 version of the report. See Appendix C for details.

- **Spatial Scale** – National-level indicators were the focus of the 2003 Draft ROE and continue to be the focus in this 2007 ROE. However, as discussed above under “Regional Indicators,” this 2007 ROE demonstrates how relevant indicators might be identified, developed, and presented at finer geographic scales in two ways:
- **Questions and Indicator Placement** – The questions in the 2007 report have been revised to present a more consistent format and depth across chapters. In addition, wherever a health or environmental effect is linked predominantly to a single medium (air, water, land), that indicator has been moved from the Human Health or Ecological Condition chapter to the relevant “media” chapter.

Conclusion

To be effective, policies and programs addressing environmental concerns must be founded in firm scientific understanding of the issues, and adjusted based on monitoring of health and environmental conditions. The *Report on the Environment* represents a commitment by EPA to continually improve the quality and quantity of information available to understand the condition of human health and the environment and how they are changing over time. Within EPA, this commitment provides ongoing opportunities to use the ROE to inform strategic planning and related activities. The ROE also creates opportunities to establish and strengthen partnerships among federal, state, and non-government organizations for monitoring, data sharing, and data needs planning to support indicator development and improvement.

Table 1-1. Chapter Questions and Supporting Indicators.¹

Air Chapter	Section	Page
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Lead Emissions	2.2.2	2-19
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Ozone and Particulate Matter Concentrations for U.S. Counties in the U.S./Mexico Border Region	2.2.2	2-82
Ambient Concentrations of Manganese Compounds in EPA Region 5	2.2.2	2-86

¹ As mentioned earlier, some indicators are used to answer more than one question. These indicators are presented where they are first used to answer a question and referenced under subsequent questions.

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U.S. Greenhouse Gas Emissions	2.3.2	2-96
Atmospheric Concentrations of Greenhouse Gases	2.3.2	2-100
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