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The Growing Importance of Scientific Rules of Thumb in Developing Indicators of Resource Sustainability

DRAFT

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If we can all agree that sustainable development is the goal of the 1990s, and I believe we can, then we need to rethink the indicators we use to measure progress.

There is growing demand for policy-relevant, useful information about the changing state of the world's environment and its relationship to development. Increasingly, environmental problems need to be assessed at national and international levels because they are global in nature, have impacts or causes that cross national boundaries, or are common to all societies. To concerns about pollution and its impacts have been added growing awareness that current patterns of resource use and deterioration are not sustainable and even now are a constraint to pursuing economic development and improving social welfare.

Policymakers in and out of government are interested in tracking measures of environmental quality and natural resource sustainability to complement their use of economic and social indicators. They want ready access to the latest information -- key trends and indicators -- and they want this information in a context they can understand and use.

Indicators can serve many purposes. They can be used to track changes in a single parameter or variable of concern, to assess the condition of the environment, to prepare strategies and action plans, to evaluate policies and programs, and to assess progress toward goals and targets. They can be used in forecasting, modelling, and developing scenarios, and as early warning signals. It is unlikely that any one indicator or index or set of indicators can meet all policy maker needs.

Goals, Targets, Standards, and Indicators

Goals, targets, standards, and indicators are linked. Each is a necessary ingredient in measuring progress towards resource sustainability and environmental quality.

Standards are those critical measurements of nature that tell us something important about society. Standards tell us: when air quality is so polluted it is harmful to human health; when the concentration of lead in drinking water is so high that children's nervous systems are at risk; when the concentration of stratospheric ozone becomes so low that harmful ultraviolet rays penetrate the atmosphere and increase the risk of cancer and threaten the human immune system; when suspended sediment loads in streams are so high as to increase sedimentation in reservoirs, reducing the useful life of a hydropower facility; when populations of the bald eagle become so reduced as to

threaten the viability of the species; when smoke and particulate matter in the air keep visitors from enjoying the views of Grand Canyon; when mangrove forests are of a sufficient size to help maintain important coastal fisheries. Standards (criteria, norms, rules-of-thumb) can be founded on concerns we have for human health, economic welfare, aesthetic appreciation, spiritual awareness, ecological sustainability, and other human values.

Usually, we use nature in so many different ways that we need a variety of standards. In the U.S., states and localities often set freshwater standards to meet needs for safe drinking water, or irrigation, or to support wildlife, recreation, and transportation, and scenic views. Farmers and agronomists have developed standards for determining soil fertility and constraints in using soils for agriculture. Biologists have developed standards for identifying when a species is threatened with extinction or when a population is merely stressed.

Standards can be formalized in legislation and become regulations, with government holding enforcement powers over those who do not abide by the law. But most standards are based on good science and considerable experience at managing resources and do not gain their acceptance and value because of the law.

The key to developing better indicators of resource sustainability and environmental quality is the development of scientifically-based standards that will help us use resources more effectively, efficiently, and sustainably.

I therefore see four requirements for building improved indicators of environmental quality and resource sustainability:

1. **Specify goals for sustainable development that can be measured.** It is not enough to say that we want to conserve biodiversity, for example. We need to specify conservation at the level of species, genes, and communities or ecosystems. It is no longer enough to argue for saving tropical forests. What forests, for what purpose, and for whose sake should they be saved, and does saving mean using the forest?

2. **Establish reasonable targets or benchmarks with which to assess progress toward goals.** It is essential that governments at all levels and many other organizations in society identify targets for achieving goals. These targets should be specified in time and space. How much carbon dioxide should be emitted per year by the United States if this country is to reduce levels observed in 1990 or 1950? How much remaining natural habitat should be set aside as protected areas in order to achieve adequate representation of national and

global ecosystems by the year 2,000? How much toxic waste can be generated and disposed of in 1995 if we are to reduce emissions by 5% per year? How much sulfur dioxide and nitrous oxide can be emitted from mobile and stationary sources in 1995 if we are going to reach 30% reduction from levels in 1980. How many species should be taken off the threatened and endangered list each year because their populations have been successfully restored?

3. **Upgrade and improve the standards, critical thresholds, or rules of thumb we use to make judgements about goals and targets.** Targets are usually based on a mixture of scientific evidence, economic and technological reality, and political will. Targets are much more likely to be achieved if standards have been scientifically determined and incorporated in the target-setting process.

   How much soil can be lost without losing fertility and reducing productivity? How much soil can be lost without degrading downstream ecosystems, including reservoirs? How much old-growth forest is enough? How much coastal habitat can be restructured before coastal resources are degraded and ecosystem properties lost? Is it 5% or 10% of an estuary, or less? How many fish can be caught from a given fishery without reducing future catches and without significantly modifying the species composition of the fishery? How many tourists can visit the mountain gorillas in Rwanda's National Park, and still maintain stable or increasing gorilla populations?

4. **Develop sets of indicators and indices based on cost-effective environmental monitoring and analysis and report this policy-relevant information to the public.** Indicators provide the ready feedback policymakers and the public need to know if we are on the right path and moving along at the right speed.

The challenge is to make progress along all four fronts at the same time. The question for us in this roundtable discussion is, "How well are we doing to develop meaningful, useful, science-based standards with which to judge the sustainable use of natural resources?" In short, what is the state of our standards for resource sustainability?

Selected Indicators of Global Resource Sustainability

I don't have a direct answer to the question, but let me share experiences we've had recently in compiling four indicators of resource sustainability on a global scale for the latest edition of World Resources. (1)

1. Land Degradation. Over the past 45 years, the soils of roughly 11% of the world's productive lands have been degraded by human activities. (See figure 1). Water and wind erosion, land compaction, loss of nutrients, and chemical contamination are limiting productive capacity and making it more difficult and expensive for farmers to increase production of food and fiber.

There is no simple threshold that determines whether we have sufficient land left in the world to produce food for future generations. Agricultural production, both crop and livestock, are at all-time highs. (See figure 2). But the world's population is expected to double by about the middle of the next century and there is little good land left for agricultural expansion. Thus, continued degradation could make providing an adequate food supply for growing populations much more difficult.

2. Marine Fish Catch. For the first time in history, stocks of most marine fish species are now being fully exploited. Annual marine fish catch in 1990 was 84.2 million metric tons, representing a 35 percent increase since 1980 and more than a fourfold increase since 1950. (See figure 3). As signs of severe pressure on this resource accumulate, there is growing concern that these tremendous gains cannot be sustained. In 8 of the world's 17 ocean fisheries, the amount of fish caught exceed the lower range of the estimated sustainable catch. (See figure 4). In 1980, only 5 areas were fished so heavily.

Increasing pollution in coastal waters and destruction of coastal estuaries, which provide reproduction grounds for 90 percent of the world's marine catch, are also degrading the fisheries. Under these circumstances, expanding the catch will prove difficult; it may take years of rehabilitation just to maintain current production levels.

3. Atmospheric Carbon Dioxide Concentrations and Emissions. The Earth's carbon cycle is being stressed by increasing emissions of carbon dioxide from burning fossil fuels and rapid changes in land use. Emissions from fossil fuel use alone have increased 3.6 times since 1950. (See figure 5). Atmospheric concentrations of carbon dioxide in the atmosphere are increasing at 0.5 percent per year. (See figure 6).

The Intergovernmental Panel on Climate Change concluded that such emissions, if continued, will enhance the greenhouse effect, resulting on average in an additional warming of the Earth's surface, The Panel estimated than an immediate 60 percent reduction in emissions would be required to stabilize atmospheric concentrations of carbon dioxide at present levels.

4. Stratospheric Ozone. Stratospheric ozone, which absorbs much of the sun's damaging ultraviolet rays, is being depleted by the production and use of chlorofluorocarbons and other related compounds. Increases in ultraviolet radiation case skin cancers and cataracts and may disrupt the marine food chain and damage crops. Recent measurements indicate that peak ozone destruction (during polar spring) has reached 60 percent over Antarctica. (See figure 7). For the first time, significant ozone losses have also been found at mid-latitudes (45 degrees corresponds to Christchurch, New Zealand in the south and Minneapolis, Minnesota in the north).

There are preliminary indicators of an Arctic ozone hole over the North Pole. Only equatorial regions so far show no significant ozone losses. Because chlorine and bromine chemicals already released to the atmosphere will reach the stratosphere in coming years, ozone losses are expected to increase at least through the end of the century. Even if use of such chemicals is rapidly eliminated, full recovery of the ozone layer is not expected until about the year 2100.

These four examples suggest that there is a growing body of quantitative materials (standards and indicators) that can be used to assess sustainability, at least at a global level. In fact, it may be easier to assess how well we are doing to achieve global sustainability than it is to assess sustainability at the national or local level. And, it is clear from these few examples, that the record is not good. It appears that we are overshooting standards and rules-of-thumb, greatly increasing the risk of losing environmental services, and perhaps limiting opportunities for development of future generations.

Prospects for Improving Standards of Resource Sustainability

A simple strategy for improving standards of resource sustainability would include the following activities:

1. First, we need to compile and carefully document standards for both environmental quality and resource sustainability at the global, national, and ecosystem levels.

Where are the gaps in standards? What do existing standards tell us about relative risk, about distributional aspects of development including human rights, about costs of achieving targets and goals, about the value we place on resources? And, do we have enough good science and management experience to modify existing standards?

As recently as 1990, researchers at Resources for the Future were unable to fully document what air quality and water quality and hazardous waste regulations were actually operational in OECD countries. (2) We should know that.

2. Second, we need to expand research in order to develop better measures of ecosystem integrity and health.

The FAO range of maximum sustainable yields for marine fisheries, noted above, are more than ten years old. How good are our estimates of resource stocks, harvests, growth, and rehabilitation? Much work needs to be done here, too.

3. Third, our inability to establish a meaningful standard does not preclude us from setting targets.

The Oregon Progress Board has prepared a set of 160 measurable benchmarks (targets) to guide the state and "keep track of progress over the next 20 years." Some of the 29 environmental benchmarks are poorly monitored and in some cases not even well specified, but they are operational. People are using them to think about the future of their state. (3)

The Dutch compile an annual report on how well they are doing to achieve targets set in their national environmental plan. The results as of 1991 were encouraging in reducing acidification, CFCs and halons, and carbon dioxide emissions. The record on waste disposal was very poor, and on reducing eutrophication, progress was minimal. (4)

4. Fourth, until we have improved standards we should make use of available substitutes. We can:

a. Compare resource use over time. When rates of resource use and land use change rapidly, this should be a sign of potential problems. Indonesia, the country with the world's greatest extent of mangrove habitat, lost approximately 19% of this valuable resource between 1969 and 1982. In the Philippines, a majority of coral reefs are in fair to poor condition, with two-thirds of sites sampled in 1982 having less than 50 percent live coral. (5) These numbers suggest declining conditions and loss of valuable resources.

b. Compare efficiency of resource use among countries. The Japanese are more efficient users of energy than Americans. Measures of energy efficiency can provide a kind of temporary target to assess how well we are doing to minimize resource throughput.

c. Compare flows with stocks. The OECD in its recent report on environmental indicators compared member countries in terms of their annual rates of forest harvest and their rates of forest growth. This kind of comparison is the basis for resource accounting. (6)

5. Fifth, we need to challenge conventional wisdom and develop better scientific and management rationale for increasing our natural resource base. Nowhere is it stated that we should be satisfied with existing natural resources and focus only on preservation and conservation. Why not expansion? For example, in the case of wetlands, why should we limit our sights to a target of "no net loss." Why not specify a target of increasing the amount of wetlands in the United States? The National Academy of Sciences suggests that damaged and destroyed wetlands "be restored at a rate that offsets any further loss and contributes to an overall gain of 10 million acres by the year 2010". (7) Similar statements could be made for recharging groundwater aquifers, expanding wildlife populations, rehabilitating coastal resources and riparian habitats, removing dams and returning rivers to free-flowing status if cost effective, expanding urban wildlife and natural areas, regenerating prairie habitat, etc.

Making progress on the development of new and scientifically-based standards will be costly and complicated. But, without this body of knowledge, it will be virtually impossible to harness public support for changing the way we use and value resources.

Endnotes

1. World Resources Institute (WRI), World Resources 1992-93, Oxford University Press (New York, 1992), p.5.

2. Kopp, Raymond J., Paul R. Portney and Diane E. Dewitt, "International Comparisons of Environmental Regulation," Resources for the Future (Washington, D.C., 1990).

3. Oregon Progress Board, Oregon Benchmarks: Setting Measurable Stands for Progress, Report to 1991 Legislature, Oregon Progress Board (Oregon, 1991).

4. Environmental Programme 1992-1995: The Netherlands, Ministry of Housing, Physical Planning and the Environment and the Department for Information and International Relations (The Hague, 1991), pp. 9-12.

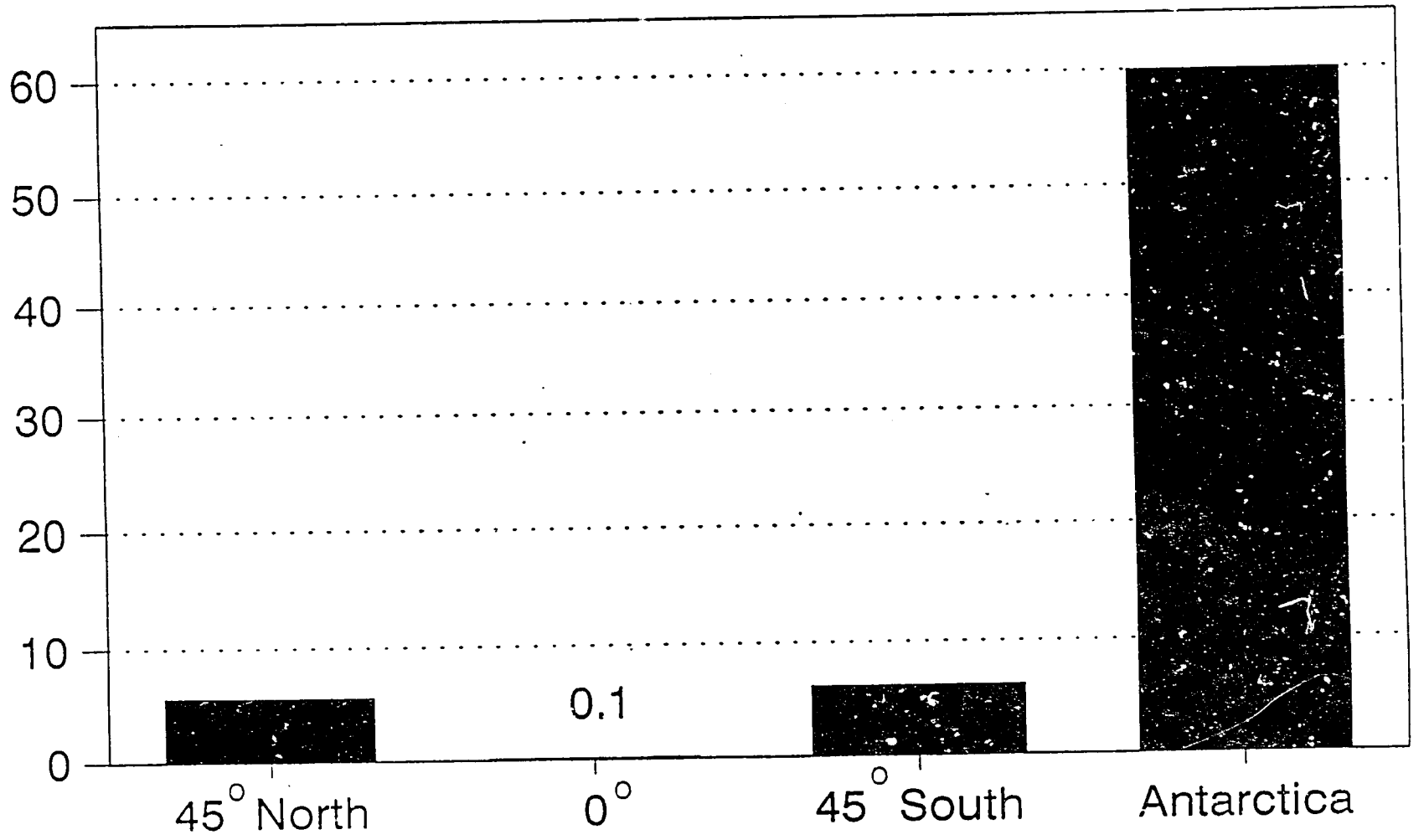
5. World Resources Institute, Toward and Environmental and Natural Resources Management Strategy for ANE Countries in the 1990s, World Resources Institute (Washington, D.C., 1990), p. 21.

6. Organisation for Economic Co-operation and Development (OECD), Environmental Indicators: A Preliminary Set, OECD (Paris, 1991), p. 37.

7. A recent report on wetlands recovery by the National Academy of Sciences as quoted in, "A Plan for Wetlands Recovery," the Christian Science Monitor (January 6, 1992).

Stratospheric Ozone Depletion
1979-91

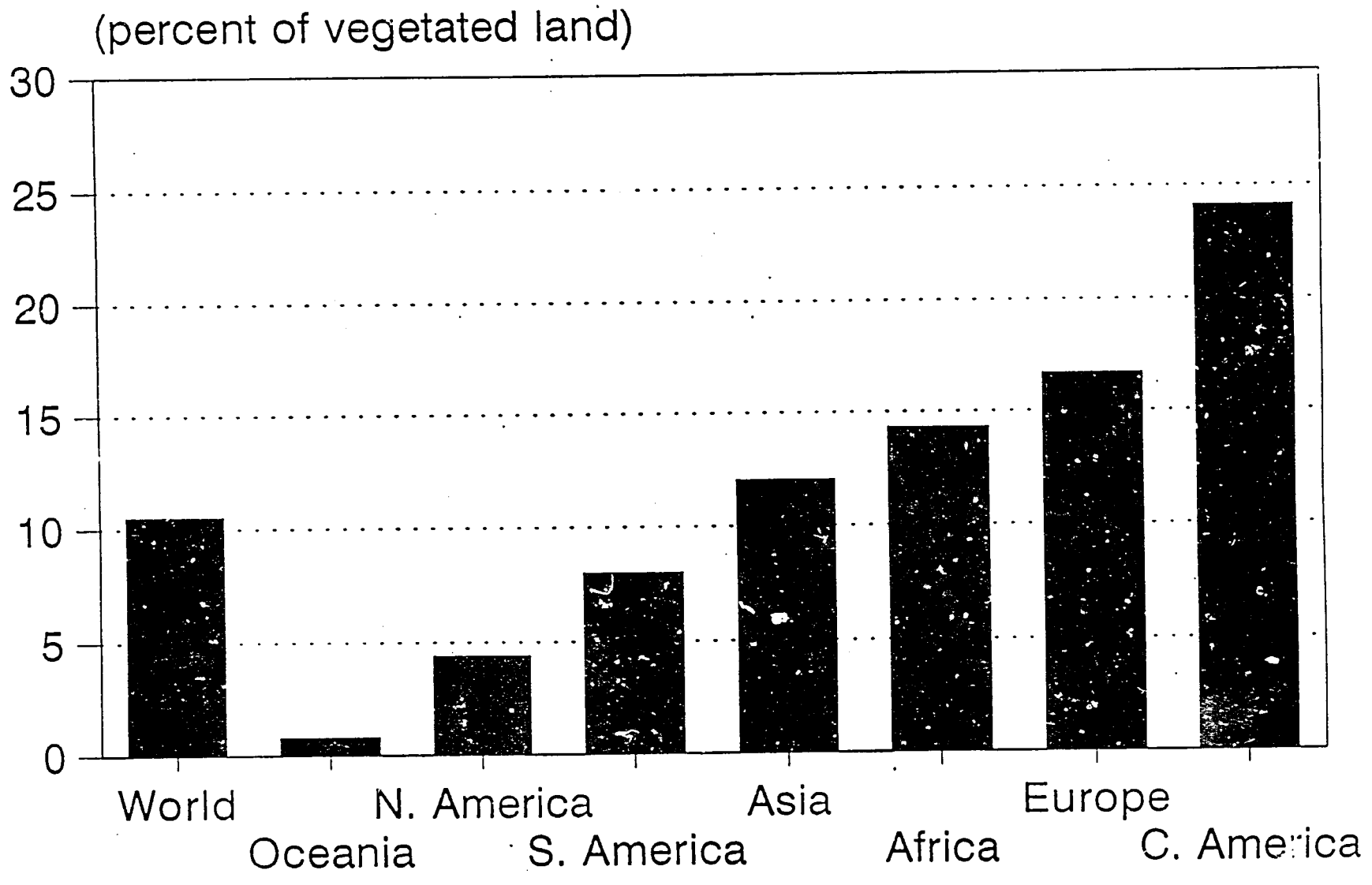
Figure 7.



Source: World Meteorological Organization (WMO) and United Nations Environment Programme (UNEP), "Scientific Assessment of Stratospheric Ozone, 1991, "executive summary (WMO, October 22, 1991) pp. 2 and 4.

Figure 1.

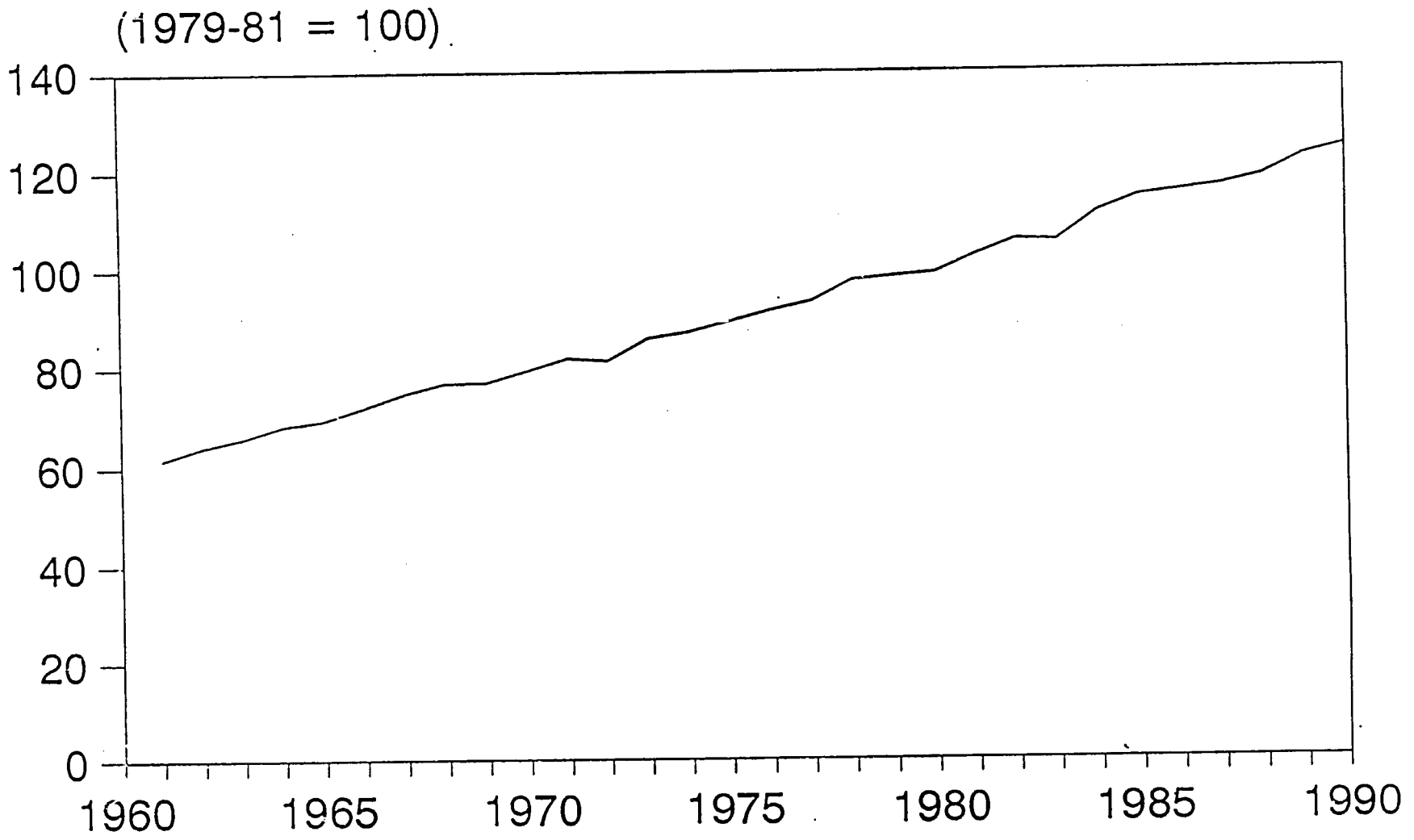
Moderate, Severe, and Extreme Land Degradation as a Percent of Vegetated Land
1945-90



Source: World Resources Report 1992-93, Chapter 8, "Forests and Rangelands," Table 8.1.
Note: Figures for European and Asian parts of the Soviet Union are included with Europe and Asia.

World Agricultural Production
1961-90

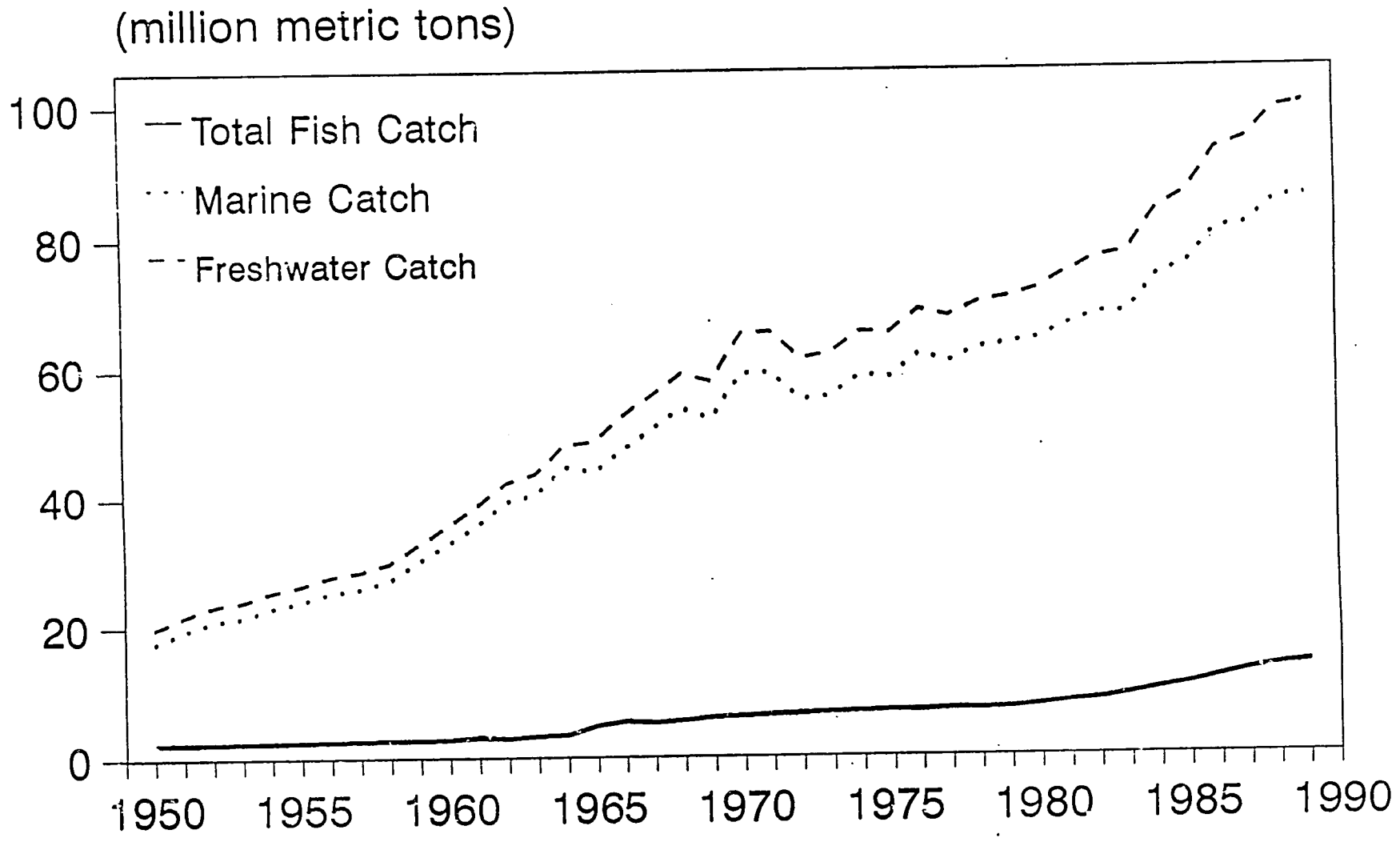
Figure 2.



Source: Food and Agriculture Organization of the United Nations (FAO), Agrostat PC (FAO Rome, July 1991).

Global Fish Catch
1950-90

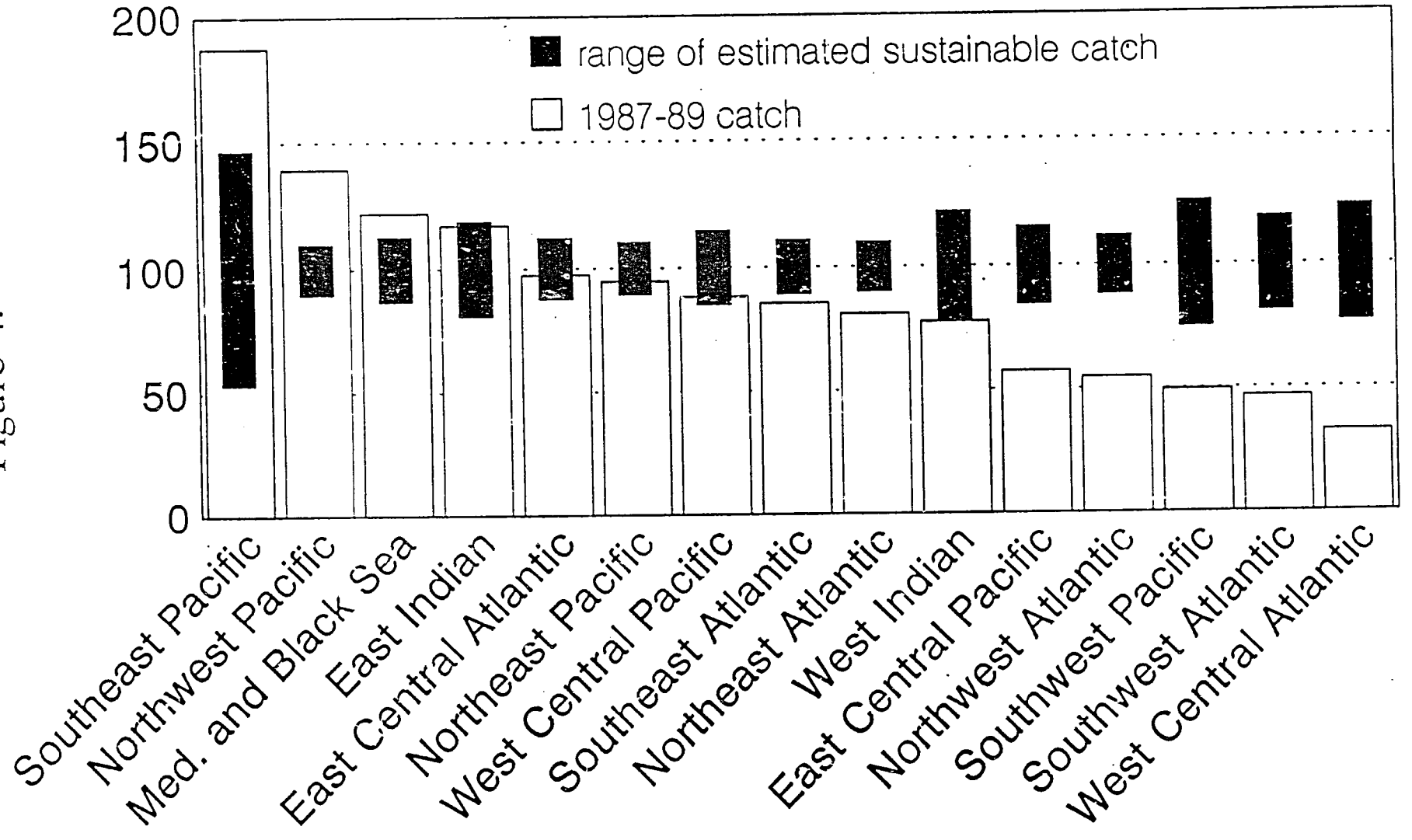
Figure 3.



Source: World Resources Report 1992-93, Chapter 23, "Oceans and Coasts," Table 23.2
Note: 1990 figure is preliminary.

Figure 4.

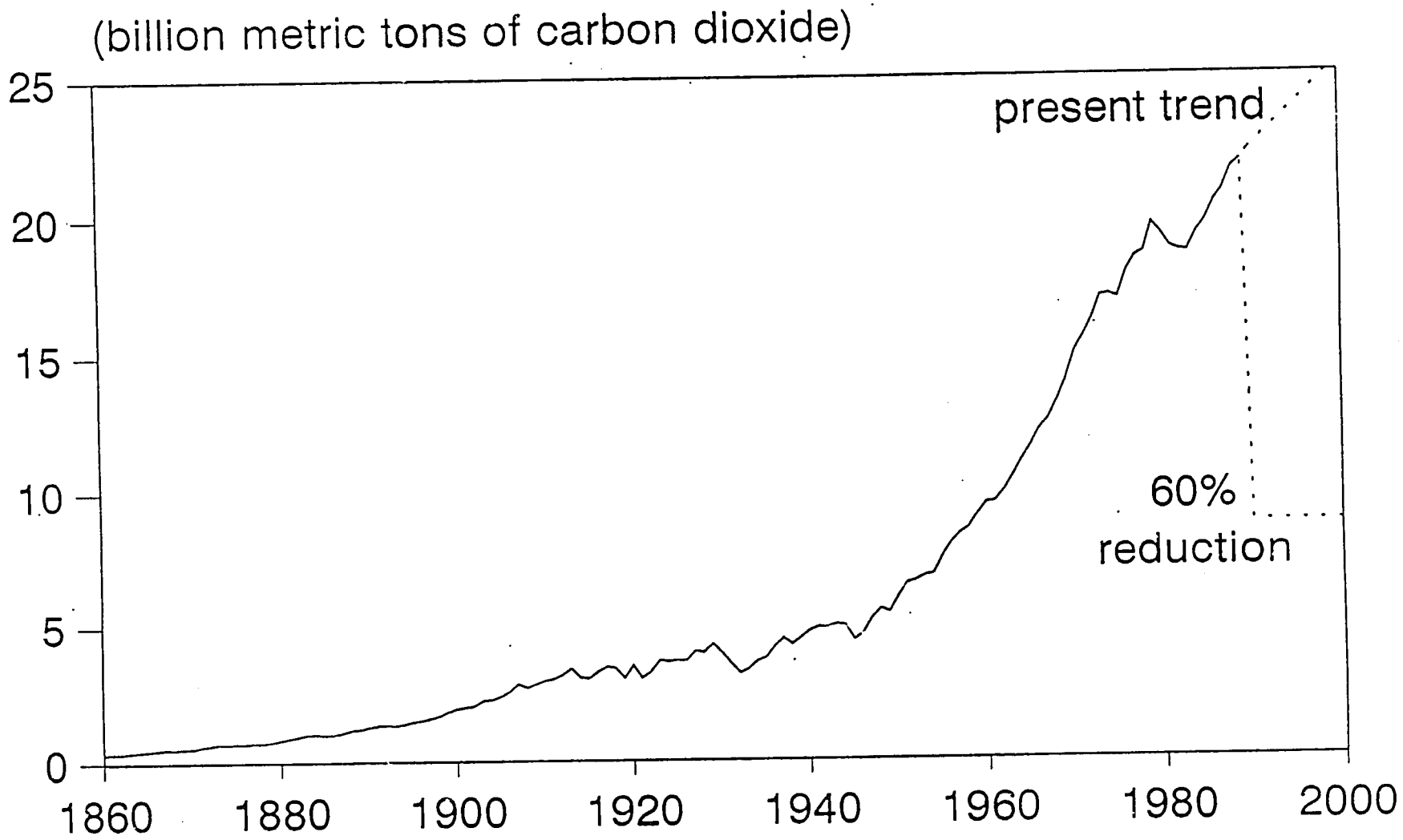
Marine Fish Catch as a Percent of Estimated Average Sustainable Catch 1987-89



Source: World Resources Report 1992-93, Chapter 23, "Oceans and Coasts," Table 23.3.
Note: Maximum sustainable yields are not defined for Arctic and Antarctic regions.

Figure 5.

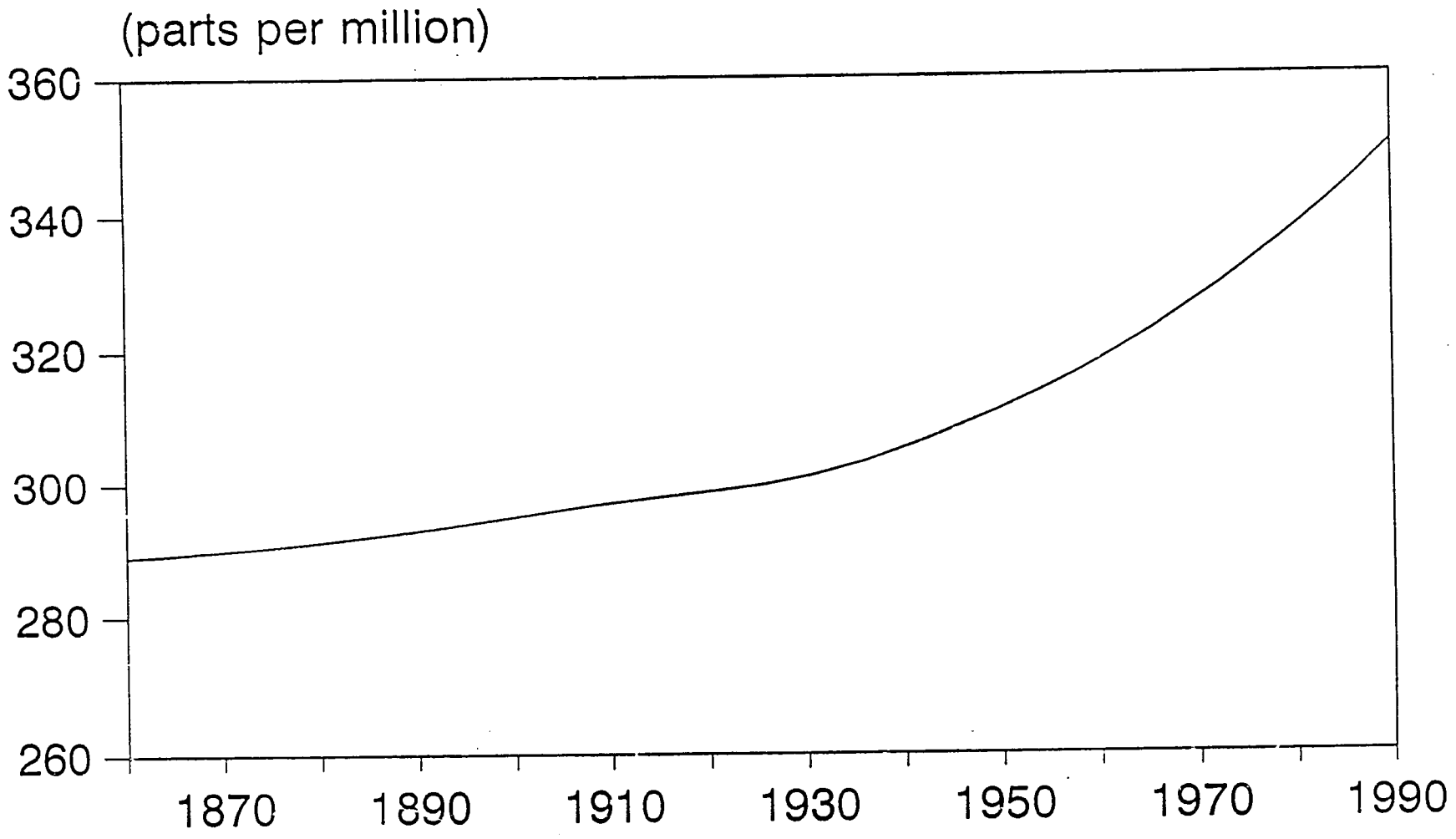
Worldwide Annual Emission of Carbon Dioxide from Industrial Sources 1860-1989



Source: Carbon Dioxide Information Analysis Center (CDIAC) (Oak Ridge Natinal Laboratory, Oak Ridge, Tennessee, unpublished data, July 1991). See also World Resources Report 1992-93, Chapter 24, "Atmosphere and Climate," Table 24.4.

Atmospheric Carbon Dioxide Concentrations 1860-1990

Figure 6.



Source: Intergovernmental Panel on Climate Change (IPCC), Climate Change: The IPCC Scientific Assessment, J.T. Houghton, G.J. Jenkins, and J.J. Ephraums, eds. (Cambridge University Press, Cambridge, U.K., 1990), p. xvi.