LIMITS TO GROWTH AND THE MESSAGE FOR SUSTAINABLE DEVELOPMENT

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Abstract: Two decades have passed since the first report to the Club of Rome. *The Limits to Growth* examined the consequences of unchecked growth and forecast global catastrophe within a hundred years if then-current trends continued. With the benefit of 20 year's hindsight, the report is re-examined and it is shown that we are closely following the patterns of growth that the model's "standard run" forecast. Yet the implicit warning about continued growth is often ignored in discussions of sustainable development.

In 1968, 30 scientists, educators, economists, industrialists and government officials from 10 countries met at the *Accademia dei Lincei* in Rome to discuss the present and future predicament of mankind. The so-called "Club of Rome" shared a concern about world problems, specifically the degradation of the environment, poverty in the midst of plenty, unemployment and inflation, uncontrolled urban spread, people's alienation and the rejection of traditional values.

Their first study examined the doctrine of continued growth by analysing and simulating world processes. A computer model, based upon System Dynamics simulation theory and termed the "World Model" was developed at Massachusetts Institute of Technology. The model outputs confirmed what many futurologists had been saying: the planet could not sustain existing growth patterns for long. There were absolute physical limits which, if ignored, would lead to sudden collapse. The Club of Rome decided to publish these results as the book *The Limits to Growth* [1].

The World Model examined five main parameters: population, industrial capital, food, non-renewable resources and pollution. Nearly 300 variables and over 100 feedback loops were identified and each relationship was quantified using global data. Starting with the year 1900, the simultaneous operation of each relationship over time was calculated through to 2100. The output was adjusted to agree with historical values between 1900 and 1970.

Despite its complexity, the World Model was a grossly simplified view of world processes. No attempt was made to model individual nations or the flows of materials between nations. The contributions of the oceans and aquaculture to food supply were ignored. Non-renewable resources were not treated individually, but rather as one "average" resource. Similarly, there was only one class of pollution, representing long-lived, globally dispersed pollutants.

The model also had to make a number of assumptions about processes, some of which are illustrated in Figure 1.

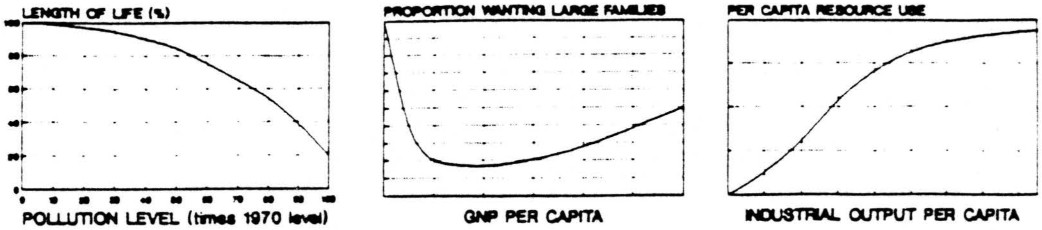

Figure 1 - Some Assumptions of the World Model

The simulation was run many times for varying growth rates and resource levels. It showed surprisingly consistent behaviour, one of growth and collapse. The "standard run", shown in Figure 2, assumed no major changes in the physical, economic or social relationships that had operated for the previous 100 years. Population and industrial

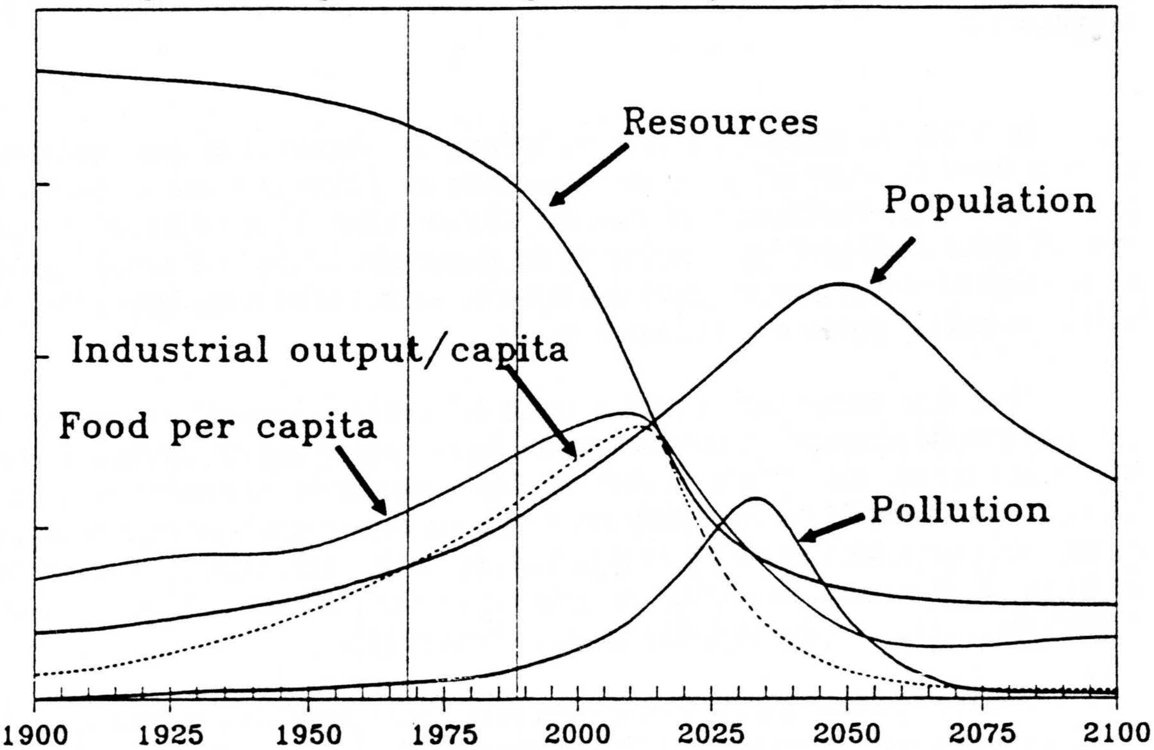

Figure 2 - World Model Standard Run Output

output continue to increase exponentially. Industry grows to a level that requires enormous input of material and the resource base is rapidly depleted. Resource prices rise rapidly, and more and more capital is devoted to extracting the dwindling resources. Eventually depreciation outstrips investment leading to a collapse of the industrial base. The agricultural and service sectors, which are dependant on industry for energy, fertilizers, pesticides, computers and such, collapse soon after. Food production drops. For a while, population keeps increasing since social adjustment to the seriousness of the situation is slow. Before long, the increasing population and dwindling food supply leads to mass starvation. Combined with the lack of medical services, this causes the population to plummet in what can only be described as a global catastrophe.

It must be emphasized that the standard run was not intended to be an accurate quantitative prediction. The authors made clear the model had insufficient detail for that type of prediction. Rather it was intended to examine the mechanisms at play--it was more interested in the overshoot and collapse mechanism than the precise year of occurrence.

The Limits to Growth provoked considerable criticism, the most serious from a group of specialists at the University of Sussex [2]. Neither the criticisms nor the replies were convincing. The basic differences were of approach--the Sussex group combined abundant confidence in technology to solve future problems with an innate distrust of computer models. The validity of any model, however, is best tested by its predictive powers. Given the seriousness of the projections, it is reasonable to ask whether, 20 years later, things are happening according to the pattern of the standard run. Some interesting comparisons can be made for each of the five main parameters.

Population: Figure 3 compares the population projections of the World Model for the period 1960 to 2030 with the latest U.N. data and projections [3]. Over the past

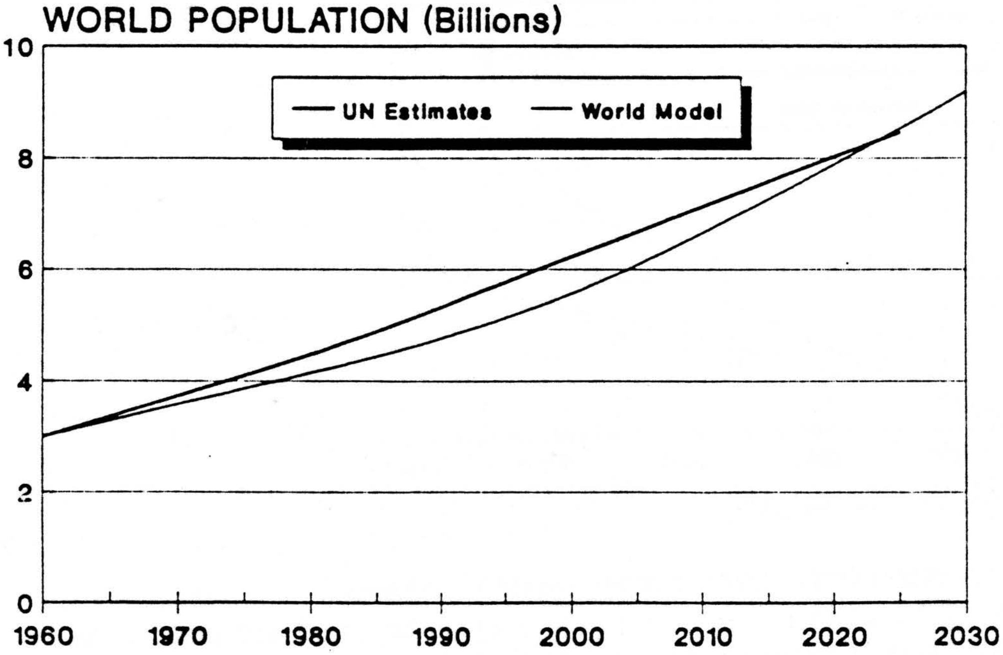

Figure 3 - World Population

20 years, we have experienced an even greater increase in world population than that predicted by the World Model.

Non-Renewable Resources: The World Model standard run assumed 250 year's reserve of all non-renewable resources in 1970. The actual reserves for selected resources in 1968 [1] is shown in figure 4 compared with figures for 1988 [3]. Reserves are expressed as years of supply at late-1960's consumption rates and include only reserves

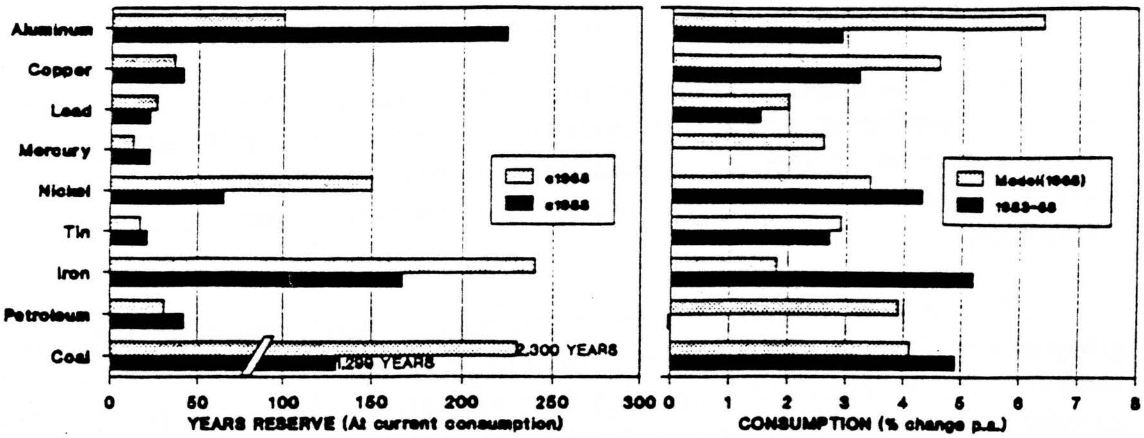

Figure 4 - Reserves of Non-Renewable Resources

that are economically extractable. It is apparent that the 250-year supply assumption remains optimistic. The fact that some reserves (e.g. copper) have increased in spite of 20 year's extraction does not offer much consolation. The magnitude of error in reserve assessment is not very significant--the important parameter is the growth rate, which is illustrated by figure 5. At today's level of consumption, there are 41 year's reserve

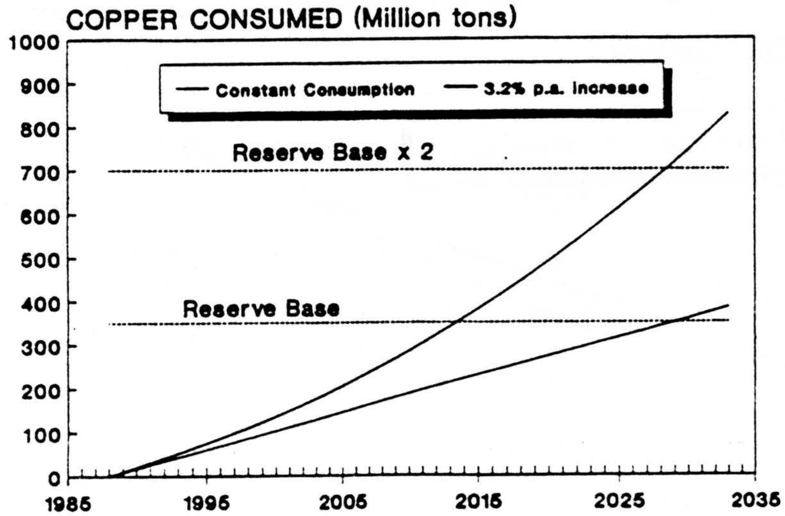

Figure 5 - Copper Consumption

of copper, but even twice current reserves would be exhausted in 42 years given current growth rates of 3.2 percent. This is not to imply that the world will actually run out of copper in 42 years. One recent analysis predicts that copper ore bodies will not be exhausted until 2070 [4]--increased costs lead to conservation, replacement and more reserves becoming economic. What is clear, however, is that unless non-renewable resource consumption growth rates are curbed, the depletion crisis shown by the World Model is unavoidable.

Food: The World Model predicted that population, agricultural productivity and the amount of arable land would all increase in the medium term [5]. Population and productivity have increased, but the amount of crop land has actually decreased, from around 1.6 billion Ha in 1968 [1] to 1.5 billion Ha in 1987 [3]. It could be anticipated, therefore, that the food/capita curve from the standard run would be optimistic. This turns out to be the case. Statistics for cereals (which supply about half of people's calorie requirements) provide a convenient indicator of world food production. The increase in cereal production from 1965 to 1988 [3] is shown in figure 6. Superimposed on the graph is the increase in food per capita predicted by the World Model standard run. As can be

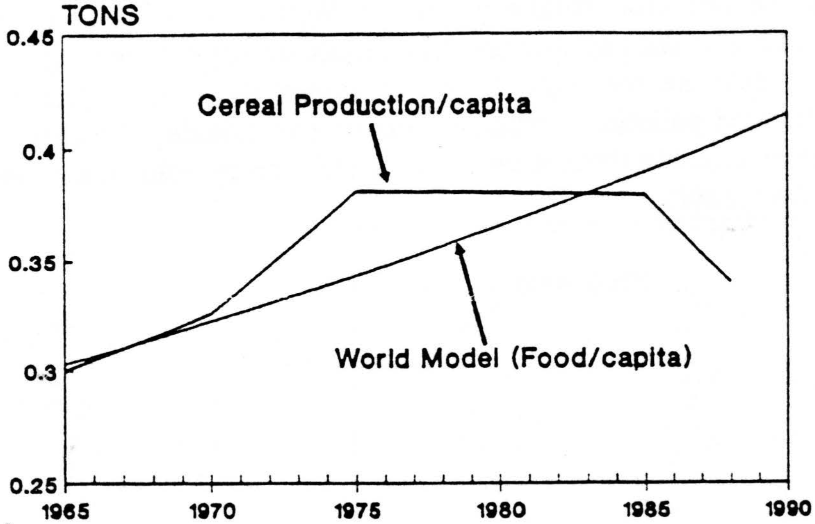

Figure 6 - World Food Production

seen, actual food production per capita has not achieved the rates predicted due to a downturn this decade.

Industrial Production: This comparison is more difficult given the ambiguity of data on world industrial production. However, industrial production is closely correlated with energy consumption for which data is readily available. Figure 7 shows the world

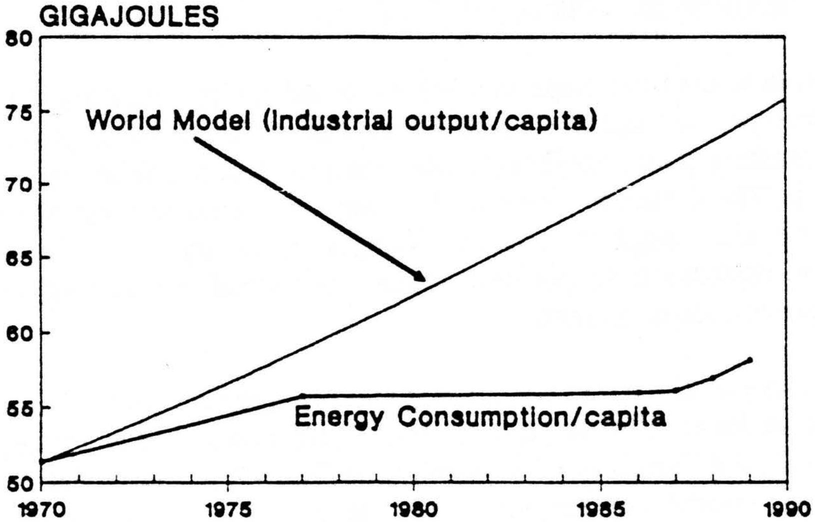

Figure 7 - World Energy Consumption

energy consumption per capita between 1970 and 1989 [3] [6]. Superimposed is the rate of increase of industrial output per capita from the World Model standard run. The actual industrial output per capita, as measured by energy consumption, continues to increase, but at a significantly slower rate than projected by the World Model. This could be due to greater energy efficiency, a move to a more service-based economy or the oil crisis of the early seventies. Whichever, the sharp increase in growth since 1986 is of particular concern.

Pollution: Since the pollution parameter in the World Model was a gross simplification, it is difficult to make any meaningful comparison against the outputs. It is possible, however, to examine the input data that shaped the model. The most significant, globally-distributed pollution considered was carbon dioxide. The data then available showed atmospheric carbon dioxide levels were 318 ppm by volume and were

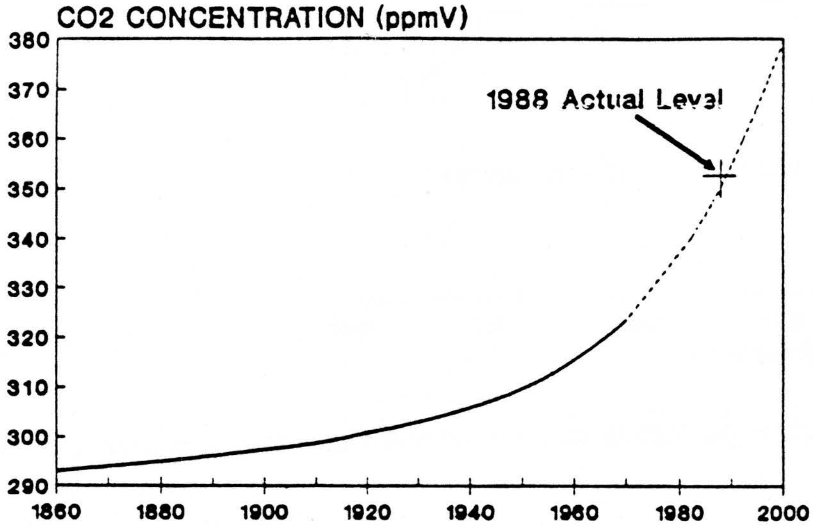

Figure 8 - Atmospheric Carbon Dioxide

predicted to be 350 ppm by 1988 as shown in figure 8. This prediction has been extraordinarily accurate--the figure for 1988 is 351.3 ppm [6].

It would be a mistake to read too much into the above indicators-- they are, after all, only a sampling of today's data against a model that was not intended to provide quantitative data. The interesting point, however, is that the world is still following the growth patterns outlined in *The Limits to Growth*. This not only lends support to the validity of the model but also suggests that the changes necessary to avoid the catastrophic overshoot and collapse have not been made--the central message of *The Limits to Growth* has apparently been ignored.

What has happened to global environmentalism that it could ignore such a serious message? The answer can be found in three publications: *World Conservation Strategy* [7]; *Our Common Future* [8], and *Caring For The World* (2nd Draft) [9]. Each represents a consensus among leading world environmental experts and is therefore a good barometer of environmental opinion. The shifts in focus over the two decades are summarized in figure 9.

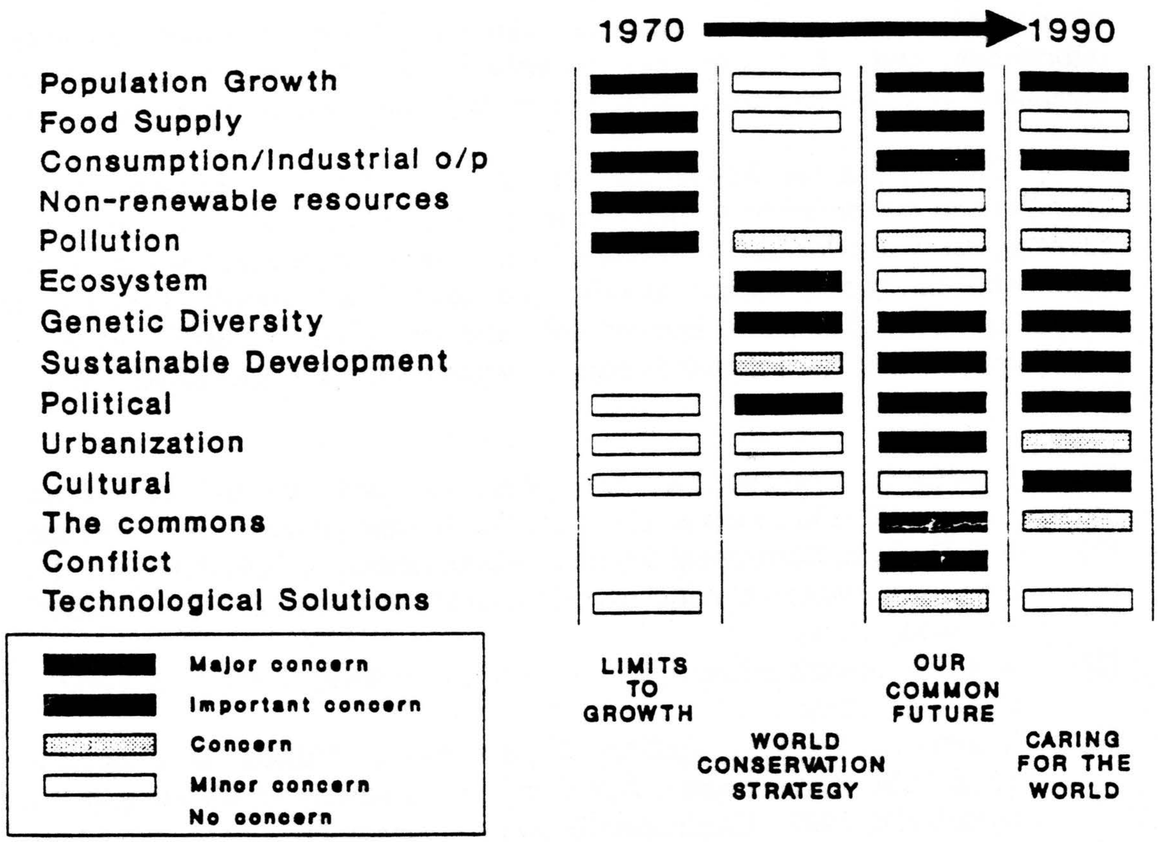

Figure 9 - Shifts in Environmental Focus

In contrast to the broader view of *The Limits to Growth*, *World Conservation Strategy* focused on human's total dependence on the ecosystem. It pointed out that while population was rapidly increasing, the ecosystem resource was just as rapidly decreasing due to soil loss or degradation, devastation of forests, destruction of aquatic habitats, loss of genetic diversity and pollution. In offering a solution, *World Conservation Strategy* introduced the idea of sustainable development. However, despite showing that the problems were real and urgent, it made no attempt to quantify the relative urgency.

By 1983, the United Nations had recognized the criticality of environmental issues and called for "a global agenda for change" [8]. A commission was established chaired by Gro Harlem Brundtland which published *Our Common Future* in 1987. It was a wide-ranging view of global problems that, in tying growth and sustainability together, popularized the concept of sustainable development. It was based on the premise that growth was essential if brute poverty in the underdeveloped world were to be overcome. The weakness of the report was that it avoided the question of how much growth was possible.

Caring for the World is the successor to *World Conservation Strategy*. Now in second draft, it should be published this year. Its principle aim is to provide a strategy for sustainability. It builds on the preceding three works and focuses on three main obstacles that have undermined sustainability over the last decade: the lack of an ethical commitment to the concept, the inequitable distribution of power, resources and information, and "the notion that conservation and development can be managed separately" [9]. Like its predecessors, it relies on illustrative data and anecdotal evidence.

Over the past two decades the focus has shifted from concerns about finite limits of growth to the problems of implementing sustainable development. But how much development is sustainable? We would do well to consider the message from *The Limits to Growth*--the warning appears as valid today as it did two decades ago. If we are to truly achieve sustainable development, policies must be based on hard quantitative data which defines how much growth is possible without foreclosing on future generations.

[1] Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, and William W. Behrens III, *The Limits of Growth*, 1972. Washington: Potomac Associates.

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[9] World Conservation Union, United Nations Environment Program and World Wide Fund for Nature, *Caring for the World: A Strategy for Sustainability* (Second Draft), June 1990.