3: Dissecting Those "Overpopulation" Numbers

> Numbers suggest, constrain, and refute; they do not, by themselves, specify the content of scientific theories. Theories are built upon the interpretation of numbers, and interpreters are often trapped by their own rhetoric. They believe in their own objectivity, and fail to discern the prejudice that leads them to one interpretation among many consistent with their numbers.
>
> —Stephen Jay Gould[1]

Ever since 1798, when the Reverend Malthus claimed that population increases exponentially (2, 4, 8, 16 . . .) while the food supply only grows arithmetically (2, 3, 4, 5 . . .), the populationist argument has depended on numbers. It's rare to read a populationist article, leaflet, or website that doesn't include statements such as these:

- *Optimum Population Trust (OPT)*: "Human numbers are still exploding. Our numbers reached 6.8 billion in 2009, and are expected to climb to 9.2 billion in 2050—by more than a third in barely 40 years . . . Every week some 1.6 million extra people are being added to the planet—a sizeable city—with nearly 10,000 arriving each hour . . . On a planet inhabited by 2.5 billion people in 1950—within the lifetimes of many alive today—there are now more than double this number."[2]
- *Global Population Speak Out*: "It took virtually all of human history for our numbers to reach 1 billion in the

1800s. It took only about a century to add the second billion in 1930. We added the third billion in just 30 years and the fourth in only 15 years. We are now at 6.7 billion with projections of over 2 billion more to come in the next 40 years. The size and growth of the human population is linked closely to nearly all forms of environmental degradation we see today."[3]

- *William N. Ryerson, president of the Population Institute*: "The world's population is growing by about 80 million people annually—the equivalent of adding a new Egypt every year. The total population is approaching 7 billion, seven times what it was in 1800. Every day approximately 156,000 people die, but 381,000 are born—a net daily growth of 225,000 human beings."[4]
- *All Party Parliamentary Group on Population* [UK]: "In 2005, global population increased by 76 million more births than deaths. India has one million more births than deaths every three weeks. By 2050, Uganda is projected to grow from 27 million to 130 million; Niger from 14 to 50 million; Iraq from 29 to 64 million; and Afghanistan from 31 to 82 million. Asia will add 500 million people in a single decade from 2005."[5]

Such numbers are impressive, but numbers by themselves don't prove anything, and it is entirely possible to draw inaccurate conclusions from accurate statistics. In this chapter we look at the frequent misuse (deliberate or not) of numbers and statistics by advocates of the "too many people" explanation of environmental destruction.

Correlation versus causation

At some point in every introductory statistics course, the instructor tells students about a European city where increases in the stork pop-

ulation were supposedly matched by increases in the number of new babies. The point being made is that *correlation isn't causation*—storks don't bring babies, no matter what the numbers seem to imply. Stephen Jay Gould explained the issue this way:

> The vast majority of correlations in our world are, without doubt, noncausal. Anything that has been increasing steadily during the past few years will be strongly correlated with the distance between the earth and Halley's comet (which has also been increasing of late)—but even the most dedicated astrologer would not discern causality in most of these relationships. The invalid assumption that correlation implies cause is probably among the two or three most serious and common errors of human reasoning.[6]

Unfortunately, the vital *correlation-or-causation* distinction is rarely observed in arguments that claim to show population growth drives environmental destruction.

No one doubts that the world's population has soared since the Industrial Revolution began in the late 1700s. After millennia in which the number of people grew very slowly, our numbers increased sevenfold in two hundred years, and the growth hasn't stopped. For almost all of human history there were fewer than one billion human beings living on earth: by 2050 there will likely be over nine billion.

And no one doubts that since World War II, economic activity, resource use, and pollution of all forms have also grown at unprecedented rates. "Many human activities reached take-off points sometime in the 20th century and have accelerated sharply towards the end of the century. The last 50 years have without doubt seen the most rapid transformation of the human relationship with the natural world in the history of humankind."[7]

Our debate with populationists is not about the raw numbers. It is about *what the numbers mean*. What are the causes of the environmental crisis, and what does that tell us about the solutions?

People, cars, and population

In his trailblazing book *The Environment: From Surplus to Scarcity*, environmental sociologist Alan Schnaiberg described populationist theory as a "two accounts" model—one set of numbers (e.g., population) is presented as the explanation of another set of numbers (e.g., pollution). The following is based on his real-world illustration of problems with that approach.

Between 1960 and 1970, US population increased by 23.8 million, and private automobile ownership increased by 21.8 million. A populationist model would conclude that more people equaled more cars.

But there is a major logical flaw in that reasoning. Population growth between 1960 and 1970 was almost entirely made up of children born in that decade, none of whom were old enough to buy cars. If population growth is the primary cause, it must involve people born before 1954.

So perhaps we should instead compare the number of cars to the number of households, or families. Did the growth in new households after World War II increase the number of cars?

What cars-per-household figures show is that "the percentage of households with one car actually declines from 62.1 percent to 50.3 percent . . . . [but] the percentage with two or more cars rose from 13.9 percent to 29.3 percent." So the increase in cars was caused

Populationists isolate one number—population size or growth—and claim it is the underlying cause for all the rest. Population increased; economic activity expanded and environmental degradation increased; so population must have caused the expansion and degradation.

That only shows *correlation*, not *causation*.

Sometimes correlation does indicate causation. For example, the average global temperature and the amount of carbon dioxide in the atmosphere have risen together for decades. Scientists know exactly how an increase in atmospheric CO_2 *causes* temperatures to rise. Since the greenhouse effect is one of the most widely accepted conclusions of modern atmospheric science, it is reasonable—indeed completely logical—to conclude that the increase in CO_2 is causing global warming.

People, Cars, and Population (continued)

not by more people or more families, but by some families buying more than one car. More detailed studies show that families with no car tended to be older, poorer, and urban, while those with two cars tended to be middle aged, better off, and suburban or rural.

Each of these pieces of information changes our sense of how population growth relates to automobile use. Each has different implications for solutions to automobile-related environmental problems.

It is likely, Schnaiberg said, that the rising number of cars was caused not by population growth but instead by the rising number of women who took jobs outside the home in the 1960s. Two-job families that didn't live in large cities with good public transit would often require two cars. "In this simple illustration our evaluation has changed from an initial estimation that up to two-thirds of the growth in autos is due to very recent population growth, to a decision that absolutely none of it can be so attributed . . . . This example illustrates some of the pitfalls of thinking in nonsocial ways about social systems of production and consumption."

To reduce the number of automobiles on the roads, "we need to understand the social system basis of such consumption."

But the fact that global emissions and global population have both increased doesn't, by itself, show that population growth causes emissions growth. The apparent relationship could be a coincidence, or both trends could be the result of a third cause, or the correlation could be an illusion, a result of the way the numbers are presented. (The box above illustrates how correlation can be misleading when one is considering an issue closely related to emissions.)

As Karl Marx wrote 150 years ago, "population" is an abstraction, not a real thing.

> It seems to be correct to begin with the real and the concrete, with the real precondition, thus to begin, in economics, with e.g. the population, which is the foundation and the subject of the entire social act of production. However, on closer examination this

> proves false. The population is an abstraction if I leave out, for example, the classes of which it is composed.[8]

That is a profound insight, one that activists who are concerned about the complex relationship between humanity and the world we live in must understand. "Population" is just a number, one that can conceal far more than it reveals. Population statistics are useful only if we understand how they are determined, what they include and leave out, and what their strengths and limitations are for any given purpose.

To determine whether population growth is causing climate change, we need to dissect the big numbers and examine the real connections and relationships.

Population where?

To begin to explain the relationship between population and climate change, it's useful to look at differences between rich and poor countries. In 2009, Dr. David Satterthwaite of the International Institute for Environment and Development did just that—and his findings exploded the myth that population growth is a major driver of climate change.[9]

His study shows that between 1980 and 2005:

- Sub-Saharan Africa had 18.5 percent of the world's population growth and just 2.4 percent of the growth in carbon dioxide emissions.
- The United States had 3.4 percent of the world's population growth and 12.6 percent of the growth in carbon dioxide emissions.
- China had 15.3 percent of the world's population growth and 44.5 percent of the growth in carbon dioxide emissions. Population growth rates in China have fallen very

rapidly while greenhouse gas emissions have increased.

- Low-income nations had 52.1 percent of the world's population growth and 12.8 percent of the growth in carbon dioxide emissions.
- High-income nations had 7 percent of the world's population growth and 29 percent of the growth in carbon dioxide emissions.
- Most of the nations with the highest population growth rates had low growth rates for carbon dioxide emissions, while many of the nations with the lowest population growth rates had high growth rates for carbon dioxide emissions.[10]

In short, the correlation between emissions growth and population growth, a connection that seems obvious when we consider only global figures, turns out to be an illusion when we look at the numbers country by country. Almost all of the population growth is occurring in countries with low emissions; almost all of the emissions are produced in countries with little or no population growth. This leads to three inescapable conclusions.

1. ***CO_2 emissions are a problem of rich countries, not poor ones.*** The nineteen countries in the G20 produced more than 22,500 million tonnes of CO_2 in 2006. That's 78 percent of the worldwide total—nearly four times as much as all other countries combined. It is more than 770 times as much CO_2 as produced by the nineteen lowest-emitting countries. Per capita CO_2 emissions in the United States are 98 times greater than in Gambia, 132 times greater than in Madagascar, 197 times greater than in Mozambique, and 400 times greater than in Mali or Burkina Faso.[11]

Note that these figures significantly understate the case, because some major emission sources that are concentrated in rich countries, such as military activity and international air travel, are not included in officially reported figures.

So the idea that providing the means for family planning to those who don't have access will somehow slow global warming makes no sense. With few exceptions, birth control has long been widely available in the countries that are doing the most to destroy the earth's climate.

2. ***There is no correspondence between emissions and population density.*** The high-emitting G20 includes countries such as India, Japan, and South Korea, which are home to high numbers of people per square kilometer—but it also includes countries with very low population density, such as Australia, Canada, and Russia.

Exactly the same is true of the lowest-emission countries, which include some with high population density (Rwanda, Burundi) and some with low population density (Niger, Chad).

So it is clearly possible to have low population density with high emissions, or high population density with low emissions.

It's also worth noting that almost all of the low-emission countries have far fewer people per square kilometer than the United Kingdom, where Optimum Population Trust promotes third world birth control as a means of slowing global warming.

3. ***Population growth rates do not correspond to CO_2 emissions.*** In fact, there's a negative correlation. Broadly speaking, the countries with the highest emissions are those whose population is growing most slowly or even declining, while the countries with the lowest emissions have the highest population growth rates.

In fact, in most G20 countries the birth rate is at or below replacement level. According to some estimates, by the end of this century the population of Italy (excluding immigration) will fall by 86 percent, Spain will decline 85 percent, Germany 83 percent, and Greece 74 percent.[12]

Only three G20 countries (Saudi Arabia, South Africa, and India) have fertility rates that are clearly above replacement level, and even they are growing far more slowly than the lowest-emitting countries.

If we were to adopt the usual populationist *correlation equals causation* stance, we'd have to conclude that high emissions cause low population growth or that high population growth causes low emissions. Of course that's absurd: both emissions levels and population growth are shaped by other social and economic causes.

This shows that there is something seriously wrong with the argument that more people equals more emissions, and something even more wrong with the idea that third world birth control will slow global warming. As environmental writer Fred Pearce says in *Peoplequake*:

> The poorest three billion or so people on the planet (roughly 45 percent of the total) are currently responsible for only 7 per cent of emissions, while the richest 7 per cent (about half a billion people) are responsible for 50 per cent of emissions.
>
> A woman in rural Ethiopia can have ten children and her family will still do less damage, and consume fewer resources, than the family of the average soccer mom in Minnesota or Manchester or Munich. In the unlikely event that her ten children live to adulthood and all have ten children of their own, the entire clan of more than a hundred will still be emitting only about as much carbon dioxide each year as you or me.
>
> So to suggest, as some do, that the real threat to the planet arises from too many children in Ethiopia, or rice-growing Bangladeshis on the Ganges delta, or Quechua alpaca herders in the Andes, or cow-pea farmers on the edge of the Sahara, or chai-wallas in Mumbai, is both preposterous and dangerous.[13]

Problems with per capita

The flip side of populationist misuse of global numbers is the equally frequent misuse of *per capita* numbers to "prove" the harmful environmental impact of individuals. As ecological sociologist Alan Schnaiberg has shown, per capita figures make it remarkably easy to make *any* social problem look like a population problem: just divide the total population into the number of problem events.[14] It's easy to

calculate violent crimes per capita, rainstorms per capita, or even Celine Dion concerts per capita—but that simple arithmetical operation doesn't tell you whether changing the number of people will change the number of crimes, storms, or concerts.

The per capita figure looks like a *rate*, an actual measurement of the number of problem events caused by each person—but it is actually a *ratio*, an abstract comparison of two numbers that may or may not be causally connected. You can't get meaningful results using a ratio as if it were a rate, but we constantly see populationists trying to do just that. Pollution divided by population equals per capita pollution—which leads to the circular claim that per capita pollution times population equals total pollution.

Recently, for example, OPT explained why it favors a "population-based climate strategy":

> The most effective national and global climate change strategy is limiting the size of the population . . . A non-existent person has no environmental footprint: the emissions "saving" is instant and total.
>
> Given an 80-year lifespan and annual per capita emissions (2006) of 9.3 tonnes of CO_2 . . . each Briton "foregone"—each addition to the population that does not take place—saves 744 tonnes of CO_2.

The briefing goes on to quantify the lifetime saving from preventing one birth at £30,000—a "nine million percent" return on a 35-pence investment in condoms.[15]

That might be a feeble attempt at humor, but OPT also published what claimed to be a serious study "proving" that birth control is the most cost-effective way to reduce carbon emissions. The study offered a forecast of the number of unwanted births that might be eliminated between now and 2050 if modern birth control were universally available—and then multiplied the number of nonpeople by the current per capita emission rates in the countries they wouldn't be born in. The result—thirty-four fewer gigatonnes of CO_2, at a cost of only $7/tonne.[16]

(OPT later added an addendum to this report, saying, "The figure of $7 per tonne of carbon abated by investment in family planning is unreliable, and should not be quoted." Despite the fact that "The true figure worldwide remains unknown," OPT reaffirmed its belief that reducing population would be the most cost-effective way of reducing emissions.)

Canadian ecosocialist Jeff White explained the logical fallacy behind such arguments on the *Climate and Capitalism* website.

> It starts with mathematical sleight-of-hand. Representing a country's total emissions as simply the sum of all the per capita emissions helps to create the false impression that total emissions are a direct function of population.
>
> The fallacy lies in the fact that the total emissions must be known before you can calculate the per capita emissions. First you take the total emissions and divide by total population to get a per capita figure; to then multiply that figure by the total population is merely to reverse the calculation back to the original number you started with—total national emissions! It's these total emissions that are the primary data; per capita figures are derived from the total, not the other way around.
>
> Per capita figures are statistical artifacts that tell us the ratio of a country's total emissions to its population. But they don't tell us about individual contributions to the country's total emissions. For example, if I tell you that Canada's annual per capita emissions are 23 tonnes of CO_2 equivalent, it doesn't tell you how much of that 23 tonnes I, as an average Canadian, am personally responsible for. It includes, for example, "my" per capita shares of the emissions caused by the mining of the tar sands in Alberta, the manufacture of cement in Quebec, and the industrialized livestock production in Ontario—none of which I have any personal control over.
>
> If half the population of Canada suddenly disappeared, my per capita share of emissions, and that of every other remaining Canadian, would increase dramatically overnight, without any change being made in my—or anyone else's—personal levels of carbon consumption. The population fetishists would realize their fondest wish (a dramatic reduction in population levels) while per capita emission levels would soar! What could demonstrate more clearly that per capita statistics tell us nothing about "overpopulation"?[17]

The circular reasoning that White exposed appears again and again in populationist works.

- Lester Brown of the Earth Policy Institute predicts that if the world's population by 2050 matches the UN's "low" projection instead of the "medium" projection, we will reduce our energy needs by the equivalent of 2,792 million tons of oil. He arrives at that improbably precise figure by multiplying the difference between the two population projections by per capita energy use.[18]
- Jeffrey Sachs, director of the Earth Institute, extends that error to the entire economy in his best-selling book *Common Wealth*: "The total magnitude of economic activity is calculated by multiplying the average income per person by the number of people."[19]
- American populationist Edward Hartman tells us: "America's *energy use per capita, i.e., per person*, was relatively unchanged between 1970 and 1990, but *total energy use in America increased 24%* . . . In other words, per capita energy conservation was overwhelmed by an increasing number of people."[20] [emphasis in original]

These authors and many others seem unaware that their conclusions are entirely embedded in their assumptions. They use per capita numbers that are derived from total amounts in order to calculate the same total amounts. In Schnaiberg's words, such calculations are "devoid of any substantive meaning."

The IPAT illusion

The most common misuse of per capita ratios in all of ecology involves IPAT, a formula that the Ehrlichs and John Holdren introduced in the 1970s. It states that environmental impact (I) is the product of three factors:

P: the size of the population
A: the affluence or income per person or consumption level, usually expressed as dollars of gross national product (GNP) per person
T: the technological intensity per unit of economic activity, usually expressed as some form of output (CO_2 emissions, for example) per dollar of GNP

So **I**mpact equals **P**opulation times **A**ffluence times **T**echnology.

Usually spelled IPAT and pronounced "eye-pat," this formula is a key element of the accepted wisdom of mainstream environmentalism in general and of its populationist wing in particular. Sooner or later, in any discussion of the relationship between population and the environment, someone will claim that the IPAT formula *proves* that "too many people" is the root cause of environmental degradation, global warming, loss of biodiversity, and a host of other problems.

IPAT says that a large number of people who live in luxury, consuming goods that were created using high-pollution technology, will cause more environmental damage than a small number of people who live in poverty and consume goods created with low-pollution technology. It is often cited as proof that to reduce the human impact on the environment, we must reduce the number of people, consume less, use cleaner technology—or some combination of the three.

But IPAT, like many other calculations based on ratios, is circular. Australian socialist Ben Courtice comments:

> It is almost mathematically meaningless, because A and T simply describe averages, per capita. Taken together, they add up to the average ecological footprint of each unit of population (each person, that is). So the total impact equals the average impact multiplied by the number of people. The mathematics of this is as profound as saying that a number equals half of itself multiplied by two.[21]

In fact, IPAT isn't a formula at all—it is what accountants call an *identity*, an expression that is always true *by definition*. Ehrlich and

Holdren didn't *prove* that impact equals population times affluence times technology—they simply *defined* it that way. Not surprisingly, their definition was based on their opinion that population growth is the ultimate cause, the universal multiplier, of other problems: "If population growth proceeds unabated, the gains of improved technology and stabilized per capita consumption will be erased and averting disaster will be impossible."[22]

IPAT is frequently cited by populationist campaigners, but it is rarely used by actual population scientists, even those who otherwise accept populationist explanations, because it doesn't produce meaningful results.

Geographers William B. Meyer and B. L. Turner point out that while "population" is a clearly defined term, "neither 'affluence' nor 'technology' is associated with a substantial body of social science theory."[23] In other words, no one actually knows how to assign values to two of the four terms in IPAT, a fatal problem for anyone who hopes to measure their effects.

Sociologists Thomas Dietz and Eugene Rosa note that while IPAT has "structured much of the debate about the effects of population, affluence and technology on the environment, and has been a widely adopted perspective in ecology . . . . it does not provide an adequate framework for disentangling the various driving forces of anthropogenic environmental change." As a result, there have been few attempts to test IPAT's assumptions. "In particular, social scientists have generally ignored the model, while biological, ecological and other physical and environmental scientists, by generally assuming the model to be true, have not been motivated to test it rigorously."[24]

Brian O'Neill, whose computer modeling study of population change is discussed below, devotes seven tightly argued pages of his book *Population and Climate Change* to an explanation of why IPAT isn't useful. Discussions based on the Ehrlich-Holdren formula, he

says, "have provided grist for the population-environment debate, [but] they have done little to help resolve it." Moreover, "taken together, all the difficulties associated with [IPAT-based] decompositions make their results of little value in assessing the importance of population policies relative to other policies to reduce GHG emissions."[25]

One of the most powerful critiques of IPAT is *Taking Population out of the Equation: Reformulating I=PAT,* by Patricia Hynes, who points out that IPAT treats the three elements P, A, and T as equal factors: increasing or decreasing any of them changes the environmental impact proportionately. That mathematical equality ignores the absence of equality in the real world.

> The P of most concern for fertility control—the "poorest of the poor"—are institutionally powerless yet collectively resilient women who have larger numbers of children for complex reasons that range from immediate survival and necessity to lack of appropriate reproductive health services to coercion by a male partner, patriarchal religion, or the state. The T of concern, the highest-polluting industrial processes that provide consumer goods for the wealthiest fifth of humanity, belong almost entirely to men in the most powerful, interlocking institutions, including multinational oil and gas corporations, governments, and industrial giants like car makers and chemical and weapons manufacturers, whose goal is maximizing economic growth and profit . . .
>
> How much imprecision and injustice is built into IPAT when an Indian tribal woman uprooted by state privatization of forests she used for subsistence, or a destitute African woman impoverished by Western "development," is considered comparable in environmental impact to a corporate or government or military person from the wealthiest one-fifth of the world? Within this model, the chasm in equity between the absolute poor and the extravagantly wealthy is invisible and irrelevant.[26]

Hynes also points out that IPAT is based on a "singular view of humans as parasites and predators on the natural environment"—it assumes that human activity always harms the natural world. There is no way, using IPAT, to account for people who devote themselves

to "restoring and replenishing their local environment as they use it, and guarding it from maldevelopment projects."[27]

Limits to Growth author Donella Meadows, who had long supported IPAT, heard Hynes articulate these and other criticisms at a conference in 1995 and agreed with them. See appendix 2 for Meadows's article discussing that meeting.

Malthus with a computer

Another approach to quantifying the impact of population growth on the environment involves computer modeling. While some such studies are much more sophisticated than IPAT, they don't do any better at *proving* the connection.

A case in point is a study announced by the Vienna-based International Institute for Applied Systems Analysis (IIASA) in October 2010. Judging by the news release, this study left no doubt: "The study showed that a slowing of that population growth could contribute to significantly reducing greenhouse gas emissions." Following the UN's lowest plausible population growth path could, all by itself, "provide 16 to 29 percent of the emission reductions thought necessary to keep global temperatures from causing serious impacts."[28]

The study, conducted by a team headed by Brian O'Neill, was published in the *Proceedings of the National Academy of Sciences* (*PNAS*).[29] Populationist groups in the United States quickly seized on it; within weeks, three had published briefs citing this study in support of their views.[30]

But there is less here than meets the eye. Further down the page, the release says:

> Scientists have long known that changes in population will have some effect on greenhouse gas emissions, but there has been debate on how large that effect might be.
>
> The researchers sought to quantify how demographic changes influence emissions over time, and in which regions of the world.

> They also went beyond changes in population size to examine the links between aging, urbanization, and emissions.

In short, O'Neill's team didn't *prove* that population growth causes greenhouse gas emissions to grow. They *assumed* that it does and then tried to determine how various demographic changes might affect the process.

That's an important distinction. No computer model can prove facts about the real world. It can only assume facts to be valid and test their implications over time, under a given set of assumptions.

For example, the computer models used by the Intergovernmental Panel on Climate Change don't prove that greenhouse gas emissions cause atmospheric temperatures to rise. That fact has been proved by decades of scientific research and confirmed by theoretical studies that show exactly how the warming process works. What the computer models show are the implications of that information under various assumptions about economic growth, technology development, and so on. As the eminent climate scientist James Hansen points out, "Models, at best, produce answers consistent with the assumptions put into them."[31]

There was an important discussion of that issue following the publication of *The Limits to Growth* in 1972. The authors of that landmark study claimed that their computer model of the global economy predicted that if then-current trends continued, "the limits to growth on this planet will be reached sometime within the next one hundred years," and that the most likely result would be "a rather sudden and uncontrollable decline in both population and industrial capacity."[32]

The Limits to Growth was a monster best seller. Millions of people read it, and its conclusions became part of the accepted wisdom of many environmentalists.

Far less attention was paid to *Thinking about the Future,* a much drier study published ten months later, in which thirteen specialists in different disciplines from the University of Sussex carefully dissected

The Limits of Modeling

"Large-scale computer programs can simulate important aspects of a process, but in the end what we are left with are more numbers. These are often useful for projections as long as nothing important changes. And they are certainly essential in design, where quantitative precision can be crucial. But there is no substitute for qualitative understanding, the demonstration of a relation between the particular and the general understanding that requires theoretical practice distinct from the solving of equations or the estimation of their solutions."

—Richard Lewontin and Richard Levins, *Biology under the Influence*

The Limits to Growth and found it wanting, to say the least. They showed in detail that the computer model was seriously flawed and that the data it used to make predictions were inadequate.

Most important, they argued that using a computer model to predict social trends gave the study a spurious appearance of objectivity, while concealing political, economic, and social biases of which even the scientists concerned might not have been aware.

In the opening essay, "Malthus with a Computer," economist Christopher Freeman wrote:

> The nature of their assumptions is not a purely technical problem. It is essential to look at the political bias and the values implicitly or explicitly present in any study of social systems. The apparent detached neutrality of a computer model is as illusory as it is persuasive. Any model of any social system necessarily involves assumptions about the workings of that system, and these assumptions are necessarily coloured by the attitudes and values of the individual or groups concerned . . .
>
> It cannot be repeated too often that the validity of any computer calculation depends entirely on the quality of the data and the assumptions (mental models) which are fed into it. Computer models cannot replace theory.[33]

Freeman exempted *The Limits to Growth* from the common accusation of "garbage in, garbage out" because the authors had obviously gone to a great deal of effort to get data, adopt reasonable assumptions, and test the model. Rather, the model's weakness was its dependence on assumptions similar to those of early populationist writer Thomas Malthus.

> Although it would be quite wrong to talk of "garbage" in the MIT model, there is a real point in the description: "Malthus in, Malthus out" . . . What is on the computer print-out depends on the assumptions which are made about real-world relationships, and these assumptions in turn are heavily influenced by those contemporary social theories and values to which the computer modelers are exposed.[34]

Today's computers are much more powerful than anything imagined by the authors of *The Limits to Growth*, but Freeman's arguments retain their full force. Indeed, given the increased complexity of the models—and thus the increased possibility of error—it is even more important today that modelers make their assumptions as explicit as possible.

One such assumption in the IIASA study was expressed clearly by Brian O'Neill in an interview with the *Los Angeles Times* on October 10, 2010: "As the economy grows faster, it raises the income for everybody, and people are spending more money and consuming more and emitting more." He said the same thing more formally in the *PNAS* paper: "In the PET model, households can affect emissions either directly through their consumption patterns or indirectly through their effects on economic growth."

The assumption that economic expansion is driven by consumer demand—more consumers equals more growth—is a fundamental part of the economic theories that underlie the model. In other words, *their conclusions are predetermined by their assumptions.*

What the model actually tries to do is to use neoclassical economic theory to predict how much economic growth will result from

various levels of population growth, and then to estimate the emissions growth that would result. Unfortunately, as Yves Smith says about financial economics, any computer model based on mainstream economic theory "rests on a seemingly rigorous foundation and elaborate math, much like astrology."[35]

In short, if your computer model assumes that population growth causes emissions growth, then it will tell you that fewer people will produce fewer emissions. Malthus in, Malthus out.