The Environmental Consequences of Having a Baby in the United States

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This paper gives crude estimates of the environmental consequences associated with the birth of one baby in the United States. We calculate the magnitude of one hundred environmental impacts which one American born today will cause over a lifetime. The impacts are grouped under five headings: waste generation, mineral consumption, energy consumption, ecosystem alteration, and food consumption. We also consider, but do not quantify, impacts on extinctions of species and indigenous cultures. Our purpose is to emphasize the role of population growth in the creation of environmental problems, and to make potential parents aware of their ability to impact the global environment. We conclude that one especially effective way for individuals to protect the national and global environment, and hence protect the wellbeing of all existing people, is to stop creating more humans.

INTRODUCTION

The United States' National Environmental Policy Act (NEPA) requires Federal agencies to include a detailed statement of likely environmental

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impacts in proposals for major actions, such as the creation of new power plants. The idea of a formal environmental impact statement has been adopted by many states to cover private projects such as shopping malls. But what induces developers to propose projects which may damage the environment? The initiating force behind any large project generally is the desire to service or to extract profit from a human population. Therefore, environmental impacts which NEPA attributes ostensibly to development projects are attributable equally to the collective demand or desire of individual consumers. Thus, we view the environmental impacts of specific facilities as the product of the number of consumers and their per capita consumption rate.

It follows that, given a nation's level of affluence and technology, the nation's population size is closely associated with its aggregate environmental impacts. For example, at the 1990 living standard, a United States of 250 million people would cause roughly double the environmental impact of a United States of 125 million people. (The United States began 1993 with a population of 257 million persons and grows at an annual rate of 1.1%.) In some sense, then, the ultimate environmental impact occurs with the birth of each new human being, for a whole suite of production and consumption activities commence with that birth, based on the anticipated demand of an average individual.

We provide here a first crude attempt to develop an environmental impact statement for the birth of one baby in the 1990s in the United States (an "American" for the purposes of this paper). We estimate the magnitude of one hundred environmental impacts which one American born today will cause over an expected lifetime. The impacts are grouped under five headings: 1) waste generation, 2) mineral consumption, 3) energy consumption, 4) food consumption, and 5) ecosystem alteration. We also consider, but do not quantify, extinctions of species and indigenous cultures.

Our purpose is to refocus attention on the role of population growth in the creation of environmental problems. We believe that the environmental impact should be one component, (added to the many other good and legitimate criteria, such as emotional and economic), in the important decision which a couple makes to create (or not to create) a child, or in the population policy which a government chooses to follow. Although we report only detrimental environmental impacts, we do not wish to imply that humans create exclusively detrimental impacts, for obviously people do many good things. Nor do we intend callousness towards humans. To the contrary, we wish to protect the quality of life for all humans present and future, for we believe that everyone's quality of life is threatened by continued population growth. In fact, although none of the authors have had a child, three of us are considering having one in the future.

Many authors agree that environmental impacts are related closely to population growth (Ehrlich & Ehrlich, 1990). Others have argued that technology offers a solution to environmental problems, and that population growth can make positive contributions to solving the world's problems, environmental and otherwise (Simon & Kahn, 1984). But for us, the fundamental issue is stated best by Ehrlich et al. (1977), who developed a formula which expresses environmental impacts as a product of population, per capita consumption, and environmental impact per unit consumed, that is:

$$I = P * (C/P) * (I/C) \tag{1}$$

where

I = total environmental impact,
P = population,
C/P = resource units consumed per capita (i.e., affluence), and
I/C = environmental impact per resource unit consumed (i.e., residual efficiency).

Other things being equal, more people will generate more pollution. Of course, all other things are not equal. Some environmental groups have argued that humans should reduce affluence, but their perspective has had little or no noticeable effect at the national level. Also, it is immoral to call for reduced consumption in those societies or sectors where per capita incomes are at or below poverty level.

Others, such as Fickett et al. (1990), predict that increases in technology will reduce substantially the rate at which humans produce pollution per unit of goods and services (Reddy & Goldemberg, 1990). While we believe that technological advances have reduced and can reduce further the rate at which humans produce pollution, we believe also that technology has not been extremely successful in reducing overall national pollution, since very substantial pollution still exists and in some cases is increasing in the United States (U.S. Census Bureau, 1991). Furthermore, in contrast to Fickett et al.'s claims, Kaufmann (1992) found very little improvement in efficiency for five leading industrial nations *when* appropriate corrections were made for 1) fuel quality (e.g., primary electricity has a much greater economic utility per calorie than fossil fuels) and 2) the nature of final use (e.g., industry generates about $15 of GNP per gallon of oil versus household use which generates only about $1 of GNP per gallon). In other words, most of the observed increase in the ratio of GNP to energy use in the industrialized nations is attributable to 1) an increase in the use of high quality energy such as nuclear and hydroelectricity, and 2) an increase in industrial use versus, e.g., automobile use. Hall and Hall (1992) examined technological improvement empirically in developing countries, and found little or no evidence for increased efficiency over the last 30 years. They argued that any improvements in efficiency appear to be countered by factors such as ongoing decreases in the quality of raw materials associated with the effects of, e.g., soil erosion and petroleum depletion. Similarly, Nilsson (1993) found *decreasing* energy efficiencies in developing countries.

Many argue that pollution will decrease in the future as a consequence of the commitment of technology to pollution cleanup. Certainly during the past 20 years some indices of pollution (such as water pollution) in the United States have declined while the population and economy have grown. But during that same 20 years new environmental problems such as the impacts of hydrocarbons on ozone and widespread deforestation have greatly intensified, and continued mining has further disturbed ecosystems, as mineral use has expanded and lower grade ores have been exploited increasingly (US Census, Hall et al, 1986). A related component, pointed out by the classical economist David Ricardo (Sraffa, 1951), is that as populations expand, humans face diminishing returns on the efficiency with which they create goods, as it becomes necessary to use ever lower quality resources, such as lower grade ores and farmland on poorer soils and steeper slopes. In the future, humans will have to increase the quantity of environmental disturbance in order to compensate for the decrease in resource quality; thus population increase almost certainly increases the per capita environmental disturbance. While there is some evidence that, for example, the United States has become more efficient in its use of energy (Hall & Hall, 1992), it is not clear at all that this is true for the rest of the world with which the United States increasingly trades. The technologically optimistic reader may choose to cut the impacts given in the tables in half (or by some other fraction) to reflect the possibility of technology's ability to reduce the impacts.

But to us, it is unclear to what degree the third term in equation (1) is improving. Efficiency improvement is greatly desired and may have great potential, but its impact to date is much less than many authors claim. In our analysis, we extrapolate present consumption levels because we are uncertain whether efficiencies will improve (or decline), and because we do not know which way present levels of per capita consumption will change.

And if efficiency were to improve, fewer people would mean an even greater improvement in environmental quality. Hence we believe that the first term, population, in equation (1) has a critical role, even when the other terms are also important.

METHODS

It is extremely difficult to create a logically and statistically sound analysis to predict the environmental impacts caused by one individual. Nevertheless, it is this sort of analytical approach that is required for people to see environmental problems in a new and personal light. With the help of a few simplifying assumptions, we analyze the available data to attempt to estimate the magnitudes of the environmental impacts. Our methods are straightforward; we use standard sources to predict total U.S. impacts and from those values we derive per capita values. Our objective is to estimate the lifelong environmental impact caused by one baby born in the United States in the 1990s.

We consider impacts to arise from both *effluents* and *consumption* (hence depletion of, for example, nonrenewable resources). We express the magnitude of each of one hundred environmental impacts in three different ways. 1) The annual aggregate impact produced by the entire United States. 2) The annual impact caused by an individual American today, which we calculate by dividing the first estimate by the appropriate year's U.S. population. 3) The cumulative impact caused by an individual American over a lifetime, which we derive by multiplying the second estimate by the expected lifetime of a U.S. citizen (presently 75 years; the impact would be larger if life span increases as expected). The results section includes brief descriptions of how impacts occur and how we derive some particular estimates. In general, our categories follow those of our sources.

RESULTS

Based on the assumptions given above and the data available for the items we considered, an American born in the 1990s would produce in a lifetime about one million kilograms of atmospheric wastes, ten million kilograms of liquid wastes, and one million kilograms of solid wastes. In addition, an American will consume 700 thousand kilograms of minerals, and 24 billion BTU's of energy, which is equivalent to 4 thousand barrels of oil. In a lifetime, an average American will eat 25 thousand kilograms of major plant foods and 28 thousand kilograms of animal products, provided in part by slaughtering two thousand animals. Tables 1-5 contain estimates for specific items.

Waste Generation

While all living things produce waste, wastes derived from human activity is a particular problem because industrial applications of modern chemistry often produce nonbiodegradable waste. Furthermore, increases in affluence and changes in lifestyles have increased the per capita amount of waste. For example, the municipal solid waste production per capita in the United States increased from 2.7 pounds per day in 1965 to 4.0 pounds per day in 1988 (U.S. Census Bureau, 1991). Table 1 shows waste production estimates classified by air, liquid, and solid. We subclassify solid wastes into two groups according to their source, i.e., municipal waste and industrial waste.

Municipal waste is post-consumer waste generated at residences, commercial buildings, and institutions (e.g., hospitals, schools, government offices). That is, municipal waste is the waste that the final consumer produces directly. Discarded paper, food remnants, dead batteries, and yard wastes such as fallen leaves and grass clippings, are all municipal solid wastes (US Congress, 1989). The public may think that municipal waste is the only waste for which we are responsible because it is the waste with which we are most familiar, but that is incorrect because industry produces wastes on our behalf.

Industrial wastes are those produced in manufacturing processes. In particular, industrial plants which produce electricity, refined minerals, and consumer goods also produce air pollution, waste water, and hazardous wastes (World Resources Institute, 1990). These industrial wastes are the by-products of consumer demands.

The following example illustrates how an individual generates municipal and industrial wastes. In 1990, Americans bought 660 million rolls of 35 millimeter film (*Syracuse Herald Journal*, 1991). Municipal wastes from photography include the wrapping paper and any discarded pictures. But these direct wastes are minuscule compared to the industrial wastes associated with photography, including the chemical waste and waste water generated. Some 75 to 95 liters of waste flow into the earth's ecosystems for every roll of film developed (*Syracuse Herald Journal*, 1991). Industrial waste often is released into the environment because of the expense of other methods of disposal. In 1989, the Kodak company alone dumped more than 9 million kilograms of toxic chemicals into the New York state environment (*The Post-Standard*, 1991). Although the quantity of waste per roll of film is decreasing, more rolls of film are used over time.

TABLE 1

United States Waste Generation (Kilograms)

Item	National 10^6/Year	Per Capita Annual	Per Capita Lifetime	Source
AIR				
CO2	4,610,800	18,902	1,417,647	1
CO	61,400	252	18,878	2
SOx	20,400	84	6,272	2
Volatile Organic Compounds	19,600	80	6,026	2
NOx	19,500	80	5,995	2
Particulates	7,000	29	2,152	2
CFC	197	0.82	61	3
Lead	8	0.03	2	2
LIQUID				
Waste Water	33,679,000	138,064	10,354,837	4
Sewage Sludge	8,400	36	2,683	5
Waste Oil	4,900	21	1,581	5
Waste Solvents	3,000	13	978	5
SOLID				
MUNICIPAL WASTE				
Paper	42,400	175	13,152	2
Yard Wastes	23,900	99	7,426	2
Metals	10,600	44	3,288	2
Food Wastes	10,600	44	3,288	2
Glass	10,000	41	3,103	2
Plastics	8,700	36	2,697	2
Wood	4,900	20	1,515	2
Rubber and Leather	3,300	14	1,034	2
Textiles	2,400	10	739	2
Other	2,100	9	665	2
WASTE FROM MANUFACTURING				
Agriculture	1,400,000	5,851	438,818	5
Mining (not coal)	1,300,000	5,591	419,319	5
Industrial	628,000	2,625	196,841	5
Hazardous Waste	265,000	1,107	83,062	3
Demolition	97,960	409	30,705	5
Energy Production	72,000	304	22,785	5
Concentrated Acid	2,738	11	858	5
Uranium Discharge	2	0.07	0.5	2

Sources:
1. Boden, Thomas A., Kanciruk, P., and Farrell, M. (1990). *TRENDS '90: A Compendium of Data on Global Change*. Oak Ridge TN: ORNL.
2. U.S. Bureau of the Census (1990). *Statistical Abstract of the United States: 1990*, 110th edition. Washington: GPO.
3. The World Resource Institute (1990). *World Resources 1990-91*. New York: Oxford University Press.
4. *Encyclopedia Americana*, 28 (1990). Danbury CT: Grolier Inc.
5. Organization for Economic Co-operation and Development (1989). *Environmental Data Compendium 1989*. Paris: OECD.

Mineral Consumption

Humans mine an increasing volume of minerals to satisfy the increasing per capita demands of an increasing number of humans. To obtain the minerals, mining companies initially exploited higher grade ores, then increasingly lower grade ores. For example, over the past 100 years the mean grade of copper ore dropped from 4% percent to 0.5% (Hall et al., 1986). When miners exploit low grade ores, they disturb a proportionately larger amount of land compared to when high grade ores are mined. Many mining methods disturb the land surface, thus mining usually decreases future land productivity. Table 2 shows the magnitude of an American's consumption of various minerals.

Energy Consumption

One way to view the relationship between economic activity and environmental impact is that each time a person spends a U.S. dollar approximately 3000-4000 kcal of energy (about 15 Joules, or the equivalent of one half liter of oil) is extracted from the earth and burned to produce the goods or services purchased by that dollar (Hall et al., 1986). Producers of goods and services use the energy in many ways. For example, industries consume fuel to change low grade energy such as coal into more useful forms of energy such as electricity. The industrial sector then uses electricity to manufacture goods. Farmers use energy directly in tractors and indirectly in fertilizers, so that nearly four liters of oil is used each day to feed an American (Hall et al., 1986).

Energy consumption causes resource depletion, hence in time humans will exhaust the useful energy resources and those particular energy impacts will be eliminated. Although there is considerable debate in scientific circles about how much energy remains, the techniques for determining the amount of remaining oil (the most important energy resource) are well developed, and estimates of ultimately recoverable reserves have changed little over time (Hubbert, 1974; Hall et al., 1986). For example, Hubbert predicted in 1955 that U.S. oil production would peak in 1970, which it did. Hubbert also predicted in 1968 that the lower 48 States would produce ultimately a maximum of 200 million barrels. By 1990, the U.S. had produced and consumed about 130 million barrels of oil, which is about two-thirds of its original oil resources. There is little evidence that the United States will ever extract more oil than Hubbert predicted. While there is a great deal of oil in the rest of the world, perhaps enough to last one hundred years at present rates of gross consumption, or perhaps one

TABLE 2

United States Mineral Consumption (Kilograms)

Item	National 10^6/Year	Per Capita Annual	Per Capita Lifetime
Stone	1,090,000	4,466	334,985
Sand & Gravel	837,000	3,431	257,362
Cement	85,000	349	26,187
Pig Iron	45,000	186	13,946
Clays	40,000	165	12,373
Salt	38,000	154	11,622
Phosphate Rock	36,000	146	10,971
Gypsum	24,000	98	7,376
Lime	14,000	59	4,434
Nitrogen (ammonia)	14,000	57	4,238
Sulfur	11,000	46	3,481
Soda Ash	6,000	25	1,911
Aluminum	5,000	22	1,681
Potash	5,000	21	1,564
Bauxite	4,000	15	1,096
Copper	2,000	9	675
Lead	1,000	5	370
Zinc	1,000	4	311
Feldspar	649	3	199
Fluorspar	644	3	198
Manganese	628	3	193
Magnesium	608	2	187
Silicon	508	2	156
Nickel	172	0.70	53
Mica	117	0.48	36
Tin	58	0.24	18
Titanium	18	0.07	6
Cobalt	8	0.03	2
Tungsten	6	0.02	2

Source: U.S. Department of Interior, U.S. Bureau of Mines (1990), *Mineral Commodity Summaries 1990*. Washington: GPO.
Note: Rounding is the source of apparent inconsistencies in table.

third of that if consumption rates continue to grow, the energy and monetary cost to locate, to extract, and to refine new energy sources has increased greatly as humans have depleted the most accessible resources (Hall & Cleveland, 1981; Cleveland, 1992). While the world will not run out of oil within the next few decades, in less than a generation most oil outside of the Persian Gulf region and perhaps Russia will be gone. Obviously, humans should not take it for granted that the people who live in oil-rich regions will allow others access to the bulk of that oil, especially as the oil producers' needs increase. One issue related to environmental impacts is, when the inevitable depletion of global oil occurs, will humans use less energy or instead turn to fuels with greater environmental impact, such as coal? Table 3 (a and b) contains U.S. energy consumption predictions assuming a constant future per capita consumption rate.

Food Consumption

Table 4 estimates the food consumption of an American. The environmental impact of an American's food consumption is a function of the

TABLE 3(a)

United States Energy Consumption (British Thermal Units)

Item	National 10^{12}/Year	Per Capita 10^6/Year	Per Capita 10^6/Lifetime
Petroleum	32,900	130	10,100
Coal	18,000	74	5,500
Natural Gas	17,700	73	5,400
Nuclear	4,900	20	1,500
Hydroelectric	3,100	13	900
Geothermal and Other	300	1	90
Total	76,800	315	23,610

Source: U.S. Burearu of Census (1990). *Statistical Abstract of the United States: 1990*, 110th edition. Washington: GPO.
Note: Items do not sum due to independent rounding.

TABLE 3(b)

United States Energy Consumption (Familiar Units)

Item	National 10^6/Year	Per Capita Annual	Per Capita Lifetime
Petroleum (Barrels)	6,083	25	1,870
Coal (metric tons)	759	3	233
Nat. Gas (cubic meters)	472,000	2	145
Nuclear (grams of fuel)	1,615	7	497

Source: U.S. Bureau of Census (1990). Statistical Abstract of the United States: 1990, 110th edition. Washington: GPO.

TABLE 4

United States Food Consumption

Item	National 10^6/Year	Per Capita Annual	Per Capita Lifetime
	(Killograms)		
PLANT			
Vegetables	18,900	77	5,797
Sweeteners	16,800	69	5,151
Wheat Flour	14,200	58	4,355
Fresh Fruit	10,900	45	3,354
Potatoes	8,400	34	2,586
Citrus Juice	5,100	21	1,582
Milled Rice	1,500	6	456
Coffee	1,100	5	347
Canned Fruit	960	4	296
Beans	870	4	269
Peanuts	700	3	214
Cocoa	540	2	169
Dried Fruit	340	1	105
ANIMAL			
Milk	66,200	271	20,351
Beef	8,100	33	2,497
Chicken	6,900	28	2,133
Pork	6,600	27	2,014
Fish	1,700	7	524
Turkey	1,700	7	514
Offals	950	4	293
Veal	170	0.7	51
Lamb and Mutton	140	0.6	44
	(Head)		
Chicken	5,381	22	1,654
Turkey	240	1	74
Pork	81	0.33	25
Beef	36	0.15	11
Lamb and Mutton	5	0.02	2
Veal	3	0.01	1
Eggs (#)	60,740	249	18,675

Source: U.S. Bureau of Census (1990). *Statistical Abstract of the United States: 1990*, 110th edition. Washington: GPO.

American diet and food production methods. In the United States, food production is as industrialized as most other aspects of U.S. society. For example, to produce one kilocalorie of food requires, on average, about 10 kilocalories of oil (Hall et al., 1986).

The high rate of meat consumption in the United States is particularly significant. The natural resource degradation entailed is related in part to the large amount of energy required to produce meat. For beef cattle fattened in feedlots, production starts with planting, irrigating, fertilizing, harvesting, transporting, storing, and processing feed. Farmers fatten cattle on large feedlots where the concentration of feed and cattle produces enormous amounts of waste. Feedlots also deplete and pollute water supplies. The consumption of beef reflects U.S. energy use, as it takes about five to ten times more energy to produce meat as an equivalent food-energy amount of grain (Pimentel & Pimentel, 1979; Steinhart & Steinhart, 1974).

Furthermore, some of the beef consumed in the United States is produced on fragile tropical soils which have been cleared of native vegetation, and sometimes of the native peoples (Meyers, 1981). Many of the tropical areas on which cattle graze are not well suited ecologically for cattle ranching. Joseph Tosi at the Tropical Sciences Center at San Jose, Costa Rica, estimates that in some areas of Costa Rica, 100 kilograms of top soil wash down the rivers for every kilogram of beef produced. Although Central America supplies only 1% of the U.S. beef consumption, the United States consumes 90% of the beef produced on recently cleared forest land in Central America (Burger, 1987).

Ecosystem Alteration

Table 5 shows the magnitude of some pathways by which the U.S. ecosystem is altered. Humans are now changing the face of the earth more rapidly than ever before and currently utilize about 40% of potential terrestrial net primary productivity on this planet (Vitousek et al., 1986). Humans have the tools to cut down in a few hours a forest that took hundreds of years to grow, and to change highly diverse meadows to a single-species crop.

All types of ecosystems are affected by humans, but the largest change comes in conversion of forests and natural grasslands to cropland and pastures. Intact natural prairies in the United States are less then 1% of their original area (World Resources Institute, 1990). There remain about half of the original forest area, although forests such as the U.S. Eastern forests are in some ways recovering. Nevertheless, the recovered forests are different and often less diverse than "virgin" forests. Moreover, about one and one half hectares of land is kept in a state of deforestation for each U.S. citizen (Terborgh, 1989).

TABLE 5

United States Ecosystem Alteration

Item	National 10^3/Year	Per Capita Annual	Per Capita Lifetime	Source
	(Hectares)			
Forest Loss	2,558	0.011	0.84	1
Cropland Expansion	169	0.001	0.06	1
Wetland Loss	162	0.001	0.05	2
Area Treated				
Fertilizer	85,419	0.4	26[‡]	3
Herbicide	69,319	0.3	21	3
Insecticide	27,852	0.1	9	3
Irrigation	18,992	0.1	6	1
	(Kilograms)			
Fertilizer	17,662,000	72	5,430	1
Pesticide	373,000	2	119	1
	(Cubic Meters)			
Water Withdrawal	517,321,000	2,126	162,150	1
Timber Consumption				
Industrial	467,563	1.9	144	3
Fuelwood	85,951	0.4	26	3

Sources:
1. The World Resources Institute (1990). *World Resources 1990-91*. New York: Oxford University Press.
2. Feierabend, J.S., and Zelazny, J.M. (1987). *Status Report of Our Nation's Wetlands*. Washington: The National Wildlife Federation; *The Christian Science Monitor* (21 November 1991), p. 1.
3. U.S. Bureau of the Census (1990). *Statistical Abstract of the United States: 1990*, 110th edition. Washington: GPO.
[‡]May be same area from one year to next.

Americans also alter wetlands, presently at a rate of between 300,000 and 500,000 acres a year (Feierabend & Zelazny, 1991; *Christian Science Monitor*, 1991). Wetlands are turned into housing developments, shopping malls, and especially, agricultural land. As the amount of land in each ecosystem decreases, it affects the species that reside there. An amount of fertilizer equal to an average American's weight is used per person per year.

SPECIES EXTINCTION

Clearly, aggregate human impact is influencing the number of species remaining on Earth. According to various sources, the earth is losing from

10,000 to 100,000 species per year, a rate hundreds of times higher than the natural rate (Lugo, 1988). Americans affect the species extinction rate in many different ways. When Americans alter ecosystems directly (or indirectly through their purchases), nearly all the species in that ecosystem are affected, some for better, most for worse. For example, when an American purchases a wooden house, at least some of the lumber is probably from Pacific Coastal forests, home to the endangered spotted owl (and many other species!). When a section of that forest is clearcut, the canopy is opened, and new and different predators move in. One such predator is the great horned owl which preys upon the endangered spotted owl. Other species may be affected in more complex ways.

Humans also advance species extinction through urbanization and habitat fragmentation. As the countryside is divided into smaller plots, many types of songbirds suffer because the songbirds need unbroken habitats in which to breed (World Resources Institute, 1990). Such unbroken habitats are becoming much scarcer in the eastern United States. Deforestation from timber production and pasture development in the tropical countries where they overwinter further impact these birds (World Resources Institute, 1990). Many songbird populations are disappearing slowly as the habitat needed for breeding decreases (Terborgh, 1989).

The United States is home to perhaps 500,000 species. Some 6,000 of these species (including subspecies) are considered rare or endangered, or have been proposed for that listing. In one opinion, three quarters of these 6,000 species are likely to go extinct in the next 75 years (Brussard, personal communication). Principal reasons are thought to be the growing human population in the United States and Americans' increasingly affluent lifestyle (Brussard, personal communication). On the other hand, some species, such as deer and geese, do better near humans.

Extinction of Indigenous Cultures

Consumers in industrialized countries impact indigenous cultures in other nations. Most obviously, the exploitation and settlement of North America by Europeans decimated the native population from perhaps 10 million individuals to less than 1 million (Zinn, 1980). While today's impact on native North Americans is less directly lethal, indirect impacts continue.

While it is an impossible task to quantify the impact of resource consumption in the United States on indigenous cultures, one may illustrate how U.S. economic activity impacts them. We calculated the amount of Brazilian iron ore which Americans consume, and focused on the impacts of its source, The Grand Carajás iron mines in the Amazon. The Grand

Carajás mines enable Brazil to maintain its position as the leading exporter of iron ore. Charcoal obtained from nearby forests fuels the mines, hence the forests around the mine will last no more than twenty years (Treece, 1989). Brazil is planning to build new dams to supply additional power for the mines and other export-driven industries. One of the dams will create the world's largest artificial lake, which will affect both the land inundated and the land downstream that will be disturbed by the dam's irregular timing of water discharges. The whole Greater Carajás Development Project will disturb directly in excess of one million square kilometers (Forrest, 1991), more than the area of France and the United Kingdom combined. This area is more than one fifth of Brazil's Legal Amazon (World Resources Institute, 1990).

The estimate for the number of tribal or indigenous people on Earth is about 250 million (Burger, 1990). One fifth of the global total are thought to live in rainforests. About 120 tribes, or distinct cultures, inhabit the lowland Amazon (Burger, 1987), and forty tribes (totalling 13,000 people) inhabit the area of the Grand Carajás mines (Treece, 1987). Thus, the Carajás mines will displace at least thirteen thousand indigenous people.

The United States in 1989 imported from Brazil 5.1 million long tons of iron ore, which is more than one quarter of U.S. iron ore imports for that year (U.S. Census Bureau, 1991). The U.S. imports about 3% of Brazil's mining output (Economist Intelligence Unit, 1989) and is thus implicated in about 3% of the environmental impacts caused by the Carajás iron ore mines including extinction of indigenous Amazonian cultures. This percentage is a lower bound because we have not considered the amount of the mines' output which other countries use to create products for the U.S. market, nor the amount Americans consume of other Brazilian resources.

If United States consumption of iron is responsible for at least 3% of the 13,000 indigenous people displaced (that is, 390 people, or about 20 people per year), then in each year, for every 12 million Americans, one indigenous person will lose her or his home in the Amazon. However, the American annual per capita impact on indigenous cultures will not continue over a 75-year American lifetime because if cultural extinction continues, the indigenous cultures will soon be lost completely.

And recently, a very large displacement of Cree Indians in Quebec, Canada, has occurred in large part to supply electricity to the Eastern United States. This U.S. demand for foreign electricity exists in part because of cancellations of proposed power plants on the Hudson River. These cancellations were made in part to protect the fish of the river, ironically, a concern originally analyzed in an ecological assessment carried out by the first author of this paper! (Hall & Day, 1977). Thus it might be said that this one American (the first author) has caused a severe impact on the Cree.

DISCUSSION

Tables 1-5 give estimates of the environmental impacts in terms of an "average" resident of the United States. Our choice of this reporting unit has been guided in part by the data available, which are aggregated to the national level. We do not suggest that any particular American causes the exact amounts of each of the estimated impacts. For example, it seems reasonable to attribute much less environmental degradation to a hungry, homeless person or to a person following a simple environmentally-conscious lifestyle, than to an extremely wealthy or prodigal consumer. On the other hand, a wealthy American who dedicates his or herself to conservation and population stabilization may compensate for some of the impacts.

Nevertheless, aggregation to the national level makes sense because 1) most Americans follow middle class lifestyles and 2) components of the U.S. economy are interconnected, hence an individual's environmental impacts are, to a some extent, independent of personal lifestyle. For example, public expenditure is more than one third of U.S. GNP (U.S. Census Bureau, 1991), and public sector activities, such as road construction, law enforcement, public education, public administration, and military actions, exist on one's behalf regardless of individual lifestyle.

Even you, the reader, are creating resource demands as you "consume" this article. Begin with the text of this paper, which is a product of academic research. In order for researchers to work, one needs universities. The universities require resources to build and much energy to run. In addition, our university needs insurance to protect its buildings and equipment. In order for the insurance system to work, insurance company employees fly to meetings in airplanes. To feed the insurance company employees, the airlines serve (among other things) roast beef. To produce the beef, cattle eat corn. To grow the corn, farmers spray fields with fertilizers and pesticides. So, in a sense, you (and we) are in part accountable for the fish which die in the water which is poisoned from the pesticides which were sprayed to protect the crops, to feed the cattle, to feed the insurance company employees, to insure the university, to support the researchers, to write this article. We have not even mentioned the computers, paper, or postal system, etc., used directly by us to produce this paper and by you to read this paper! As you can see, it is nearly impossible to specify the resource demands of a specific individual's lifestyle or purchases, because the processes of the economy are so interwoven. Thus we have found it most appropriate to use broad national averages.

We have just argued that it makes sense to use a typical American as our reporting unit because the U.S. economy is intricately interconnected. But the global economy is also interconnected, so why should not we report our results in terms of global per capita impact without regard to nationality? One reason is that the United States is substantially different from other countries when it comes to population growth and per capita consumption rate. The U.S. impact is very high and relatively stable. This is not the case everywhere.

Within a decade, the world will have another billion people (U.S. Census Bureau, 1991). More than half of the next billion people will live in South and East Asia, 42% and 19% respectively. Approximately one quarter will be Africans, and 10% will be Latin Americans. The United States, Canada, Russia, and all of Europe will account for only about 5% of the world's next billion people. Nevertheless, even though population growth in the United States is relatively low,* any U.S. population increase will cause much environmental damage because the U.S. per capita consumption rate is 10 to 100 times that of most of the rest of the world's countries.

Consider China, India, and the United States. During the next decade, India and China will each add to the planet about 10 times as many people as the United States. Nevertheless, if per capita consumption levels stay constant, environmental degradation and natural resource depletion caused by the U.S. population increase may exceed the environmental stresses caused by the increase in the populations of India and China combined. Compared to Indians, Americans (on a per capita basis) produce 27 times as much carbon dioxide (Boden et al. 1990), spend 101 times as much on the military, and consume 127 times as many telephones, 116 times as many televisions, and 35 times as much energy (U.S. Census Bureau, 1991). Compared to the Chinese, Americans (per capita) produce 10 times as much carbon dioxide (Boden et al., 1990), and consume 600 times as many cars and 13 times as much energy (U.S. Census Bureau, 1991). Furthermore, the American per capita consumption of resource-expensive meat is nearly the same in mass as the Chinese per capita consumption of rice (U.S. Census Bureau, 1979-1988). Although the impacts on ecosystems (i.e., erosion and deforestation) are very large in China and India because of the large number of people, the per capita impact of a

Editor's note: Population growth in the United States is 1.1% per year, faster than that of any other industrialized country. Immigration and the children born to immigrants subsequent to their arrival in the United States account for about half of U.S. population growth.

new person is greater in the United States. Thus, although we think that population control is critical in the developing world (because the developing world needs to balance its resource demand with its resource availability), population control in the United States is as important in determining the health of the planet.

Many factors influence one's attitudes and actions concerning the environment. Curiously, almost all of contemporary U.S. culture is oriented toward increasing consumption of nearly all resources. Some religious sects promote unrestrained procreation. The U.S. media uses advertisements incessantly to encourage resource-consuming lifestyles and the identification of personal worth with consumption. The universities teach consumption insatiability as a basic axiom of introductory economics, which rarely examines the consequences of personal consumption on the environment. Although the present formal educational system is partly responsible for environmentally destructive American attitudes, we believe that education offers a channel for attitude change. We believe that education should be transformed from principally a discipline-oriented endeavor, that teaches economics separate from ecology and both separate from energy, into a multidisciplinary endeavor (Hall, 1990). If Americans learn the effects of consumptive lifestyles, then Americans may alter their behavior to reduce their impacts on the environment. We hope this article is another step on the road to a new environmental consciousness, one that links environmental activities to economic activities and reproductive choice.

CONCLUSION

From the perspective of the mother, father, family members, and friends, the arrival of a new baby is usually considered a wonderful event, as indeed it is; but from the perspectives of the world's natural ecosystems, another human being means additional strains on already severely strained resources. In the past, one additional human caused a relatively small impact on a large pool of the world's resources, but today each additional person has a much larger impact on a smaller pool of the world's remaining resources. We have predicted the magnitude of one hundred environmental impacts an American baby will cause during her or his estimated 75 year lifetime. The total is an astonishingly large and complex set of impacts. This paper shows that the United States' growing population, combined with its high per capita consumption level, limits the wellbeing of this and future generations everywhere, and impacts strongly other species and cultures.

Many Americans are looking for ways in which they can protect the environment for the sake of this and future generations. The success of such aspirations will be influenced by American economic processes, government regulations, cultural attitudes, educational orientations, and technological advances and limitations, which are outside the influence of most individuals. But the decision to create a child is within the influence of an individual. We would like all potential parents to be aware that, more than any other decision they may ever make, their decision on whether or not to create a child will have the largest impact on our global environment. We conclude that the most effective way an individual can protect the global environment, and hence protect the well being of all living people, is to abstain from creating another human.

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