

Climate Change

Population, Economics & Energy

Human Factors & Climate Change

Anthropogenic emissions of GHGs are affected by a myriad of different, yet interrelated, variables. These variables can be broadly summarized into three categories:

- Population
- Economics
- Energy

Human Factors & Climate Change

- Pollution, including emission of GHGs, arises because production of goods and services (and often their consumption as well) gives rise to residuals.
- Population growth, economic development, and energy choices impact GHG emissions through their impact on the consumption demands.

Human Impact on Climate

Total environmental impact can be expressed as the product of population and per capita environmental impact.

- $\text{Impact} = \text{population} \times \text{impact per capita}$

“Impact per capita” is considered to be a function of economic output (“affluence”) and impact per unit of output produced (“technology,” or energy choice).

- $I = P \times A \times T$

I = PAT

- The I = PAT identity was developed in the early 1970s by Paul Ehrlich and John Holdren
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- I = PAT is useful as an organizing tool in environmental impact analysis; it divides the driving forces into a manageable number of broad categories.
- The I = PAT identity indicates that any environmental policy must address population, affluence, and technology.

I = PAT (continued)

- The I = PAT identity also illustrates an important consequence of the multiplicative relationship between driving forces: each variable amplifies changes in any other.
- I = PAT has been criticized for its oversimplicity. However, it remains useful as a general framework for understanding environmental impacts.

Population

- Demographic change is a significant driving force in future GHG emissions.
- Most demographers believe population projections are most accurately performed with the Cohort-Component Model, which projects the population by age group.
- Cohorts are groups of men and women that are born during the same time interval and represent a specific age group at any later point in time.
- Cohort size can only change through mortality, and, if also defined by region, through migration.

Population Variables

The Cohort- Component Model predicts future population trends from three variables:

- Fertility
- Mortality (or Life Expectancy)
- Migration

A simple model of population change would look like this:

$$\text{Population} = \text{Fertility} - (\text{Mortality} + \text{Net Migration})$$

However, these factors are strongly interrelated and, therefore, population models must consider how a change in one variable might affect another.

Fertility

- Fertility has the greatest impact on population growth because of its multiplier effect. Also, in aging populations, the effect of very low fertility — aging from the bottom — tends to be greater than the effect of increasing life expectancy — aging from the top.

There are four proximate determinants of fertility:

- Age at first marriage (or beginning of sexual activity);
- Prevalence and effectiveness of contraception;
- Prevalence of induced abortion;
- Duration of postpartum infecundibility.

Contraception

The adoption of contraception has been the principal source of fertility decline in less-developed countries. However, how couples adopt contraceptive practices is a function of many influences. Coale (1973) lists three preconditions required for fertility decline:

- Fertility must be regarded as being within the realm of conscious choice;
- There must be objective advantages to lower fertility;
- Acceptable means of fertility reduction must be at hand.

Fertility Decline

These three preconditions for a lasting fertility decline suggest three parallel strategies:

- Education — to bring fertility into the realm of conscious choice. Mass media may be influential.
- Pursue changes in socioeconomic variables. Changes in the “value” of children have an impact on the couples’ desired family size.
- Invest in reproductive health. Help couples match their desired and actual number of children by focusing on family planning.

Fertility & Economics

- Poverty is usually, although not always, positively correlated with household size.
- The neoclassical economic model of fertility explains child bearing behavior as the outcome of a utility maximization decision made by parents. The economic benefits from children are mainly of two types:
 - Current income flows.
 - Future old age security.

Fertility & Life Expectancy

- High fertility and large family size are inversely correlated with children's living conditions and education and, as a result, may give rise to low levels of human capital.
- Rapid population growth is associated with short birth intervals, and many studies have concluded that closely spaced children are subject to lower life expectancy.
- Inadequate birth spacing also adversely affects maternal health.

High Fertility & Girls

High fertility has three effects that fall disproportionately on girls:

- *An opportunity effect;*
- *An equity effect;*
- *An inter-generational effect.*

Women's Status

- It is consistently observed in surveys that women's desired number of children is lower than their husbands.
- Higher social status of women within the family and in society can be expected to empower women in pursuing their own, lower desired family size, rather than that of their husbands.

Fertility & Education

The strongest social correlate of fertility is female education because it strongly affects the other factors:

- Status and empowerment of women;
- Economic costs and benefits of fertility;
- Acceptance of the services offered by national family planning programs.

Education

One part of the impact of education is an accounting effect:

- If girls are attending secondary school, age at first marriage, one of the principal proximate determinants of fertility, is higher.

More important, however, is the effect of education on fertility decisions:

- Married women who were schooled as girls are more likely to use contraception.

Education (continued)

- Part of the effect of a girl's education is economic. It increases the cost of children by making girls unavailable for domestic chores.
- Parents' decision to endow girls with even a modicum of education, as opposed to none at all, reflects a fundamental shift in the status of women.

Life Expectancy

- More so than for fertility, changes in life expectancy (or mortality) are directly related to biomedical aspects of development.
- Life expectancy is positively correlated to economic development.
- The United Nations has estimated maximum global life expectancy to be 87.5 years for women and 82.5 years for men. If this upper limit does in fact exist, any improvement in life expectancy will slow as it approaches this number and then no improvement will be seen.

Life Expectancy (continued)

- Future mortality conditions in LDCs will be determined by the effectiveness of local health services, the spread of diseases, and the general standards of living and education.
- How AIDS will affect population numbers is uncertain. Many factors that might reduce the spread of infection, such as social responses (eg. condom use) or biomedical responses (eg. vaccination) are unknown. If high prevalence rates become widespread, AIDS could have a significant impact on population dynamics.

Migration

- On a global scale, migration alone has no effect on world population as it is merely a redistribution of people, rather than an increase or decrease in numbers. However, migration affects other population variables.
- The direction of international migration is generally from LDCs to MDCs, with a corresponding reduction in fertility rates and an increase in life expectancy. Therefore, all other variables remaining constant, high migration will result in a lower world population than with low migration and vice versa.
- Predicting future migratory streams is more difficult than fertility and mortality rates because migration is greatly affected by short-term political and economic changes in both the sending and receiving countries.

Economic Development

- The overall well-being of a nation's economy is usually referred to in terms of Gross Domestic Product.
- $\text{GDP} = \text{Consumer Spending} + \text{Business and Residential Investment} + \text{Government Spending} - \text{Trade Deficit}$.
- The UN defines development as the furthering of human choices. Regardless of the level of development, the three essential choices are to have access to the resources needed for a decent standard of living, to lead a long and healthy life, and to acquire knowledge.

Historic Economic Development

- Historically, economic growth has been concentrated in Europe, the Americas, and Australasia. Latecomers (such as Japan) rapidly caught up in the post-World War II period.
- In the past two centuries MDCs have seen a shift in economic structure from agricultural production to industry. In the past half-century, the industry share declined and MDC economies are now dominated by service sectors.
- In LDCs, a decline in the contribution of agriculture to GDP has occurred in recent years, but the contribution of services is larger than it was historically in industrial countries at the same level of income. This indicates the dangers of using past history too literally as a guide to future behavior.

Economics: Conclusion

- Economic development and growth are prerequisites to achieve an increase in living standards. Assumptions about economic development, therefore, are an important determinant of GHG emissions levels.
- There is also a weak, slightly negative, relationship between population and economic growth. Scenarios that lead to high economic growth are generally associated with central to low population projections.
- High economic growth tends to result in higher life expectancies and lower fertility. High human capital (education), a favorable institutional environment, free trade, and access to technology are acknowledged as key factors for rapid economic growth.

Energy

- High energy dependence and consumption tends to lead to high GHG emissions. In addition, all other factors being equal, faster economic growth results in a decline in primary energy use.
- Different regions can follow different development paths.
- Factors that affect energy dependence include changes in consumer preferences, energy and technology costs, settlement and infrastructure patterns, and technology.
- While energy dependence is an important indicator of GHG emissions, the type of energy used is even more significant. A fossil fuel intensive society will result in high GHG emission levels.

Conclusion:

Relationships Between Variables

- Populations in rich countries grow more slowly than populations in poor countries. Mortality rates are lower but the gap between fertility rates is even wider.
- Economic structure and technology are, in large degree, responses to population pressure.
- The more efficiently materials can be transformed into an economic product, and the less noxious the residuals generated during the process, the higher the level of income.
- Environmental impact per unit GDP tends to decline in the long-run. This path reflects not only changes in economic structure, but also the fact that rising income stimulates demand for environmental quality.