

## **Health and Wealth**

### **How Geography Influences Socioeconomic Development**

*By John Gallup and Jeffrey Sachs*

The difficulties of operating in a tropical environment were already abundantly clear during the building of the Panama Canal more than a hundred years ago. "The effect of the climate on tools, clothing, everyday personal items, was devastating," described historian David McCullough. "Anything made of iron or steel turned bright orange with rust. Books, shoes, belts, knapsacks, instrument cases, machete scabbards, grew mold overnight. Glued furniture fell apart. Clothes seldom ever dried."

The decisive challenge, though, was malaria and yellow fever. Although the French made major investments in medical care, in the 1880s they did not understand the means of transmission of these two major mosquito-borne diseases. Besides the fearsome mortality of workers and the recurrent debilitation of those who survived, many of the most dynamic project leaders and engineers perished from tropical disease. On top of unrealistic technical

goals and organizational difficulties, the loss from disease was more than the project could sustain. At least twenty thousand lives were lost to disease during the nine years of the French effort.

Geography has always had strong and pervasive effects on economic and social development in Latin America, as elsewhere. The tropical Caribbean and the temperate Southern Cone differ greatly by almost any measure of development. Within Brazil, there is a gulf between the dry, poor Northeast, the rich, temperate Southeast, and the still sparsely populated wet tropical Amazon region. In all of the neighboring countries with an Amazonian frontier, the jungle regions are a world apart. In Nicaragua, the malarial east coast is isolated from the more productive west coast. For Bolivia, being landlocked is a fundamental aspect of economic life, and the highlands, the valley region, and the tropical lowlands

have each developed separate urban centers with limited connections between them. Similar patterns hold for the distinct geographical zones of Colombia, Ecuador, and Peru.

Although more middle income countries exist in the tropics of Latin America than the rest of the tropics around the world, the geographical gradients within Latin America are nevertheless clear and dramatic. The 1995 purchasing-power parity GDP per capita levels in the region follow roughly a U-shape in latitude, with much higher levels in the temperate south, and a minimum level just below the equator in the 20° South to 0° latitude band. The geographical tropics is defined as the region from 23.45° South to 23.45° North where the sun is directly overhead at some point during the year. The tropics have much lower income levels than temperate South America or temperate Mexico. The average GDP per capita of \$4580 U.S. dollars in the 20° South to 0° latitude band is just under half the level at the temperate high points. The variation in income by latitude within Latin America is more striking given that the countries in the region share many common aspects of colonial and cultural history.

Physical geography mainly impacts economic and social development through three pathways: accessibility, agricultural productivity, and disease.

Two simple facts suggest the magnitude of the economic impacts of geography. Tropical countries have an average income per capita of just one-third that of non-tropical countries. Likewise, landlocked countries have an average income per capita of only one-third the income of countries with access to the sea.

The economic disadvantage of the tropics can be largely attributed to lower agricultural productivity and a higher burden of disease. Natural disasters, especially hurricanes, probably also play a role, but one that is difficult to quantify for lack of good data.

Agricultural yields depend sensitively on climate and soil resources. Climate and soil conditions are characteristically different in temperate and tropical ecological zones. Furthermore the tremendous differences in the natural plant and animal communities of the tropics and the temperate zones suggest that the productivity of the narrow range of plants used for agricultural staples

would also be systematically different between the two regions. Although it is possible, in principle, for food staples to be adapted to be equally productive in temperate and tropical zones, in practice this has not happened. Even after accounting for differences in input use in agriculture, tropical yields of the main agricultural crops are starkly lower than temperate yields.

Here we choose to focus on disease as one of the primary side-effects of geography. The range and intensity of many diseases, particularly vector-borne ones, vary according to climate. Malaria, hookworm, and schistosomiasis, have been relatively easy to control in temperate zones, but still defy major control efforts in the tropics.

The relationship between geography and development in the region extends beyond purely economic indicators. Latin American infant mortality rates peak in the tropics and decline more or less continually to either side of the peak.. The highest rates in the 10° to 20° South are more than double the rate in the southern temperate zone, and 50% higher than the rates in the northern temperate zone. The tropics are a more challenging disease environment, regardless of income levels.

When Europeans brought Africans to the New World as slaves, they also imported a panoply of African diseases new to the Americas. Malaria, yellow fever, hookworm, schistosomiasis, and other diseases further devastated the indigenous population and have had a persisting impact on the burden of disease since then. Most of these diseases remain major public health and economic problems in the American tropics to the present day.

The tropics have had much poorer economic performance than the rest of the world because of the impacts of climate on agricultural productivity and disease. The tropics are, essentially, a band of poverty. Among tropical health problems, malaria in particular is strongly correlated with poor economic performance. The relationship of malaria to poor economic performance is distinguishable from the tropics, per se, because the intensity of malaria varies considerably within the tropics. Malaria is one of the least likely health problems in the tropics to be ameliorated by economic growth through better living conditions and household behavior.

Yellow fever is no longer a major public health problem due to a successful worldwide control effort by the 1930s and the development of an effective vaccine. The situation for malaria is completely different. The worldwide eradication effort begun in the 1920s and intensified in the 1950s and 1960s largely failed in the tropics. Vaccines are still many years from development, due to little funding and the extraordinary complexity of the pathogen and its life cycle. Currently, all the inexpensive drugs for treatment of and protection from malaria are losing their effectiveness in the face of resistance strains. Latin America has made great strides since 1965 in terms of pursuing policies conducive to international trade and making government institutions more efficient and responsive to citizens, which our analysis suggests is crucial. Geography appears also to play an important role in Latin America's performance compared to the wealthiest countries. Improving health, including malaria, and overcoming other tropical and accessibility problems could help Latin America to catch up economically with the more developed countries in the world.

Life is short in the tropics. Inhabitants of the temperate northern and southern ends of Latin America can expect to

live about 75 years, but the trend line sags markedly in the tropical middle, dropping down to 65 years just south of the equator. The very low average lifespans, below 60 years, are all in the tropics, seeming to drip from the sagging trend line. The below-60 life expectancies are in provinces of Bolivia and Peru, and in Haiti. The two provinces close to the equator with life expectancies above 75 years are also in Peru: the capital Lima and its sister *departamento* of Callao, a clear sign of the regional disparities within the country.

Poor health and poverty are closely linked. Bolivia and Haiti, with the low life expectancies, are poor countries. Peru is not as poor, on average. We have already seen that income per capita is lower in the tropics than the temperate zones of Latin America. Perhaps poor health in the tropics is simply due to poverty, not direct geographical influences. If we are concerned with life expectancy as a measure of human welfare, it doesn't matter much whether climate affects it directly, or indirectly through economic development: welfare is lower in the tropics. If we want to change health conditions, though, it matters a great deal whether it is necessary to curtail the transmission of disease directly, or it is perhaps more

effective to invest resources in economic growth which will solve the health problems indirectly.

To assess the direct influence of climate on disease, we control for the influence of income levels. Provincial life expectancy in Latin America is still strongly correlated with climate after taking into account income levels. Provincial GDP per capita levels are independently correlated with life expectancy, but their inclusion does not change substantially the association of climate with health.

One of the most robust correlates of health status is the education of mothers. When the influence of female literacy on health is included along with income levels, it is large and significant, and income loses its independent association with life expectancy.<sup>1</sup> Climate, however, is still strongly correlated with health outcomes.

Controlling for female literacy and GDP per capita, life expectancy is four years lower in the wet tropics as in the moist temperate zone. The regression results predict that life expectancy is seven years lower in the wet tropics than in desert and dry regions with the same income and

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<sup>1</sup>

female literacy. Similar results pertain to infant mortality, which is a component of life expectancy. Infant mortality is four percent higher in the wet tropics than in humid temperate regions, and six percent higher than dry regions, other factors being equal.

Our analysis suggests that rising income levels *per se* will not take care of health in the tropics; direct action is required. For some tropical diseases there are few affordable and effective treatment and control strategies; for others the means of conquering the disease are well known, but major efforts of education and mobilization required. The prime example of the former is malaria. Vector control in the worst affected areas is at best a holding action, and the effective drugs are rapidly losing their effectiveness due to drug resistance. Tropical diseases do not get the benefits of spillovers from biomedical and pharmaceutical research in the developed countries, because there are no significant tropical developed countries. The tropical countries are too poor to offer an attractive stand-alone market to induce pharmaceutical firms to invest in drug development for tropical diseases.



## **Policy and Conclusions**

Geography may be largely immutable, but its impact on the economy and society are not. The right policies or technological developments can overcome many geographical obstacles. Tackling geographical problems has important “public good” aspects. Investments to overcome these obstacles, such as disease control or roads, typically benefit whole regions rather than particular individuals. To make these investments at the socially desirable level, they need coordination by the government or other organizations. The individual will not capture the benefits that he or she provides to the wider society, and so is likely to invest less than is desirable. Individuals would not likely take upon themselves the task of controlling a dispersed disease vector, for example, but everyone benefits when each person contributes a small amount to the eradication of the disease. Sharing the burden requires coordination.

The evaluation of the social return on infrastructure investment in geographically-challenged regions is complex. There are many white elephants among the projects pursued in the name of regional equity, with many examples during

the decades of public investment in Southern Italy. Just because there are public good spillovers does not mean that investing in difficult regions will be more socially beneficial. The economic rate of return to infrastructure is likely to be lower in areas with difficult geography. It may be more successful to help isolated regions by investing more productively elsewhere creating economic spillovers to the isolated regions. Certain basic infrastructure, nevertheless, can have large impacts on poverty, such as the building of inexpensive, basic, roads with labor-intensive methods.

The geographical deficits of the tropics in agriculture and health suggest that basic and applied research is a high priority. Unlike most other parts of the economy and society, the technological advances in the wealthiest countries in the areas of agriculture and disease will not spill over as readily to poor countries in the tropics precisely because the agricultural and disease processes are distinct there. Developing country consumers cannot pay premium prices for new drugs and vaccines, so they do not provide a profitable market. At the same time the tropics is left out of the revolution in corporate scientific research, public funding for research on

tropical agriculture and disease has been, if anything, declining. The research and development budget of the entire CGIAR system of institutes studying developing world agricultural problems is less than half of the R & D budget of one life-sciences multinational, Monsanto.

With a new era of rapid advances in biology, applied research on the obstacles to tropical agriculture and disease appears promising. Agricultural research, most of it public, has almost always had very high rates of return. The near-term welfare of more than half the households in most tropical countries (69% of the labor force of low-income economies on average in 1990), and an even higher proportion of the poor, still depends on agriculture.

Tropical medicine research funding is also severely limited due to the lack of market incentives for pharmaceutical firms. Malaria, with an estimated 2.4 billion people at risk, 300-500 clinical cases, and 1.5 to 2.5 million deaths per year, receives a total worldwide research funding of about \$84 million in 1993 (Welcome Trust, 1999).

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## Characteristics of Latin American Geographical Zones

Geographical Zone	GDP per person (1995\$)	Population Density (persons/sq km)	GDP Density (\$1000/sq km)	Area (million sq km)	Population within 100 km of coast (%)
Tropical Highlands	4343	52	226	1.9	11
Lowland Pacific Coast	4950	61	302	0.8	95
Lowland Atlantic Coast	5216	46	240	2.2	83
Amazon	5246	6	31	9	1
Temperate Southern Cone	7552	35	264	3.2	31
Mexican-U.S Border	7861	17	134	1.1	30
Highland and Dry Southern Cone	9712	7	68	2.2	16

Source: Author's calculation