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Climate Change and Mosquito-Borne Disease: Causal Link or Green Alarmism?

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The World Health Organization (WHO) claims that climate change caused 150,000 deaths in 2003. Most of these deaths are presumed to have resulted from mosquito-borne disease in poor countries. However, this figure relies on comparative models that fail to account for the major causal factors in changes to disease frequency and severity.

Temperature is a causal factor in disease, but small temperature changes are unlikely to have a significant impact on the spread of disease. Malaria, for instance, was endemic in temperate regions (such as Europe and the United States) and epidemic in at least one part of the Arctic Circle in the early twentieth century. The reasons for its eradication are technical and developmental.

The recent increase in mosquito-borne disease is likely due to failed national health policies in tropical countries, as well as poor advice from the WHO. The cause of this failure is undue deference paid to environmental fears and their supposed remedies.

Trying to prevent the spread of disease by combating energy use, as advocated by the WHO, is an extremely uncertain and possibly counterproductive policy. Energy is essential to wealth generation, and health is strongly correlated with wealth. Given the uncertainties of the existence of human-induced climate change, its long run effects on disease, any health policy decision based around energy restriction is unwarranted.

According to several recent papers, modeled estimates claim that between 150,000[1] and 160,000[2] excess deaths are caused every year by human-enhanced climate change. Some of these deaths occur in the developed parts of the world (the recent hot European summer was responsible for between fifteen thousand and twenty thousand excess deaths, mostly in France), but models attribute the vast majority to the developing world.

In the past decade, diseases such as dengue fever, yellow fever, and above all else, malaria, have increased in frequency and distribution.[3] And by 2020 the number of excess deaths due to climate change is projected to have doubled.[4]

These claims, made by respected authors and institutions, deserve to be examined. If true, they may strengthen the case for action recommended by the Intergovernmental Panel on Climate Change (IPCC) to combat human emissions of greenhouse gases. This paper provides a brief analysis of the recent increase in mosquito-borne disease and discusses the likelihood of a spread of such diseases from the tropics to more temperate latitudes.[5]

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Disease and Climate Change—the Alleged Link

The IPCC claims that human emissions of greenhouse gases are altering the climate.[6] But some climate scientists challenge the assumption that human emissions are causing significant, irreversible, or harmful effects.[7]

The concern about climate change has led to an increasingly prominent debate about the impacts of that change on human health and

especially mosquito-borne disease,[8] the focus of this paper. The IPCC Third Assessment Report (2001) concluded that: "Overall, climate change is projected to increase threats to human health, particularly in lower income populations, predominantly within tropical/subtropical countries."

The WHO uses demographic disease models as the basis for its estimates of how temperature might affect the burden of disease. These models are the source of the claim that many tens of thousands of excess deaths arise from malaria—the excess is supposed to be caused by man-made climate change. The most significant anticipated impact is that the regions where mosquito-borne disease is endemic will expand.

The WHO acknowledges: "Such models cannot predict exactly what *will* happen, but they indicate what *would* occur if certain climatic (and other specified) conditions were fulfilled."[9] These models have been heavily criticized by some experts since "they cannot predict the presence or absence of the disease, nor its prevalence in any situation, because they do not account for the parasite-rate in humans or mosquitoes, nor any of the many ecological and behavioral factors that affect the interaction of mosquitoes and humans."[10] Other studies have been more equivocal, refraining from drawing strong conclusions as to whether and how anticipated climate change will affect insect-borne disease.[11]

All models need a proper baseline measurement—the status quo at the beginning of the study period—before they can produce any meaningful output. Again, the WHO acknowledges it is extremely hard to establish a baseline. This is because real data for many disease-endemic nations are simply not available: even the population figures are estimates. "Disease incidence data is needed to provide a baseline for epidemiological studies. The lack of precise knowledge of current disease incidence rates makes it difficult to comment on whether incidence is changing as a result of climatic conditions."[12] Despite this, the WHO claims that malaria "is of great public health concern, and seems likely to be the vector-borne disease most sensitive to long-term climate change;"[13] it is therefore the focus of much of what follows.

Given that even proponents of the climate-health models acknowledge their substantial problems, both in terms of data quality and forecasting ability, it is instructive to examine how the disease burden has changed in relation to past climate change. Since malaria is an age-old disease, one can learn a great deal about the relative importance that changes in climate have played in its reach and severity.

The History of Climate and Malaria

Health has always been affected by local weather conditions—the link was made by Hippocrates. Most directly, extreme hot and cold can cause death outright, but moderate changes may have indirect effects, such as enhancing or suppressing the breeding of pathogens or their vectors (carriers). Furthermore, alteration of an ecosystem might affect water quality, air quality, food availability and quality, or have even more diverse socio-economic effects, such as social dislocation and conflict.[14] These indirect impacts of temperature change are expected to account for a much greater disease burden than do the direct effects.

Temperature change is the most obvious climatic factor affecting health, and from at least the seventeenth century onward, Europeans attributed summer "fevers" to the elevated temperature at that time of year.[15] And when it was discovered by a British army doctor in 1898 that malaria was transmitted by the mosquito, the association was finally established.[16]

It is therefore tempting to assume that, if the planet is warming up, diseases (especially insect-borne ones) will also increase. The media have reported these conclusions eagerly.[17] But it is becoming increasingly clear that this is a far too simplistic view. For example, some experts[18] found that rainfall, rather than temperature, was the primary forcing factor in malaria transmission trends in Africa during most of the twentieth century. And more importantly, historical factors that determined the prevalence and demise of malaria had very little to do with climate.

Many temperate regions have summer temperatures as high as locations in the tropics and have the same or similar mosquito species. However, the tropics do not have cold winters, which often eliminate the mosquito vector in the temperate regions, preventing year-round transmission. Nevertheless, mosquitoes do survive, as do the parasites they transmit, and malaria seasons in places like Italy were historically the same as equatorial countries like Mali—July to September.

During the bitterly cold Little Ice Age five hundred years ago, malaria persisted throughout Europe. William Shakespeare (1564–1616) wrote about malaria (the ague) in eight of his plays, and Oliver Cromwell, Lord Protector (de facto British monarch),

died from the disease in September 1658 just before a severe winter set in.[19]

Records of nineteenth-century epidemics in Finland, Sweden, and Russia attest to the fact that malaria assailed places not normally associated with warm weather. Archangel, in the Russian Arctic Circle, even had an epidemic as late as 1923.[20]

Mosquito species capable of carrying malaria and other parasitical diseases still proliferate in these regions—Finns and Scots are plagued by mosquitoes in the summer months. The key difference is that the parasite died out, largely because the pool of human and animal carriers fell below the critical level needed to sustain it.

Thanks to changes in farming practice and domestic development, people and animals were simply no longer living close enough to each other, or being bitten enough to allow the parasite to complete its reproductive cycle. Malarial mosquitoes tend to feed at night, and it used to be common for animals to be brought at night into barns that shared a common, open roof with the farmer's living quarters. This arrangement provided perfect conditions for mosquitoes to rest and feed, but once houses were separated from barns and built with sealed windows, doors, and ceilings, nighttime exposure to mosquitoes was all but eliminated.

Many technical developments coincidentally reduced the breeding grounds of mosquitoes, such as the draining of marshlands (particularly in the Netherlands and East Anglia, where Oliver Cromwell met his demise) for agricultural purposes. Mechanization on farms reduced the number of workers in the fields exposed to mosquitoes, and finally, medical care improved with greater access to quinine, which cures malaria. With the exception of the last intervention, none of these reasons had anything to do with recognition of the role the mosquito played in the transmission of the disease.[21]

Malaria began to decline in Northern Europe during the nineteenth century and was no longer endemic in most places by 1900, but still persisted in Southern Europe after World War II. The Pontine Marshes that had hosted so many malarial deaths in imperial Rome were still causing devastation during WWII. Italy, Greece, and the Balkans all had major malaria problems.

Malaria was prevalent in North America with epidemics in the nineteenth century as far north as New York City and Minnesota. There were 120,000 cases reported in 1934 and still sixty-three thousand cases reported in 1945.[22]

These problems were finally resolved by a massive WHO campaign to eradicate malaria using the insecticide DDT after World War II. The advent of DDT revolutionized malaria control by targeting the home, leading to widespread eradication of the disease from Europe and North America. By 1975, Europe and North America were entirely free of endemic malaria.

But perhaps the most startling data come from the subcontinent. Malaria rates in India after the Second World War were over seventy million cases a year and hundreds of thousands of deaths. Vector control with DDT began in 1953, and by 1965 rates had fallen to fifty thousand cases a year and approximately one thousand deaths.[23]

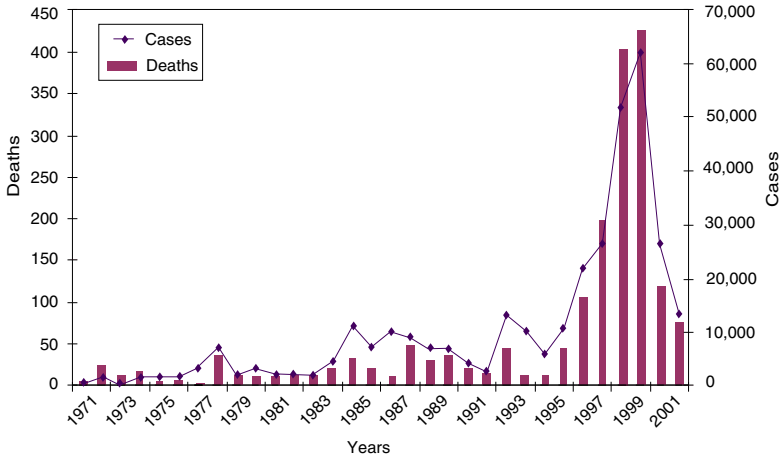
The Return of Malaria

Climate has historically been a minor factor in the spread of disease. Nevertheless, in the past decade there has been a notable rise in the number of malaria cases and deaths, and those of several other mosquito-borne diseases (e.g., West Nile virus in the United States; dengue fever in numerous parts of Latin America; malaria all over the tropics, including 22 percent of U.S. forces sent to Liberia in 2003; leishmaniasis in various parts of the tropics, including recently among U.S. servicemen in Iraq). So what has been the cause, if not climate change?

Malaria persists in poor countries, with over three hundred million cases a year and over one million deaths. The WHO claims that the "disease's sensitivity to climate is illustrated by desert and highland fringe areas where higher temperatures and or rainfall . . . may increase transmission of malaria. In areas of unstable malaria in developing countries, populations lack protective immunity and are prone to epidemics when weather conditions facilitate transmission."[24] But, as has been shown, the mosquito is resilient and adaptable. Small changes in temperature have a minimal impact.

The most likely explanation for the rise is a change in health policies in key countries. The most important change in the last decade has been the move away from the use of insecticides (especially DDT) to control disease-carrying mosquito populations. Surveys in Italy show that anopheles mosquitoes have returned to population levels not seen since before the DDT era. "In entomological terms, the infestations are comparable to those in areas of Africa that have extremely high transmission rates."[25] Nevertheless, malaria has not returned because

Malaria Cases and Deaths in South Africa, 1971–2002



Source: South African Department of Health

of good health systems, air-conditioning, windows, and other physical barriers preventing contact between humans and mosquitoes.

However, in developing countries mosquito proliferation has led to increases in disease. The most illustrative case is South Africa, which stopped using DDT for mosquito control in 1996 under pressure from environmental groups.[26] The chart above shows the change in malaria rates and deaths in South Africa. The temperature during the time period 1971–2002 was stable, yet there was a massive spike in malaria rates after 1996, when DDT use was withdrawn.

During this period the health authorities switched to an alternative insecticide, which proved less effectual. The *anopheles arabiensis* mosquito developed resistance to it and the *anopheles funestus* mosquito (not seen in South Africa for many decades) returned. This vector is extremely effective and within two seasons malaria rates had increased by 1,000 percent.[27] After DDT was reintroduced in 2000, infection rates were reduced by 85 percent in eighteen months. Roberts reports similar events and effects in parts of Latin America.[28]

Another reason for the resurgence of malaria is the build up of resistance in the parasites to the front-line drug treatments.[29] The WHO is even implicated in a charge of medical malpractice in the supply of failed malaria medicines to the developing world.[30]

It is therefore likely that the rise in malaria rate has been caused by human policies (a de facto DDT ban and failed drug treatments) rather than human emissions and any subsequent warming of the planet. One paper in the respected science journal *Nature* even claimed the link between climate and malaria did not exist.[31] Another paper concluded that "climate changes have not caused the highland malaria resurgence in western Kenya."[32]

But, for the past decade the IPCC has confidently forecast that malaria and other mosquito-borne diseases would move from the tropics into temperate regions.[33] In 1997, the U.S. Environmental Protection Agency (EPA) stated that there could be 50–80 million more malaria cases as a result of warming in the twenty-first century.[34]

In neither of these publications, nor in any environmental group publications, was the demise of the use of DDT (and other insecticides) or the failure of therapeutic drugs mentioned, even as possible causal factors of an increase in disease now or in the future.

As Reiter concludes: "None of us denies that temperature is a factor in the transmission of mosquito-borne diseases, and that transmission may be affected if the world's climate continues to warm. But it is immoral for political activists to mislead the public by attributing the recent resurgence of these diseases to climate change, particularly in Africa."[35]

Focusing attention on climate change, and its possible link with mosquito-borne disease, diverts scarce human resources from the urgent and real causes of these diseases. One of the main arguments in favor of mitigation (energy reduction) strategies is that the poor are "most at risk," from climate change. "However, if the underlying objective is to help developing countries it would be better to invest resources in addressing these problems now, rather than expend them on mitigation."[36]

Eradicating Malaria Again

Climate is a causal factor in the range and severity of diseases like malaria. But minimal changes in climate (man-made or natural), the likes of which have been witnessed in the previous century, have had no discernible affect on the spread of diseases like malaria. Relatively small temperature and other climatic changes simply are not important as compared with other factors, such as improvements in housing and medical technology, and great public health knowledge.

More lives are being lost to malaria than a decade ago, mainly because of misguided insecticide and drug policies rather than climate. It does seem odd that the international community would worry about these lives now, when very little has been done by aid agencies to halt these diseases from taking hold in the recent past. Indeed, as explained above, many of their actions have been harmful (such as restricting the use of DDT and procuring defective drugs).

Africa used to be a place where Russia and America bolstered pro- and anti-communist regimes. Today, Africans are routinely put in front of cameras to make political points about health—notably AIDS. The current interest in malarial deaths appears to be more about making anti-energy political points than combating the disease.

If the planet is warming because of man's emissions then energy restriction policies may well be required. There is a reasonable likelihood that a much warmer world will lead to certain diseases increasing in severity and frequency. Therefore, widespread and massive energy restriction measures could indirectly save some lives. But lowering energy use to improve health when the effects of such a policy are largely unknown and unknowable and are incredibly expensive, is folly when there are so many more effectual and far cheaper interventions.

A healthier and wealthier developing world will find it easier to cope with and reduce its vulnerability (including to mosquito-borne disease) to climate change. Any policies that hinder developing-country growth (especially energy limitation policies) would be far worse for them than a small increase in disease.[37]

If the Western world really wanted to help the poor with malaria it would fund a massive insecticide spraying campaign to control the disease. The last great international campaign in the 1960s (using DDT) either eradicated malaria or reduced transmission massively, and we could do it again.[38] Any takers?

Notes

1. WHO, "New Book Demonstrates How Climate Change Impacts on Health," December 11, 2003, available at http://www.who.int/mediacentre/releases/2003/pr91/en/print.html.

2. See Alister Doyle, "160,000 Said Dying Early from Global Warming," Reuters, (September 30, 2003), available at http://www.greenhousenet.org/news/sept-2003/dyingyearly.html.

3. Amir Attaran, Donald Roberts, Chris F. Curtis, and Wenceslaus L. Kilama, "Balancing Risks on the Backs of the Poor," *Nature Medicine*, 6 (July 2002): 729–731.

4. Some even claim that malaria could become an endemic disease in England by 2050. See *Getting Ahead of the Curve: A Strategy for Combating Infectious Diseases* (London: United Kingdom Department of Health, 2002).

5. See Roger Bate "WHO's to Blame?" for comment on the 15,000 French deaths, which were attributable to poor health care management and an inadequate use of energy for air conditioning, available at http://www.techcentralstation.com/101403F.html. See also Noelle Knox, "France Shoulders Shame of Heat Deaths," *USA Today* (August 27, 2003), which claims that lack of air conditioning is due to "health laws", available at http://www.usatoday.com/weather/news/2003-08-26-france-death_x.html.

6. IPCC, *Climate Change 2001: Third Assessment Report*, 1 (Cambridge: Cambridge University Press, 2001).

7. See, for example, John Emsley (ed.), *The Global Warming Debate* (Cambridge: European Science and Environment Forum, 1996); and R. S. Lindzen and K. Emanuel, "The Greenhouse Effect," in the *Encyclopedia of Global Change, Environmental Change, and Human Society, Volume I*, Andrew S. Goudie, (editor in chief), (New York: Oxford University Press, 2002), 562–566.

8. See, for example, A. J. McMichael, J. Patz, and R. S. Kovats, "Impacts of Global Environmental Change on Future Health Care in Tropical Countries," *British Medical Bulletin*, (1996): 384; J. Mouchet, S. Manguin, J. Sircoulon, S. Laventure, O. Faye, A. W. Onapa "Evolution of Malaria in Africa for the Past 40 Years: Impact of Climatic and Human Factors," *Journal of the American Mosquito Control Association*, 2 (1998): 522–23; and P. Reiter, "From Shakespeare to Defoe: Malaria in England in the Little Ice Age," *Emerging Infectious Diseases*, 6 (2000): 141–61.

9. WHO, *Climate Change and Human Health–Risks and Responses*, (Geneva: WHO, 2003).

10. Paul Reiter, "Could Global Warming Bring Mosquito-Borne Disease to Europe," in Kendra Okonski (ed.), *Adapt or Die*, (London: Profile Press, 2003), 24.

11. Jonathan Patz, "Comments to Conference of National Academies on 'Climate, Ecosystems, Infectious Diseases, and Health," (April 10, 2000), available at http://www4.nas.edu/ webcr.nsf/MeetingDisplay5/BASC-U-98-02-A?OpenDocument.

12. WHO, *Climate Change and Human Health*, 31.

13. WHO, *Climate Change and Human Health*, 14.

14. WHO, *Climate Change and Human Health*, 3.

15. Paul Reiter, "Could Global Warming Bring Mosquito-Borne Disease to Europe," in Kendra Okonski (ed.), *Adapt or Die*, (London: Profile Press, 2003), p. 24.

16. Robert S. Desowitz, *Federal Bodysnatchers and the New Guinea Virus,* (New York: W.W. Norton and Company, Inc., 2002).

17. See, for example, "Climate Change Blamed for Deaths," *CBS NEWS,* December 11, 2003, available at http://www.cbsnews.com/stories/2003/12/11/tech/printable588011.shtml. Also "Climate Change Bolsters Diseases," *The Age*, (January 7, 2004), available at http://theage.com.au/ articles/2004/01/07/1073437337180.html.

18. J. Small, S. I. Hay, and S. J. Goetz, "Climatic Suitability for Malaria Transmission in Africa, 1911–1995," *Proceedings of the National Academy of Science*, 100 (December 23, 2003): 15341–15345.

19. Reiter, "From Shakespeare to Defoe," 5.

20. Reiter, "From Shakespeare to Defoe," 1.

21. Reiter, "Could Global Warming," 24.

22. H. Sterling Burnett, "Sick Argument: Global Warming and the Spread of Tropical Diseases," National Center for Policy Analysis Press Release (September 29, 1997), http://www.ncpa.org/ba/ba241.html.

23. Roger Bate and Richard Tren. *Malaria and the DDT Story*, (London: Institute of Economic Affairs, 2001): 37.

24. WHO, *Climate Change and Human Health,* 14.

25. Reiter, "Could Global Warming," 35.

26. Bate and Tren, *Malaria and the DDT Story,* 68.

27. Bate and Tren, *Malaria and the DDT Story,* 72.

28. Roberts et al. "DDT, Global Strategies."

29. Amir et al, "Balancing Risks," 731; and Roberts et al, "DDT, Global Strategies."

30. Attaran et al, "WHO, the Global Fund."

31. John Whitfield, "Link Between Climate and Malaria Broken," *Science Update,* (February 21, 2002*), available at* http://www.nature.com/nsu/020218/020218-12.html. The paper Whitfield cited was S. I. Hay et al, "Climate change and the resurgence of malaria in the East African Highlands," *Nature*, 415 (February 21, 2002): 905–909.

32. Shanks et al. "Meteorological Influences on Plasmodium Falciparum Malaria in the Highland Tea Estates of Kericho, Western Kenya", *Emerging Infectious Diseases*, [8] (December 2002): 1404–1408.

33. R. T. Watson, M. C. Zinyowera, and R. H. Moss, (eds.), *Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analyses*. Contribution of Working Group II to the Second Assessment of the Intergovernmental Panel on Climate (Cambridge: Cambridge University Press, 1996).

34. EPA. *Global Warming—Impacts: Health* (Washington: Office of Policy, Planning, and Evaluation, 2002).

35. Reiter, "Could Global Warming," 37. Also Paul Reiter, a professor at France's respected Pasteur Institute was quoted on CBS News: "Why don't we devote our resources to tackling these diseases directly, instead of spending billions in vain attempts to change the weather?" available at http://www.cbc.ca/stories/2003/12/11/who_warming031211.

36. I. Goklany, "Relative Contributions of Global Warming to Various Climate Sensitive Risks, and Their Implications for Adaptation and Mitigation," *Energy and Environment,* 4 (2003): 789–822.

37. Goklany, "Relative Contributions," 739–822.

38. Roberts et al, "DDT, Global Strategies;" and Bate and Tren, *Malaria and the DDT Story*.