Editorial

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Impacts of climate change on vector borne diseases

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Many questions arise regarding the transmission of vector borne diseases. The role of the environment is very important to determine the appearance, persistence and spread of these diseases. In fact, arthropod vectors are very sensitive to the environmental conditions (climate, landscape) that regulate their population dynamics and therefore have a significant impact on the dynamics of disease transmission. According to global climate models, the world has experienced by the end of the last century an increase in its average temperatures, a variation in its rainfall and a change in its level of humidity.[1,2] These climatic changes could modify the distribution of certain parasites and diseases transmitted by animals, including arthropods and insects, which can lead to an increase in current infectious diseases and the appearance of new ones. Climate influences several aspects of infectious disease cycles such as the production of various vectors, the ease with which insect vectors can transmit disease, and the human behavior that leads to exposure to different vectors. For example, in addition to vector– borne diseases already known in Europe for many years, such as visceral leishmaniasis (canine and human), Lyme borreliosis and tick– borne encephalitis, several outbreaks of diseases considered exotic have been observed last years in Europe. This is the case for the fever in Chikungunya in Italy in 2007, the West Nile fever in Greece since 2009, dengue in Madeira (Portugal) in 2012; as well as chikungunya in France since 2010 and malaria in Greece since 2009. This demonstrates Europe's vulnerability for these vector– borne diseases and the importance of research on the biology and ecology of travelers for better monitoring and control.

Some researchers have described climate change as a greater health hazard that the world has ever faced. It is now indisputable that the health of the planet is linked to that of its population. As the Earth heats up, ecosystems are visibly struggling to withstand rapid ecological change. Global warming has already triggered changes in weather including floods, storms, heat waves and drought that are affecting the health of people around the world. In summit meetings, governments in developed and developing countries are fighting over emissions targets. Reflections on the possible implications of climate change on the human health have been conducted.[3] Various authors mention that the impacts of climate change on health will be different depending on the level of development of the country's health infrastructure.[4] In developing countries, rising temperatures and moisture would facilitate the emergence, or re– emergence, and the expansion of several vector infections.[5] The studies even mention that an increase in the prevalence and mortality infectious diseases would have several negative consequences such as lowering of economic productivity and the increase in the cost of drugs. In recent years, publications on this subject multiply. They are controversial and fuel a lot of debate about the relative effects of climate versus social, economic and topographies of vector– borne infectious diseases.[6] Meanwhile, the world's poor, who already carry the heaviest burden of disease, can expect an alarming deterioration in their health. This deterioration will be partly due to changes in population dynamics, with some fleeing flooded shores or glowing deserts for more habitable areas. An increase in insect– borne diseases from vectors such as mosquitoes or ticks may also play a key role. Climate influences these vectors in many ways by regulating the length of their life cycle, or by influencing their reproductive conditions. While scientists agree that climate change will affect insect– borne diseases, the exact consequences remain unknown. Whether warmer or wetter conditions facilitate the multiplication of vectors such as mosquitoes and the spread of disease will depend on a range of ecological and societal factors that are much wider than rain and good weather. There is an urgent need to increase our knowledge of how climate change will affect human health and insect– borne diseases. We need to strengthen health care systems to face these new challenges.

Because of their complex biological nature, the diversity of transmission modes and the strong influence of environmental conditions on transmission cycles, vector–borne diseases represent a real challenge for public health authorities faced with changing environmental conditions. The most sensitive effect of climate change on transmission is likely to occur at the extremes of the favorable temperature range for transmission, ie, for many diseases, from 14–18°C to 35– 40°C. A warming of the minimum temperatures will have a large non– linear impact on the extrinsic incubation period[7] and consequently on the transmission of diseases, while at the high end of the interval, transmission may cease. However, around 30– 32°C, the vector capacity may increase significantly due to the shortening of the extrinsic incubation period, despite a decrease in the survival rate of the vectors. Mosquito species such as the *Anopheles gambiae, Anopheles funestus, Anopheles darlingi, Culex quinquefasciatus* and *Aedes aegypti* complexes are responsible for the transmission of most vector–borne diseases and are sensitive to temperature changes as immature stages in aquatic environment and as adults. If the temperature of the water increases, the larvae mature more quickly[8] and produce more offspring during the transmission period. In warmer climates, adult female mosquitoes digest blood more rapidly and feed more frequently,[9] which increases the intensity of transmission. Likewise, malaria parasites and viruses complete their extrinsic incubation in the mosquito organism in a shorter time when the temperature rises,[10] which increases the proportion of infective vectors. Warming above 34°C generally has a negative impact on vector and parasite survival.[8] The climate–arbovirus relationship is not solely based on the variable temperature. The population dynamics of many mosquito vectors virus is also strongly related to the rate and amounts of rainfall, these causing the impoundment of breeding sites.[11,12] Unlike the thermal factor, the link between rainfall and arbovirosis remains more difficult to establish and more complex.[3] Changes in the rainfall regime can have short and long term effects on vector habitats. Increase in total

precipitation can increase the number and quality of breeding sites and the density of vegetation, with an influence on rest homes. However, torrential rains can, at conversely, overflow the deposits and cause the destruction of the larvae. The water storage and the presence of breeding sites around dwellings may be more important than rainfall itself.[13] Beyond climate change, we must not neglect the consequences of human actions, land use change, pollution and biological invasions. For example, globalization, with increasing mobility of goods and people around the world, has enormous consequences for the circulation of hosts, pathogens and vectors. In rodents, disease pools can increase when favorable shelter and abundance of food leads to an increase in population, resulting in outbreaks of disease. The distribution of human settlements also influences trends in morbidity. In South America, more than 70% of the population lives in cities and only a small proportion is exposed to infections that occur in rural areas However, 70% of the population in Africa lives in rural areas where vector control, for example the elimination of breeding sites, is often difficult. Dengue is essentially an urban disease and will be more important in highly urbanized communities with poor water and waste disposal systems.

All scientists agree that our planet is experiencing global warming, a consequence in part due the increase in the concentration of greenhouse gases in the atmosphere caused by human activity. According to the 2001 report of the Intergovernmental Panel on Climate Change, several scenarios are possible and, in the optimistic hypothesis, it is estimated that, by 2100, the global temperature could increase on average from 1.0 to 3.5 °C. Whatever the warming scenario, the climate threat poses a risk to human health, particularly because of the development and frequency of many vector– borne diseases.[14–16] Most of these diseases are seasonal and suggest their sensitivity to climatic conditions. Spatio– temporal variations in temperature, precipitation, humidity and wind, which could occur in such climate change scenarios, would affect the biology and ecology of vectors and intermediate hosts and, therefore, the risk of transmission of these diseases.

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Conflict of interest

Teh author declares there is no conflict of interest.

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