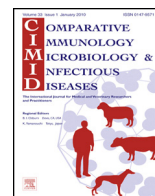




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### Review

## Impact of climate change in the epidemiology of vector-borne diseases in domestic carnivores<sup>☆</sup>

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### ABSTRACT

Vector-borne diseases are medically important in humans and animals but were long considered tropical and known to first affect production animals. This is no longer true and we can see today that they are common in domestic animals and that they are also present in temperate countries, especially in Europe. In recent years, an increase in the diagnosis of vector borne diseases among humans and animals has been observed, which may partly due to the development of diagnostic tools. Their study requires exchanges and collaborations between the many actors involved, especially since the epidemiology seems to be constantly evolving. The veterinary practitioner is the first one to notice the emergence of cases and to implement prevention measures. He also acts as a sentinel to alert epidemiologists. Many factors can explain the epidemiological changes, i.e. all human factors, such as the increase in commercial transportation, but also owners traveling with their pet during the holidays, the development of “outdoor” activities, the increase of individual housings with gardens; to these human factors must be added the ignorance of the risks, linked to animals in general and to wildlife in particular; then the environmental changes: forest fragmentation, establishment of parks; the increase of wild mammal populations (deer, carnivores, rodents, etc.); finally, climate changes. Climate change is a reality which may explain the increase of density of arthropod vectors, but also of their hosts, changes in periods of activity and variations in geographical distribution. The authors show the proof of the climate modifications and then explain how it has an impact in Europe on ticks, mosquitoes, sandflies and even fleas. They conclude on the practical consequences for veterinary practitioners, especially with the diagnosis of parasitic diseases or diseases in areas where they usually do not occur. However, not any epidemiological modification should be linked to climate change, since many other factors are involved and often even overriding.

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## 1. Introduction

Vector-borne diseases seem to be “fashionable” when we look at the number of journals and publications that relate to them. They are medically important in humans and animals but were long considered tropical and known to first affect production animals. This is no longer true and we can see today that they are common in domestic animals and that they are also present in temperate countries, especially in Europe [1].

Their interest and importance are increased by the fact that most vector-borne diseases, including bacterial and viral, are zoonotic diseases [2]. Especially in recent years, an increase in the diagnosis of rickettsial diseases among humans and animals has been observed in the United States and in Europe [3,4]. The development of the diagnostic tools and the easiness to have access to them may also play a role in the increased diagnosis of vector-borne diseases. Their study requires exchanges and collaborations between the many actors involved, such as veterinarians, physicians, epidemiologists, but also entomologists, meteorologists, experts in geographic information systems, etc., especially since the epidemiology of vector-borne diseases seems to be constantly evolving [5]. The veterinary practitioner is the first one to notice the emergence of cases and to implement prevention measures. He also acts as a sentinel to alert epidemiologists [6].

Many factors help to explain the epidemiological changes, they were summarized in 2005 by Harrus and Baneth [7]:

1. First of all human factors, such as the increase in commercial transportation, but also owners traveling with their pet during the holidays, the development of “outdoor” activities, the increase of individual housings with gardens. To these human factors must be added the ignorance of the risks, linked to animals in general and to wildlife in particular, among the actors of rurbanization<sup>1</sup> and neo-rural dwellers;
2. Then the environmental changes: forest fragmentation, establishment of parks, various developments;
3. Without a doubt, the increase of wild mammal populations (deer, carnivores, micromammals, etc.);
4. And finally, climate changes.

Statements 1, 2 and 3 explain the increase in the number of reservoirs of vectors or pathogens and the increase

<sup>1</sup> A term coined in the 1970s from combining the words rural and urban to describe the process of “return” or “escape” of city dwellers to the countryside. Rurbanization is the transformation of rural communities around the city and is characterized by land-use changes. Lands (especially farmlands) are used for new constructions for residential purposes, services or industrial activities, in direct relation with the city. In the end, it is primarily a process of spatial extension of the city.

in the risk of contact with humans and domestic animals. Let us take the example of the strong interest in Siberian chipmunks in the 1980s. These rodents were very popular and sold in all pet stores in France. Unfortunately noisy and capable of biting, they were released to the wild. They proliferated in certain forests and sometimes supplanted our red squirrel or voles, with which the competition is strong.

However, Siberian chipmunks are obviously the host of choice for tick nymphs and they are also responsive to *Borrelia*. A recent study thus shows their role in the maintenance, or even in the increasing risk for humans, of Lyme disease in the Melun-Sénart forest in the suburbs of Paris [8].

Many factors are therefore involved in the increased risk of developing vector-borne diseases. Climate changes are added to those factors. Climate change may explain the increase of density of arthropod vectors, but also of their hosts, changes in periods of activity and variations in geographical distribution.

## 2. Evidence of climate change

Climate changes are no longer being debated, only the mechanisms responsible for them are a matter of controversy [9,10]. Global warming has accelerated over the last hundred years (Fig. 1) with an average gain of 0.74 °C in 100 years [11]. It is not uniform, affecting the Northern more than the Southern hemisphere, and is definitely not characterized by “more beautiful summer days”. The result is rather a reduction in the number of cold days, thus a shorter winter period, often alternating with milder periods. Rainfall may be higher in certain areas and lower in others, for instance, the annual distribution may be: more winter precipitation and increased summer drought in Mediterranean areas.

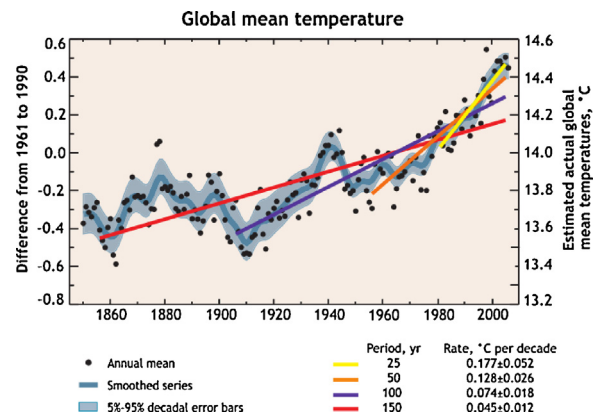


Fig. 1. Exponential increase of global temperature since 1860 [9]. Source: Reservoir Rodents. PLoS ONE; [www.plosone.org](http://www.plosone.org), 2013, 8(1), e55377.

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