European Commission

SCIENCE FOR POLICY BRIEFS

# Toward climate change impact: Vectors carrying viral infections[1]

## The problem

Climate change, international trade and international travel are key factors in promoting the spread of disease-bearing insects to ever-wider parts of the world.

More humans are therefore exposed to viral infections such as Dengue fever, Zika, Chikungunya, West Nile fever, Yellow fever and Tick-borne encephalitis. All these diseases are transmitted by mosquitoes, with the exception of Tick-borne encephalitis, which is predominantly caused by transmission of the tick-borne encephalitis virus to humans by tick bites. For many of these diseases, there are as yet no specific vaccines or antiviral agents.

Global warming has allowed mosquitoes, ticks and other disease-bearing insects to proliferate, adapt to different temperatures, migrate to places that have become warmer and adapt to new niches and new areas (e.g. urban areas).

In suburban and urban settings, the viruses can be acquired by mosquitoes from an infected person and then transmitted to other humans. Only female mosquitoes bite humans and other animals.

As mosquitoes are vectors of major major pathogens worldwide, the surveillance of mosquito poulations is one way to fight vector-borne diseases. At present, mosquito control strategies are highly controversial, in particular when they involve the use of insecticides, which are dangerous to human health and the environment. Globally, policy decisions should give greater support to the effective, efficient and environmentally sustainable surveillance of mosquitoes. Control practices should therefore discourage the application of pesticides, and promote the optimal use of resources to manage mosquito populations, so as to minimise the number of human cases of mosquito-borne diseases and, at the same time, guarantee the protection of the environment.

## Headlines

- Climate change promotes the spread of mosquito- and tick-borne viruses.
- Viral infections caused by mosquitoes (e.g. Dengue fever, Chikungunya, Zika, West Nile fever, Yellow fever) or by ticks (e.g. Tick-borne encephalitis) are globally increasing.
- The use of alternative mosquitoes control strategies is necessary to minimise the pesticide applications.

## How to control mosquitoes spread?

*Aedes mosquitoes* spread several arboviruses, including Dengue, Zika, Chikungunya, West Nile and Yellow fever viruses. These mosquitoes thrive in urban areas due to the lack of natural predators, and the ready availability of food and habitats in which to lay their eggs. Virus outbreaks, caused by mosquitoes, which were once common mainly in Africa and Asia, are now becoming more and more widespread. Mosquitoes have recently become established in some European countries and the

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## Quick guide

Mosquitoes and ticks are migrating to places that have become warmer, enabling them to adapt to new niches and to spread to new areas (e.g. urban area).

In urban areas, due to the temperature changes (i.e. warm temperature in winter time) and the egg resistance, they are active in all seasons of the year.

The reduction of potential breeding sites (e.g fountains, ponds, water-filled containers) can decrease mosquito abundance, however an early warning system would mitigate the risk.

Americas, largely as a result of international travel and trade (Figure 1).

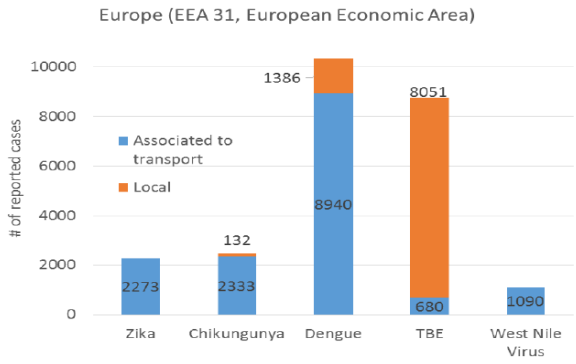


**Figure 1.** Number of reported cases in Europe of Zika virus (2015-2017), Chikungunya vírus (2008-2015), Dengue fever vírus (2008-2015), Tick-borne encephalitis vírus (2012-2015), and West Nile fever vírus (2008-2015).
*Data source*: https://ecdc.europa.eu/en/surveillance-and-disease-data, last access date on 1/12/2017

Their alarming spread poses a problem to public health. They are difficult to eradicate - their larvae can survive for months, even in suboptimal humidity and temperature conditions (Figure 2).

There are currently five main methods of mosquito control i) extermination through the use of insecticides; ii) biomass reduction through the use of traps; iii) reduction of biomass through genetic modifications; iv) land reclamation in order to fight or prevent the spread of mosquitoes; v) control of

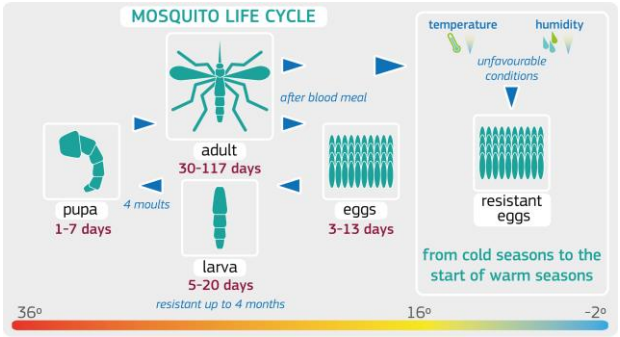


**Figure 2.** The mosquito life cycle takes place in four distinct stages (from egg to larva, pupa and the adult mosquito). The first three stages occur in water. In periods of dehydration or eminent decrease of temperature, laid eggs can survive (resistant eggs) and will hatch once optimal conditions for development are present. Larvae can also survive for months.

water spaces (places) where the eggs and larvae can survive. Most common insecticides used for mosquito control are chemical-based compounds that are applied by nebulisation or fumigation. Unfortunately, they raise (eco-) toxicological issues and their use should be discouraged in order to safeguard the human health and the environment. Other mosquito control strategies include the use of *Bacillus thuringiensis* var. *israelensis* (Bti), a group of toxin-producing bacteria, and the introduction into the field of sterile male mosquitoes in order to reduce offspring. These approaches, however, have some limitations. Indeed, a negative impact of Bti has been observed on non-target organisms like birds, with a reduction in bird breeding behaviour as a result of decrease in food supply. The release of

sterile mosquitoes is complicated by the great number needed to cover a vast geographical area.

Molecular insecticides could provide an alternative approach to fight mosquitoes. The technology behind their production is called RNA interference (RNAi) and works by disrupting the expression of any gene of interest in a specific manner by using double-stranded RNA (dsRNA). The dsRNA targeting key genes involved in the regulation of cell death can be topically applied to mosquitoes and used as molecular insecticides to limit their spread. However, mass production of RNAi products is currently not possible, and specific formulations should be developed to ensure the efficient delivery of the dsRNA into mosquitoes.

Currently, mosquito traps and nets are the safest and most available method of mosquito control. Indeed, in inhabited areas, the use of traps together with the active reduction of potential breeding sites are valid strategies for mosquito control and for decreasing the biting pressure on the public. Development of a vaccine against these infections would also help to reduce the health risk, especially for more vulnerable populations.

## Key conclusions

A dedicated JRC report about climate changes and their role in spreading vectors carrying viral infections shows that several methods are used to control mosquito populations, including insecticides, traps, genetic modification, land reclamation and habitat monitoring. Currently, the safest and most available and effective methods of controlling mosquitoes are mosquito traps and nets (for relatively small areas), and the reduction of potential breeding sites (such as fountains, ponds or water-filled containers).

Synthetic insecticides have been widely used to control mosquito populations, but the negative health and environmental impacts due to their toxicity need to be considered. Environmentally sustainable measures are needed to control mosquitoes, without relying on widespread pesticide applications but rather based on surveillance data. This means that policies focused on habitat management and on controlling life stages before the mosquitoes become adults, could efficiently reduce the spread of mosquitoes and pesticide use.

While better control of mosquito populations is advocated, it would be unwise to remove mosquitoes completely from the ecosystem. They are part of the food chain for some species, and pollinate many plants. Wiping them out completely, could have negative effects on nature, and consequently on humans.

## Related and future JRC work

Mosquito control is an important public health concern. Since the transmission of the arbovirus to the offspring of mosquitoes has already been reported, the JRC will carry out field campaigns to collect mosquitoes in all developmental stages (i.e. the egg, larvae, pupae and adult stages). Mosquito populations can be most readily controlled when they are immobile, concentrated and more accessible. The environmental samples will therefore be tested for the presence of the pathogen-carrying mosquitoes, so as to evaluate the mosquito biomass and the potential risk they pose to the human population in Europe.

A predictive model for the spread of arboviruses will also be produced for crisis mitigation and management. Collaboration with European and national agencies would allow for the development and regular updating of this predictive model, which could become a useful precautionary system to control the spread of mosquitoes.

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