Impact of global warming on arboviral diseases

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EMERGING ARBOVIRAL DISEASES

In the past 50 years, many **vector-borne diseases** have emerged. Some of these diseases are produced for exotic pathogens that have been introduced into new regions and others are endemic species that have increased in incidence or have started to infect the human populations for first time (new pathogens).

Many of these vector-borne diseases are caused by **arbovirus**. Arboviruses are virus transmitted by **arthropods** vectors, such mosquitoes, ticks or sanflys. The virus is usually transmitted to the vector by a blood meal, after replicates in the vector salivary glands, where it will be transmitted to a other animal upon feeding. Thus, the **virus is amplified by the vector** and without it, the arbovirus can't spread.

In 1991, Robert Shope, presented the hypothesis that **global warming** might result in a worldwide increase of zoonotic infectious diseases. Today, we can say that during the past 50 years patterns of emerging arbovirus diseases have change considerably. Can this be attributed to climate change?

GLOBAL WARMING

The accumulation of greenhouse gases (GHG) in the atmosphere by **human activity** altered the balance of radiation of the atmosphere, altering the **TEMPERATURE** at the Earth's surface [1].

Growth human population + **Increased per capita consumption of resources** (water, energy, material, land, biodiversity) = **Accumulation of greenhouse gases in the atmosphere** (burn fuels in electricity generation, transport, industry, agriculture and land use change, use of fluorinated gases in industry)

→ **Some longwaves radiation from the sun are absorbed and re-emitted to the Earth by GHG molecules**

- ↑ Air Temperature Near Surface
- ↑ Specific Humidity
- ↑ Ocean Heat Content
- ↑ Sea Level
- ↑ Sea-Surface Temperature
- ↑ Temperature over the oceans
- ↑ Temperature over the land
- ↓ Snow Cover
- ↓ Glacier mass balance
- ↓ Sea-Ice

! The global temperature has risen **0.8 ºC** over the past 150 years. A 2ºC rise is the point at which some of the most devastating and dangerous processes brought on by climate change could become unavoidable.

IMPACT OF GLOBAL WARMING ON ARBOVIRAL DISEASES

➔ Climate is a key determinant of the emergence of infectious diseases: it **constrains the range of infectious diseases** and influence **pathogens**, **vectors**, **hosts defences** and **habitat**. Arthropod vectors are cold-blooded (ectothermic) and thus especially sensitive to climatic factors [1].

Increase temperature

Effects on humans
- Modifies host susceptibility
- Changes human behaviour (more vector-human encounters)

Effects on vector
- Decreased survival of some mosquitoes
- Expansion to a new regions
- Change susceptibility to some pathogens
- Population growth
- Increase reproductive rate
- Increased feeding rate
- Reduce period of larval development

Effects on arbovirus
- Reduce the extrinsic incubation period
- Promotes evolution of novel-vector virus associations

Intensify hydrological cycle

Effects on vector
- Decreased vector population (death and destruction habitats by flooding)
- Increase breeding sites
- Increase vector survival (↑ humidity)

Effects on humans
- Increase the susceptibility
- Changes human behaviour

THE SPREAD OF A DANGEROUS VECTOR

Aedes albopictus is the fastest spreading vector over the past two decades and is considered the **most invasive mosquito species in the world** [2]

- ♦ It's original from **Southeast Asia**. Now is present in **North**, **Central** and **Southern America**, parts of **Africa**, northern **Australia** and several countries in **Europe**
- ♦ Is associated with the transmission of several arbovirus, such **Dengue**, **West Nile**, **Chikungunya**, **Yellow fever** and **Japanese encephalitis**
- ♦ Is adapted a **temperate climates**
- ♦ Can **compete** and **eradicate** resident species

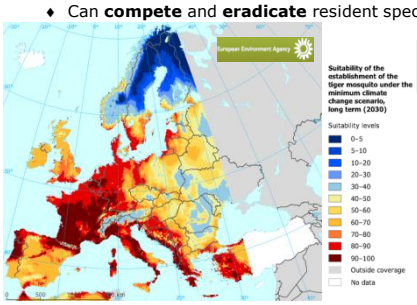

Figure [1]: Suitability of the establishment of the tiger mosquito under the minimum climate change scenario, long term (2030). (source: www.eea.europa.eu/data-and-maps/figures/suitability-of-the-establishment-of)

Figure [2]: *Aedes albopictus* (© James Gathany, CDC)

EMERGING MOSQUITO-BORNE DISEASES

Dengue is the **world's fastest-spreading tropical disease** and represents a pandemic threat [3].

- ♦ First isolated: Japan (1943)
- ♦ Actually range: **Africa**, **America**, **Eastern Mediterranean**, **South Pacific** and **Europe**
- ♦ Cycle: **human-mosquitoes**
- ♦ Transmission: only by the **bite** of the mosquito
- ♦ Disease: **Dengue Fever**, **Dengue Haemorrhagic Fever** and **Dengue Shock Syndrome**

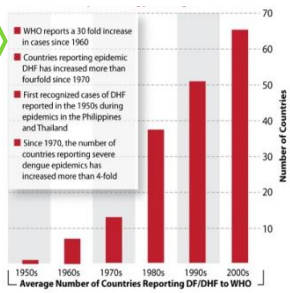

Figure [3]: Dengue epidemiology (source: DengueMatters, www.denguematters.info/content/issue-11-spotlight-dengue)

Because of the absence of available vaccine, the primary preventive measure to reduce dengue infections is the control of mosquito populations [4]
- Monitoring mosquito populations
- Source reduction
- Biological control
- Chemical adulticing
- Personal protections measures
- Genetic modified mosquitoes

CONCLUSIONS

Climate is a factor that determine; the **geographic and temporal distribution of arthropods**, the **characteristics of arthropod life cycles**, the **dispersal patterns** and **evolution of arbovirus** and the **efficiency of the transmission**.

However, climate is only one of many factors which has influence in the arboviral emergence. Others would be deforestation, land use, international trade and travel, host density or globalization [5].

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