# Emerging viruses: the effect of climate change on the *Bunyaviridae* family

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## Introduction

Anthropogenic climate change are the physical and biological changes affecting global climate dynamics produced by human activity.

Intergovernmental Panel on Climate Change (IPCC) has concluded that global warming is real and affects all continents (figure 1) and that human health will be affected on several regions of the world, either directly (through changes on climatic patterns) or indirectly (through changes on food production and ecosystems). As a consequence, it might lead to the increase of diseases (12). Emerging viruses are those that have an alarming incidence. These agents reside in animal reservoirs and cause highly pathogenic diseases with epidemic or epizootic potential if transmitted to humans or livestock (1). Genetic mutations may increase their virulence and socio-ecological factors may facilitate their expansion (7).

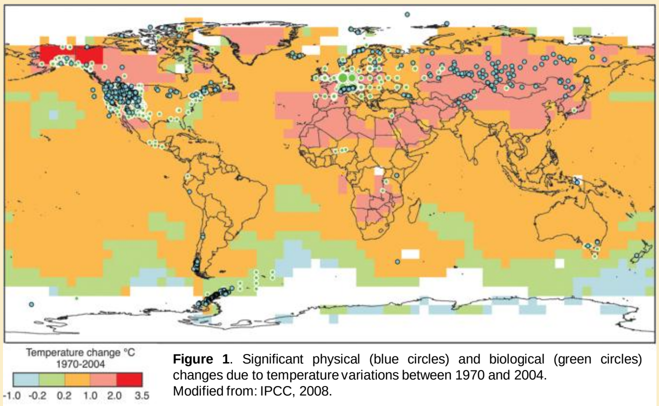


**Figure 1**. Significant physical (blue circles) and biological (green circles) changes due to temperature variations between 1970 and 2004. Modified from: IPCC, 2008.

The most important vectors in viral diseases are arthropods and rodents, also called arboviruses (**ar**thropod-**bo**rne **viruses**) and roboviruses (**ro**dent-**bo**rne **viruses**).

Arboviruses are found in many viral families; the most relevant examples are those found in the *Flaviviridae* family (Dengue virus or yellow fever virus), the *Bunyaviridae* family (Rift Valley fever virus or Crimean-Congo hemorrhagic fever virus) and the *Alphavirus* genus (Chikungunya virus), as they can produce outbreaks with a large number of deaths (9). For example, in 2008 Dengue virus killed more than 1.5M people around the world, most of them in southeast Asia (10).

Robovirus are those found in *Arenaviridae* and *Bunyaviridae* families. *Hantavirus* is the most important genus of the *Bunyaviridae* family and their reservoir are mice of the *Muridae* family. Each species of the *Hantavirus* genus is associated with species of this rodent family, which is an indication of coevolution (3).

## The *Bunyaviridae* family

This family of viruses is interesting because it contains both arboviruses and roboviruses and some species which can be considered as human emerging pathogens (table 1). The *Bunyaviridae* is the biggest RNA viral family, formed by more than 300 species; the members of this family are enveloped and spherical virions of approximately 100nm in diameter which possess a tripartite ssRNA with negative or ambisense coding strategy (2). The family is divided in five genus, based on serological and biochemical differences: *Orthobunyavirus*, *Hantavirus*, *Nairovirus*, *Phlebovirus* and *Tospovirus*; all of them can infect vertebrates, except the genus *Tospovirus* which can only infect plants.

Humans can suffer four different main diseases associated to infections of these viruses: fever, encephalitis, hemorrhagic fever and fatal hantavirus pulmonary syndrome (table 1).

Currently there are no efficient vaccines available for most of the *Bunyaviridae* family members, because the existing ones are not safe or do not confer a good immunogenic response (4). As there are no vaccines, it is necessary to adopt proper preventive actions which consist on an exhaustive vector control. Individual preventive measures (like setting traps for mice or putting up mosquito nets) are effective locally, but on a larger scale it is recommended to apply an environmental management plan, which basically tries to modify environmental conditions with the purpose of reducing the vector-pathogen-human interaction (11) (figure 2).

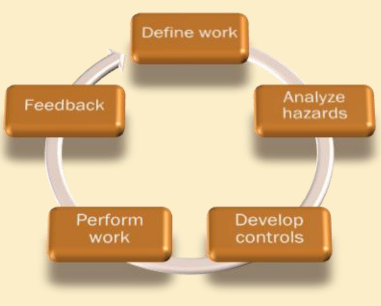


**Figure 2**. Before implementing an environmental management plan is important to know the features of the affected area (*define work*), to know vector-pathogen's biology (*analyze hazards*), how the transmission occurs and how to stop it (*develop controls*), act properly (*perform work*) and observe the results and redefine work if necessary (*feedback*).

| *Genus*/virus | Disease | Vector | Distribution |
|---|---|---|---|
| ***Orthobunyavirus*** | | | |
| **La Crosse** | Encephalitis | Mosquito | North America |
| **Oropouche** | Fever | Mosquito | South America |
| **Tahyna** | Fever | Mosquito | Europe |
| ***Hantavirus*** | | | |
| **Hantaan** | Hemorrhagic fever with renal syndrome. M: 5-15% | Field mouse | Eastern Europe, Asia |
| **Puumala** | HFRS. M: 0,1% | Bank vole | Western Europe |
| **Sin Nombre** | Hantavirus pulmonary syndrome. M: 50% | Deer mouse | North America |
| ***Nairovirus*** | | | |
| **Crimean-Congo hemorrhagic fever virus (CCHFV)** | Hemorrhagic fever. M: 20-80% | Tick | Eastern Europe, Africa, Asia |
| ***Phlebovirus*** | | | |
| **Rift Valley fever virus (RVFV)** | Hemorrhagic fever, encephalitis, retinitis. M: 1-10% | Mosquito | Africa |

**Table 1**. Main human pathogens of the *Bunyaviridae* family. Modified from: Elliott R.M., 2009. M= mortality.

## Vector-borne viral diseases and climate change

Vector-borne disease emergence results from a complex interplay of host, pathogen, vector and environmental factors, including climate change. These diseases are seasonal, so they are sensitive to climatic conditions (12) (figure 3).

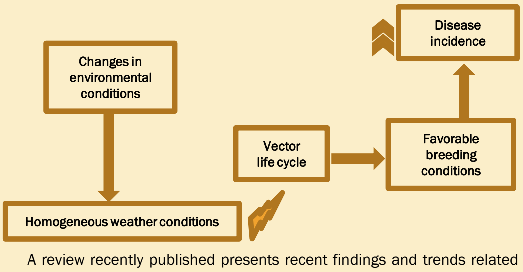


**Figure 3**. How changes in environmental conditions would increase disease's incidence.

A review recently published presents recent findings and trends related to hantaviruses in the perspective of climate change (5). Many examples of the relationship between vector-borne viral diseases and climate change may be found in the literature, for instance, it has been shown an increase of dengue fever during the year following an El Niño event, when monsoons are particularly extreme (8). Another example could be Puumala virus and its reservoir host *Myodes glaerolus*. Elevation of the average temperature in Europe might lead to a significant increase of the reservoir and consequently an increase of Puumala virus-HFRS incidence (5).

## Conclusions

Global warming will affect *Bunyaviridae* through their natural reservoirs (rodents and arthropods) changing their distribution patterns and/or their breeding season.

It is difficult to predict the extension of climate change effects, so more studies are needed linking in a conclusive way global warming and the expansion of viral-born diseases.

An international an interdisciplinary collaboration is needed to collect more data and information about the life cycles of vectors, the relation vector-pathogen and de molecular biology of the pathogens, to work collectively in a solution.

## Bibliography

1. **Deutsche Forschungsgemeinschaft**. Ecology and Species Barriers in Emerging Viral Diseases, 2010.
2. **ELLIOTT,R.M.** Bunyaviruses and Climate Change. Clinical Microbiology and Infection : The Official Publication of the European Society of Clinical Microbiology and Infectious Diseases, 2009, vol. 15, no. 6. pp. 510-517.
3. **GEGÚNDEZ,M.I.; LLEDÓ,L.** Infección Por Hantavirus y Otros Virus Transmitidos Por Roedores. Enfermedades Infecciosas y Microbiología Clínica, 2005, vol. 23, no. 08. pp. 492-500.
4. **INDRAN,S.V.; IKEGAMI,T.** Novel Approaches to Develop Rift Valley Fever Vaccines. Frontiers in Cellular and Infection Microbiology, 2012, vol. 2.
5. **KLEMPA,B.** Hantaviruses and Climate Change. Clinical Microbiology and Infection : The Official Publication of the European Society of Clinical Microbiology and Infectious Diseases, 2009, vol. 15, no. 6. pp. 518-523.
6. **MILLS,J. N.; CHILDS,J. E.** Ecologic Studies of Rodent Reservoirs: Their Relevance for Human Health. Emerging Infectious Diseases, 1998, vol. 4, no. 4. pp. 529-537.
7. **MORSE,S. S.** Emerging Viruses. . Stephen S. Morse ed., 198 Madison Avenue, New York, New York 10016: Oxford University Press USA, 1996. ISBN 0-19-507444-0.
8. **MYERS,S. S.; PATZ,J. A.** Emerging Threats to Human Health from Global Environmental Change. Annual Review of Environment and Resources, 2009, vol. 34, no. 1. pp. 223-252.
9. **WHO**. Vector-Borne Viral Infections. , 2013Available from:<http://www.who.int/vaccine_research/diseases/vector/en/>.
10. **WHO**. Causes of Death 2008 Summary Tables. May 2011, 2011Available from:<http://apps.who.int/gho/data/node.main.887?lang=en>.
11. **WHO**. Environmental health in emergencies and disasters: a practical guide. Wisner B.; and Adams J. eds., Geneva, Switzerland: WHO Library Cataloguing-in-Publication Data, 2002. Vector and Pest Control, pp. 158. ISBN 92 4 154541 0.
12. **WHO/WMO**. Atlas of Health and Climate. , 2012. ISBN 978 92 4 156452 6.