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An increase in vector-borne disease in Florida, USA, as a result of climate change

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Problem Statement: : How will global warming effect the spread of vector-borne disease in South Florida?

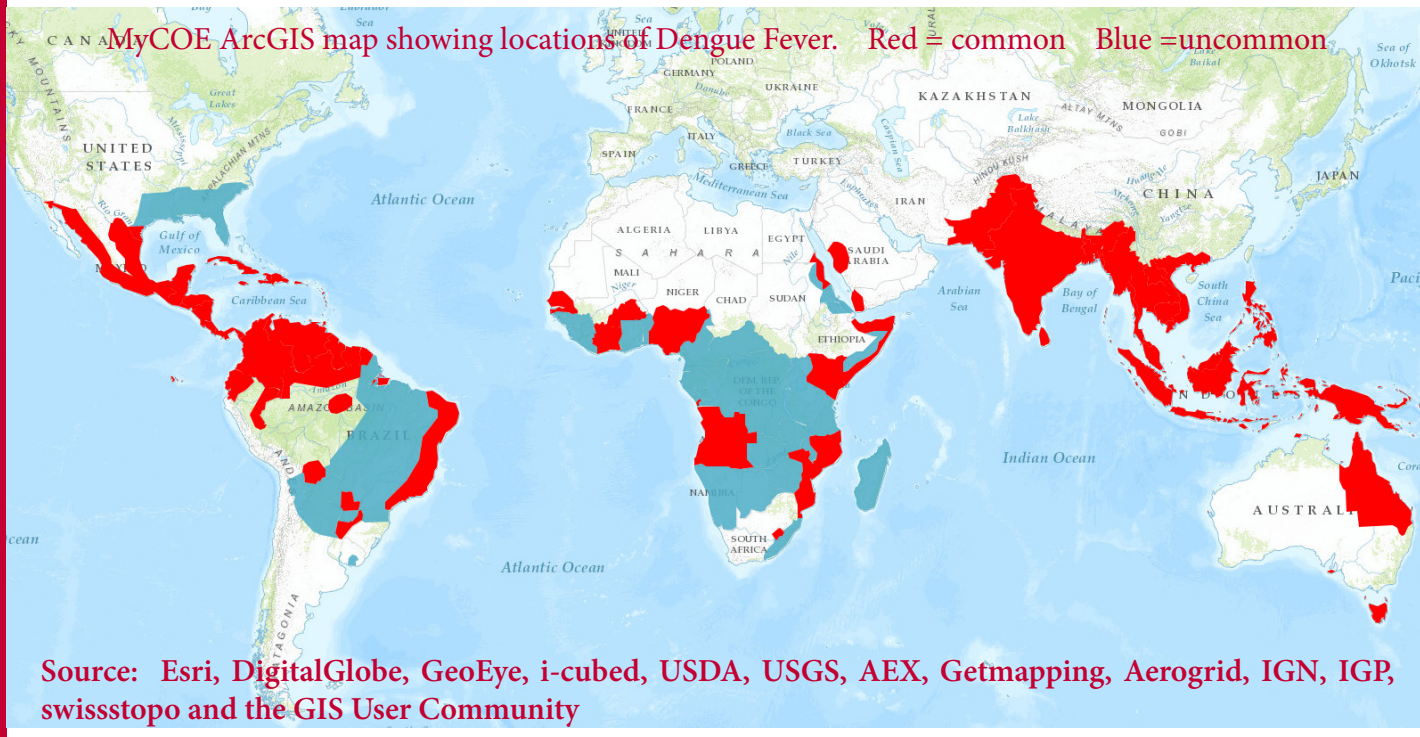
Abstract

Scientists have recognized that global warming is shifting the location of the earth's climate zones. Along with this shift is a change in the location of ecosystems. As a result, plants and animals are changing the extent of their living ranges. Vector-borne diseases are also shifting their range as the vectors' environments become extended. Vector-borne disease is being reported in all parts of the United States as a result of the shifting climate zones. Every state except Alaska and Hawaii have confirmed cases of West Nile Virus and Florida is also experiencing reported cases of Dengue Fever.

Global Warming

The world's average temperature has risen during the last 100 years, with most of it occurring during the last few decades. Although there are many consequences of global warming including changes in ocean acidification, increase in sea level, and stronger storms, there is also an increase in the range and types of vector-borne disease in the United States. In South Florida there has been an increase in the number of cases of diseases carried by mosquitoes: West Nile virus and Dengue Fever. The Center for Disease Control (CDC) in Atlanta, Georgia, has been monitoring the shift in the range of the disease carrying mosquitoes and is concerned about the threat of future outbreaks.

The shift in the range of mosquitoes may be related to a shift in the climate as a result of global warming. As the local climate reacts to the overall increase in the earth's temperature, wind and ocean



MyCOE ArcGIS map showing locations of Dengue Fever. Red = common Blue =uncommon

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swissstopo and the GIS User Community

patterns are being altered. These alterations result in a shift where ecosystems are located, for example, areas of cooler dryer climate may become warmer and wetter. As areas become warmer and wetter, mosquitoes are extending the area where they live and breed.

Vector-Borne Disease

A vector-borne disease is an illness caused by a microorganism that is transmitted to people by either insects or arachnids that bite people. If people are bitten by these insects, such as mosquitoes, fleas, lice, etc., or by arthropods such as ticks or mites, then the bitten person is exposed to the infectious microbe and may not be able to fight the disease. Some vector-borne diseases are merely a nuisance and are only serious for those who have impaired immune systems, however, other diseases are serious and can even be fatal.

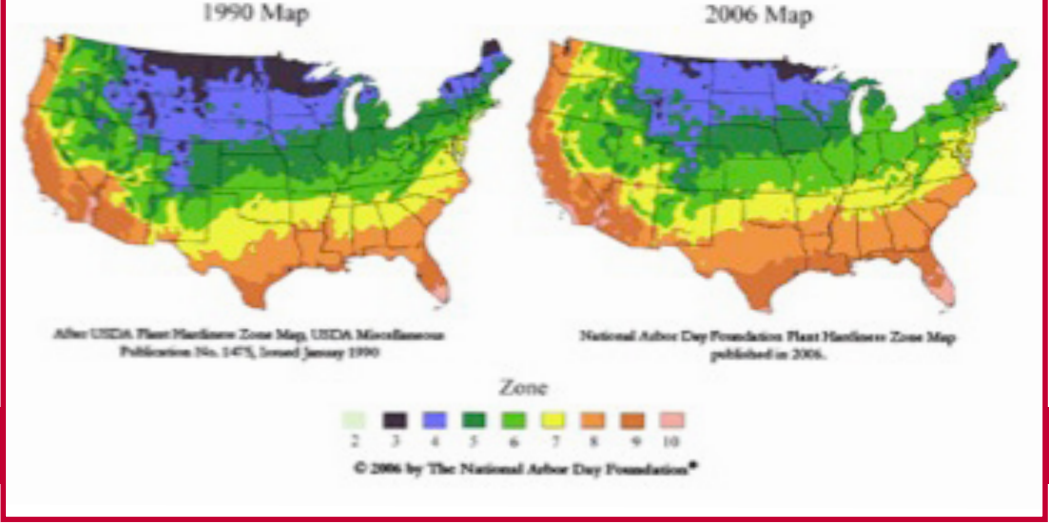
A vector is the term given to the organism that is "hosting" the microorganism that causes the illness. Often the microorganism is a virus, protozoa, bacteria or worm. Sometimes there is an intermediate host such as a domesticated animal which will hold the pathogen. When the vector bites the intermediary host it can then carry the microbe to humans. In turn, a different vector can bite a human and then pass the infectious microorganism on to another human.

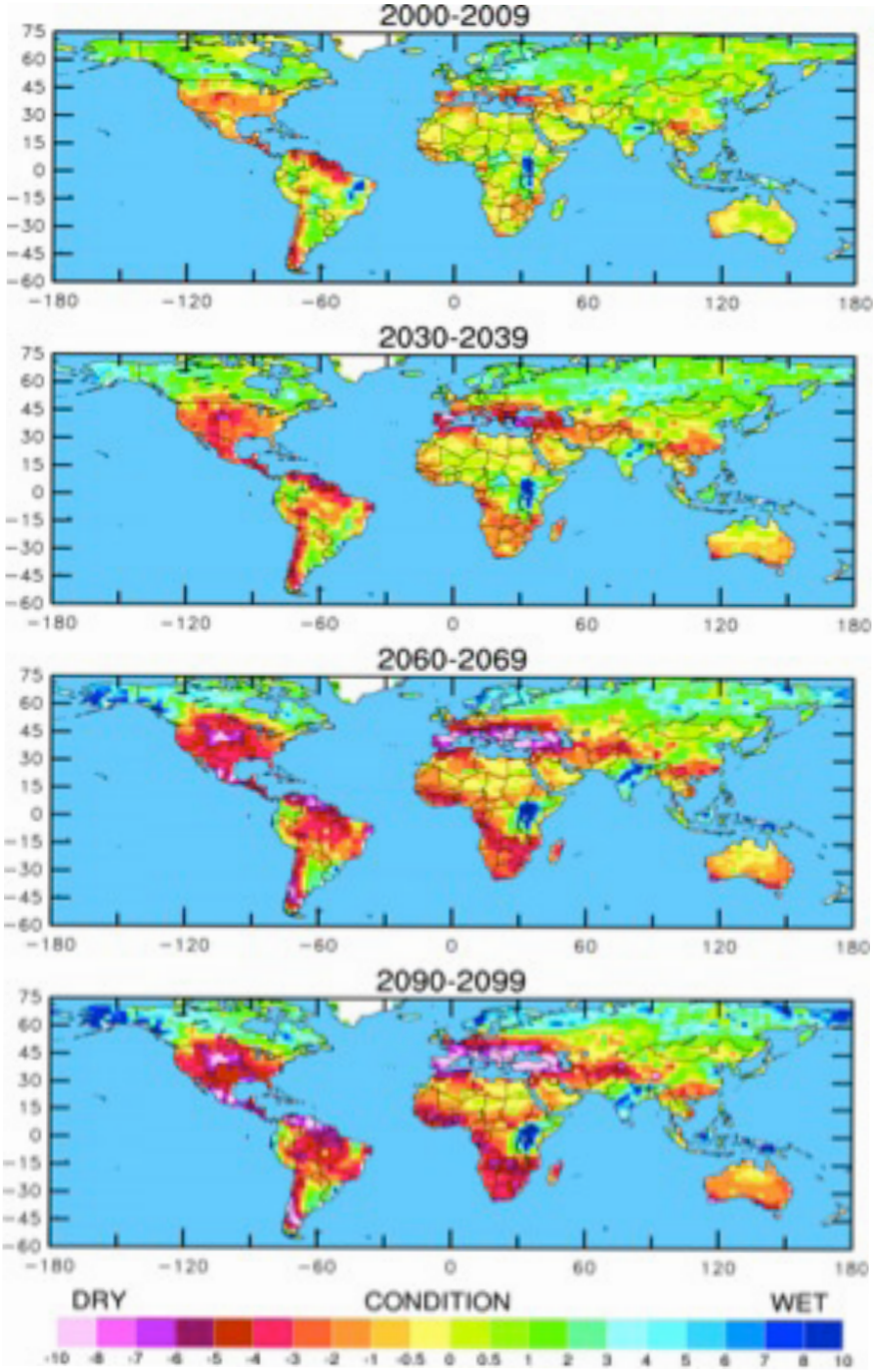
Most vector-borne diseases occur in warm and humid environments such as the tropics and subtropics around the world. For example, Dengue Fever is carried by a mosquito. Since mosquitoes exist in warm and moist climates, it makes sense that Dengue Fever is also found primarily in warm and moist climates. Below is a world map showing the occurrence of Dengue Fever. Like most vector-borne diseases, it primarily occurs in tropical and subtropical environments.

Climate Shift

Global warming is expected to cause a change in the location of the world climate zones. The changes have already been noticed. In fact, companies that make seed packets have changed their instructions as when to plant seeds to adjust to a longer growing season. The instructions now have people plant seeds earlier than they used to. The map below shows how the hardiness zone has changed in the United States. The climate zones have moved northward by about 100 miles.

The changes in world-wide climate has been predicted. It is predicted that much of the Western Hemisphere may experience extreme drought by the end of the century. However, it is also thought that higher-latitude regions might become more moist. What is also alarming is that warming water conditions that affect climate conditions such as El Nino may become more frequent as the earth continues to warm. Below is a series of maps showing the progression of the predicted drought areas:





The ecosystems will adjust and shift as the climate zones shift. Plants will seed and grow in different locations as along with them will move the insects and animals that live off the plants. The entire food web will shift. Along with the change in the location of the food web will be a change in the location of vector-borne diseases.

Mosquito-Borne Diseases

Mosquitoes are vectors for several diseases, two of which are prevalent in the Caribbean, Central America, and South America and are occasionally reported in the United States: Dengue Fever and West Nile virus. Both can be fatal and attempts are made to try to keep their outbreaks under control. But it is difficult to control the mosquitoes in tropical climates.

Dengue Fever, is also known as "breakbone fever. Dengue Fever is carried by the mosquitoes Aedes aegypti and Aedes albopictus which are found worldwide. At first Dengue Fever does not show any symptoms after a mosquito bites a person, however the person may have the microbe incubating inside his/her body. It can take up to 4-7 days before symptoms start to show. Some symptoms of the disease are severe headaches, eye pain, extreme muscle/joint pain (therefore the nickname breakbone fever), high fevers of 103°F, and rashes. The disease lasts about 2 weeks with a long recovery as the victim regains strength.

West Nile Virus is also a potentially serious illness which sometimes results in meningitis or encephalitis. Like Dengue Fever, it is also carried by a mosquito, but there are 43 different types of mosquitoes that are known to be West Nile Virus vectors. Most people who are bitten by a West Nile Virus carrying mosquito will not show any symptoms or will only have very mild ones. If symptoms will show it will take about 5-15 days after the person is bitten while the microorganism completes the incubation period. Symptoms of West Nile Virus include fever, headache, body aches, skin rash, and swollen lymph glands. In severe cases the symptoms become extreme: very high fever, painfully stiff neck, muscle weakness, disorientation, tremors, convulsions, and even paralysis.

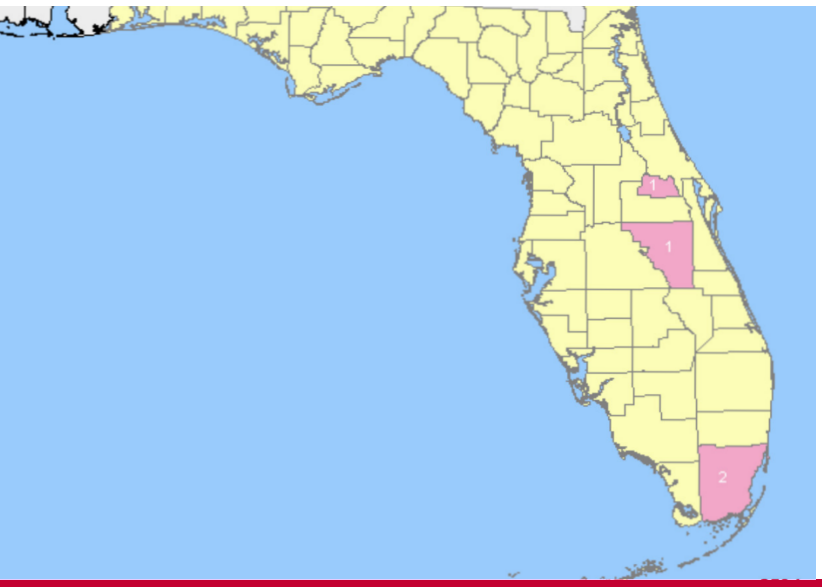
Florida

Until recently, Dengue Fever was restricted to the underdeveloped countries and was not reported in the United States for over 80 years. However, in 2009, the first case of locally acquired Dengue Fever

The Dengue Fever rash looks like measles

in Florida was reported in Key West, Florida. All it takes is one mosquito to start the infectious cycle, so by 2010 there were over 50 confirmed cases in Florida but it was assumed the actual number of cases was much higher. Two of the cases were in Miami, which was a concern to city officials. Standing water in cities is a popular breeding ground for mosquitoes making officials fearful of an outbreak. To stop the threat of a Dengue Fever outbreak an aggressive spraying campaign began. As a result of the increased spraying for mosquitoes, there were only 4 locally acquired cases in 2012. Below is map showing where Dengue Fever was reported in Florida.

West Nile Virus had an active outbreak in the United States in 2012 with 5,387 cases reported nationwide. Only 65 of them were in Florida, and most of those were along the northern Gulf Coast. At first it may seem good news for Florida that there so few cases in 2012, but officials are worried because the number of cases is rising after reducing the number cases after the record year of 2003 which had 94 cases. What is also worrying

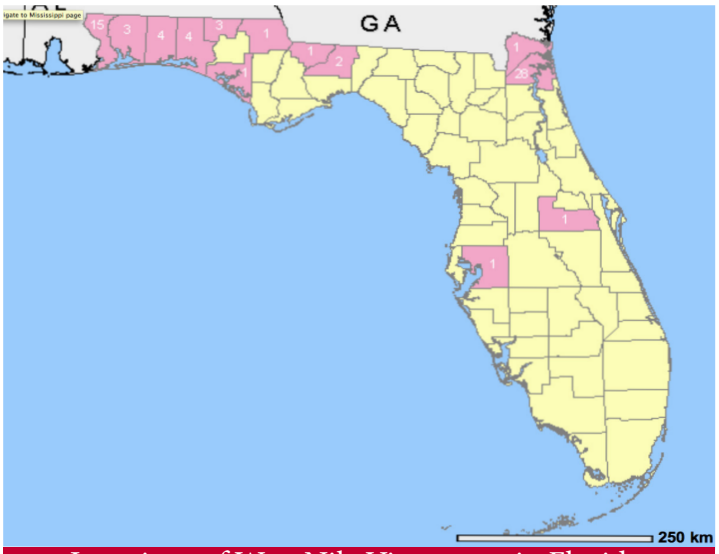


Locations of Dengue Fever in Florida

officials is that the cases in 2012 were the most severe form of the West Nile infection. As with Dengue Fever, the mosquitoes thrive when standing water is around, therefore officials are not only spraying to avoid Dengue Fever, but West Nile Virus as well. Below is a map showing the locations in Florida that West Nile Virus was reported.

The Future

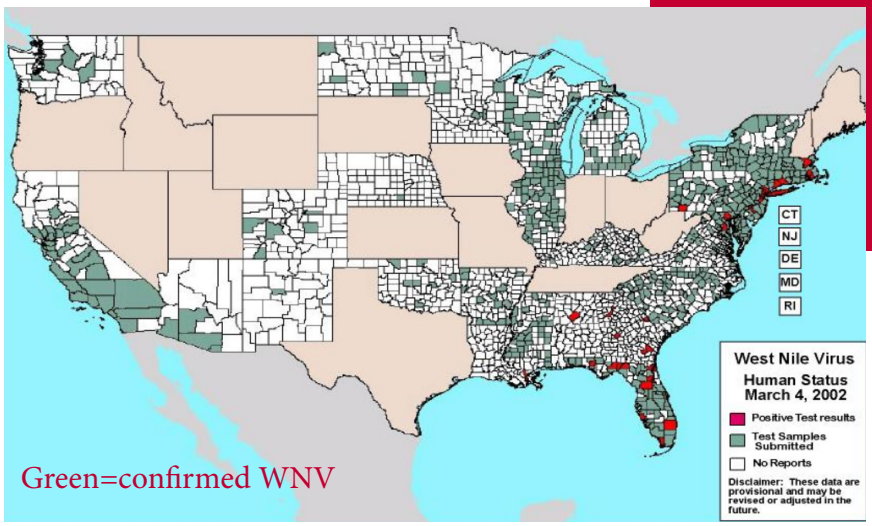
The role of global warming on the spread of vector-borne disease is critical. Scientists are very worried that as the climates shift, the range of serious vector-borne disease will dramatically increase. Global

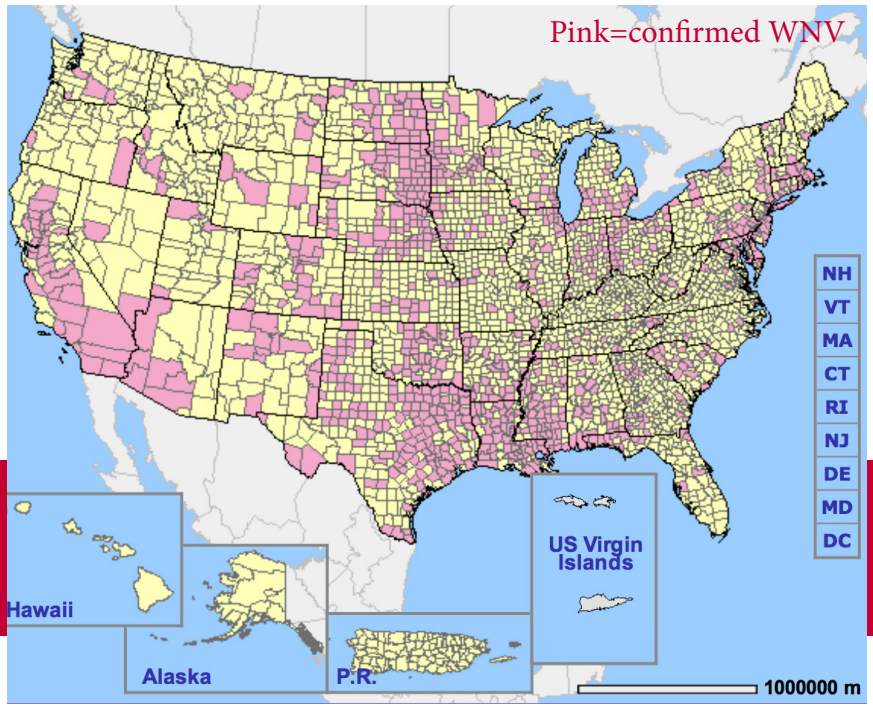


Locations of West Nile Virus cases in Florida.

warming is providing a way for vectors, such as mosquitoes, to reach other parts of the United States. Warmer temperatures provide an environment with promotes faster reproduction of both the mosquito and the virus, therefore, not only does global warming increase the land mass in which mosquitoes can live, but the warmer temperature also provides a stimulus for the birth of more mosquitoes. Warmer temperatures also make mosquitoes more active, especially at night when they are searching for a bite.

Global warming is also changing the wet and dry weather cycles. Some of the global warming climate models predicted there will be times of drought and downpour, conditions which are good for mosquitoes. Sudden heavy rains allow water to pool up, which then become stagnant and turn into a virulent breeding





ground for mosquitoes. If, however, the rain is regular then the pools of water keep getting washed away avoiding the formation of the stagnant breeding grounds. Officials fear that as the climate become more extreme, there will be more cases of vector-borne disease.

Since 2002, the occurrence of West Nile Virus has steadily increased. Today, it is found throughout the continental United States.

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