MEDECINS SANS FRONTIERES
DOCTORS WITHOUT BORDERS

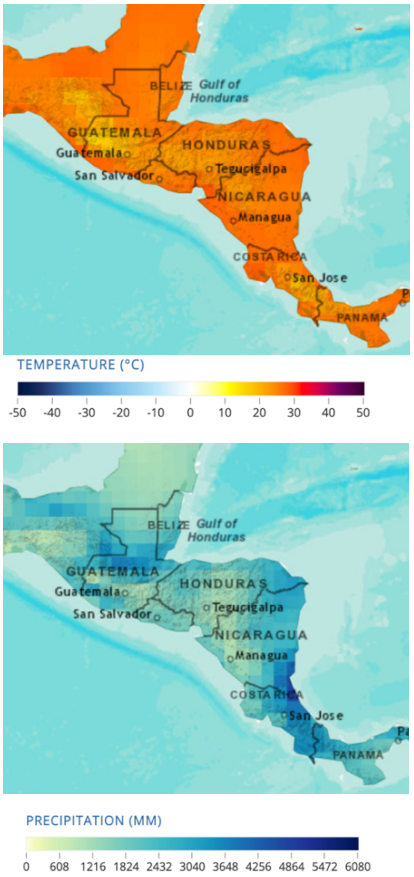
CLIMATE OF FOCUS COUNTRIES

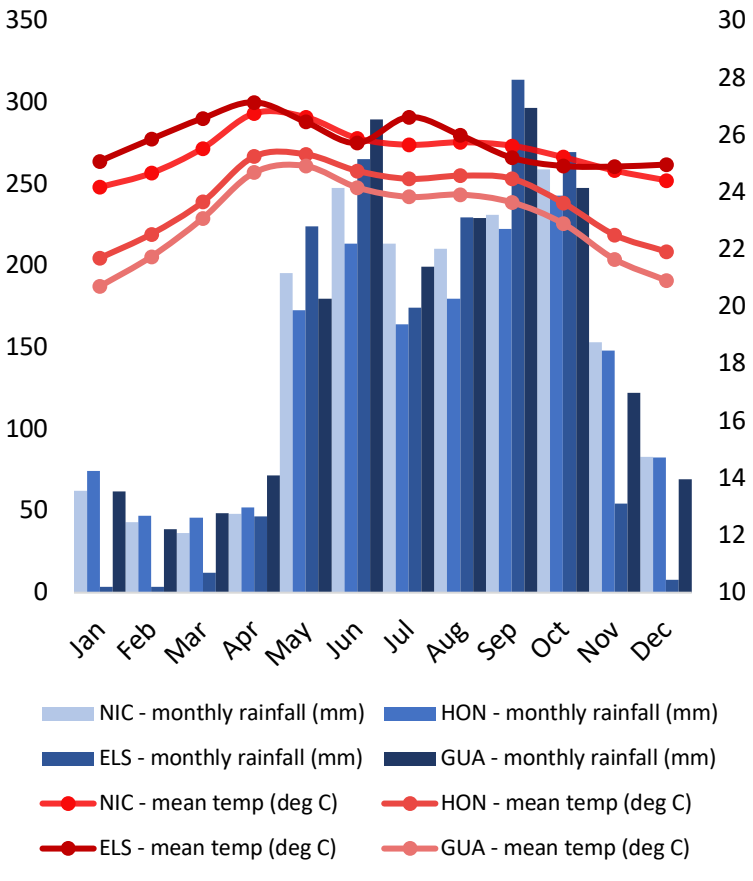
GUATEMALA

Heterogenous climate with warmer coastal areas and cooler mountainous interior areas. Average minimum daily temperatures as low as 17° in the winter, with average high daily temperatures up to 31° in spring and summer. Rainy season May to October and dry season November to April. Intense rainfall from the end of August.

HONDURAS

Tropical climate in the coastal lowlands with annual temperatures averaging 26° to 29° becoming more temperate in the highlands (average 16°– 24°). Average annual precipitation lowest in the mountainous interior areas and highest on the Caribbean coast where rainfall is year-round. The Pacific coast and interior highlands have a wet season (May to October) with a short break July/August (the canícula).





NICARAGUA

Tropical climate with little seasonal variation in temperature, ranging between 21° to 27°. Rainy season (May to October) with a short break July/August (the canícula). From July to October subject to increased rainfall and winds resulting from its location in the path of Pacific cyclones and Atlantic hurricanes

EL SALVADOR

Tropical climate with little seasonal variation in temperature, ranging between 22° to 25°. Rainy season (May to October) with relatively very low average rainfall during the dry months. Frequently exposed to Pacific storms and Atlantic hurricanes resulting in extreme weather events.

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CLIMATE OF FOCUS COUNTRIES

OBSERVED AND PROJECTED CLIMATE CHANGE TRENDS

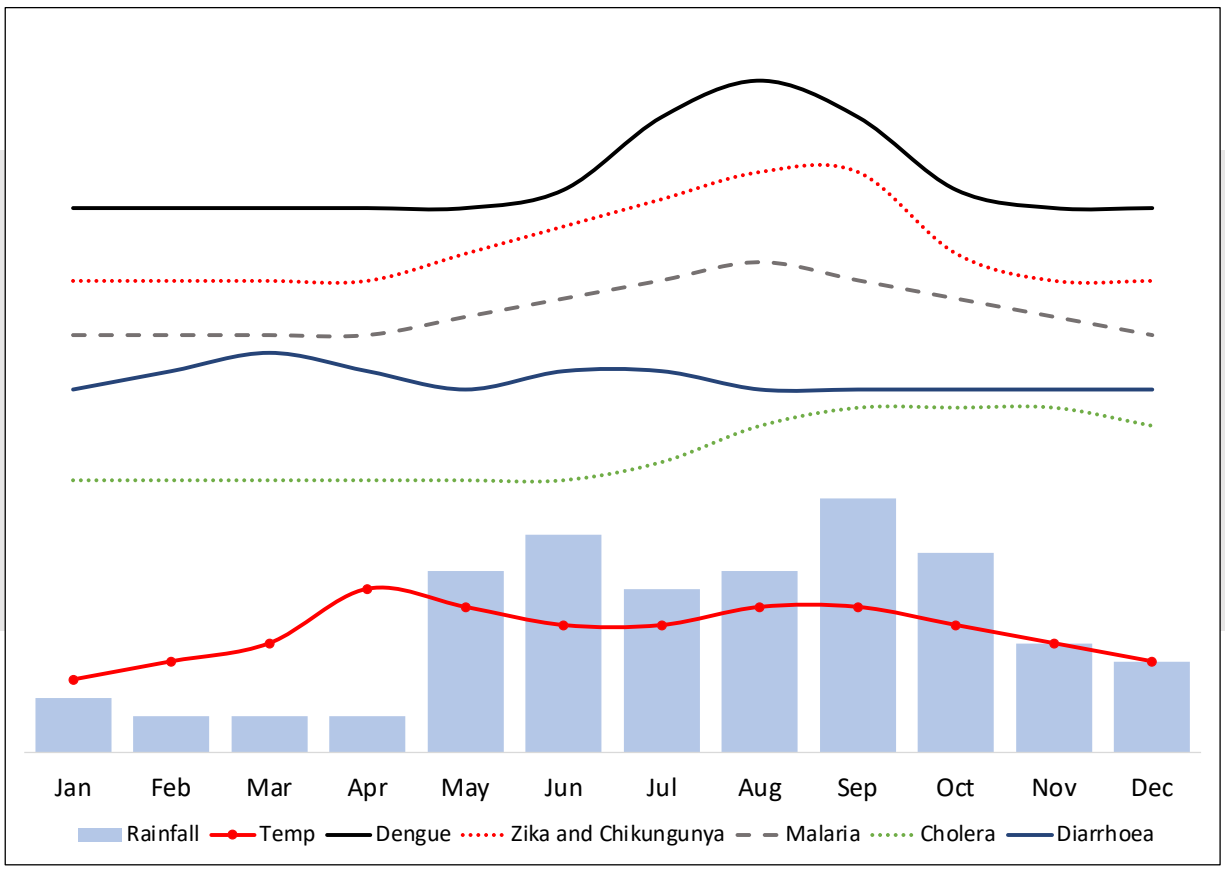
(ADAPTED FROM WORLD BANK CLIMATE CHANGE KNOWLEDGE PORTAL)

- Over the coming decades, in all four focus countries, temperatures are projected to increase overall, with higher minimum and maximum temperatures.
- Projected rainfall patterns are more complex: rainfall may remain stable, or decrease overall, with lower rainfall expected in coastal areas but higher rainfall possible in highland areas.
- Greater variability is expected as a result of changes to El Nino events.
- The frequency and intensity of droughts is expected to increase, and also for heatwaves. The intensity of tropical cyclones and hurricanes is expected to increase, although changes in frequency are unclear. Changes in flooding patterns are less well understood.

INTERANNUAL VARIABILITY

In all four countries, the weather is influenced by El Niño events, which decrease rainfall and increase temperatures, while La Niña events decrease temperatures and increase rainfall.

Annual weather and seasonality of focus diseases in focus countries



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ARBOVIRUSES IN FOCUS COUNTRIES

DENGUE, ZIKA AND CHIKUNGUNYA

Dengue virus (DENV) is transmitted to humans through the bite of an infected Aedes mosquito, principally *Aedes aegypti* or *Aedes albopticus*, which are both present in all four focus countries. All four DENV serotypes are circulating in Central America, and the disease is endemic. Chikungunya (caused by the alphavirus CHIKV) and Zika (a flavivirus) are viral diseases transmitted by mosquito bites of Aedes species, like dengue, and considered alongside dengue as arboviruses. Due to the involvement of vectors in transmission, and an association with water storage, these arboviruses are climate sensitive diseases.

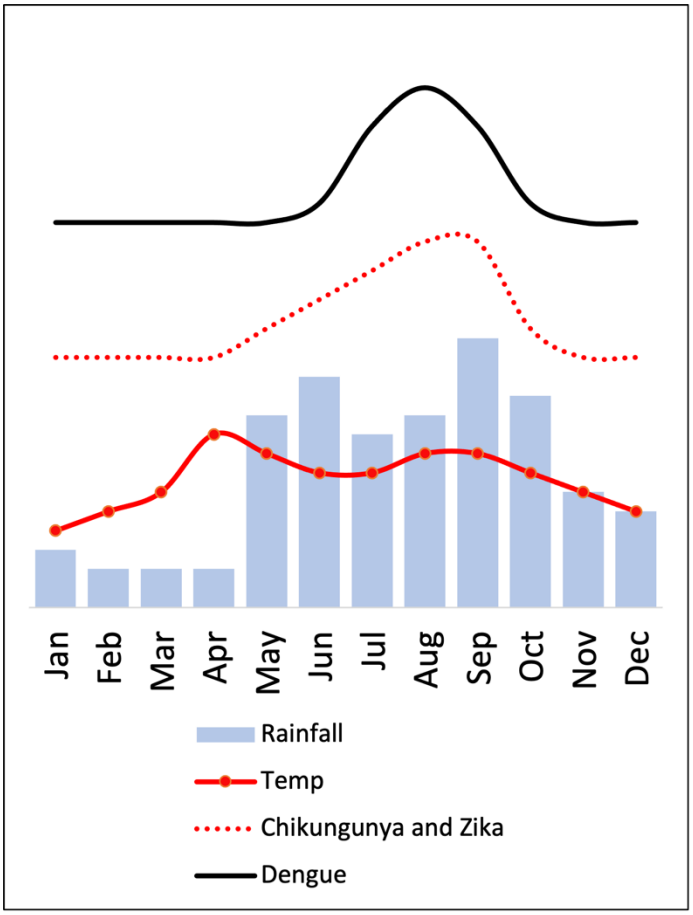
SEASONALITY

Dengue has a well described seasonality across the focus countries, peaking between July and September, coinciding with the rainy season. Generally, the peak month for transmission is September. Seasonality of Zika and chikungunya, as emerging viruses in immune naïve populations, is less clear, as data relates only to widescale outbreaks over a few years from 2014 to 2017.

The two epidemic waves of chikungunya in Nicaragua occurred between September and February then July and February of successive years. Guatemala and Honduras experienced double waves of epidemic, the first in the winter during a period of environmental unsuitability, followed by a later peak when environmental conditions became more favourable.

The period of maximum suitability, from May to September, corresponded with outbreak peaks in Honduras, Nicaragua and Guatemala.

Annual weather and seasonality of arboviruses in focus countries[1]



[1] This project is part of Humanitarian Action on Climate and Environment (HACE), an MSF Canada initiative. HACE is a collaborative and networked initiative that supports the MSF movement in applying a climate change and environmental lens to its humanitarian work in practical, transversal, and patient-centred ways. The initiative works with others across the movement supporting MSF's efforts to adapt to and mitigate climate and environmental risks with tools, research, capacity-building, advising and more. This project aimed to develop tools to connect weather and climate services to health outcomes in Central America to better prepare MSF for and respond to increased humanitarian needs driven by climate change and environmental degradation.

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MEDECINS SANS FRONTIERES
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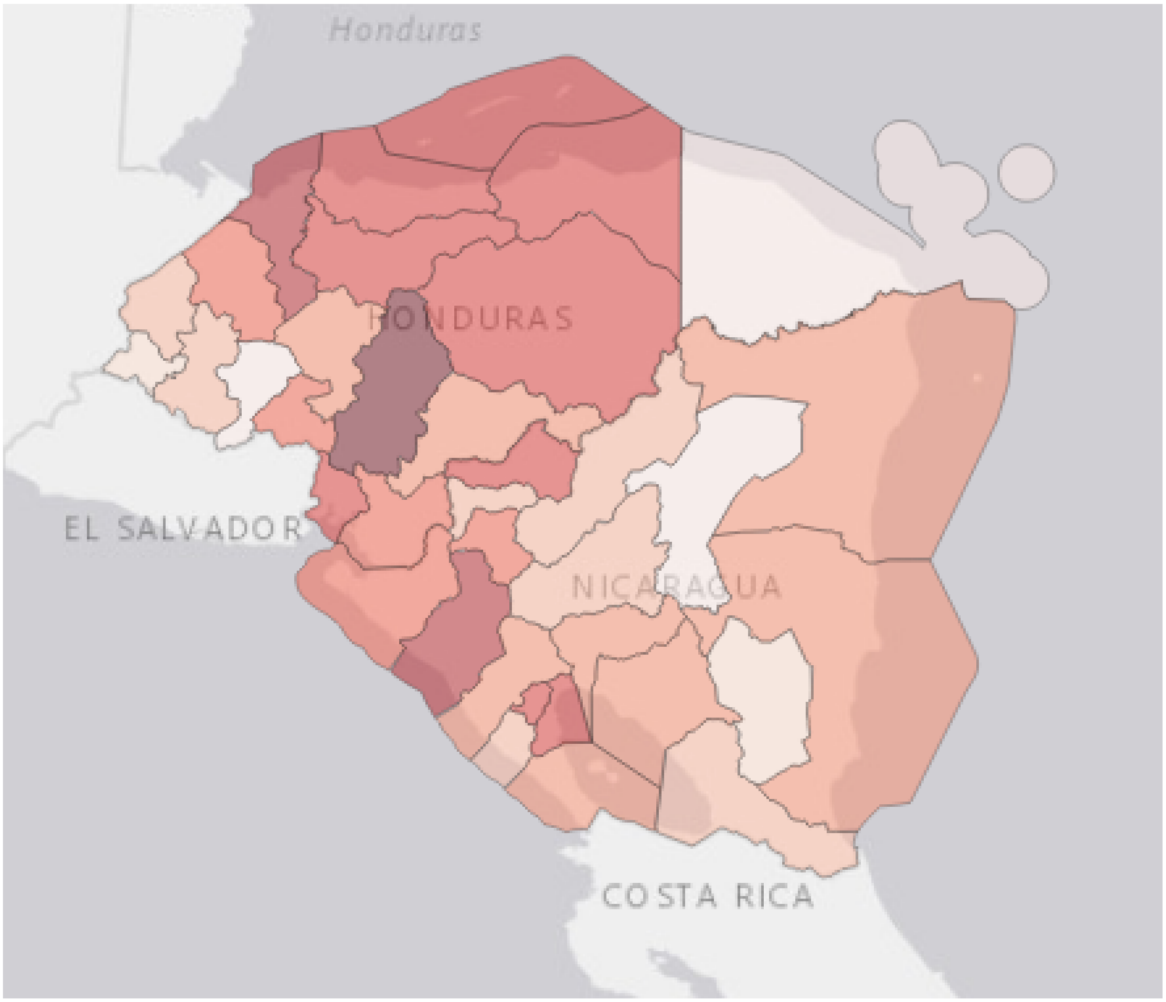
SPATIAL DISTRIBUTION OF DENGUE IN NICARAHGUA AND HONDURAS



Data from PAHO (PLISA). Data for Guatemala and El Salvador not available

OVERVIEW OF LINKS BETWEEN CLIMATE VARIABLES AND ARBOVIRUSES

Although these diseases are known to be climate sensitive, evidence for using climate and weather indicators to predicting arbovirus incidence and outbreaks is limited in these countries. Overall, there is reasonable confidence that higher minimum and average temperatures leading up to and at the start of the rainy season are linked with higher dengue incidence up to a 2-months lag. It is likely that the timing of the onset of the rainy season can be linked to the timing of peak dengue transmission with a lag of approximately 2 months. Evidence on the use of climate and weather indicators for predicting Zika and chikungunya incidence or outbreaks is limited, although climatic and environmental conditions in Central America remain suitable for these diseases. Increased El Niño activity has been linked to increased dengue incidence (through higher temperatures and lower rainfall) with reasonable confidence, and this can also be monitored.

Climate change is not projected to have a substantial impact on arbovirus disease incidence in Central America in the short term, however over the coming decades it is likely transmission risk will extend into highland areas, as overall incidence remains the same or declines. The influences of other factors on these associations, particularly human factors including population movements, urbanisation and land use change are of considerable importance.

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USE OF WEATHER INICATORS AND EARLY WARNING

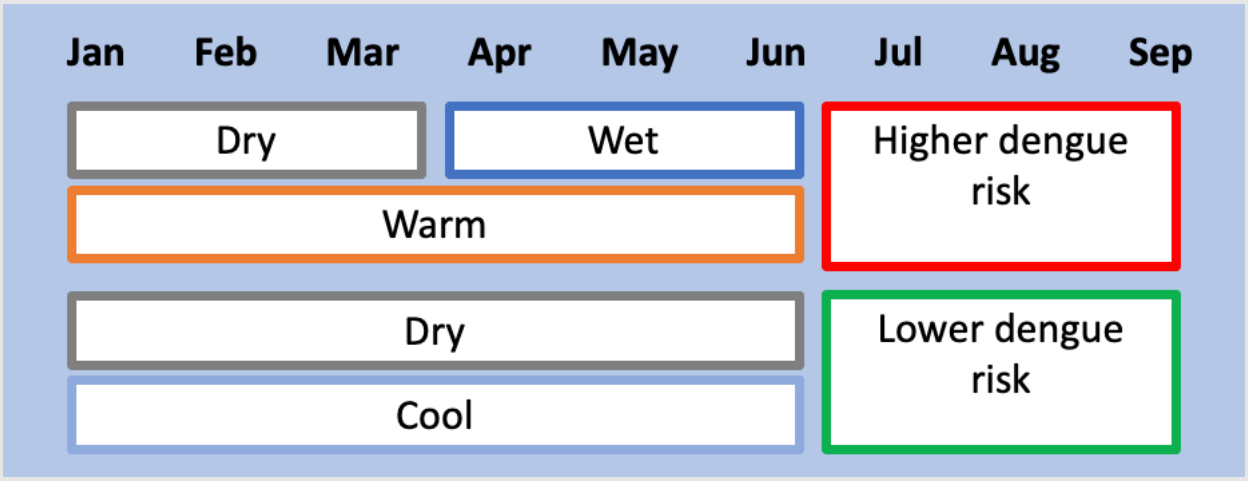
Evidence suggests the following environmental indicators could be useful for forecasting dengue[2]:

- *Weekly average minimum temperature and weekly total precipitation*
- *ENSO index*
- *Longer term regional forecasts*

These data can be used to give limited indicative predictions of the timing and intensity of dengue outbreaks in the focus countries:

- Onset of rainy season, as measured by weekly precipitation, indicates timing of onset of dengue season within 2 months
- Occurrence of increased El Nino activity suggests increased incidence of dengue will be experienced during the dengue season

Weekly weather data are available from WMO (http://worldweather.wmo.int/)
Longer term forecasting, including assessment of ENSO activity, are available monthly from Guatemala National Meteorology service (https://insivumeh.gob.gt/?p=13162)



[2] Any early warning should consider previous outbreaks and circulating serotypes, which alone are key determinants of dengue dynamic (and assumed also for Zika and chikungunya). Assessment of temperature, rainfall, and risk should be done at a local level, to account for local environmental conditions and prevailing average temperatures. The size of the lagged effect of temperature and rainfall changes on incidence requires further assessment using data from these countries to be reliably used in forecasting for public health decision making. These indicators are intended to be illustrative and indicate where further modelling would be useful.

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