CENTRAL AMERICA AND CARIBBEAN SEASONAL OUTLOOK

August – October Outlook 2024

Released August 9th

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HIGHLIGHTS

- **May-July Review:** Droughts, forest fires and extreme heat, as well as unseasonally early and severe arbovirus outbreaks (e.g. dengue) have hit the region. An unprecedentedly early category 5 hurricane (Beryl) formed in late June, as Atlantic surface temperatures were as warm as it is in Sep (peak season), providing ample fuel for storms to form and intensify.
- **August-October Outlook:** The 2024 Atlantic hurricane season (June-November) is likely to be one of the most severe on record, with 8-13 hurricanes expected to form (of which 4-7 will be major) due to hotter-than-average ocean temperatures from anthropogenic climate change, La Niña and the West African Monsoon. Monitoring these events and their trajectories and reviewing preparedness plans will be crucial to minimize impacts on lives, agriculture and infrastructure. Dengue and other arboviruses e.g. Oropouche virus (OROV) are also increasing in the region and are likely to worsen over the coming months.

Past Season Review

- **Extreme heatwaves** have caused >125 excess deaths, with records broken for both day and night temperatures across Mexico, Guatemala, Honduras and the USA. A large region of high pressure, known as a **Heat Dome (Fig 1)** covered Mexico where hot air is trapped near the ground and further heated under blue skies and sunshine. This extreme heat event was made about **35-times more likely (+1.4 °C hotter) by anthropogenic climate change** [WWA]. Deforestation is also reducing the tolerability of heat in the region [Parsons et al].
- **Drought and fires:** El Niño brought hotter, drier conditions to Central America in early 2024, especially the north Pacific coast [FEWSNET]. Forest fires have affected Guatemala damaging 9K hectares [GDACS]. From February, drought has affected 809K km^2 across Guatemala, Honduras, Mexico, Nicaragua and El Salvador, damaging agricultural land [GDACS], making the ground harder and more vulnerable to subsequent flooding if heavy rains follow [Video].

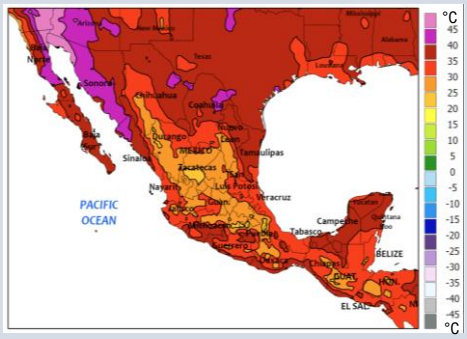

Fig 1. 'Heat Dome' effect over Mexico, southern USA and northern Central America in July [NOAA].

- **Tropical storm** ALBERTO made landfall on June 20th in Veracruz, Mexico displacing 15K people, causing severe flooding, landslides and 34 deaths. Shortly after, the earliest ever Category 5 Hurricane on record, BERYL, wreaked havoc across the Caribbean and Yucatan with wind speeds of 269km/hr. It caused 44 deaths, wiped out 98% of banana and plantain crops and devastated lobster and fishing industries. Warmer seas are increasing hurricane frequency, strength and season length (**Fig 2**).

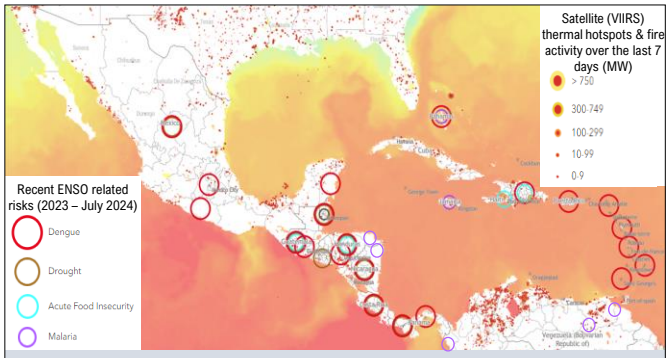

Fig 2. El Niño Southern Oscillation (ENSO) related alerts and ocean temp

- **Dengue** cases have reached 10.9M for 2024 in LATAM, an increase of +233% compared to the same period in 2023, and +418% vs the 5-year average [PAHO]. This rise in cases may be attributed to several factors, including territorial expansion of the *Aedes aegypti* mosquito [Gubler et al], which has increased its coverage massively since the 1970's, partly due to urbanisation, globalisation, climatic change and El Niño [PAHO].
- **Unseasonally early and severe** outbreaks of other arboviruses are ongoing in nearby South America and the Caribbean: e.g. Zika, chikungunya, yellow fever [PAHO] and OROV - of which a death had never been recorded until May 2024 [WHO]. Whilst most cases are in Brazil, outbreaks threaten to spread.
- **Malaria** cases have been rising in parts of Nicaragua and Honduras, as well as rates of *P. Falciparum* and rates of pyrethroid insecticide resistance [WHO]. Two malaria outbreaks with 440 cases (no deaths), occurred in southern Dominican Republic [E-Hub]. Central America is an important transit route for migrants from many countries where chloroquine-resistance is present, whilst surveillance systems and diagnostic capacities in the region are limited [Higuita et al].
- **Violence and unrest:** Haiti has seen many months of instability and violence, causing many deaths, injuries and difficulties for MSF missions. Collapse of the healthcare system could increase the incidence of many infectious diseases (e.g measles, diptheria, malaria, TB and HIV), as has been seen in Venezuela following recent economic and political crises [Tuite et al].
- **Food and agriculture:** Rainfall deficits related to El Niño damaged agriculture in the 'Dry Corridor' and northern Honduras. Heat and drought has also increased the risk of agricultural diseases and pests, e.g. Coffee Rust (*Roya* or *Hemileia castatrix*). In Haiti, emergency food assistance has been insufficient, reaching just 4% of the population [FEWSNET]. Anthropogenic wetland destruction and intensive poultry farming has facilitated the spread of highly pathogenic avian influenza (H5N1), from Central to South America, decimating wild bird and mammal populations, causing devastating biodiversity loss [Mongabay].

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AUGUST TO OCTOBER CLIMATE OUTLOOK

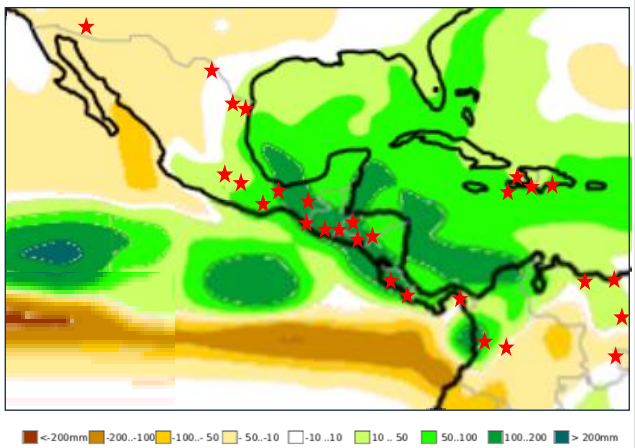


Fig 3. Rainfall seasonal forecast (ensemble mean anomaly) for Aug-Oct [CS3] ★ = MSF project locations in Central America and Caribbean.

- **Above average rainfall** is forecast for August-October across most of the region (high probability **Fig 3**), except the north-west of Mexico where rainfall will likely be below average.
- There is a high likelihood (77%) that **La Niña** will return during the peak hurricane season months of August-October, and a 45% chance that this La Niña event will be moderate-to-strong. La Niña reduces vertical wind-shear and increases atmospheric instability which reinforce the conditions associated with high activity for Atlantic Hurricanes (NOAA), although higher intensity La Niña does not always translate into greater storm impacts.
- Atlantic hurricane risk peaks in September, both in terms of the size of area affected and frequency and intensity of storms. In August, most hurricane landfall is along the eastern Caribbean and East coast of the USA, but in September and October the risk distribution of hurricane landfall increases along the east coast of Central America (NOAA). Pacific hurricanes also cause most damage to Mexico's West Coast in September [NOAA].

AUGUST TO OCTOBER HEALTH & NUTRITION OUTLOOK

Fig 4A – Dengue in the Caribbean subregion

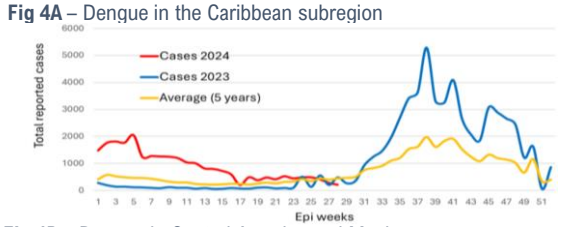
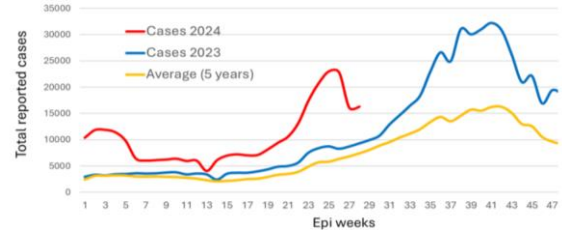


Fig 4B – Dengue in Central America and Mexico



Suspected dengue cases in the Caribbean **Fig 4A,** Central America and Mexico **Fig 4B** for 2024, 2023 and 5-year average [PAHO].

- **Outbreaks:** Mosquito-borne diseases typically increase in risk, peaking towards the end of the rainy season around September-November. **Dengue** is the most widespread arbovirus in the region, with cyclical epidemics every 3-5 years and cases have been significantly above the 5-year average (**Fig 4A+B**). OROV cases have been reported in Cuba and it threatens to spread. As with other tick-borne and mosquito-borne diseases [Ortiz et al], OROV outbreaks are associated with deforestation [Romero-Alvarez et al].
- **Health impacts of hurricanes** include immediate and devastating loss of life from trauma, electrocution and drowning. Over following weeks, infrastructure damage has WASH impacts, increasing the risk of waterborne diseases (e.g. cholera, hepatitis A/E and other diarrhoeal diseases). Later, atypical mycobacterial and fungal infection risk rises, and snakebite and rodent-borne infections (e.g. leptospirosis) increase as they are both are forced out of flooded borrows. Mosquito-borne diseases rise later as stagnant puddles form breeding grounds and rains allow hatching of *Aedes Aegypti* eggs, which can lay dormant in dry soil for up to 8 months.
- **Respiratory diseases** such as allergic rhinitis and asthma can be exacerbated by episodes of Saharan dust coming to the Caribbean this season [RCC], and Covid-19, influenza and RSV cases are increasing, leading PAHO to make an alert [PAHO].
- **Non-communicable diseases** are heavily impacted by hurricanes as both physical and emotional stress exacerbate chronic diseases and mental health conditions. Infrastructure damage delays access to healthcare, and injury risk remains high in the aftermath due to dangerous rescue, debris-clearing and reconstruction efforts. Health impacts of hurricanes and flooding cut along lines of poverty and inequality and can disproportionately affect women. Gender-based violence can increase when shelters are deficient. Salinisation of drinking water increases pre-eclampsia and hypertension risk, and exposure to contaminants (e.g. oil, toxic industrial waste), increase cancer risk and cause catastrophic environmental degradation.
- There is never one single reason that people migrate, rather many complex colliding factors, but climate plays a crucial role, with hurricanes [Spencer et al] and droughts [Murray-Tortarolo et al] identified as key regional factors.
- **Food/agriculture:** Most very poor households in rural areas of the 'Dry Corridor' will likely remain at a 'stressed' or 'crisis' (IPC2-3) levels of food insecurity, especially in Honduras where the population in need (500-750K) will peak in late August. The situation in Haiti is also severe with 2-2.5M people in need of emergency food assistance. Improvement is expected with the delayed '*Primera*' harvest in September, but the transition towards La Niña will bring erratic rainfall and high temperatures, increasing the risk of pests and diseases, especially for bean crops [FEWSNET].

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Calendar bars

50	200	336
0	8	16

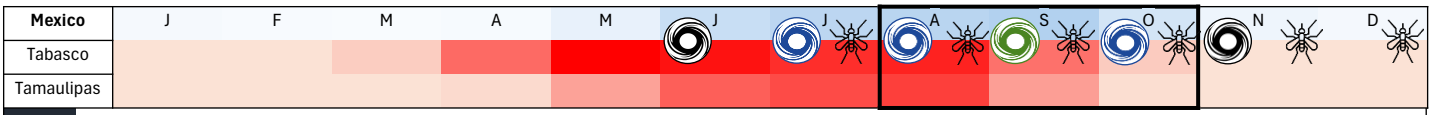
Blue bars represent national average precipitation from 1991-2022, with the blue gradient ranging from 0-336mm per month. Red bars represent the average number of days per month above Heat Index >35°C, a measure which combines humidity and heat and is more representative of heat stress to the body. We used HI>35°C projections for 2020-39 for the optimistic socioeconomic emission scenario (SSP1-1.9), as it best-fits current regional temperature increases (+1 to 1.9°C) [CKP]. This data is not a forecast for *this* upcoming season. Many countries have *highly variable* local rainfall and HI>35°. For each country we have chosen states where HI>35°C will reach dangerous levels or the majority of MSF projects are located: Tabasco and Tamaulipas for Mexico, Guatemala City for Guatemala, Monte Cristi and Santo Domingo for Dominican Republic, Usulutan for El Salvador, Ouest for Haiti, Chinandega for Nicaragua, and Choluteca for Honduras. For precise local data we recommend [ERA5] and for weekly updates here.

The colour of the hurricane symbol represents the average number of Atlantic Hurricanes that made landfall on the coast of that country for each month per 100 years: black for <5, blue for 5-19 and green for 20-34 hurricanes. Data from NOAA. (N.b. hurricanes from the Pacific were not included.) Near-real time updates here

Black mosquitos represent historical monthly dengue peaks (from PLISA or peer-reviewed literature). In Haiti, we also show malaria ( ) and cholera ( ) peaks. Malaria is endemic across the region but was eliminated in El Salvador (2021) and Belize (2023). Mosquito-borne diseases mostly peak with rainfall, and with a longer lag-time following drought [Lowe et al]. Outbreaks increasingly occur outside of historical seasons due to atypical climatic patterns impacting vectors and migration affecting local immunity.

NDGI 0-100

ND-Gain Index (NDGI) is composed of two key climate adaptation dimensions: **Vulnerability:** a combination of food, water, health, ecosystem, human habitat, and infrastructure indicators and **Readiness:** a country's ability to leverage and convert investment into adaptation actions, composed of economic, governance and social readiness (from 0-100).



Mexico

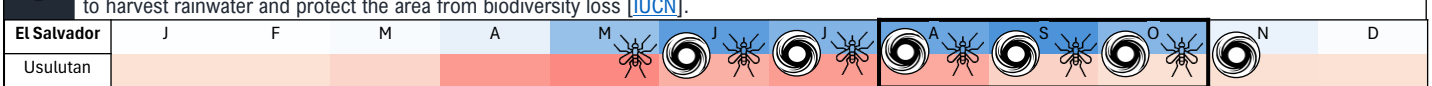
NDGI 48.8

Climate: Tropical storms Alberto and Chris have caused severe damage in Veracruz, causing landslides, flooding and displacing thousands. A severe heatwave hit Mexico in May/June causing over 125 excess deaths due to extreme heat [WWA]. Since Feb 2024, drought has impacted much of the southeastern part of Mexico [GDACS], and has been almost as severe as the 2012 droughts [MSM]. Climate change is projected to dramatically increase the impact of heatwaves from May-September time in Mexico in years to come [FEWNET]. Climate-shocks like drought are one of the many causes of migration north to the USA. They also increase rural-to-urban migration within Mexico, especially when communities are exposed to over a certain threshold of dry months [Nawrotzki et al]. Whilst there has been concerns of groundwater running out in CDMX [CNN], there has also been flash flooding in Guerrero state in July due to heavy rains, causing deaths and displacement [GDACS]. The August-October forecast is one of above average rainfall (especially in the Yucatan and along the Belize and Guatemala borders). There will likely be below average rainfall in the northwest of the country around Baja California, Sonora and Chihuahua. Above average temperatures are predicted nationwide for August-October [CS3]. With the upcoming hurricane season predicted to be severe, the Atlantic coast (and pacific coast to a lesser degree) are at increased risk. Of course, the location of hurricane landfall is impossible to predict until closer to the time. Areas in the Yucatan that are at risk of flooding from storm surges are mapped here by NOAA. **Health**: There has been 139.7K cases of dengue reported in Mexico so far for 2024 and 49 deaths [PAHO]. Cases have historically increased across Central America and Mexico over the second half of the year (July-December) and peak around October [PAHO]. Deforestation is associated with an increase in local dengue risk: a 1% loss of forest cover corresponding with a 17% rise in risk [Galeana-Pizaña et al]. Hurricane Otis (2023) led to debris, garbage and puddles that provided breeding grounds for mosquitos and a subsequent spike in dengue cases in Acapulco [Smith]. Leishmaniasis is also re-emerging [PAHO], especially in Yucatan, partly due to climate change [Canché-Pool et al]. In Mexico there were 163 cases of malaria (all *P. Vivax*), and no deaths reported in 2022. Indigenous cases have been reducing annually since 2018. In the longer-term and more generally, Mexico is predicated to have an increased burden of Chagas disease due to climate change and increased distribution of the *triatomine* vector of *Trypanosoma Cruzi*. In 2024, most migrants arriving at the US-Mexico border came from 6 Latin American countries: Mexico, Guatemala, Venezuela, Cuba, Ecuador, and Colombia, but there is an increasing number travelling from as far as China, India Afghanistan and West Africa [WRC]. **Nutrition:** The transition from El Niño to Neutral conditions caused the irregular start of the rainy season, with a delay of approximately one month, delaying the establishment of the '*Primera*' cycle until early June, which will delay the harvest until September. If hurricanes do make landfall the flooding, infrastructure damage and landslides they cause may kill livestock and dramatically damage crops and reduce yields from the September harvests. Coffee Rust has increased due to high temperatures, and this is likely to continue to damage crops [Castillo et al].

Guatemala

NDGI 43.9

Climate: Rainfall is likely to be above average from August-October for much of Guatemala, especially the central states and Mexican border [CS3]. **Health**: There have been 53,489 cases of dengue in Guatemala so far in 2024 (10x more than this time last year) and 59 deaths [PAHO]. Cases historically have increased from June-July, peak in August and slowly drop from September-December (mostly DENV1 and DENV2) [Signor et al]. Although malaria risk is not as high as in eastern Nicaragua and Honduras, climate change has caused an increase in the number of months suitable for malaria transmission in Guatemala between 1950 and 2019 [Fig 12.4, IPCC]. There were 1.9K malaria cases (no deaths) in 2022 and as in Mexico main vectors are *An. albimanus, pseudopunctipennis, vestitipennis* and *darlingi* [WHO]. **Nutrition**: During the intense hurricane season of 2020, Eta and Iota inflicted major damage to infrastructure, agriculture, and housing, displacing >100K people in the northeast and in Alta Verapaz, soil damage is still present due to sand and sediment that covered the fertile land. Central states are likely to see many households in IPC3 (crisis) level of food insecurity, the areas of greatest concern are the Dry Corridor, Alta Verapaz, and Altiplano, where consecutive climate impacts have reduced resilience. Erratic rainfall and high temperatures damaged the basic grain crops of at least three past cycles, reducing availability of food and income from labour for poor rural households. An estimated 2M-2.5M people are in need of food assistance over the June-September lean season, and improvements are unlikely until October [FEWSNET]. The transition to La Niña brings increased risk of flooding, soil erosion and landslides to highland communities, but some farmers are using 'Ecosystem-based Adaptation' practices to harvest rainwater and protect the area from biodiversity loss [IUCN].



El Salvador

NDGI 45.9

[MSF discontinued projects in 2021]. **Climate:** Above average rainfall and temperatures are forecasted for the upcoming season across El Salvador [CS3]. The IPCC report highlights El Salvador as being at high risk of hydric scarcity and water stress in years to come [IPCC]. Between 2020–2022, violence and conflict internally displaced 362K people, while natural hazards displaced 22K people[acaps]. Tropical storm Alberto caused 34 fatalities and displaced thousands. **Health**: El Salvador was certified malaria free by the WHO, but outbreaks of other mosquito-borne diseases such as arboviruses (dengue, chikungunya and zika) are ongoing and often peak over the coming months. In July 2024, the ministry of health declared an alert due to a steep rise in dengue cases and 4 child deaths, there has been over 4,188 cases so far in 2024 [MINSAL]. The world mosquito program began its Wolbachia project, releasing infected mosquitoes from Janurary-June 2024 in Santa Ana, San Sebastián Salitrillo and Chalchuapa [WMP]. **Nutrition**: The lean season was extended due to delayed rains in the 'Dry-Corridor' and the border regions of El Salvador are forecast to remain in a state of mild food insecurity (IPC2, stressed) over the coming months [FEWSNET]. Deforestation, water pollution and land erosion is damaging health in the region, disproportionately affecting poor communities [USF].

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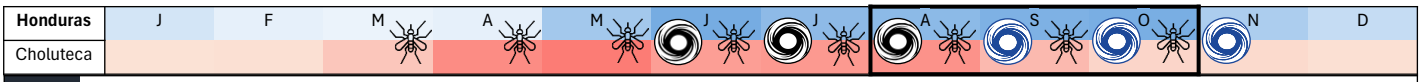


Honduras

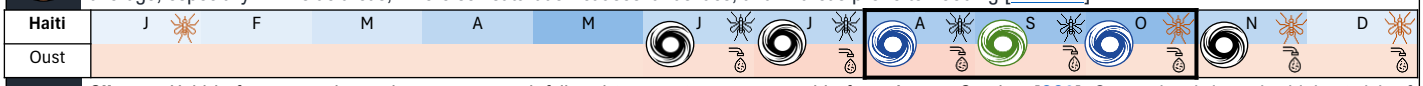
NDGI 40.3

Climate: Rainfall is likely to be above average for the upcoming August-October season across all of Honduras, especially along the coastal area bordering Nicaragua and the North border with Guatemala [CS3]. Usually, the highest risk of drought is also from May-November [CHD]. **Health:** Honduras declared an emergency in June due to increasing dengue, with 58,270 cases so far in 2024 and 26 deaths [PAHO]. Most affected areas are Tegucigalpa and Cortés. Previous outbreaks have peaked around July in Cortés, Francisco Morazán and Yoro [Zambrano et al]. Since July 2023, MSF and the WMP has been running the Arbovirus Prevention Project, involving *Wolbachia* introduction in Tegucigalpa [MSF]. Dengue outbreak prediction models for Honduras based on climatic factors are improving [Martheswaran et al]. There were 3.5K cases of malaria and no deaths reported in 2022, but the proportion of cases that are *P. Falciparum* has tripled over 12 years. The main vector is *An. Albimanus* and insecticide resistance is increasing [WHO]. In June >40K refugees and migrants arrived in Honduras needing medical assistance [E-hub]. **Nutrition**: Food insecurity is at crisis (IPC3) levels, particularly for subsistence farmers in the north who suffered crop losses in 2023 due to dry and hot conditions caused by El Niño. In recent months, poor households have resorted to relying on food purchases earlier and more heavily than usual. This is unlikely to improve until the delayed '*Primera*' harvest in late September [FEWSNET].

Nicaragua

NDGI 41.5

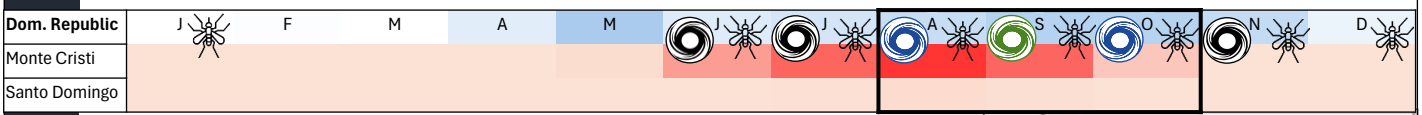
[MSF currently has no ongoing projects in Nicaragua, with the OCBA project on access to healthcare for populations in areas affected by gang violence finishing in Nov 2021]. **Climate:** Nicaragua is forecasted to have above average rainfall for August-October, especially along the Northwestern coastal area, bordering Honduras [CS3]. Following catastrophic hurricane Mitch in 1998 (the second deadliest Atlantic hurricane on record), displacement disproportionately affected women and poorer households, and subsequently increased the likelihood of developing respiratory diseases [Loebach et al]. **Health:** Malaria cases have been increasing from 2,279 in 2015 to 23,259 in 2021 and the proportion of cases that are *P. Falciparum* has increased from about ~20 to ~30% too. The main vectors are *An. Albimanus* and *pseudopunctipennis* and insecticide (pyrethroid) resistance is on the rise too [WHO]. There has been a total of 17,339 cases of dengue in 2024 so far and no deaths [PAHO]. Peak incidence of both dengue [Theodorakos et al] and malaria is historically around October/November towards the end of the rainy season [PATH]. **Nutrition**: The areas of greatest concern for food insecurity are in the 'Dry Corridor'. Abnormally high temperatures have increased risk of pests and diseases. Although this hasn't caused significant damage, it has led to higher costs for farmers. Due to La Niña, warm conditions and irregular rainfall are expected to continue. The '*Primera*' harvest is expected to be below average, especially in hillside areas, where soil saturation causes landslides, and in areas prone to flooding [FEWNET].



Haiti

NDGI 35.5

Climate: Haiti is forecast to have above average rainfall and temperatures countrywide from August-October [CS3]. September brings the highest risk of Hurricane impact. Deforestation is exacerbating the risk of damage and flooding [Louis et al]. **Health**: Due to ongoing violence, nearly 600K people are internally displaced [IOM], with 300K women and girls facing unprecedented levels of gender-based violence. Haiti's largest hospitals have intermittently had to close amid drug/supply shortages and many medical staff have resigned or had to leave. The airport reopened in June bringing some much-needed supplies and assistance to MSF projects [Souk]. IDP sites are overcrowded with 76% lacking adequate lighting, and 31% without latrines. At least 1.4K Haitian refugees have been encountered by government authority vessels at sea – of increasing concern as the Atlantic Hurricane season intensifies [UNHCR], and 50K Haitians have been forcibly returned to Haiti by various countries over recent months. Around 80% of the population are at risk of malaria (especially those living <300m altitude), prevalence is ~5%, or 50K cases/year, and there were 89 deaths in 2022. Despite the importance of malaria as a top ten cause of morbidity and mortality in Haiti (especially for pregnant women and children), few studies describe seasonality. Cameron et al and Eisele et al show that for most of the country, (especially the central and valley) malaria cases rise from October to peak in December (🦟) and decline rapidly from to a low over April–May. There is a hotspot of cases on the north coast of Grand'Anse, and this area shows a potential biphasic pattern with a smaller second peak in June. The main vector is *An. Albimanus* [WHO]. Although dengue outbreaks can occur year-round in the Caribbean, most are from June-September (🦟) [Amarakoon et al]. The recently emerging zoonosis OROV was reported nearby in Cuba. Since the 2010 cholera outbreak, cases were mostly during the rainy season (🌧) May-December, falling to a low from January-April [Rebaudet et al and Gaudart et al]. **Nutrition**: Nearly 5M Haitians (~½ the population) face acute hunger, with 1.6M at risk of starvation. Haiti has experienced widespread crisis and emergency (IPC3-4) levels of food insecurity with some areas coping slightly better (IPC2) [FEWSNET]. Although violence decreased from March-May by about 60% (in number of violent events and deaths), transportation remains disrupted by gangs forcing bribes, keeping food prices high. Erratic rains led to a below-average spring harvest. Food insecurity is predicted to improve slightly from October in some areas (Nord, Sud and Centre), but most areas will remain in crisis.



Dominican Rep.

NDGI 47.2

Climate: The August-October season brings above average rainfall and temperatures, and the highest risk of Hurricane impact is during September. Areas in Hispaniola that are at risk of flooding from hurricane related storm surges are mapped here by NOAA. **Health**: Dengue cases historically have increased from June-September, peaking around October, and decrease from November-February. Zika (2016) and chikungunya (2014) outbreaks occurred earlier between March-June, but this is not enough data to confirm seasonality. Malaria cases are almost exclusively *P. Falciparum* but have reduced from 1,291 in 2019 to 320 in 2022 and Dominican Republic (DR) is part of the E-2025 malaria elimination plan. From October 2022, to 30th December 2023, 332 confirmed Cholera cases were reported, including two deaths. The provinces with the largest number of cases were Distrito National (112), Barahona (67), Santo Domingo (51) [ENSO-RAD]. **Nutrition**: About 1M people faced acute food insecurity from May-August 2024 despite above average main paddy crop harvest and reducing inflation [FAO]. Biodiversity loss, deforestation and water scarcity is concerning longer term. With population growth, a projected -20% reduction in rainfall and increased evapotranspiration due to climate change, freshwater resources could decline from 2,200m^3 to <400m^3 per capita by 2100 [IANAS].

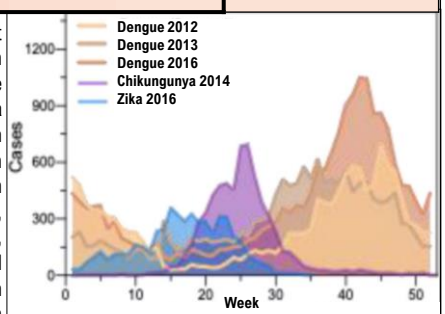


Fig 5 – Dominican Rep. arbovirus outbreak seasonality 2012-2018 [Petrone et al]

DISCLAIMER: While climate forecasts can offer insights on health outcomes, other drivers (e.g. conflict, displacement, migration, socio-economics, politics and immunity and vaccination) modulate disease transmission and should always be considered. Furthermore, the impact of weather conditions may peak well after shifts in weather.