Malaria is one of the leading causes of infectious disease worldwide, with between 154 and 289 million people being infected by it in 2010 alone. Of these people, around 660,000 of them died from the disease.[[1]](#footnote-1) Malaria is caused by a single-cell parasite (genus *Plasmodium*) and is transmitted to humans via mosquitoes (genus *Anopheles*). The parasite’s success in a mosquito host depends on environmental factors such as temperature and humidity; the parasite thrives in a host when temperatures are higher, and mosquitoes thrive when the temperature is in the right range and there is enough water present for viable eggs.[[2]](#footnote-2) The transmission of malaria from mosquitoes to humans is complex and is related to both environmental and socioeconomic factors. Parham and Michael[[3]](#footnote-3) determined that the transmission of malaria is optimized around 32-33 degrees Celsius. Mosquitoes do not thrive as well in temperatures both below and above this temperature, which prevents more mosquitoes from living long enough for the parasite to complete its life cycle. This temperature range has been debated, though, with another study done by Gillioli and Mariani[[4]](#footnote-4) concluding that there is a bell-shaped distribution of mosquito population that peaked at 24-25 degrees Celsius; this was supported by a study conducted by Mordecai *et al*.[[5]](#footnote-5) The study that reported higher ideal temperatures analyzed more recent data, while the studies that found lower ideal temperatures included data from farther back. The discrepancy could be related to global warming and increases in baseline temperatures, or the first study just had fewer data and only looked at recent years where temperature has been high.

A graphical analysis of malaria and environmental data from Mozambique was conducted using R. Because of known environmental factors influencing malaria transmission and endemics, the cycle of malaria cases was compared to the cycles of temperature and rainfall. The data were from 2010-2016. There were some data from 2017, but a complete years’ worth of data was not available for 2017 and was thus excluded from some analyses. Cases were counted each week and analyzed as cases per thousand (CPT) for children under the age of 5. This was calculated first at the province level and then aggregated over entire districts of the country. Temperature was averaged over each week by province and district. Rainfall was aggregated over each week by province and district. Due to meteorological systems and the life cycle of mosquitoes, malaria cases increase a certain amount of time after rainfall and during ideal temperatures. Because of this, one primary question of interest was what the optimum lag time between CPT and total rainfall, and CPT and average temperature were to predict future malaria case numbers. Other questions considered were whether how any of the variables of interest vary across the country of Mozambique, and how they vary across time. Additionally, the difference in CPT between 2010 and 2016 were examined.

First, optimum lag times were examined using the ccf function of the Stats package (found in base R). This allows us to check each potential lag time (in weeks) between the number of CPT and the predictor of interest. It was found that CPT is most correlated with total rainfall when there is a lag of 4 weeks (), and that CPT was most correlated with average temperature when there is a lag of 16 weeks (). Correlations can be found in Table 1. After graphing CPT and total rainfall with a 4 week lag, we can see that the peaks of the two variables line up in Figure 1; this is also apparent with average temperature with a 16 week lag and CPT in Figure 2.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | 2 wk Lag | 4 wk Lag | 8 wk Lag | 16 wk Lag |
| Raintot:CPT Corr | 0.1207327 | 0.1612867 | 0.1150122 | 0.0484301 |
| AvgTemp:CPT Corr | 0.0534146 | 0.0815300 | 0.1621366 | 0.2123718 |

Table 1: Correlations between lag times of predictors and CPT.

1. Organization, *World Malaria Report 2014*. [↑](#footnote-ref-1)
2. Prevention, “CDC - Malaria - About Malaria - Biology - Mosquitoes - Anopheles Mosquitoes.” [↑](#footnote-ref-2)
3. Parham Paul Edward and Michael Edwin, “Modeling the Effects of Weather and Climate Change on Malaria Transmission.” [↑](#footnote-ref-3)
4. Gilioli and Mariani, “Sensitivity of Anopheles Gambiae Population Dynamics to Meteo-Hydrological Variability.” [↑](#footnote-ref-4)
5. Mordecai et al., “Optimal Temperature for Malaria Transmission Is Dramatically Lower than Previously Predicted.” [↑](#footnote-ref-5)