Spatio-temporal Spillover Risk of Yellow Fever in Brazil

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Supplemental Information

Monthly confirmed cases of yellow fever for each Brazilian Município (sub-state administrative units) from 2001 to 2013 were downloaded from the Brazilian government's portal da saúde website, `tabnet` (`http://tabnet.datasus.gov.br`) on 05 June 2017. Confirmed cases were reported by the Ministry of Health Notification of Injury Information System (SINAN-Net) as determined using clinical-epidemiological criteria.

The annual population for each Município from 2001 to 2013 was also downloaded from the Brazilian government's portal da saúde website, `tabnet` on 05 June 2017. The estimated population was calculated by the Instituto Brasileiro de Geografia e Estatística (Brazialian Institure of Geography and Statistics) as intercensorial estimates.

Monthly land surface temperature and normalized difference vegetation index (NDVI) data from 2001 through 2013 were downloaded from the NASA Land Processes Distributed Active Archive Center (LP-DAAC). The MODIS MOD11C3 product contains monthly temperature data at a 0.05°resolution. THE MODIS MOD13A3 product contains monthly NDVI data at a 1 km resolution. Both gridded data products were then aggregated to the municipality level to obtain a monthly spatially averaged temperature and NDVI value for each municipality.

Rainfall data was obtained from the NASA GESDISC data archive in the form of data from the Tropical Rainfall Monitoring Mission from 2001 through 2013. The 3B43 product contains an average rainfall rate for each month at a 0.25°resolution. We aggregated the gridded data to the municipality level by taking the spatial mean.

Monthly fire locations were downloaded from the Fire Information for Resource Management System (FIRMS). The MODIS Active Fire Product (MCD14ML) reports fire at a 1 km resolution by month. This data was then aggregated to the total number of fires per municipality by month, and scaled to density by dividing by the municipality's total area.

Primate species richness data was obtained from the IUCN Redlist of Terrestrial Mammals for species in genera known to be susceptible to yellow fever (*Ateles, Aotus, Alouatta, Saimiri, Cebus, Callicebus, Callithrix, Saguinus, Lagothrix*) [1, 2]. Individual species' ranges were combined to calculate the number of species found within a municipality, defined as species richness. We also estimated the relative proportion of primate habitat overlapping with agricultural land use per municipality per year. Shapefiles of geographic

ranges of each genus were constructed from the above range maps. Yearly land cover data from 2001 - 2013 was downloaded from the NASA Land Processes Distributed Active Archive Center (LPDAAC). The MODIS MCD12Q1 dataset contains yearly land cover categories at a 1 km resolution by year. The proportion of total municipality area that was both agricultural land use and within a genus range was then calculated for each genus. These proportions were then summed over all nine genera, resulting in a value from 0 - 9 per municipality by year, defined as the Agricultural and Primate Overlap.

References

[1] Bicca-Marques, J.C., de Freitas, D.S.: The Role of Monkeys, Mosquitoes, and Humans in the Occurrence of a Yellow Fever Outbreak in a Fragmented Landscape in South Brazil: Protecting Howler Monkeys is a Matter of Public Health. Tropical Conservation Science **3**(1), 78–89 (2010). doi:10.1177/194008291000300107

[2] Hamrick, P.N., Aldighieri, S., Machado, G., Leonel, D.G., Vilca, L.M., Uriona, S., Schneider, M.C.: Geographic patterns and environmental factors associated with human yellow fever presence in the Americas. PLOS Neglected Tropical Diseases **11**(9), 0005897 (2017). doi:10.1371/journal.pntd.0005897

Table 1: Data summary

Model	Positive Observations			Background Observations		
	Training	Testing	Total	Training	Testing	Total
SPP	81	35	116	607,070	260,174	867,244
LRR	67	28	95	584,159	250,346	834,505
HRR	14	7	21	22,911	9,828	32,739