Leptospirosis Exposure Risk Analysis, Thailand

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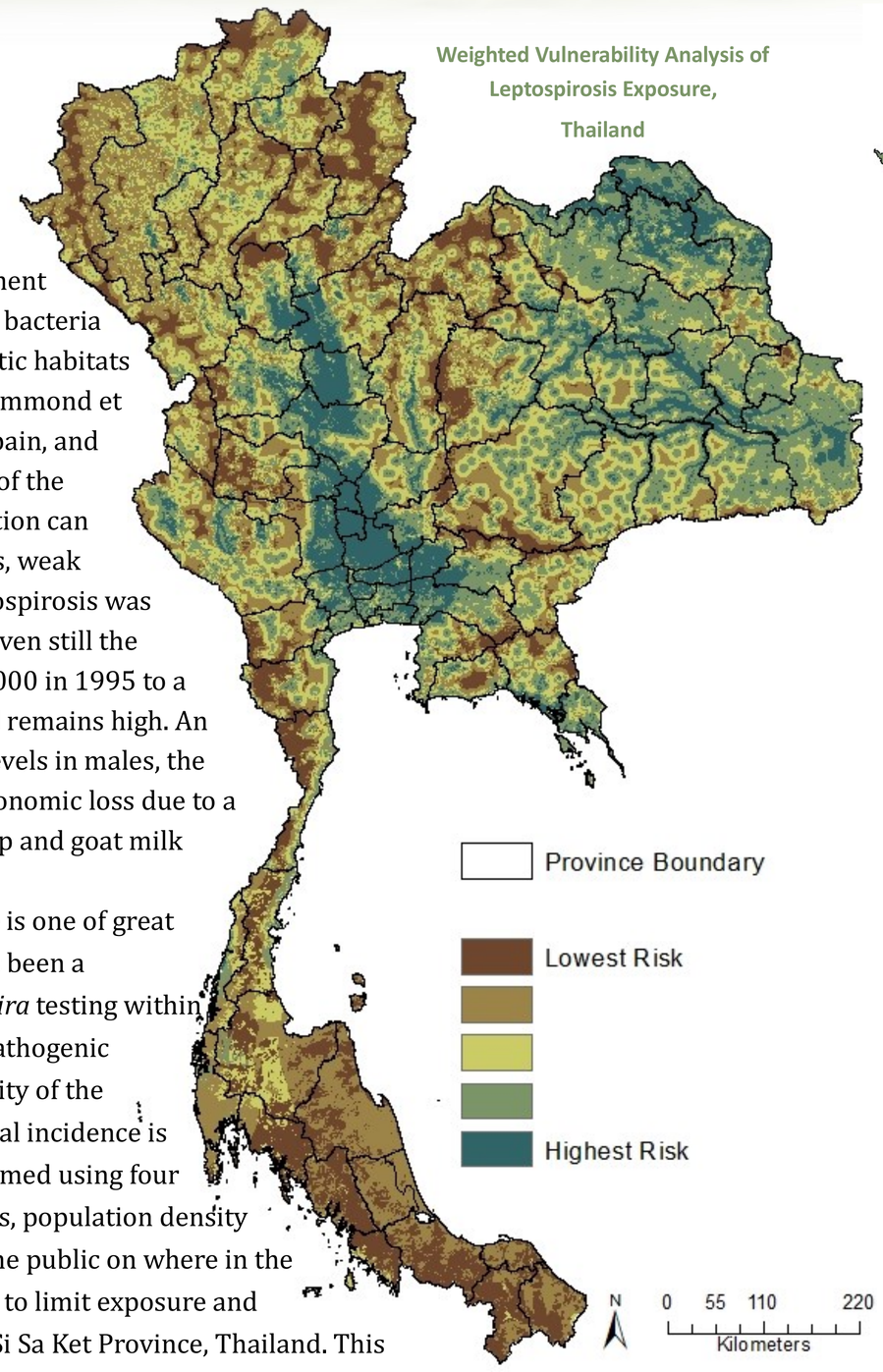
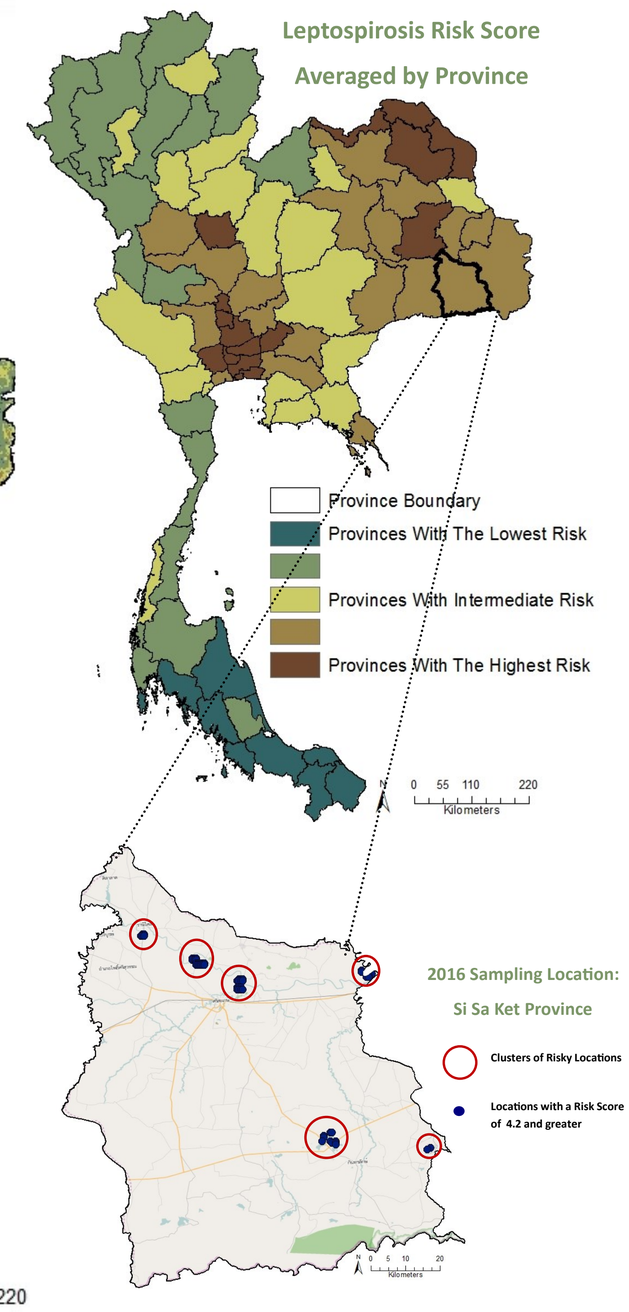
Leptospirosis In Thailand

Leptospirosis is a zoonotic disease derived from spirochete bacteria of the genus *Leptospira* (Hammond et al, 2014). Transmission of the bacteria, known as leptospires, involves contact with contaminated water. Leptospires are shed in the urine of infected host animals, and maintained in the environment due to chronic renal infection in carrier animals such as rats and cattle. These bacteria persist in certain environments because they can thrivein nutrient-poor aquatic habitats due to protective interactions with other bacteria and biofilm formation (Hammond et al, 2014). In humans common symptoms include fever, nerve, joint and head pain, and redness of the eyes, with patients developing renal complications about 10% of the time (Tangkanakul, 2005). In ruminants persistent reproductive system infection can lead to lowered fertility, prolonged time between calving, abortions, stillbirths, weak juveniles and a drop in milk production (Martins and Lilenbaum, 2014). Leptospirosis was first reported in Thailand in 1942 and has been on the rise since the 1960's. Even still the number of cases continues to rise, from an incidence of less than 0.3 per 100,000 in 1995 to a peak in the year 2000 with an incidence of 23.7 cases per 100,000 people and remains high. An average of 80% of cases are in people between 25-54 years old, with higher levels in males, the typical working class (Tangkanakul, 2005). This presents the burden of economic loss due to a drop in healthy working-age men compounded by the decrease in cattle, sheep and goat milk and meat yield.

Although it has been established that this disease is one of great environmental influence within Thailand, there has been a surprisingly low amount of environmental *Leptospira* testing within the country. Results have not found high levels of pathogenic leptospirosis in the water bodies, however a majority of the sampling is being done in Bangkok where the clinical incidence is low (Thaipadungpanit et al, 2013). A weighted vulnerability analysis is preformed using four risk factors for leptospirosis: amount of precipitation, proximity to flood zones, population density and land use type. This analysis is done in effort to inform researchers and the public on where in the country is most vulnerable to the risk of environmental leptospirosis in order to limit exposure and target their sampling efforts. Rodent sampling is already being performed in Si Sa Ket Province, Thailand. This analysis will not only give researchers a broad view of Leptopsirosis risk within the country, but the results will be directly applied to a field sampling effort during May and June 2016.





Methods

Vulnerability Analysis: Raster calculator was used to perform a weighted risk analysis. See the reclassification table for weight of each risk factor.

Risk Score Average by Province: Zonal Statistics was performed on the vulnerability map for mean score within the province. Province boundaries were taken from Global Administrative Area (GADM), 2015.

Si Sa Ket Focus: The vulnerability was clipped to the Si Sa Ket province. The raster was then converted to points, each of which contained an individual risk score. Select by attributes found all points over 4.2 to get 55 of the most risky points. An ESRI open street map background was used.

Table 1: Reclassification Criteria

Factors	Weight	Risk Score 1 (Lowest Risk)	Risk Score 2	Risk Score 3	Risk Score 4	Risk Score 5 (Highest Risk)
Accumulated Precipitation (mm)	20%	<100	100.1 - 200	200.1 - 300	300.1 - 400	> 400.1
Population Density (persons per sq km)	10%	<100	100.1–1,000	1,000.1–10,000	10,000.1-100,000	>100,000.1
Distance to Flood Zones (m)	40%	0	>0–1,000	1,000.1–5,000	5,000.1-10,000	>10,000.1
Land Use Type	30%	Non-Vegetated, Ocean	Primarily Forested (>60%), Primarily Grassland (>60%)	Mixed Agricultural / Forested Land	Cropland, Pasture	Wetlands, In-land Water

Table 2: Top 10 Most Risky Provinces

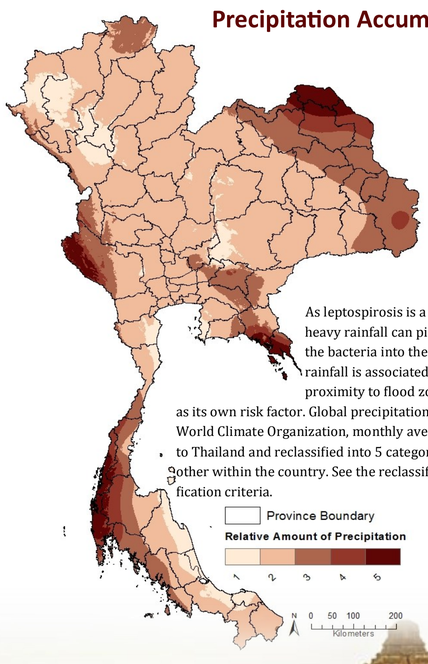
Rank	Province Name	Risk Score
1	Ang Thong	3.859895
2	Phra Nakhon Si Ayutthaya	3.844617
3	Sing Buri	3.787817
4	Pathum Thani	3.690705
5	Bueng Kan	3.588513
6	Nonthaburi	3.568071
7	Phichit	3.465416
8	Nakhon Pathom	3.437427
9	Nakhon Nayok	3.431587
10	Bangkok Metropolis	3.392048

Conclusions

The average vulnerability score within the country was 2.7. See the table 2 to the left for the top 10 provinces and their average risk score. The riskiest points within Si Sa Ket had a risk score range between 4.2 and 4.4. The points all tended to cluster together, most of which of the clusters were around a body of water of some sort. These 6 clusters represent the targeted sampling areas for the May and June 2016 sampling effort.

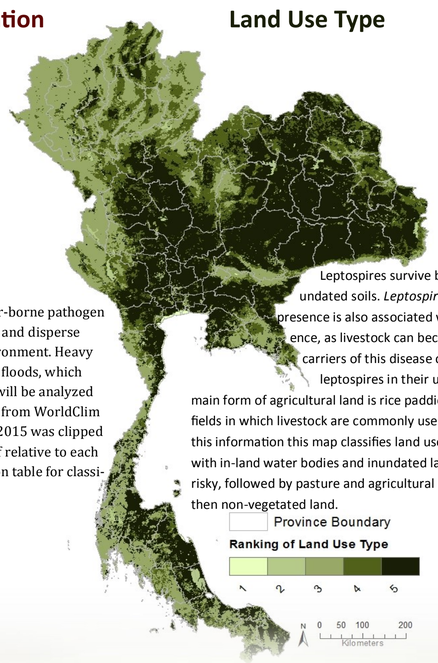
In a country in which Leptospirosis clinical incidence is high, however environmental sampling and testing yield is low, there is a clear disruption between sampling location and environmental presence of the bacteria. This analysis has produced very informative results. These results will be used summer 2016 to direct sampling efforts within the Si Sa Ket Province of Thailand. On a broader scale this project will contribute to the small, but growing, information base on environmental *Leptospira* presence. This vulnerability analysis highlights where within the country is the most at risk, as well as focuses on an average score per province. Governments can take this information and take measures to reduce exposure to this disease, in both humans and animals. This hypothetical project will help direct further research, efforts to raise quality of life in lower income areas and caution the public to ensure a stable agricultural economy and preserve human and animal health.

Precipitation Accumulation



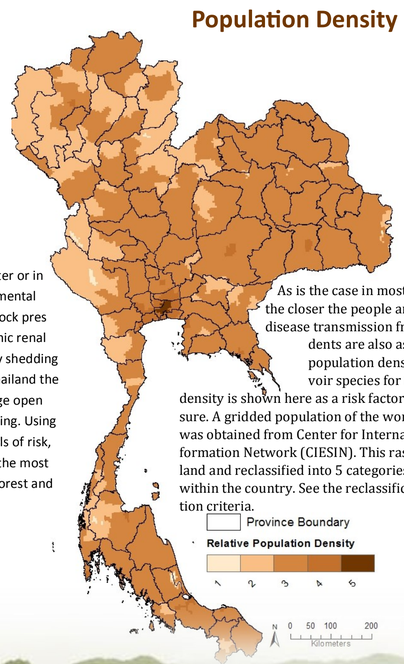
As leptospirosis is a water-borne pathogen heavy rainfall can pick up and disperse the bacteria into the environment. Heavy rainfall is associated with floods, which proximity to flood zones will be analyzed as its own risk factor. Global precipitation data from WorldClim World Climate Organization, monthly average 2015 was clipped to Thailand and reclassified into 5 categories of relative to each other within the country. See the reclassification table for classification criteria.

Land Use Type



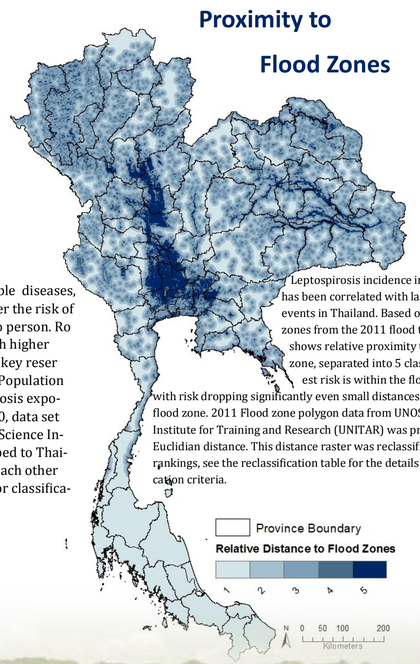
Leptospires survive best in water or in undated soils. *Leptospira* environmental presence is also associated with livestock presence, as livestock can become chronic renal carriers of this disease continually shedding leptospires in their urine. In Thailand the main form of agricultural land is rice paddies and large open fields in which livestock are commonly used for plowing. Using this information this map classifies land use into levels of risk, with in-land water bodies and inundated land being the most risky, followed by pasture and agricultural lands, to forest and then non-vegetated land.

Population Density



As is the case in most communicable diseases, the closer the people are the stronger the risk of disease transmission from person to person. Rodents are also associated with higher population density and are a key reservoir species for this disease. Population density is shown here as a risk factor for leptospirosis exposure. A gridded population of the world, from 2010, data set was obtained from Center for International Earth Science Information Network (CIESIN). This raster was clipped to Thailand and reclassified into 5 categories relative to each other within the country. See the reclassification table for classification criteria.

Proximity to Flood Zones



Leptospirosis incidence increase has been correlated with large flooding events in Thailand. Based on the flood zones from the 2011 flood this map shows relative proximity to a flood zone, separated into 5 classes. The highest risk is within the flood zone itself, with risk dropping significantly even small distances from the flood zone. 2011 Flood zone polygon data from UNOSAT is the UN Institute for Training and Research (UNITAR) was processed using Euclidian distance. This distance raster was reclassified into 5 risk rankings, see the reclassification table for the details of the classification criteria.