ESTIMATING LEPTOSPIROSIS BURDEN IN SOUTHEAST ASIA AND ITS FUTURE EVOLUTION BASED ON CLIMATE AND ENVIRONMENTAL DETERMINANTS

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CONTEXT: Leptospirosis, a zoonotic disease

Caused by *pathogenic leptospires* (bacteria)

- Grow in the kidney tubules of animals that act as *reservoir*
- *Shed into the environment* through urine
- *Survive in water and soil* for weeks to months
- *Human infection mostly occurs through contaminated environment*
Leptospirosis in Southeast Asia

Estimated annual morbidity of leptospirosis by country or territory. Annual disease incidence is represented as an exponential colour gradient from white (0–3), yellow (7–10), orange (20–25) to red (over 100), in cases per 100,000 population. (source: Costa et al., 2015)

In Southeast Asia:
- Endemic with estimated high incidence
- Mainly occupational
- Remains under-reported and poorly documented
- Favorable environment and climate for leptospirosis outbreaks
CONTEXT:
Using remote sensing to inform on the environmental risk of leptospirosis

Data from satellite images are promising tools to study leptospirosis burden.

Climate and environment impact:
- the survival of the leptospires
- the behaviors of reservoirs animals and human populations
- the exposure of human populations
OBJECTIVES

1. Identify environmental and climate determinants of leptospirosis in Southeast Asia

2. Estimate leptospirosis burden in Southeast Asia

3. Predict its evolution along with climate change
Epidemiological data

Median of yearly incidence between 2003 and 2019 for each Thai provinces

Data from satellites images

Environment

Climate

Humans

Modèle validation

cross-validation

Machine Learning (Support Vector Machine)

Model extrapolation to Myanmar, Cambodia, Laos and Vietnam

CMIP6 climate projections (Eyring et al., 2016)

Predictions along with climate change
RESULTS

Environmental determinants

Observed and predicted incidence for the actual period (2003-2019)
RESULTS

Environmental determinants

Estimating leptospirosis burden

Distribution of leptospirosis in Southeast Asia.

2003-2019

Estimated incidence per 100k pop

- [0,0.6]
- (0.6,1.7]
- (1.7,3.5]
- (3.5,6.4]
- (6.4,11.2]
- (11.2,19.1]
Distribution of leptospirosis in Southeast Asia and its predicted evolution under the no-climate policy scenario (SSP5-8.5) of climate change.
## DISCUSSION

**A robust model of leptospirosis distribution**

- Accurately estimate Leptospirosis in Thailand

- Rely on *landscape and climate data available at large extent*

- Highlights the *importance of climate* on the disease distribution
DISCUSSION

A robust model of leptospirosis distribution

Unravelling leptospirosis distribution in Southeast Asia

➢ First estimates of leptospirosis burden at local scale encompassing 5 countries of Southeast Asia

➢ Neglect behavioral and socio-economics aspects shown to impact leptospirosis incidence

➢ True burden likely underestimated in countries less informed than Thailand
DISCUSSION

A robust model of leptospirosis distribution

Unravelling leptospirosis distribution in Southeast Asia

Predict the evolution of the distribution along with climate change

➢ Leptospirosis globally decreases with climate change

➢ Spatio-temporal aggregation likely hide localized extreme climate event in the future that would trigger outbreaks

➢ Climate projections globally agree on the temperature trend but not for precipitation trends

➢ Models predictions are only driven by climate projections but modification of the landscape and development of the countries could also impact the distribution
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**CMIP6** Projected climate variables

| Partial dependancy ± sd | Observed variables values | *CMIP6 Projected climate variables |

- Variance of slope
- *Wettest quarter (mm)*
- *Hottest quarter (°C)*
- Floodable area (%)
- *Mean precipitation (mm)*
- *Variance of T\textsubscript{range} (°C)*
- Number of raining days (days)
- Mean elevation (m)
- *Variance of precipitation (mm)*
- Urban coverage (%)

Graphs showing projected climate variables for different regions and parameters.
National surveillance of leptospirosis in Thailand

Cases

Values

Deaths

Date