Spatial risk assessment of dog-mediated rabies incursion and spread in Singapore

Country Assignment for OIE Advanced GIS Training

30 Aug 2021

Singapore

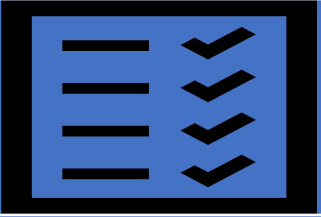**Dr Kelvin Lim (Team Lead)**

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Terence Xie (GIS resource person)

Background

- **Dog population in Singapore**
  - Stray dog population ~ 7,000
  - Pet dog population ~ 70,000

- **Singapore has been rabies-free since 1953.**

- **Rabies risk not zero as there are still reported cases of rabies in neighboring countries.**

Singapore's Layered Approach

Pre-border
- Veterinary import condition; import permit; health certification
- Risk assessment and horizon scanning (for early detection of suspect cases) to continue to monitor rabies prevention and control efforts in at-risk countries
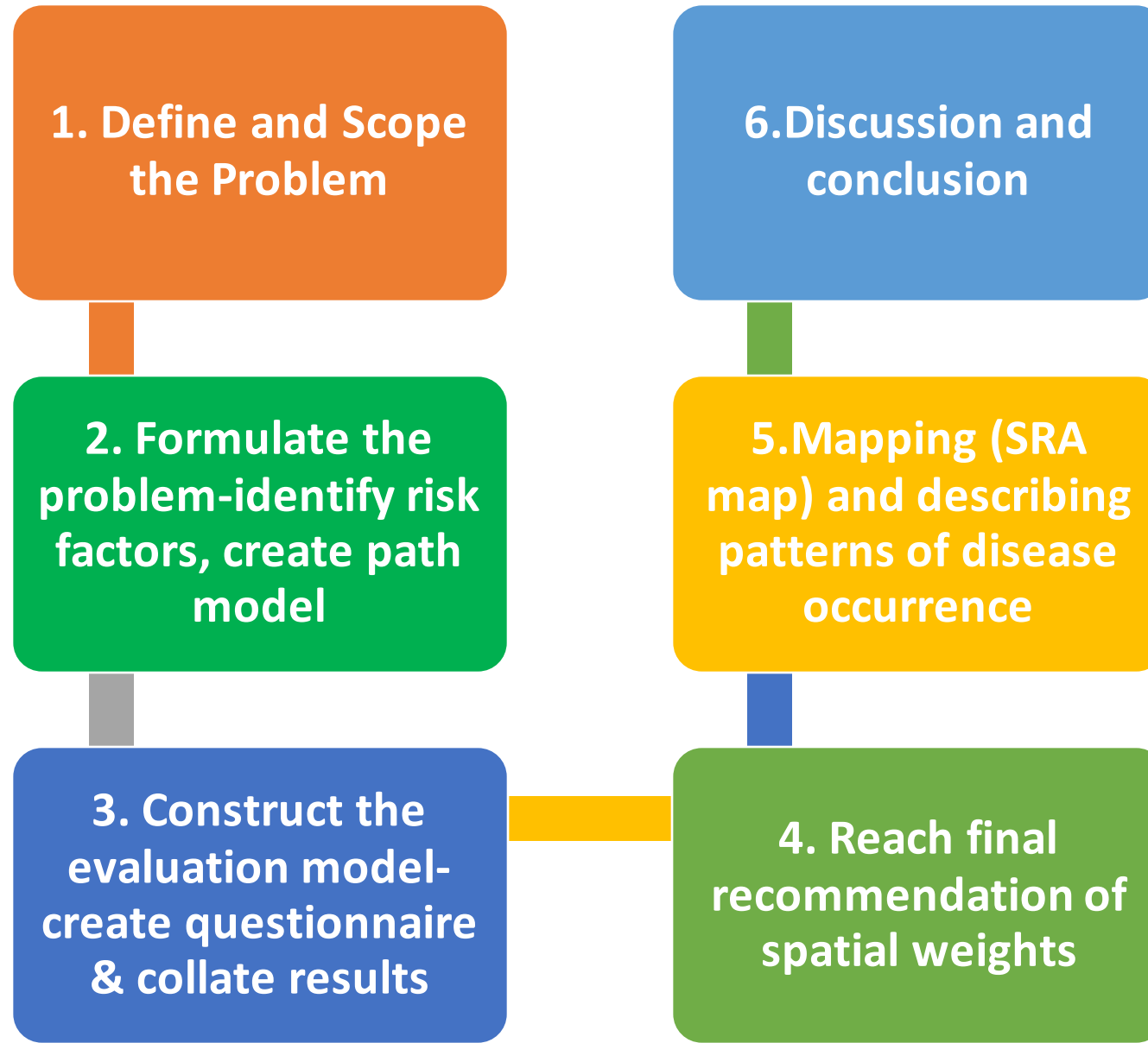
Border
- Clinical inspection
- Documentary checks
- Quarantine (for dogs from rabies endemic countries)

Post-border
- Disease notification (rabies is a notifiable disease under the Animals & Birds Act)
- Licensing of pet dog establishments
- Licensing of pet dogs
- Trap-Neuter-Release-Manage Programme (TNRM)
- Targeted rabies vaccination for at-risk dogs i.e. dogs at coastal fish farms
- Stakeholder communication to raise awareness (World Rabies Day) etc

Methodology

1. Define and Scope the Problem

2. Formulate the problem-identify risk factors, create path model

3. Construct the evaluation model-create questionnaire & collate results

4. Reach final recommendation of spatial weights

5.Mapping (SRA map) and describing patterns of disease occurrence

6.Discussion and conclusion

Define and Scope the Problem

- **Which disease of interest?**

  - **Rabies (in dogs)**

- Although rabies free, Singapore currently has about 7,000 stray (or free roaming) dogs originating from previously abandoned pet or guard dogs. As these dogs are more likely to be in contact with other strays or wild animals of unknown health status, there is a potential risk of rabies transmission in the stray dog population from contacts with rabid animals in the environment.

- **Knowledge gap exists and it would be useful to do a SRA for rabies incursion and spread in Singapore**

Formulate the problem

- Inclusion of the following Identified risk factors:

Risk factors for rabies incursion	Spatial feature	Data source
Susceptible population	Stray dog population locations	Stray dog sightings (NParks GIS System)
Movement of dogs (legal)	Entry points	Singapore Land Authority's Geospatial portal
Pet dog population		Dog licensing system
Dog runs	Dog run locations	NParks GIS system

- Exclusion of following risk factors:
  - Coastal fish farm population and locations; entry points – illegal points; animal rescue/welfare group locations; dog swimming pools

Causal Path Diagram
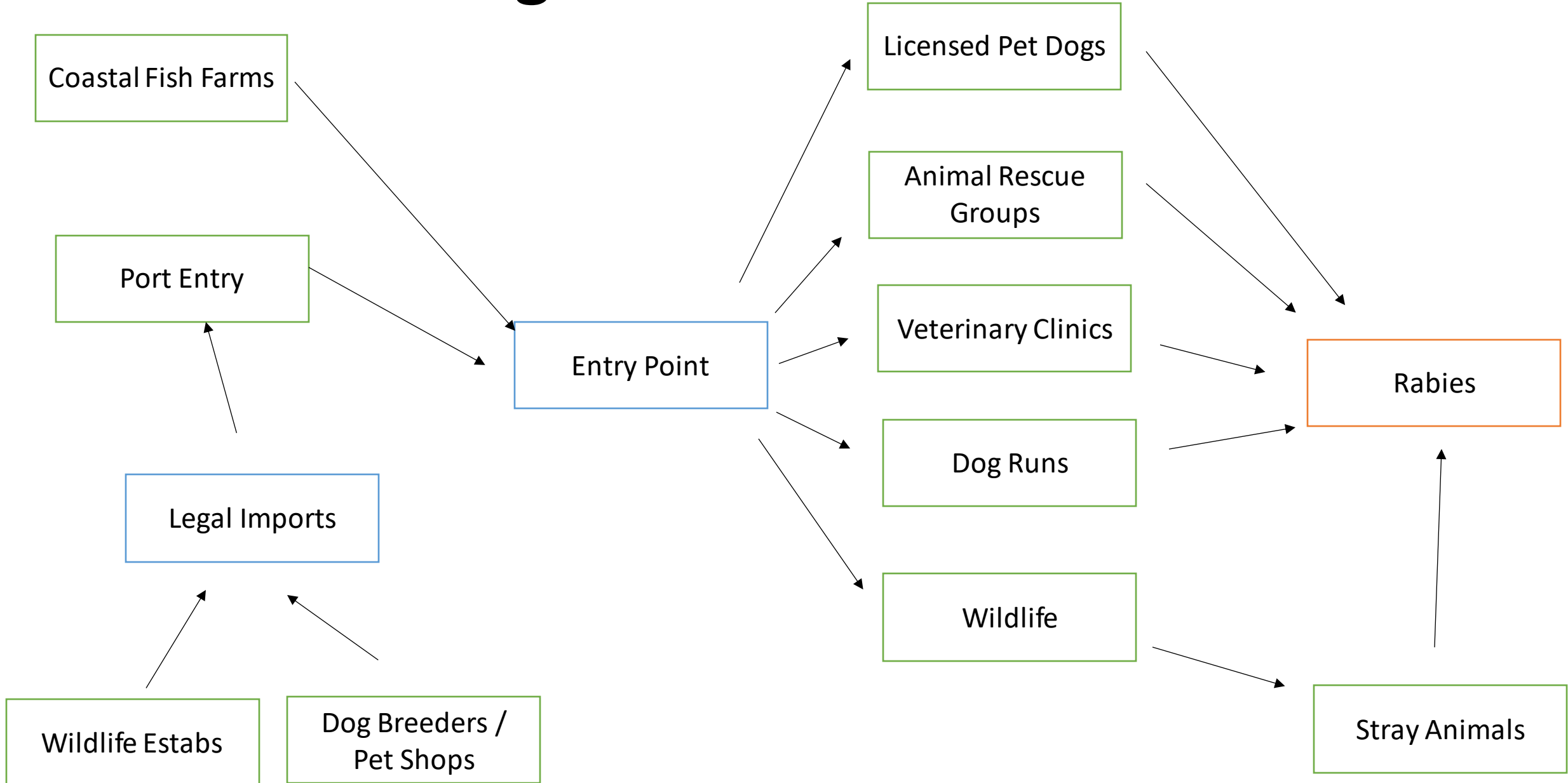
Mapping Process

Collecting Variables

o Assessing relevant variables in assessing rabies risk map

  ▪ Stray Dog Heat Map
  ▪ Pet Dog Heat Map
  ▪ Locations of major ports of entry
  ▪ Locations of dog run parks

Data Structure

o Ensure all data variables to be in similar data formats

  ▪ All polygons rasterized, Buffer areas created with point data and then rasterized
  ▪ Normalization of all pixel value

Calculate weighted risk for each variable

o Using pairwise comparison, assess the different weights assigned to each variable via survey results distributed to relevant parties

Final map

o Re-evaluate the newly calculated pixel values for each variable depending on their assigned weights, then combine the raster layers for final output

Question Number	Question (circle only one answer)
1	**When comparing PortsofEntry with StrayDogPopulations for the incursion and spread of rabies, PortsofEntry is**
	extremely less important
	very strongly less important
	strongly less important
	moderately less important
	equally important
	moderately more important
	strongly more important
	very strongly more important
	extremely more important

Transformed scores, geometric means & weights

| | | Transformed score for each risk factor comparison | | | | Risk Weights | |
| | | Risk factor 2 | | | | | |
		StrayDogPopulations	PortsofEntry	DogRunLocations	PetDogLocations	Geometric row mean	Weight for spatial risk layer
Risk factor 1	StrayDogPopulations	1.00	1.00	3.33	1.83	2.19	0.43
	PortsofEntry	0.30	1.00	3.33	1.00	1.69	0.33
	DogRunLocations	0.30	0.30	1.00	1.83	0.55	0.05
	PetDogLocations	0.55	1.00	1.83	1.00	1.00	0.19
							1.00

Results

Major Ports of Entry

- Mapped out the legal and unauthorised entry points in Singapore

Results

Dog Run Servicing Area

Legend

Dog Run Servicing Area

Value

High : 1

Low : 0.25
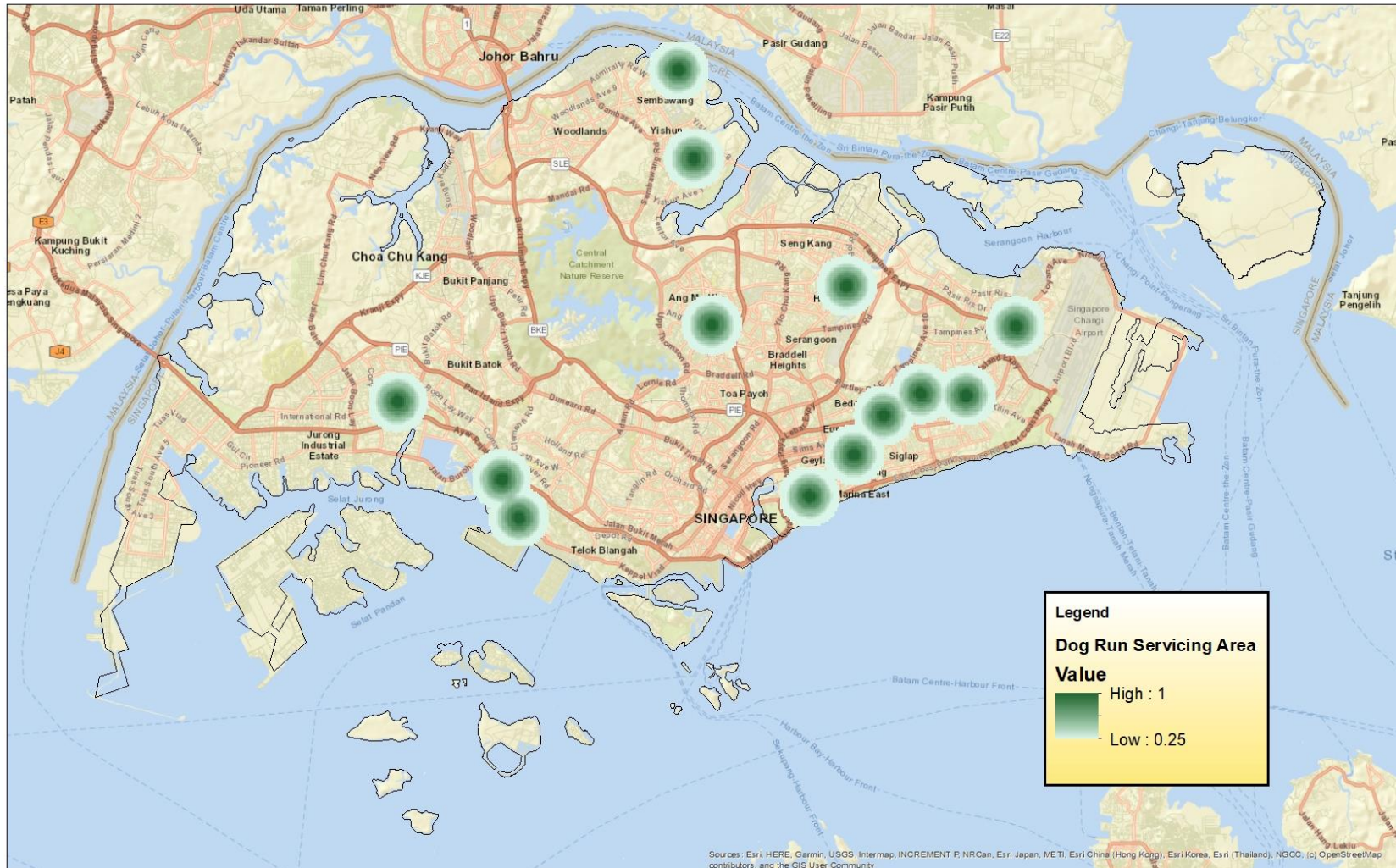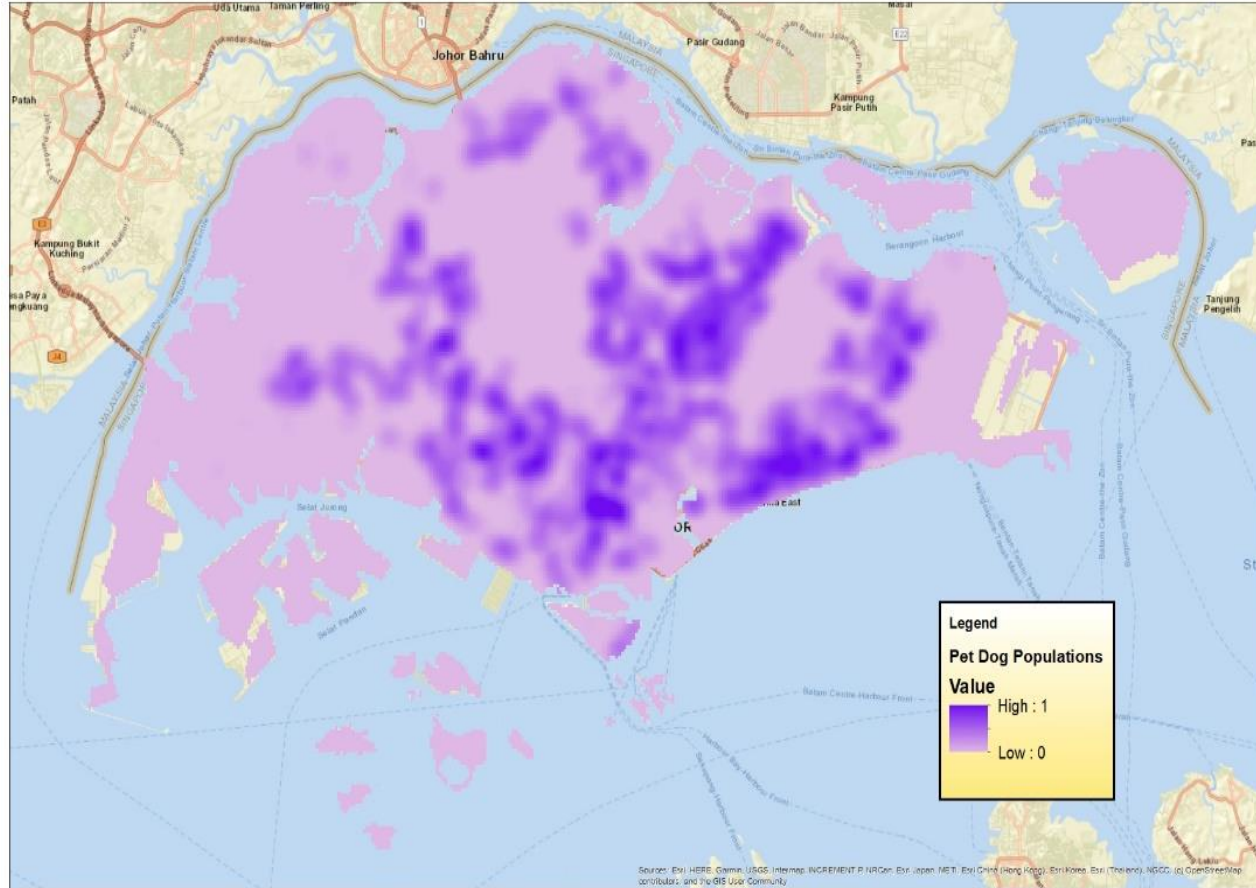
There are 13 dog runs located in different parks in Singapore.

- Differ in size
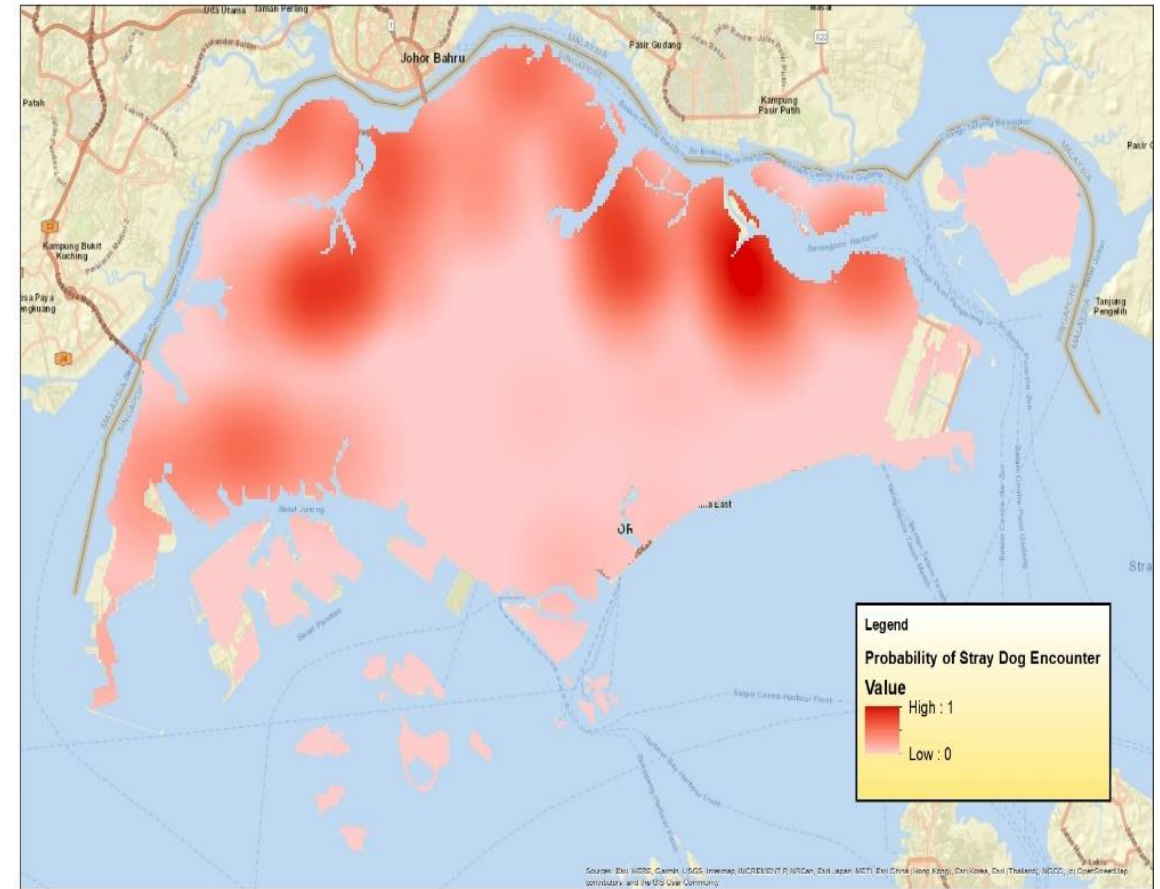- Differ in usage (some parks are more popular than others)

Results

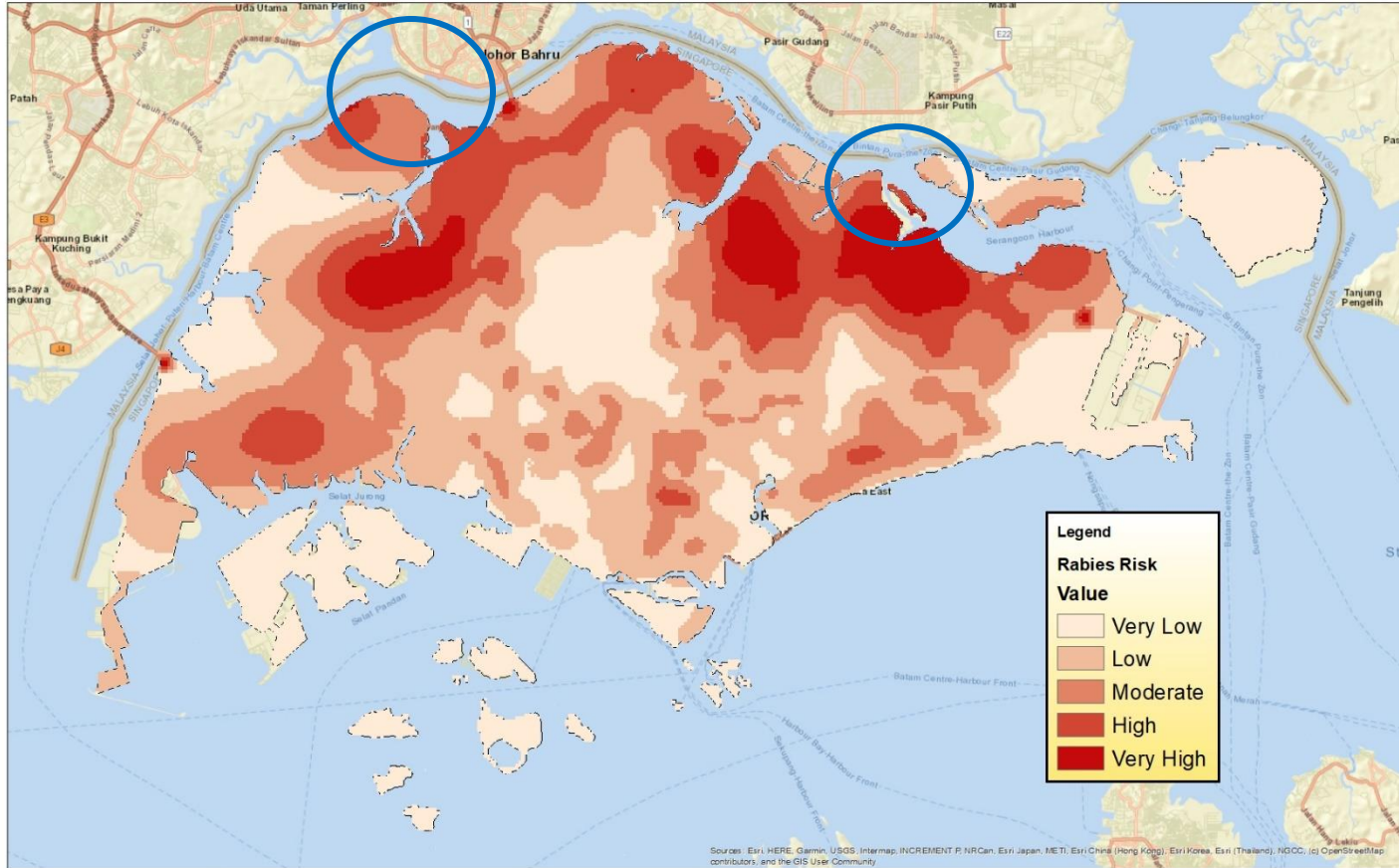Risk layers of pet dog encounter and stray dog encounter

Results- Spatial Risk Map

Spatial Risk Map for rabies incursion and spread in Singapore

Legend
Rabies Risk Value
- Very Low
- Low
- Moderate
- High
- Very High

Proability of Dog Attack/Bite in Singapore (2019-2021)

Legend
Dog Attack/Bite Probability Value
- High
- Low
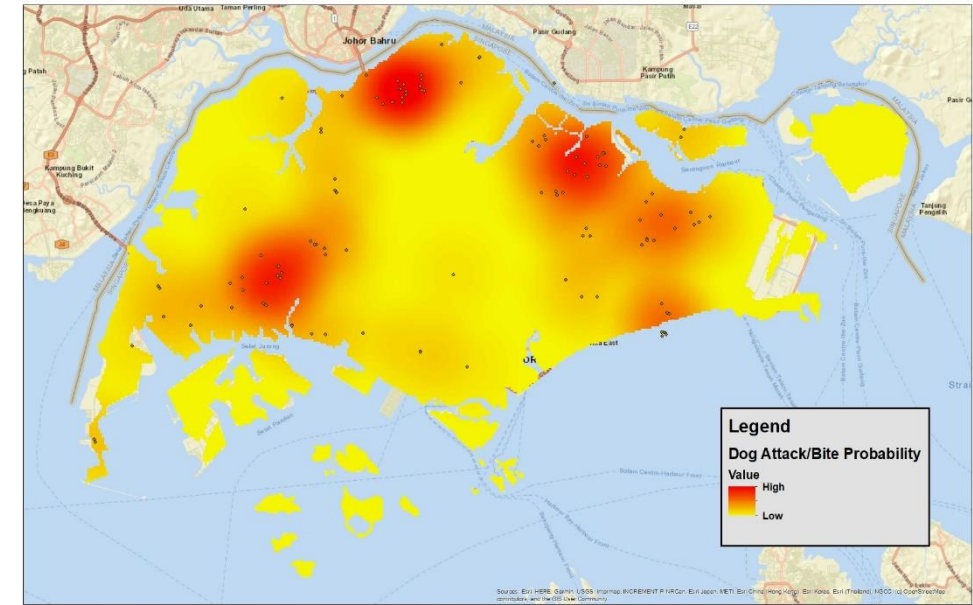
Difference between dog attack/bite probability and rabies risk map

Legend
Percentage Difference Value
- High
- Low

Red represents high probabilities of dog bite but relatively low risk
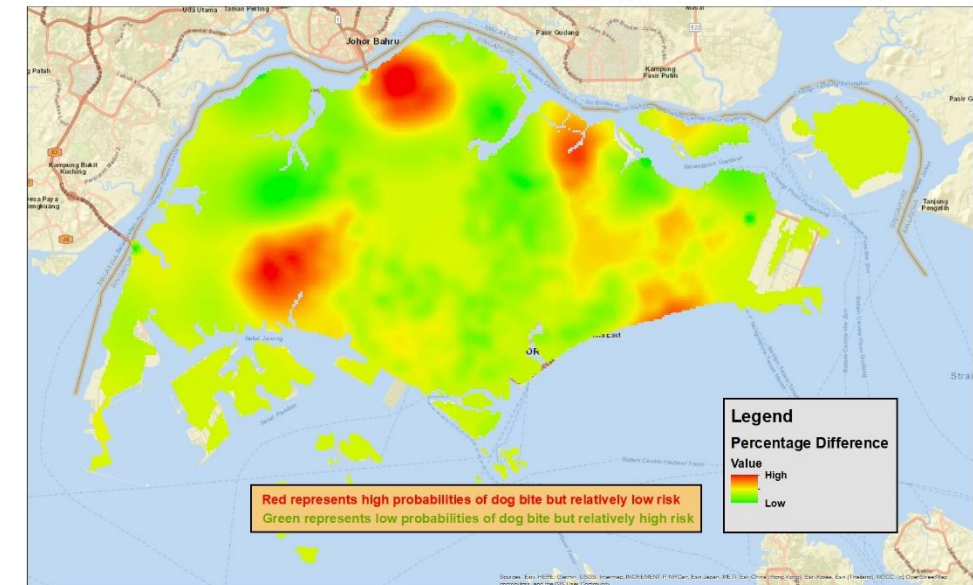Green represents low probabilities of dog bite but relatively high risk

The ranked factors favour stray dog, ports of entry and licensed dog locations over dog runs.
Blue circles refer to locations of coastal fish farms

Discussion

- Dog Runs not considered relatively high priority.
- High risk areas associated with Northeast and Northwest points of Singapore
- Closely associated with location of stray dog sightings
- Dog bite cases reflection of stray dog locations

Conclusion and Next Steps

- Trap-Neuter-Release-Manage (TNRM) stray dog programme provides good information for rabies spatial risk maps

- Coastal fish farm vaccination programme targets spatial risks

- Future
  - Include stray cat population information
  - Use the model to inform mathematical models
  - Determine differences due to vaccination status of dogs
  - Input different weightage to legal and unauthorized routes of entry

Thank you!