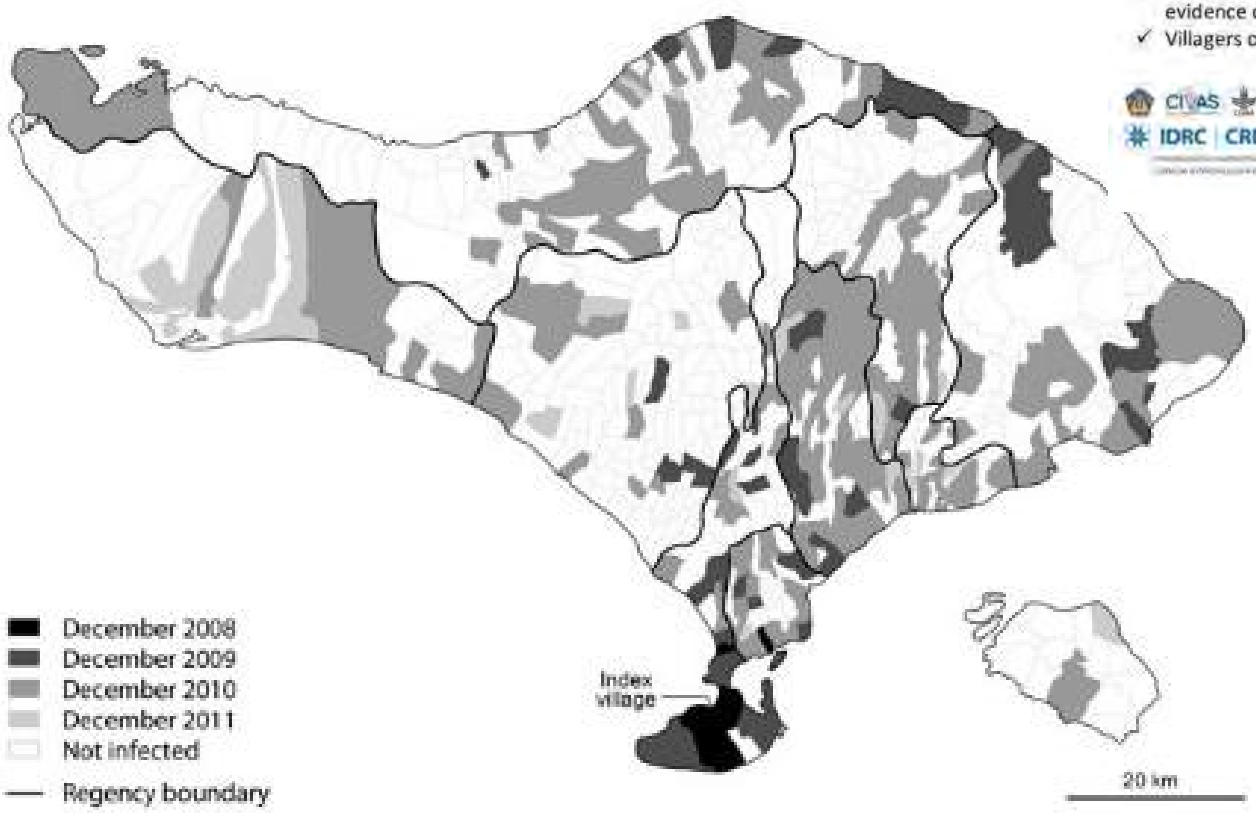
Regional risk assessment on the cross-border spread of dog-mediated rabies in south-East Asia

Michael Ward and Victoria Brookes

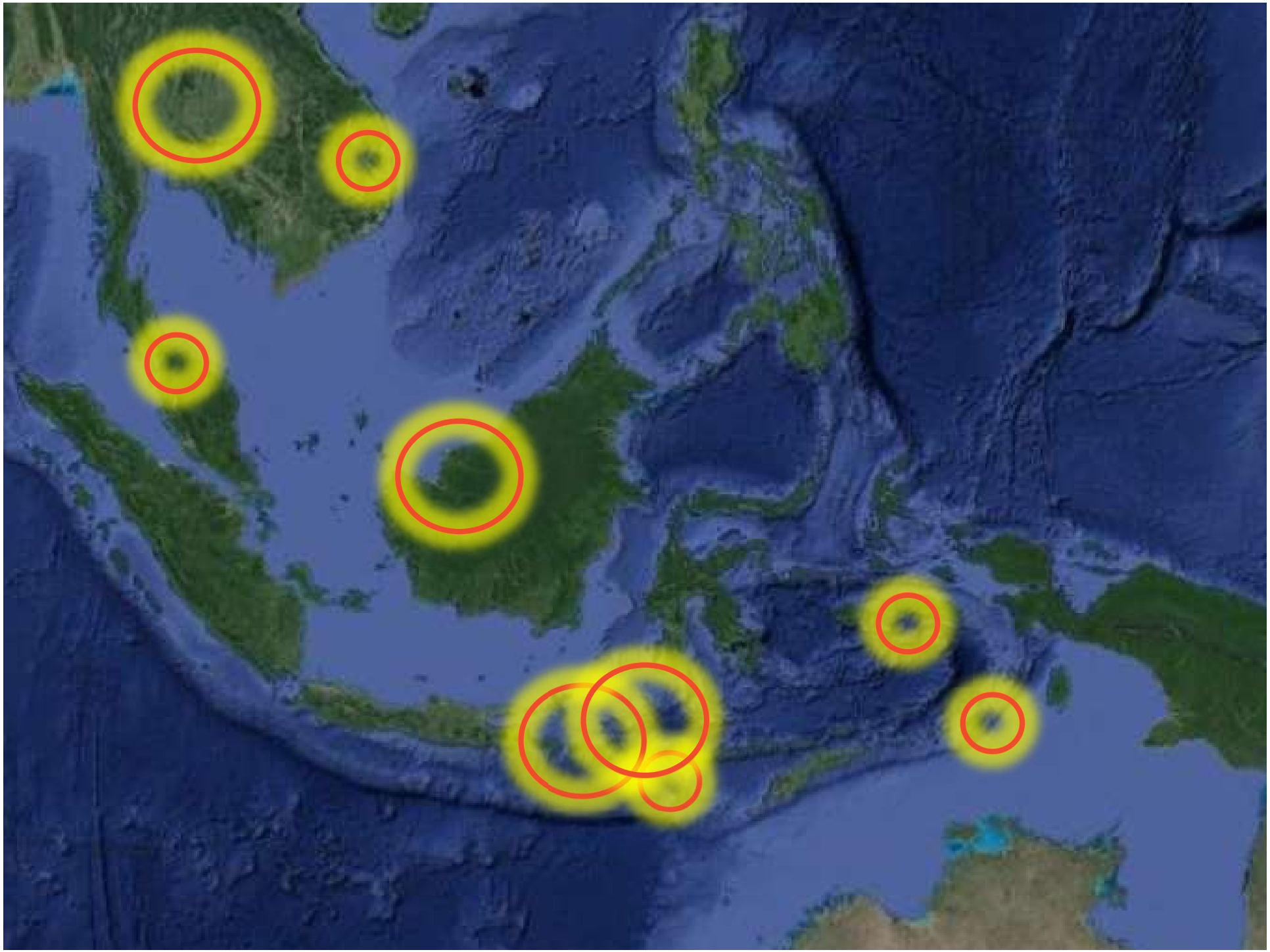
Australian Government
Department of Agriculture and Water Resources

Rabies Bali - Chronology

- ✓ **21 Nov 2008** DIC Denpasar informed from local authorities about a increase of dog bites in Badung District, Ungusan village **and the dead of 3 yr old boy**
- ✓ Boy had history of been **bitten by dog on 19 Oct** 2008
- ✓ Dog appeared healthy but was killed by the family
- ✓ **2 more people** died with history of dog bites (**17 Sep & 14 Nov** 2008) with encephalitis like symptoms
- ✓ Investigation showed increased dog bites in the village but no evidence of rabies in dogs
- ✓ Villagers ordered to tied up their dogs after bitten somebody



Rabies – a transboundary disease



Objectives

- Review status of rabies in dogs and assess existing rabies surveillance and reporting systems
- **Describe dog movements in the region and the cross-border spread of dog-mediated rabies**
- **Describe the socio-cultural drivers that influence the dog-human interaction in the region**
- **Identify key risk factors and risk pathways involved in the spread and maintenance of dog-mediated rabies in the region**
- Draft recommendations to mitigate the cross-border and inter-island spread of dog-mediated rabies in the region

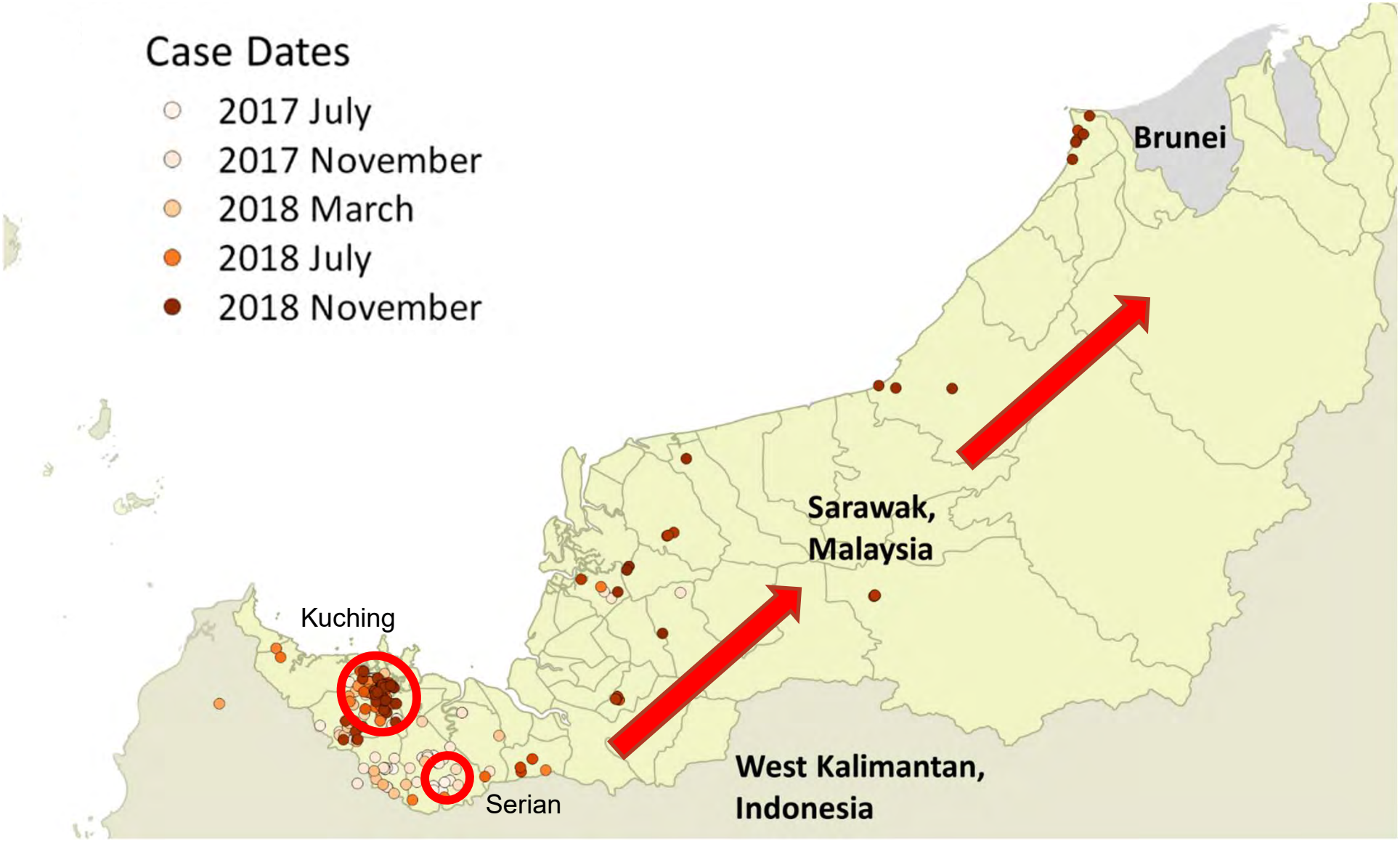
Transboundary rabies spread 1974–present

West Kalimantan infected districts:

2014 … 2
2015 … 5
2016 … 7
2017 … 12
2018 … 13*

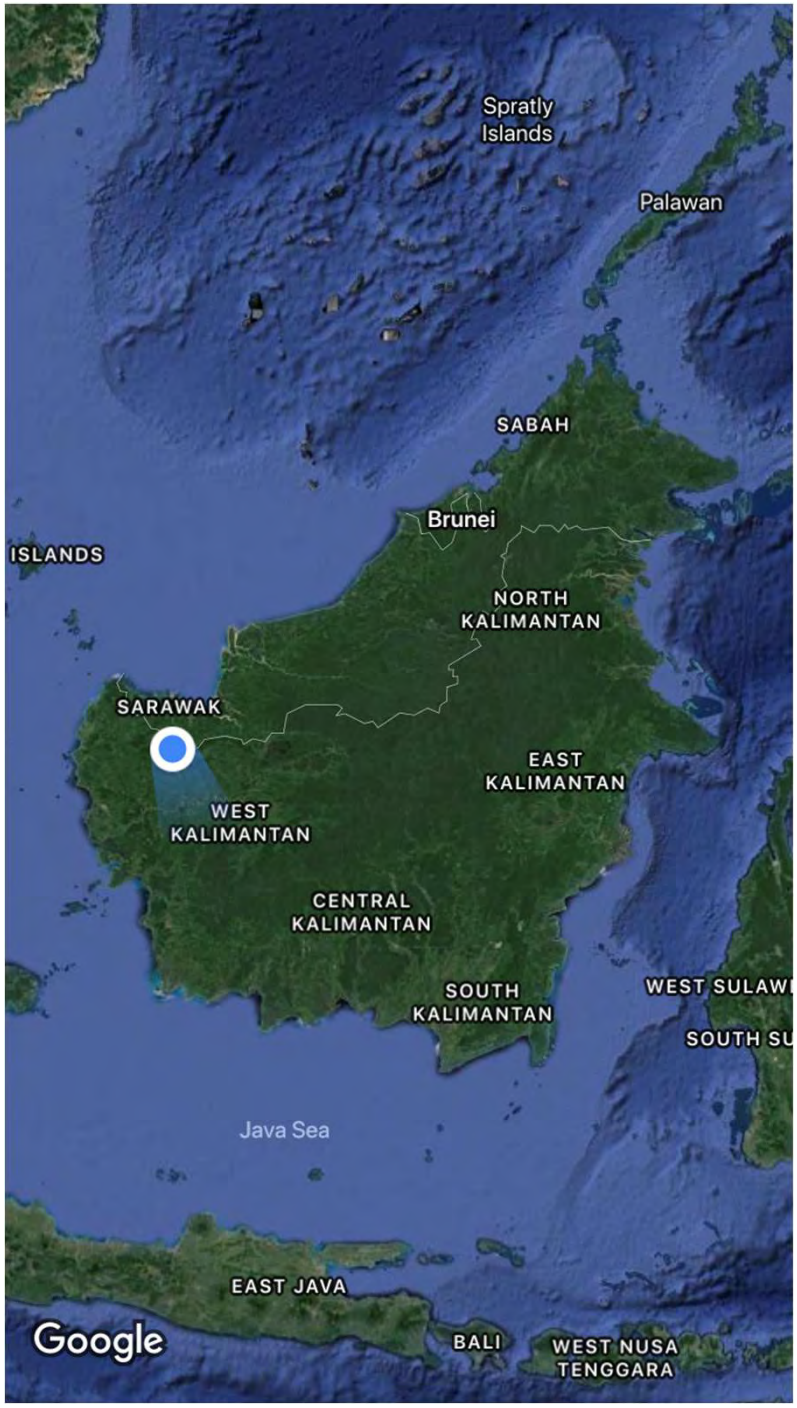
* 13/14 districts excl. Pontianak

Transboundary rabies spread 2017–2018




• situation reports
• surveillance and monitoring
• response strategies


RABIES CONTROL
IN WEST KALIMANTAN
DEPARTMENT OF FOOD, LIVESTOCK AND ANIMAL
HEALTH OF WEST KALIMANTAN
MULTIVISION


Spratly Islands
Palawan
SABAH
Brunei
ISLANDS
NORTH KALIMANTAN
SARAWAK
EAST KALIMANTAN
WEST KALIMANTAN
CENTRAL KALIMANTAN
SOUTH KALIMANTAN
WEST SULAWE
SOUTH SU
Java Sea
EAST JAVA
BALI
WEST NUSA TENGGARA
Google

- history and local situation
- dogs demographics
- drivers of spread
- logistics of response
- One Health approaches

- history and local situation
- dogs demographics
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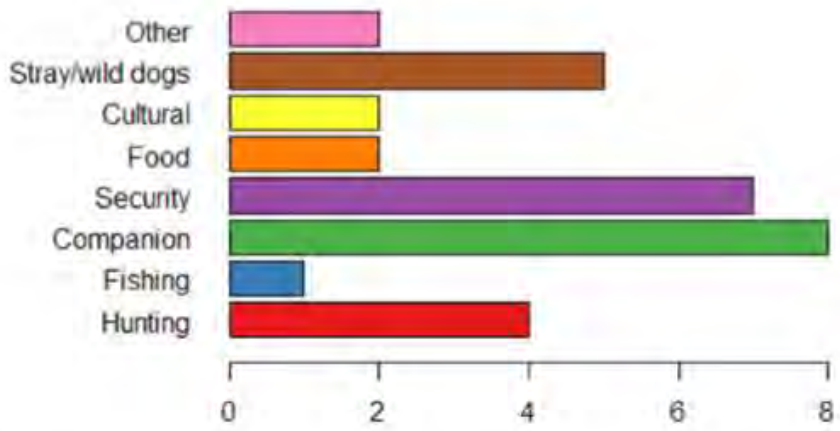
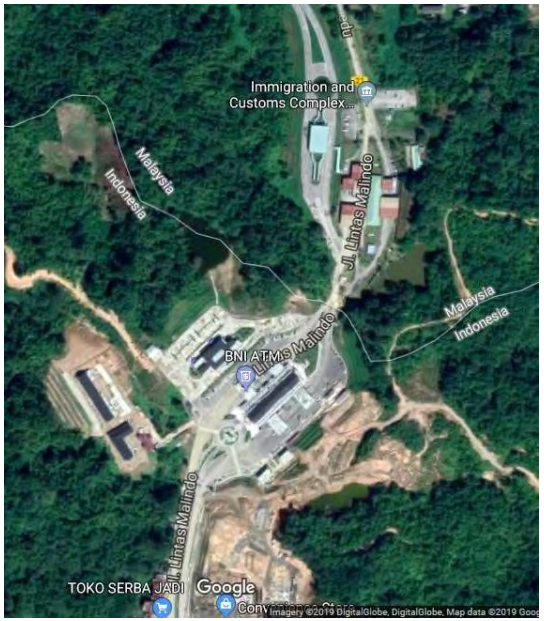
Reasons for local dog movements

- dog consumption
- hunting
- protection
- companion
- gifts





West Kalimantan – Sarawak border

Reasons for cross-border movement of dogs; results from pre-workshop questionnaire

(Singapore, Malaysia, Indonesia, Philippines, Timor Leste, Papua New Guinea)

What's changed? Drivers of dog movements (1)

Highways

- northwards spread of rabies in West Kalimantan within 4 years, 2014–2017
- the major highway north to the Malaysian border completed about 2015 (dirt → bitumen)
- national infrastructure development
- journey reduced from days → hours
- ease of travel: facilitated the movement of rabies infected dogs?

TheJakartaPost

NEWS > NATIONAL

Borneo road, railway projects 'world's scariest environmental threat'

Kharishar Kahfi

The Jakarta Post

Jakarta / Sun, February 3, 2019 / 12:36 pm

https://www.thejakartapost.com/news/2019/02/03/borneo-road-railway-projects-worlds-scariest-environmental-threat.html

What's changed? Drivers of dog movements (2)

Palm oil plantations

- West Kalimantan and Sarawak are major producers
- development during the past few decades
- mostly Malaysian-owned, Indonesian workers
- dogs known to be brought to camps (protection), but little other information available

What's changed? Drivers of dog movements (3)

Festivals

- *Gawai*: village harvest festivals → mid-year provincial festival
- dog consumption (ex-hunting or pet dogs) associated with festivals
- an existing pathway (local dog consumption)

are festivals a driver for longer distance movement of dogs?

- southern district of Ketapang:
  renowned for dog restaurants
  (2004 & 2014 rabies incursions)

https://s3-eu-west-1.amazonaws.com/assets.barcroft.tv/0bf88c95-f4f6-4822-8476-a2fbbb61a940.jpg

What's changed? Drivers of dog movements (4)

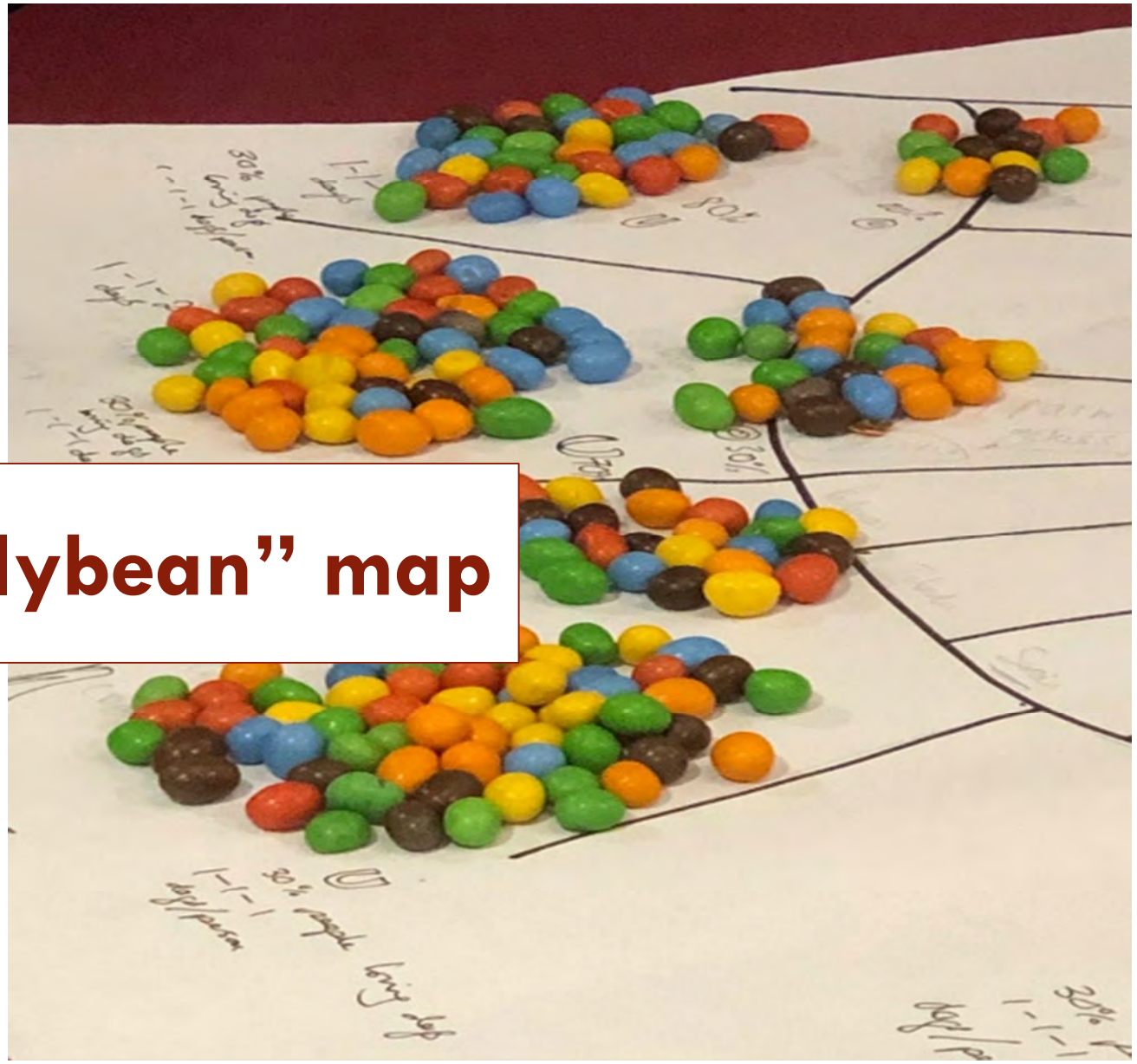
Hunting

- traditional activity, necessary for food security
- mainly pigs for home consumption (occasionally traded)
- less hunting now? (oil palm plantations → land loss)
- village-based, group hunting, day or overnight
- hunting on foot with 5–15 dogs
- retired hunting dogs often consumed
- hunting dogs usually sourced within communities
- Sarawak: less hunting, more recreational

https://forestsnews.cifor.org/wp-content/uploads/2018/11/WestKalimantan.jpg


Australian Government
Department of Agriculture and Water Resources
oie
Rabies Risk Assessment Workshop
Bali, Indonesia, 6-8 March 2019

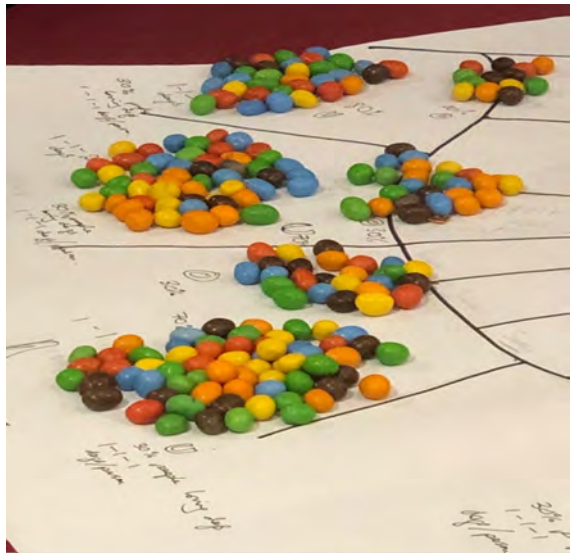
The “jellybean” map




Day Movement
80/100
Day Movement
50/100

- Malaysian and Indonesian teams discussed and identified their perceived risk pathways from their own country across the border amongst their own team members

- final risk maps then inspected and discussed by both country teams



LAND ROUTES	Country =	Malaysia							
ID	A. Route	B. Origin(s)	Units per year	Unit description	Proportion unr	Dog Unit/Proportion	E1. Minimum	E2. Most likely	E3. Maximum
1	COMMERCIAL	KALIMANTAN	730000		0.25	0.6	10	109500	100
2	COMMERCIAL	KALIMANTAN	500000		0.2	0.5	10	50000	100
3	COMMERCIAL	KALIMANTAN	18250		0.001	0.001	10	0.01825	100

INDONESIA											
ID	Route	Origin	Regulated	Reason	Unit/yr	Unit	Prop UnRegulated	Dog/unit unregulated	Min	Most Likely	Max
1	Land Border	Malaysia	Y	Companion	4320	Bus	0.010000	0.100000	1	4.32	12
2	Land Border	Malaysia	Y	Companion	90000	Car	0.010000	0.050000	1	45	80
3	Land Border	Malaysia	Y	Companion	28800	Truck	0.100000	0.002000	1	5.76	10
4	Land Border	Malaysia	Y	Companion	144000	Motorcycle	0.001000	0.001000	0	0.144	10

12	LOCAL TRADE	KALIMANTAN	1825		0.95	0.001	30	1.73375	90
13	LOCAL TRADE	KALIMANTAN	300		0.95	0.5	10	142.5	50
14	LOCAL TRADE	KALIMANTAN	10		0.95	0.005	15	0.0475	50
17	Workers in farn	KALIMANTAN	300		0.95	0.6	30	171	150
18	Commercial	Kalimantan	547500		0.01	0.01		54.75	
19	Local Trade	Kalimantan	182500		0.95	0.3		52012.5	

FROM Indonesia:

➔ **unofficial** crossing for –

- farming
- trading
- hunting
- social visits
- work (oil palm plantations)

➔ **official** crossing for –

- holidays
- work
- trade

FROM Indonesia

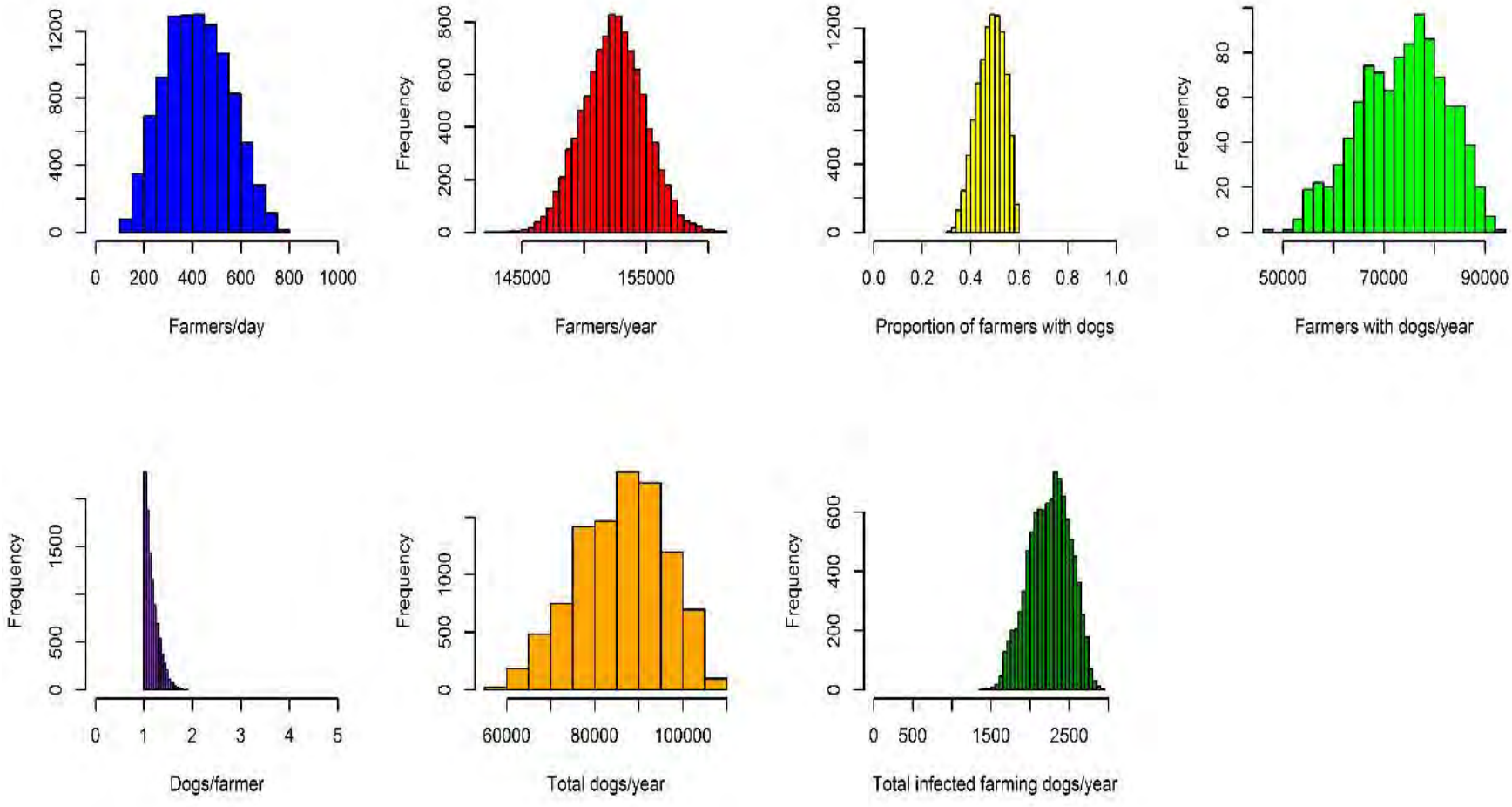
- highest volume movements via border posts, ~ 70%
- but <1% with dogs (2 people/1000 people) = low risk
- unofficial border crossers
  - 20% of traders, farmers → 100% hunters
  - hunters median 2 dogs/hunter, range 1—5 dogs
- district-specific
  - Bau and Padawan (farming and hunting)
  - Serian (farming)
  - Sri Aman (trading and farming)
  - Song (daily work on oil palm plantations and trading)

FROM Malaysia

- ~ 30% via border posts, very low risk
- but ~ 30% of unofficial travellers (mostly for trade) might have a dog (usually either 1 or 2)
- district-specific
    - western districts of Sambas, Bengkayang and Sanggau

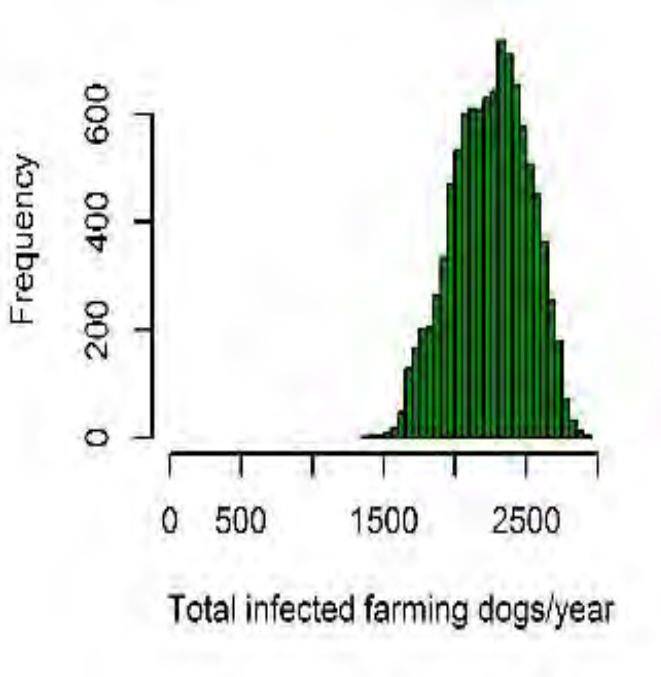


- hunter and farmer pathways:
  - Sanggau, West Kalimantan $\rightarrow$ Bau and Padawan, Sarawak
- illustration of detailed risk analysis using R software
  - comparison of routes, not accurate absolute risk estimation
  - useful for resource allocation
- participant-estimated PERT distributions (min / most likely / max):
  - number of farmers or hunters
  - proportion who would bring dogs
  - number of dogs they would bring
  - expected rabies prevalence



Distributions of parameters from a risk analysis of the annual number of rabies infected dogs entering with farmers from Sanggau, West Kalimantan, Indonesia to Bau and Padawan districts of Sarawak*, Malaysia.*

- median number of rabies infected dogs brought to Sarawak annually by
  - farmers: 2239 dogs (95% predicted interval 1678—2698)
  - hunters: 2837dogs (95% predicted interval 2680—2914)
- Note: simplified risk assessments that did not account for parameters such as duration of travel and the time that the dog would spend in Malaysia.



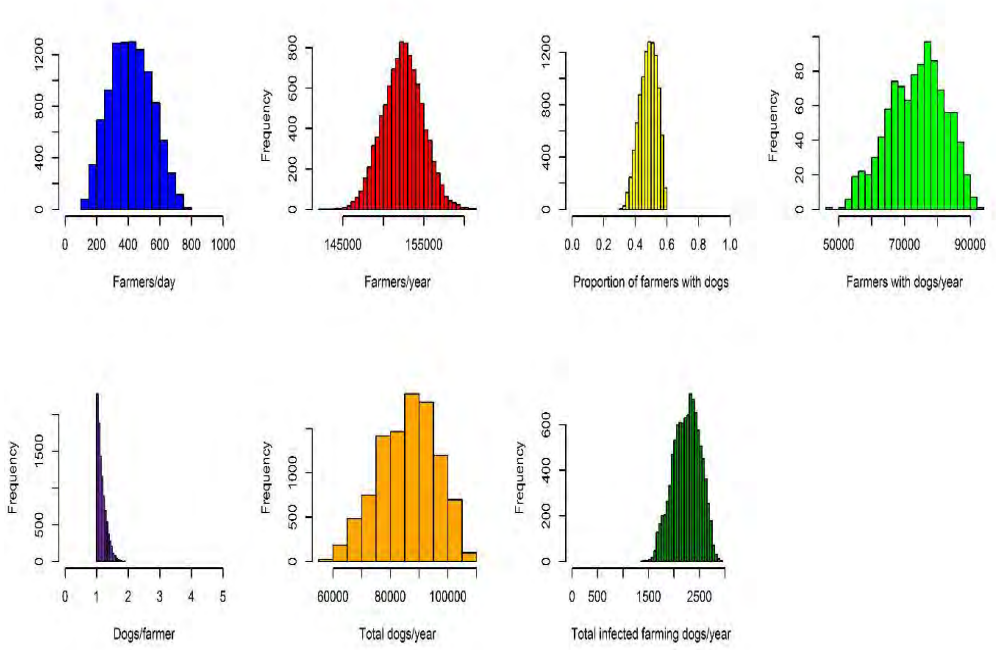
Discussion points, **the jellybean-map exercise** included:

- apparent lack of knowledge – important disease risk pathways
- inter-country discussions needed: share knowledge to mitigate these risk pathways
- further data collection needed: social drivers of travel with dogs, amount of unofficial travel between areas

- ease of use of this method to derive expert-opinion about risk pathways at border areas both within and between countries
- how this method could be extrapolated to other diseases

Discussion points, **the risk-assessment exercise** included:

- sources of data to parameterise risk assessments
- need to simplify risk assessments so that they were accessible by participants
- purpose of risk assessment as a tool to target resources
  - using risk assessment for comparison of routes rather than to define the absolute risk for a single route




OIE

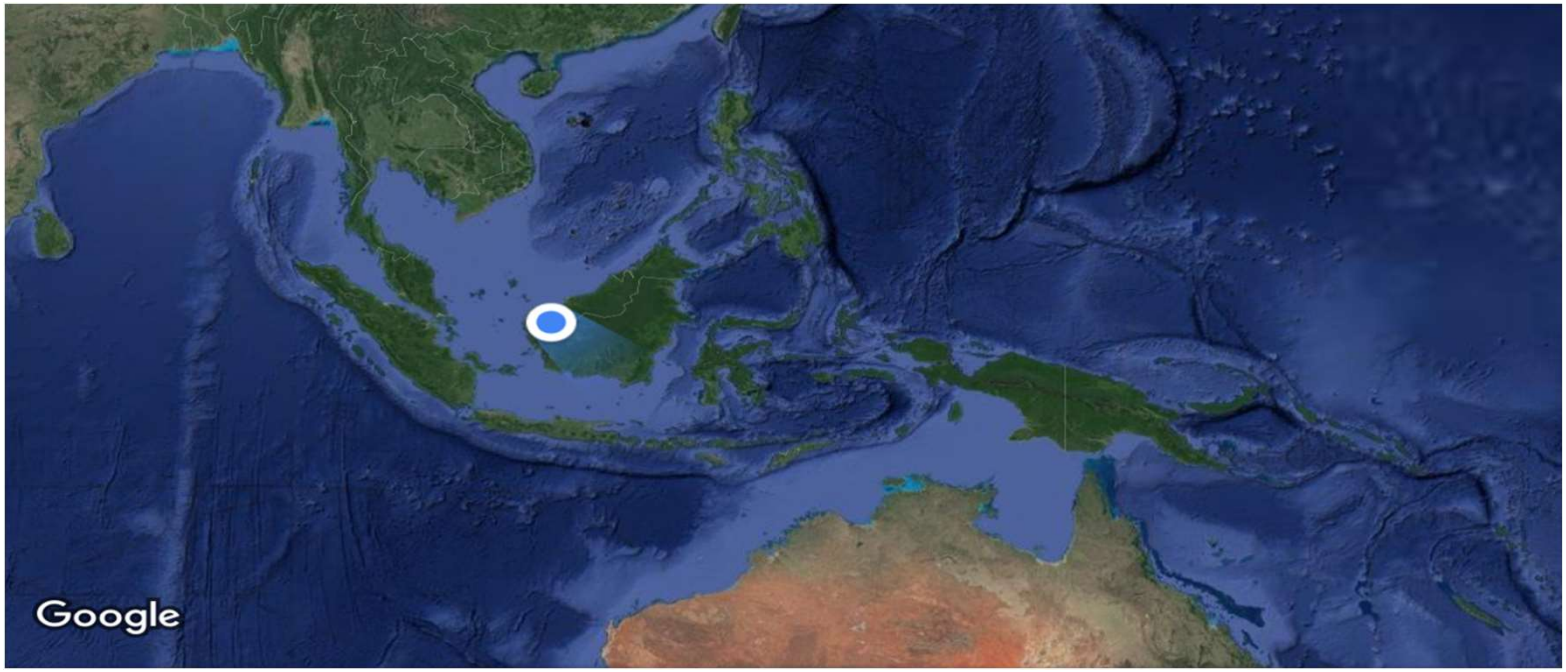
Workshop Part 2

- Joined by representatives from PNG, Timor Leste, the Philippines and Singapore

- Objective:
  - Regional risk assessment for the transboundary spread of rabies

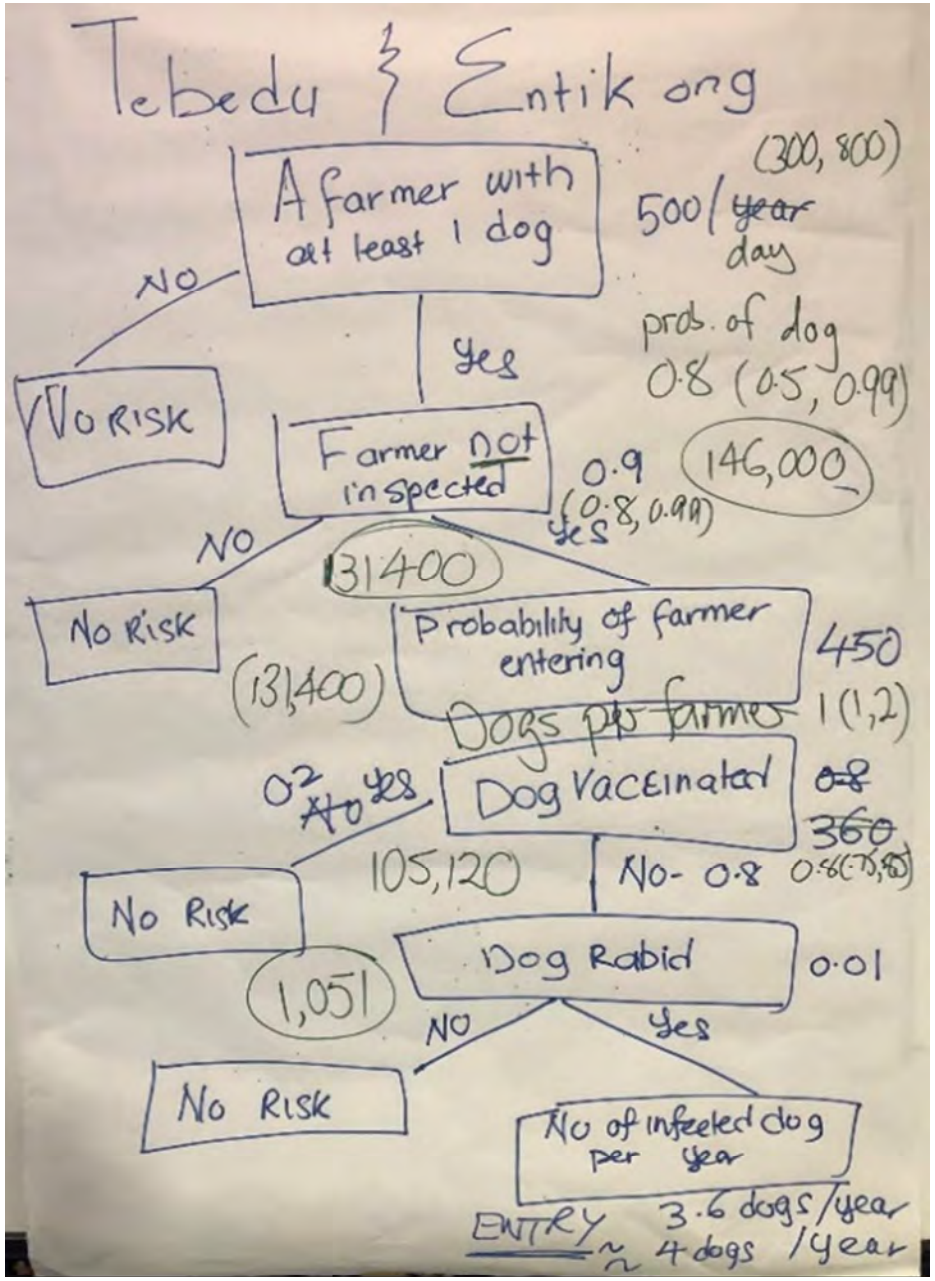
Regional risk assessment

- Why is this needed?
- Target limited resources to high priority areas for
  - Prevention
  - Surveillance
- Regional approach
  - Coordinated action



Risk assessment… the usual process…

- Choose one pathway from many
- Develop a scenario tree of that pathway
- Collect data for each node
- Estimate the probability of that pathway


Tebedu } Entikong
A farmer with at least 1 dog
(300, 800)
500/day
prob. of dog 0.8 (0.5, 0.99)
NO
Yes
No Risk
Farmer not inspected
0.9 (0.8, 0.99)
146,000
Yes
NO
131400
No Risk
Probability of farmer entering
450
(131,400)
Dogs per farmer
1 (1,2)
Dog Vaccinated
0.8
360
105,120
No- 0.8
No Risk
Dog Rabid
0.01
1,051
NO
Yes
No Risk
No of infected dog per year
ENTRY
3.6 dogs/year
~ 4 dogs /year

The Scenario-Spreadsheet method

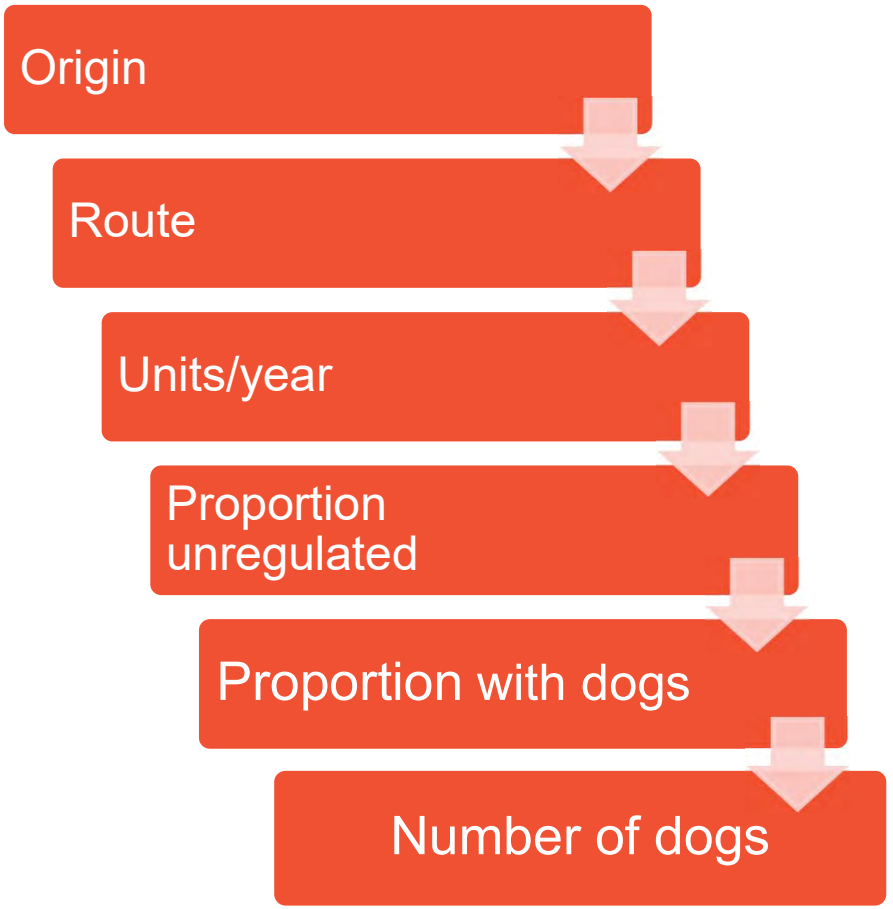
- Any method needs to be:
  - Repeatable & Reproducible

- This method **at a regional level** is also:
  - collaborative
  - quick
  - useful! (representative)

The Scenario-Spreadsheet method

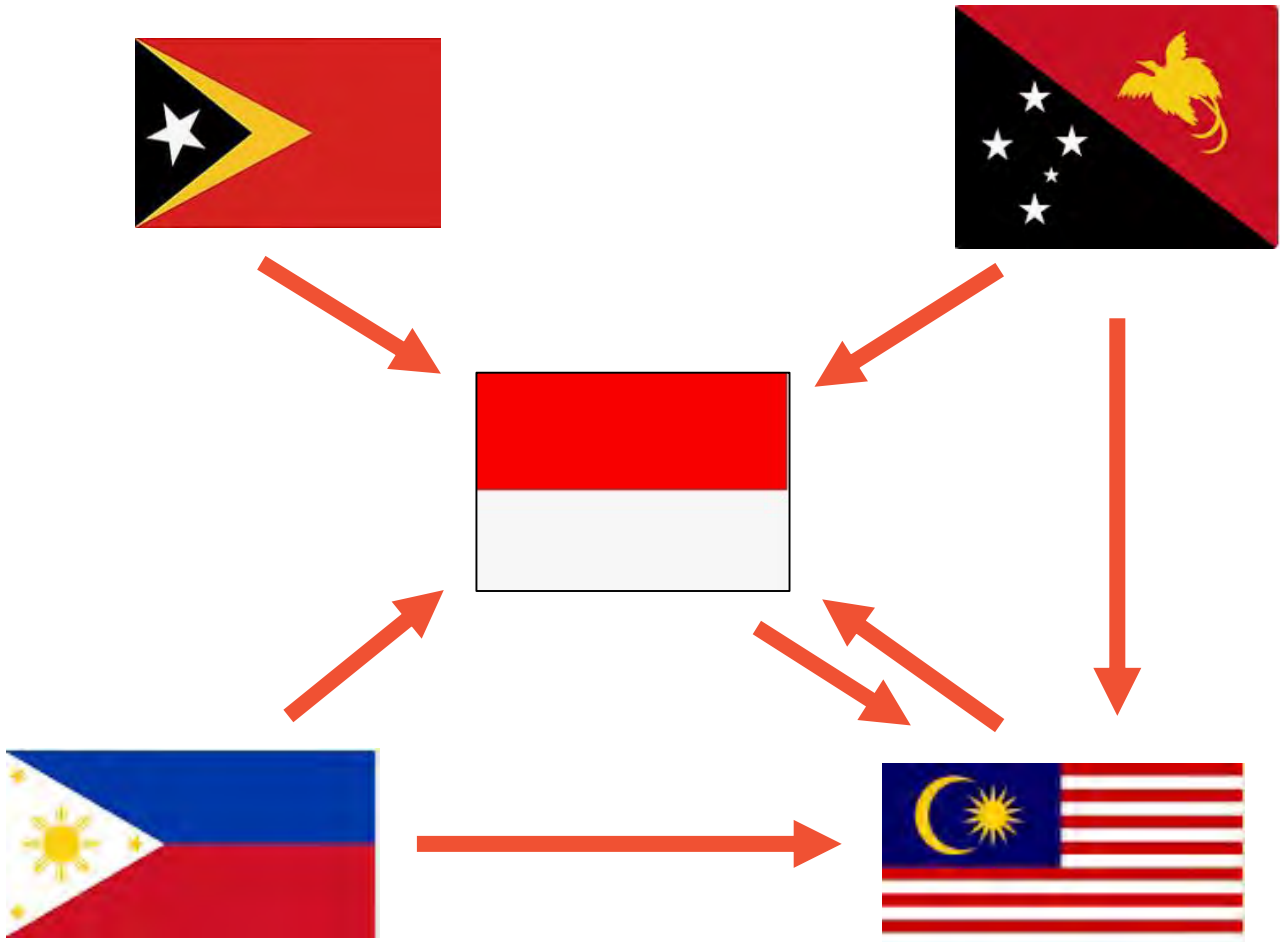
- Extracted the key nodes from a 'Generic scenario tree'

- Put them in a spreadsheet!



Example spreadsheet

To	From	Route	Reason	Unit	Number	Prop_Unreg	Prop_dogs	ML_dogs	Estimate Dogs/yr
W_Malaysia	Singapore	Personal vehicles	Pet	Vehicle	45,000,000	0.005	0.0001	1	22.5
W_Malaysia	Singapore	Commercial vehicles	Pet	Vehicle	8,000,000	0.05	0.00001	0	0
W_Malaysia	Singapore	Buses	Pet	Bus	300,000	0.00001	0.00001	0	0
W_Malaysia	Singapore	Pedestrians	Pet	Person	3,650,000	0.00001	0.00001	0	0
PNG	Indonesia	Land Border	Companion	Motorcycle	7200	0.01	0.01	0	0
PNG	Indonesia	Land Border	Companion	on foot	18000	0.1	0.01	1	18
PNG	Indonesia	Land Border	Companion	Car	36000	0.01	0.01	1	3.6
PNG	Indonesia	Unofficial	Companion	Motorcycle	360	1	0.001	1	0.36
PNG	Indonesia	Unofficial	Companion, hunting	on foot	90000	1	0.1	2	18000
PNG	Indonesia	Unofficial	Companion	Car	360	1	0.001	1	0.36
PNG	Indonesia	Unofficial	Companion	Boat	8000	1	0.05	1	400



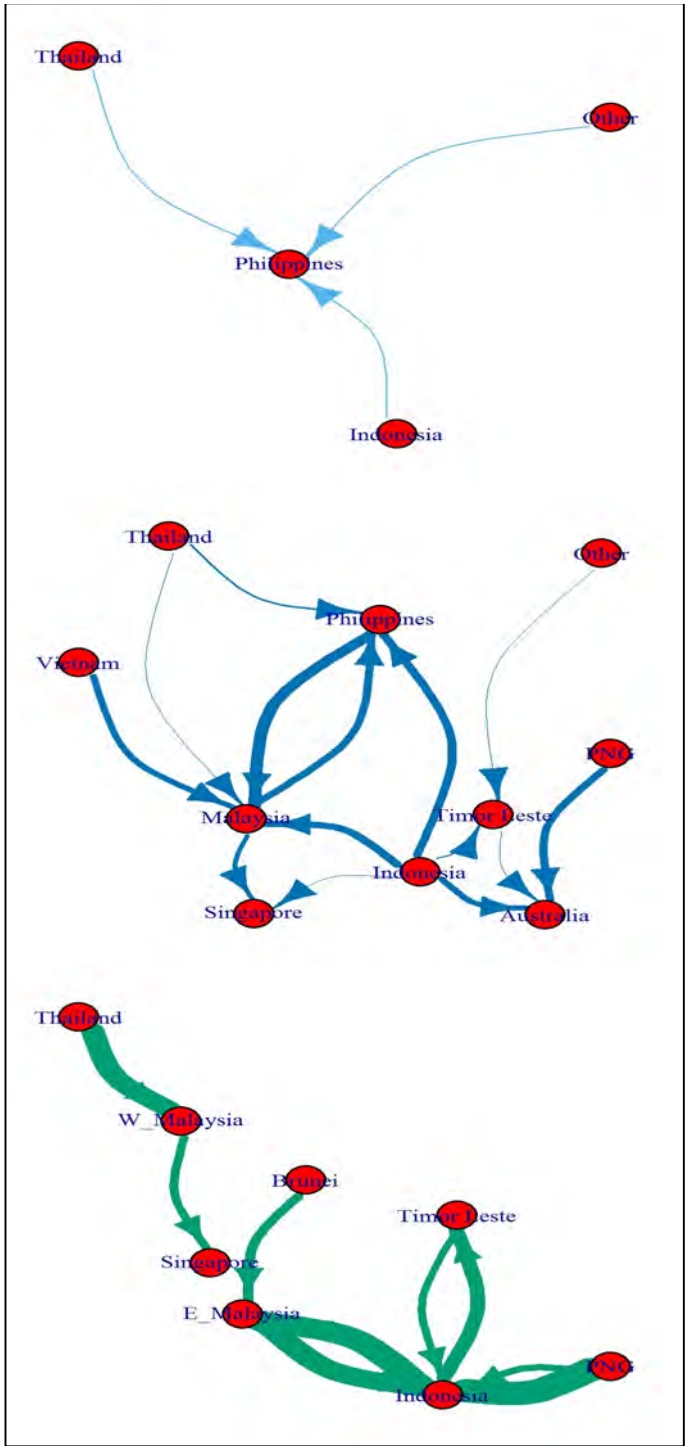
The Scenario-Spreadsheet method in the workshop

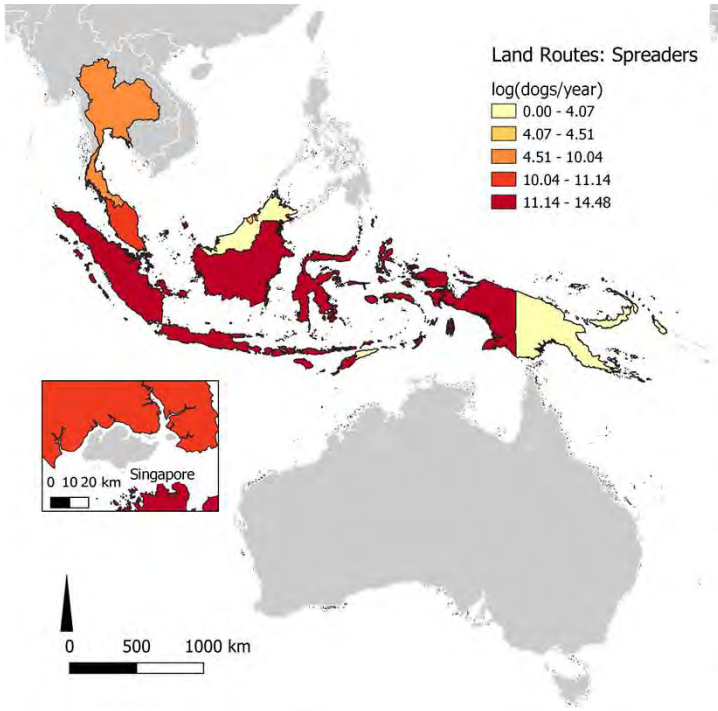
- Each country completed spreadsheets for
  - Air
  - Sea
  - Land routes

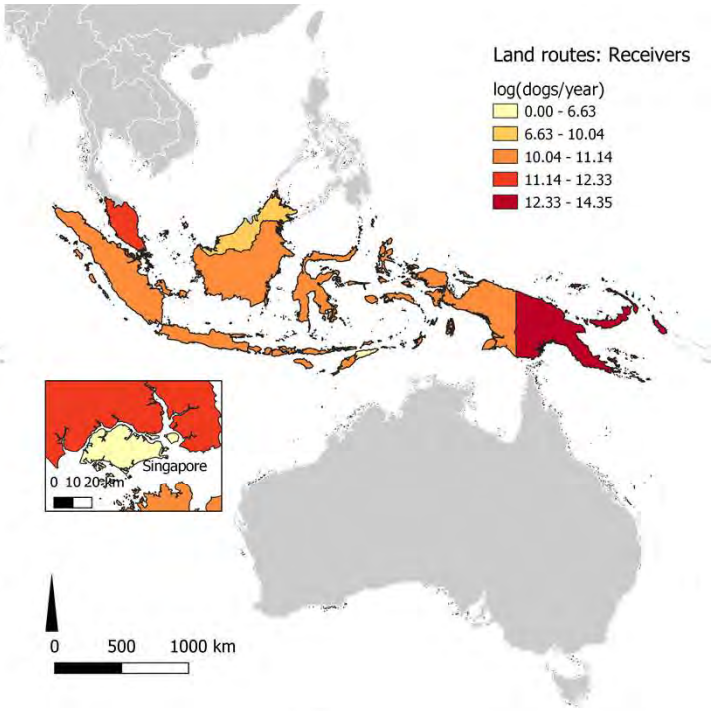
- Total 157 pathways
- Indonesia and Malaysia 47%
- Commercial 48%
- Regulated 84%

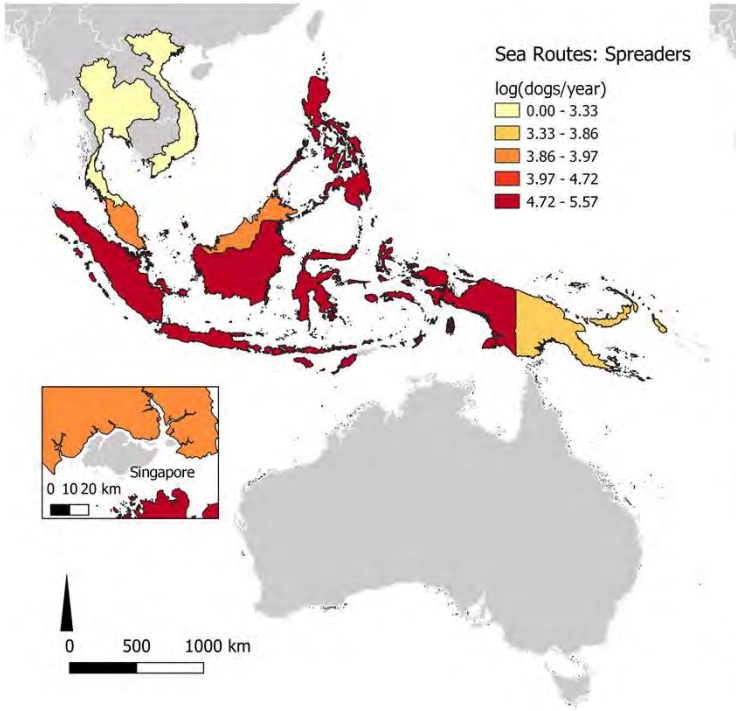
- Air (37%
- Sea (38%)
- Land routes (25%)

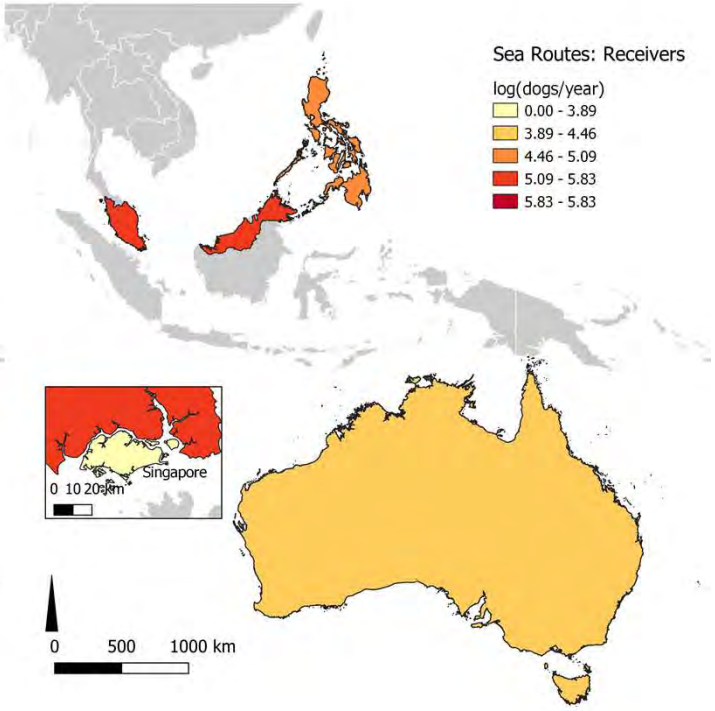
- Land: >2 million undetected dogs/year
- Sea: 525 dogs/year
- Air: 6 dogs/year




Land Routes: Spreaders
log(dogs/year)
0.00 - 4.07
4.07 - 4.51
4.51 - 10.04
10.04 - 11.14
11.14 - 14.48
Singapore
0 10 20 km
0 500 1000 km


Land routes: Receivers
log(dogs/year)
0.00 - 6.63
6.63 - 10.04
10.04 - 11.14
11.14 - 12.33
12.33 - 14.35
Singapore
0 10 20 km
0 500 1000 km


Sea Routes: Spreaders
log(dogs/year)
0.00 - 3.33
3.33 - 3.86
3.86 - 3.97
3.97 - 4.72
4.72 - 5.57
Singapore
0 10 20 km
0 500 1000 km


Sea Routes: Receivers
log(dogs/year)
0.00 - 3.89
3.89 - 4.46
4.46 - 5.09
5.09 - 5.83
5.83 - 5.83
Singapore
0 10 20 km
0 500 1000 km

Scenario-Spreadsheets – Insights

- Benefits
- Visual display
- Encourages discussion
  - Within and between!
  - Routes that are unregulated routes are very difficult to assess
    - Solutions
      - Site visits
      - Interviews
      - More jellybeans!!!
- Limitations
- Not directly considering rabies
- Uncertainty

Conclusions: Where to from here?

- To improve rabies preparedness
- (prevention, surveillance, response strategies)

- We need an integrated epidemiological–sociological approach
  - To understand and predict drivers of dog movement

- This requires
  - Development appropriate tools
  - Building capacity in data gathering
    - expert opinion
    - Dog demography
  - Regular inter- and intra-country discussions