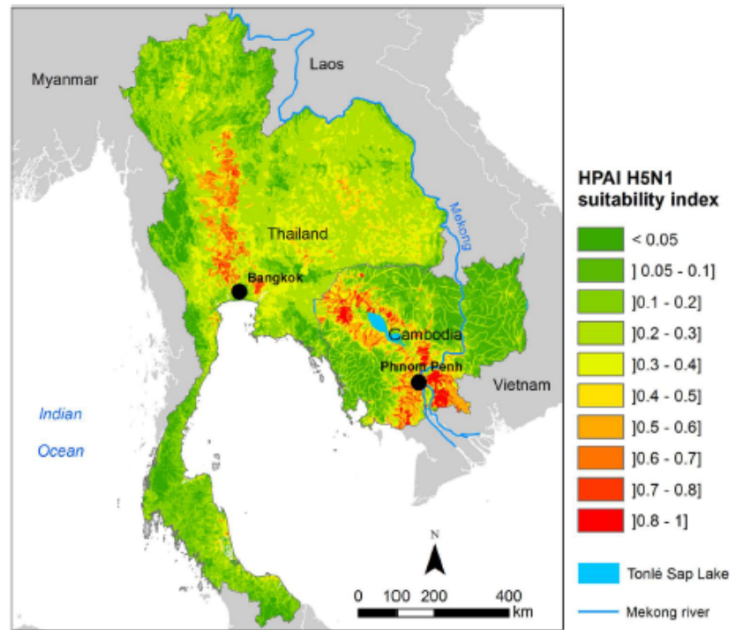# Advanced GIS Virtual Training Course- Day 02- Introduction to Spatial Risk Assessment

Chris Compton and Art Subharat, EpiCentre, Massey University, New Zealand
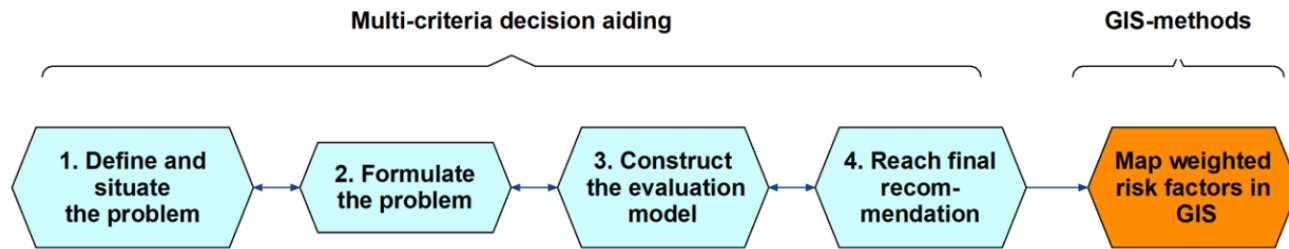
July 2021

# Roadmap

- Day 01 review

- MCDA Step 2- Formulate the problem (contd.)

  - Risk factors- which to choose for SRA modelling?

- MCDA Step 3- Construct the evaluation model

  - Spatial weights- how to convert questionnaire answers to spatial weights

# Day 01 Review



Suitability map for occurrence of HPAI H5N1 in domestic poultry in Thailand and Cambodia- from Paul et al. 2016 Nature Scientific Reports

- SRA is knowledge-driven
- Uses (local) knowledge about spatial risk factors for disease incursion or spread
- SRA map provides a measure risk of disease occurrence on a 0 - 1 scale

Multi-criteria decision aiding — GIS-methods

1. Define and situate the problem ↔ 2. Formulate the problem ↔ 3. Construct the evaluation model ↔ 4. Reach final recommendation → Map weighted risk factors in GIS

| Times | Activities |
|---|---|
| **10:00 - 10:20** | Presentation- MCDA- choosing risk factors |
| **10:20 - 11:00** | Exercise- breakout groups |
| **11:00 - 11:05** | Break |
| **11:05 - 11:25** | Presentation- MCDA- working with questionnaires and results |
| **11:25 - 11:30** | Wrap-up |
| **Self-directed** | Exercise- Individual- using Excel spreadsheet for creating questionnaire and managing results |

# Risk factors- which to choose for SRA modelling?

# Causal path models

- Describe hypothesised
  - Causal relationships between the risk factors and the occurrence of disease
  - Relationships between risk factors
- Path model is constructed during discussion between the subject experts
- Typically done in facilitated focus group

# Steps to build causal path model (1)

- Record the risk factors for the selected disease
  - Divide risk factors by
    - Factors relating to incursion or spread (some factors may be included in each category)
    - Factors that have or do not have a geographic characteristic that can be mapped

# Steps to build causal path model (2)

- Decide type of disease occurrence to create a model for
    - Incursion or spread, or both combined
- Base decision on data available and the needs of the DM's
    - From MCDA step 1- Define the problem

# Steps to build causal path model (3)

- Draw an hypothesised causal path diagram
  - Use single direction arrows for the direction of the causal path
  - Join the risk factors to
    - Disease occurrence
    - Other risk factors where they are causally linked

# Steps to build causal path model (4)

- Eliminate risk factors that
    - Intervene between other risk factors and disease occurrence
    - Are highly correlated with other risk factors
    - Don't have spatial data to represent them
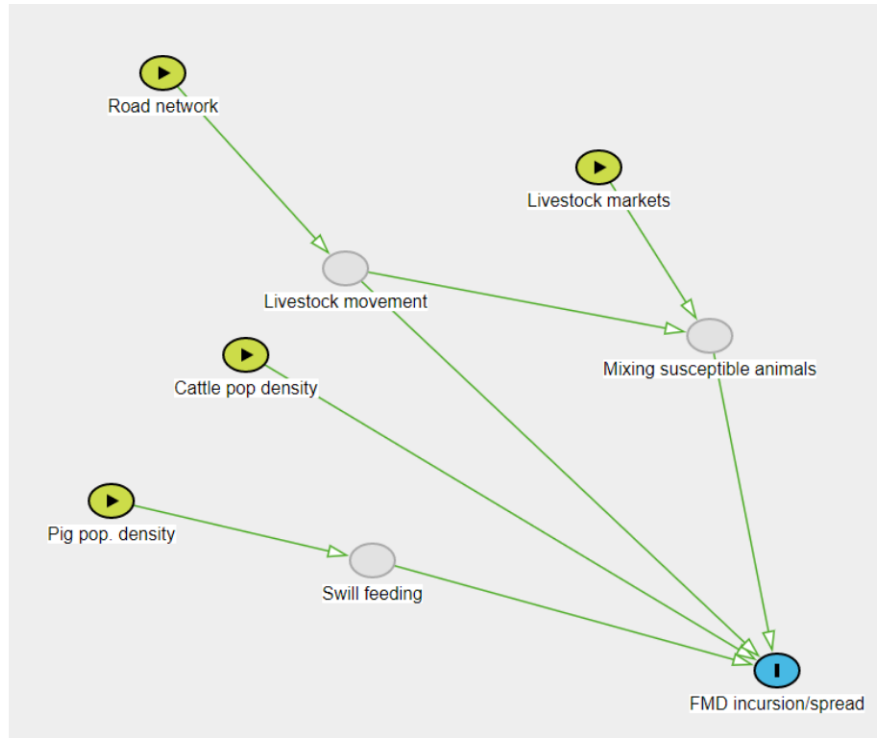
# Steps to build causal path model (5)

- Agree within the focus group to keep for analysis
    - The likely most important risk factors
    - Limited number of risk factors to model (< 4 - 5)

# Example- preliminary risk factors for incursion & spread of FMD in Myanmar
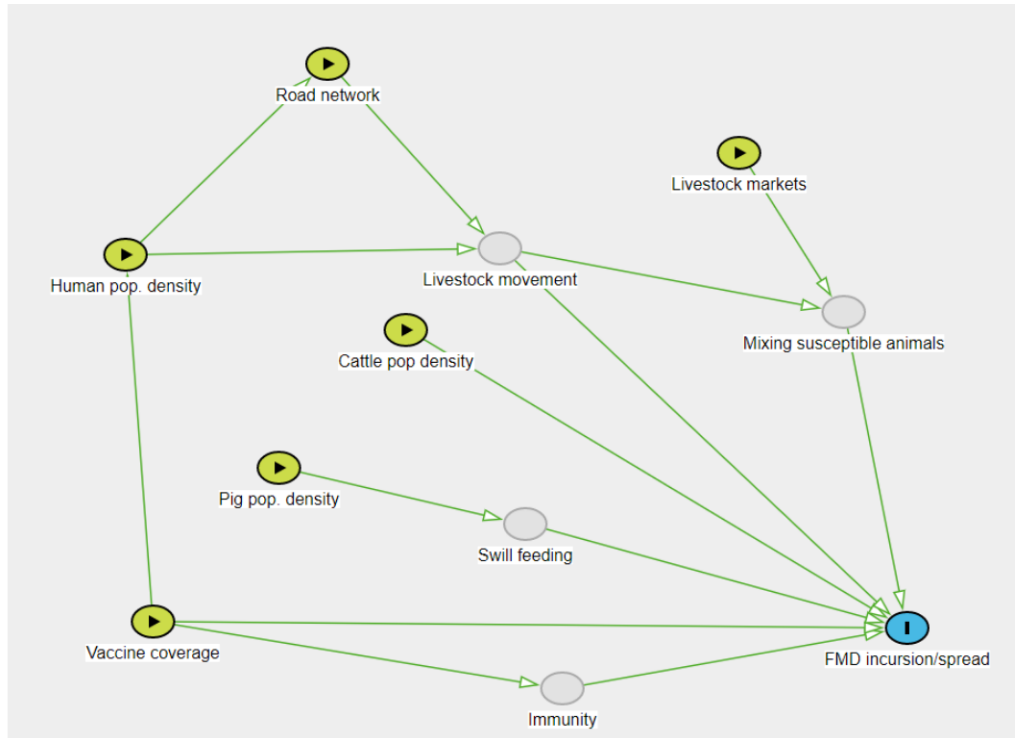
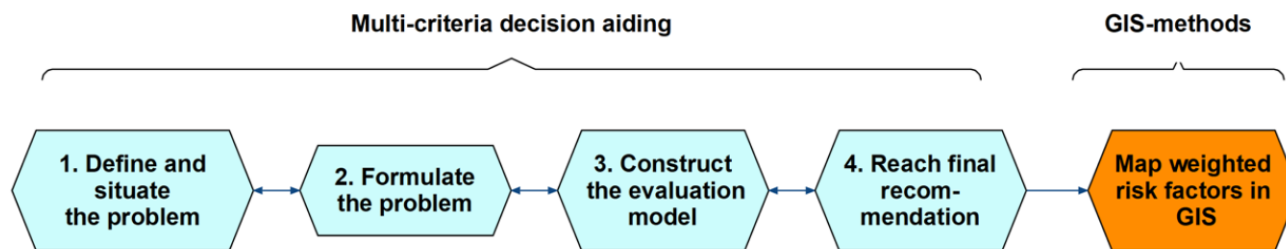# Example- Final risk factors for incursion & spread of FMD in Myanmar

| Risk factors for FMD incursion | Spatial feature | Data source |
|---|---|---|
| **Livestock movement (legal and illegal)** | Major and minor roads | OSM National roading network map |
| **Susceptible population density** | Cattle population density | FAO Gridded Livestock of the World |
| **Multiplier population density & swill feeding** | Pig population density | FAO Gridded Livestock of the World |
| **Animal mixing and spreading locations** | Live animal markets | Government locations and status of livestock markets |

# Exercise

- Work in Zoom breakout groups from Day 01

- Create a diagram of your own causal path models based on the risk factors discussed on Day 01

- Use either computer software (e.g. PowerPoint) or pen and paper to record your model

- Record your group name by combining the countries involved on the diagram and post it on the Stream Forum site "Causal path models"

# MCDA Step 3- Build evaluation model



Multi-criteria decision aiding

GIS-methods

1. Define and situate the problem

2. Formulate the problem

3. Construct the evaluation model

4. Reach final recom-mendation

Map weighted risk factors in GIS

# The questionnaire and result data management system

- Based on Microsoft Excel workbook- MCDAExercise-MMR.xlsx
- Partly automated, partly manual system
- FMD incursion/spread in Myanmar (2019) example
- Partly completed already
- Finish analysis in exercise

# Questionnaire & result data capture (1)

- Enter risk factors into RiskFactors worksheet



|   | A | B | C | D |
|---|---|---|---|---|
| 1 | Enter factor abbreviation and description in yellow cells | | | |
| 2 | | | | |
| 3 | FactorCode | FactorAbbrev | FactorDescription | |
| 4 | A | RDS | Major and minor roads | |
| 5 | B | CTL | Cattle population density | |
| 6 | C | PIG | Pig population density | |
| 7 | D | MKT | Live animal markets | |
| 8 | | | | |

# Questionnaire & result data capture (2)

- View and check risk factor comparisons in RiskFactorComparisons worksheet

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | | | | Risk factor 2 | | |
| 2 | | | Major and minor roads | Cattle population density | Pig population density | Live animal markets |
| 3 | | Major and minor roads | | | | |
| 4 | Risk | Cattle population density | Cattle population density vs Major and minor roads | | | |
| 5 | factor 1 | Pig population density | Pig population density vs Major and minor roads | Pig population density vs Cattle population density | | |
| 6 | | Live animal markets | Live animal markets vs Major and minor roads | Live animal markets vs Cattle population density | Live animal markets vs Pig population density | |
| 7 | | | | | | |

# Questionnaire & result data capture (3)

- View and check questionnaire before printing in Questions worksheet and edit if necessary

# Questionnaire in print form

FMD Risk Factor Questionnaire

Question-
naire ID:
Participant
role:              Myanmar student    Laos student    Other    (circle one only)

Question
Number        Question (circle only one answer)
1             **When comparing Cattle population density with Major and minor roads for the incursion and spread of FMD, Cattle population density 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
2             **When comparing Pig population density with Major and minor roads for the incursion and spread of FMD, Pig population density 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

# Questionnaire & result data capture (4)

- Code results in questionnaire responses according to REMBRANDT scoring system in ComparisonValues worksheet

| | A | B |
|---|---|---|
| 1 | Comparison | Value |
| 2 | extremely less important | -8 |
| 3 | very strongly less important | -6 |
| 4 | strongly less important | -4 |
| 5 | moderately less important | -2 |
| 6 | equally important | 0 |
| 7 | moderately more important | 2 |
| 8 | strongly more important | 4 |
| 9 | very strongly more importan | 6 |
| 10 | extremely more important | 8 |

# REMBRANDT MCDA weights

- Exponentially greater weights given to the stronger opinions in answers to questions
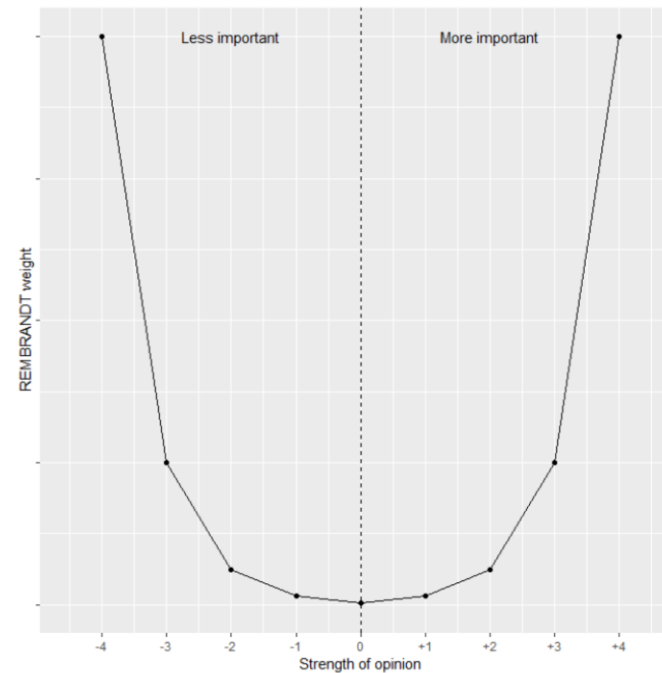
# Questionnaire & result data capture (5)

- Enter results from each questionnaire by Questionnaire ID and Question into Value column in Results worksheet

| | A | B | C |
|---|---|---|---|
| 1 | Questionnaire | Question | Value |
| 2 | 1 | 1 | 4 |
| 3 | 1 | 2 | 2 |
| 4 | 1 | 3 | -2 |
| 5 | 1 | 4 | 0 |
| 6 | 1 | 5 | 4 |
| 7 | 1 | 6 | 4 |
| 8 | 2 | 1 | 4 |
| 9 | 2 | 2 | 2 |
| 10 | 2 | 3 | 0 |
| 11 | 2 | 4 | 2 |
| 12 | 2 | 5 | 0 |
| 13 | 2 | 6 | 2 |
| 14 | 3 | 1 | -4 |
| 15 | 3 | 2 | -4 |
| 16 | 3 | 3 | -6 |
| 17 | 3 | 4 | -4 |
| 18 | 3 | 5 | -6 |
| 19 | 3 | 6 | 4 |
| 20 | 4 | 1 | -2 |

# Questionnaire & result data capture (6)

- Copy results filtered by question number from Results worksheet into Raw values column to calculate median result for each question

| | A | B | C | D | E |
|---|---|---|---|---|---|
| 1 | Step 1: Copy raw values from Results worksheet filtered for each question into yellow cells below, over-writing any previous values | | | | |
| 2 | Step 2: Manually enter the calculated median result in the orange cell for each question into the upper left blue cells to the right of the corresponding question number | | | | |
| 3 | | | | | |
| 4 | Question | Median result | | Raw values | |
| 5 | 1 | 0 | | 4 | |
| 6 | 2 | 0 | | 2 | |
| 7 | 3 | -2 | | 4 | |
| 8 | 4 | 2 | | 0 | |
| 9 | 5 | 2 | | 0 | |
| 10 | 6 | 0 | | 0 | |
| 11 | | | | 4 | |
| 12 | | | | 0 | |
| 13 | | | | -4 | |
| 14 | | | Question median | 0 | |
| 15 | | | | | |

# Questionnaire & result data capture (7)

- View final results of weight for each spatial risk layer in FinalResultsMatrix worksheet

|  | | Major and minor roads | Cattle population density | Pig population density | Live animal markets | Geometric row mean | Weight for spatial risk layer |
|---|---|---|---|---|---|---|---|
| **Median scores for risk factor comparisons** | | | | | | | |
| | | | Risk factor 2 | | | | |
| | | Major and minor roads | Cattle population density | Pig population density | Live animal markets | | |
| | Major and minor roads | 0 | 0 | 0 | -2 | | |
| Risk | Cattle population density | 0 | 0 | 2 | -2 | | |
| factor 1 | Pig population density | 0 | -2 | 0 | 0 | | |
| | Live animal markets | 2 | 2 | 0 | 0 | | |
| | | | | | | | |
| **Transformed scores, geometric means & weights** | | | | | | | |
| | | | Transformed score for each risk factor comparison | | | | |
| | | | Risk factor 2 | | | | |
| | | Major and minor roads | Cattle population density | Pig population density | Live animal markets | Geometric row mean | Weight for spatial risk layer |
| | Major and minor roads | 1.00 | 1.00 | 1.00 | 0.55 | 0.77 | 0.18 |
| Risk | Cattle population density | 1.00 | 1.00 | 1.83 | 0.55 | 1.00 | 0.24 |
| factor 1 | Pig population density | 1.00 | 0.55 | 1.00 | 1.00 | 0.77 | 0.18 |
| | Live animal markets | 1.83 | 1.83 | 1.00 | 1.00 | 1.69 | 0.40 |
| | | | | | | | 1.00 |

# Self-directed learning exercise

- Download MCDAExercise-MMR-FMD.xlsx from Stream course site Spatial Risk Assessment Section

- View each worksheet including cells with functions to better understand process

- Complete steps 6 and 7

- Use values entered from questionnaires of Myanmar participants at 2019 course in Results worksheet