INVESTIGATING THE RELATIONSHIP BETWEEN SURFACE WATER AND DENGUE INCIDENCE: A CASE STUDY IN VIENTIANE CAPITAL, LAO PDR (2017)

The GeoOneHealth Symposium

Phnom Penh, Cambodia
5 December 2022

Research objectives

- To examine methods used for extracting surface water from a ‘free of charge’ satellite images.
- To examine a ‘correlation’ between water bodies and dengue incidence.

Research Methods

Data sources

- Series of satellite images (Jan-Dec) derived from PlanetScope and RapidEye
- Dengue incidence in 2017 with geolocation derived from Institut Pasteur du Laos (IPL)
- Monthly rainfall in 2017

Methodologies

- Indices methods (NDWI, NDMI, NDVI) were explored for extracting water information from satellite images
- Spearman's correlation and coefficient, and linear regression model were used to examine an association between dengue incidence and surface water

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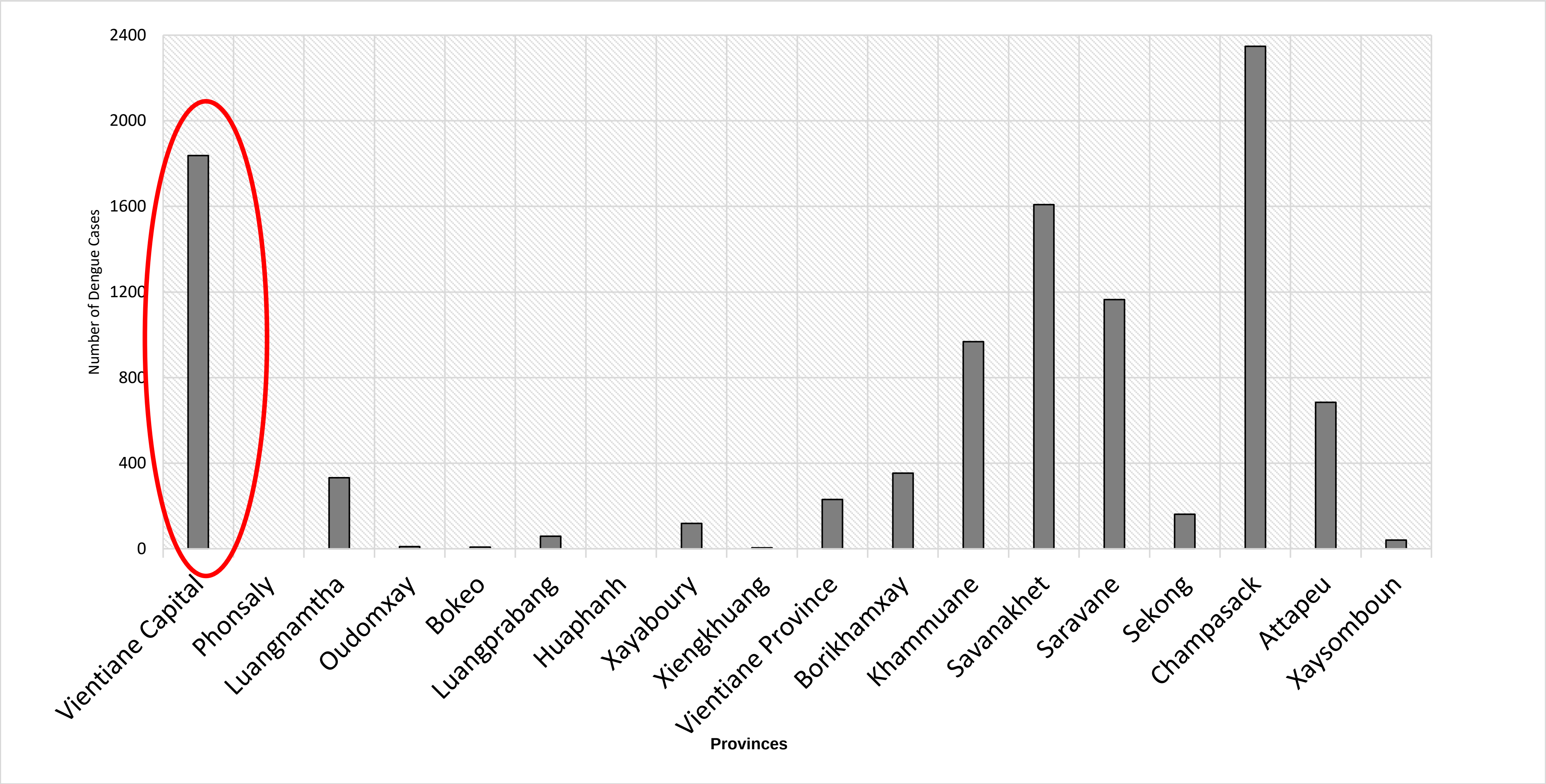
INSTITUT PASTEUR DU LAOS

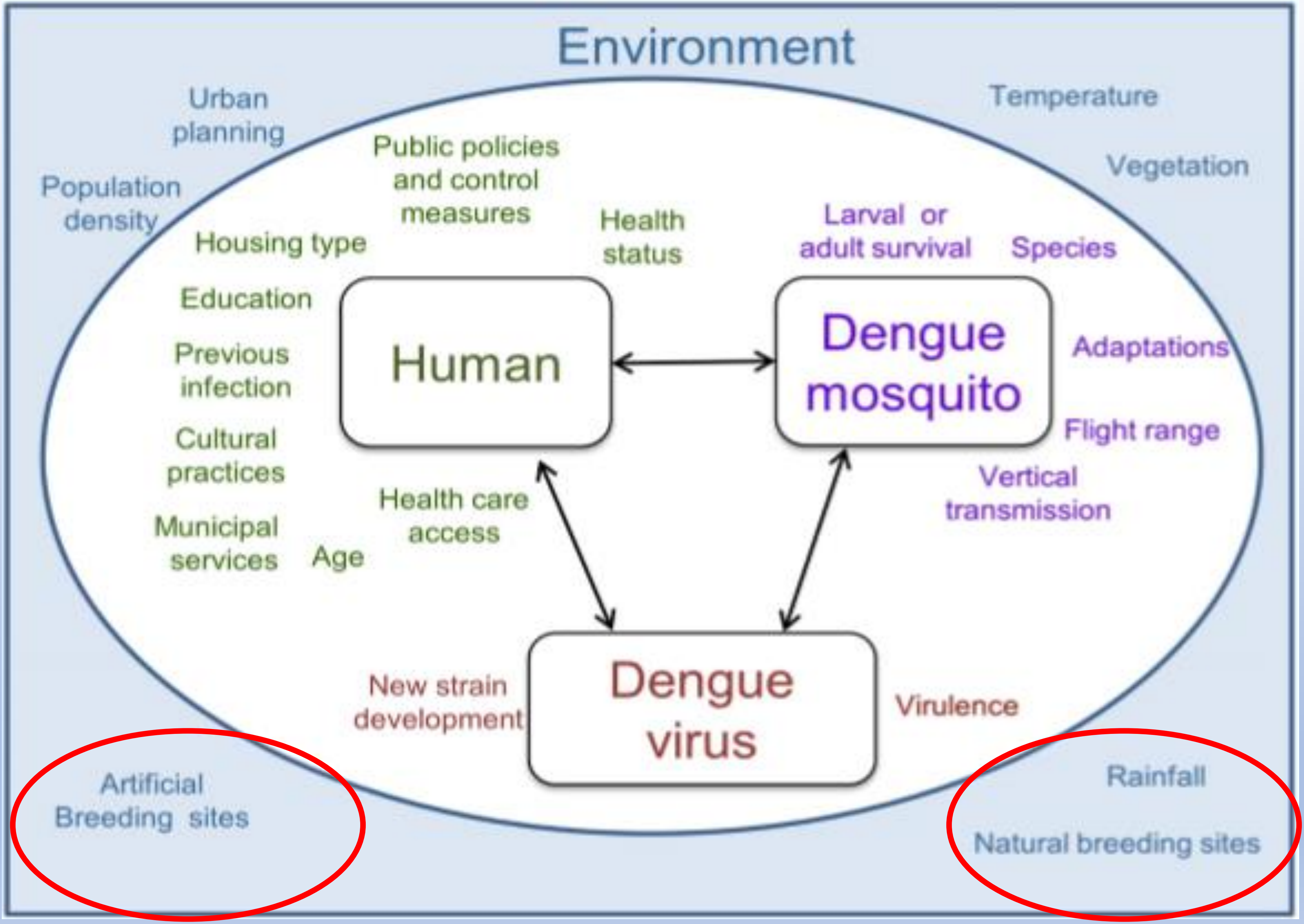
Study Area

- Laos is located in tropical area, South-east Asia region
- Dengue infection was found since 1983 in Vientiane, and later the disease has been an epidemic across the country
- The large epidemic was in 2010, 2013, 2017 and 2019 *(see next slide)*



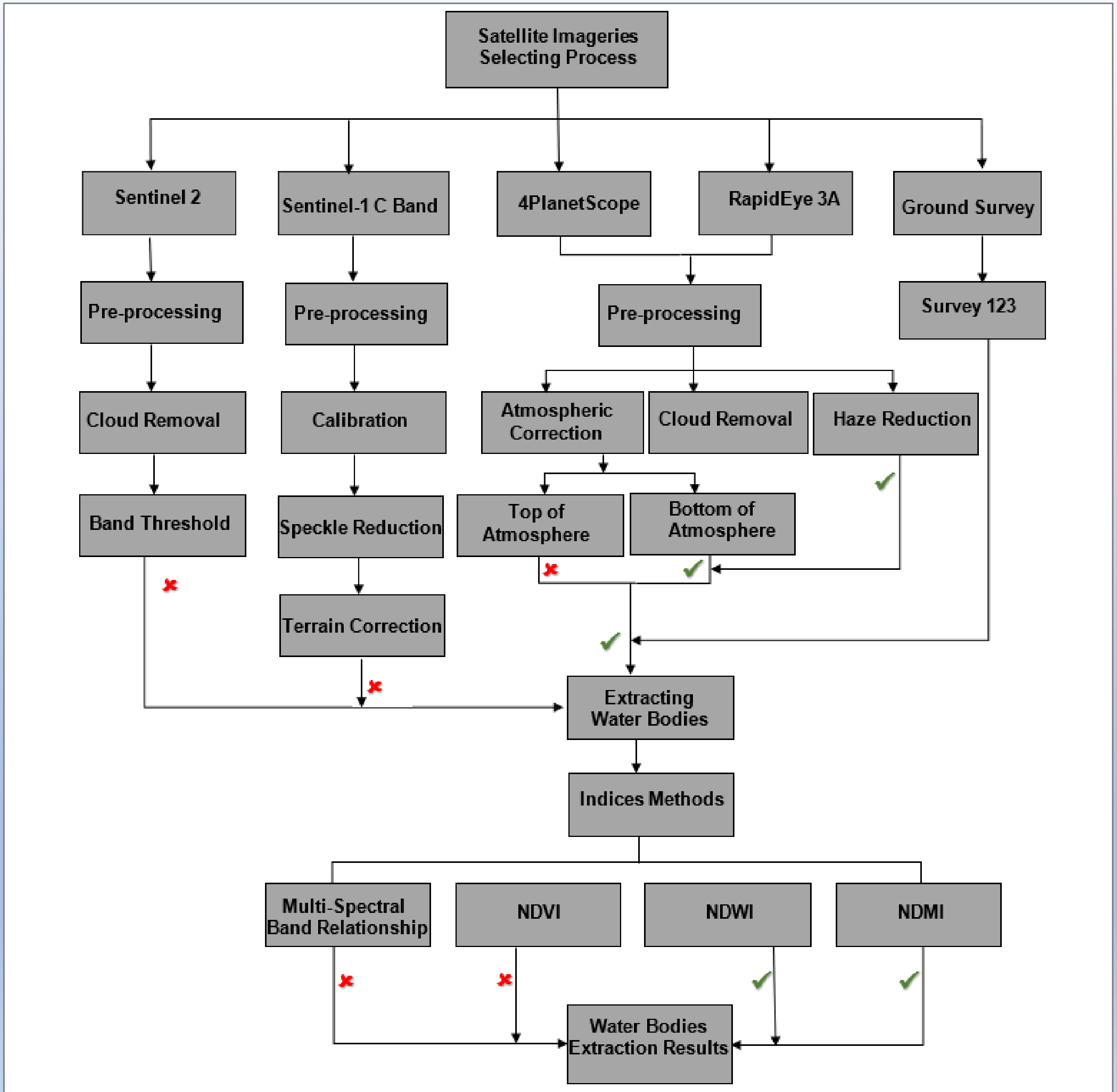
Dengue Epidemic 29/12/2018 to 01/07/2019

Dengue occurrence and factors



Source: Dickin, Schuster-Wallace and Elliott (2013)

Data Preparation



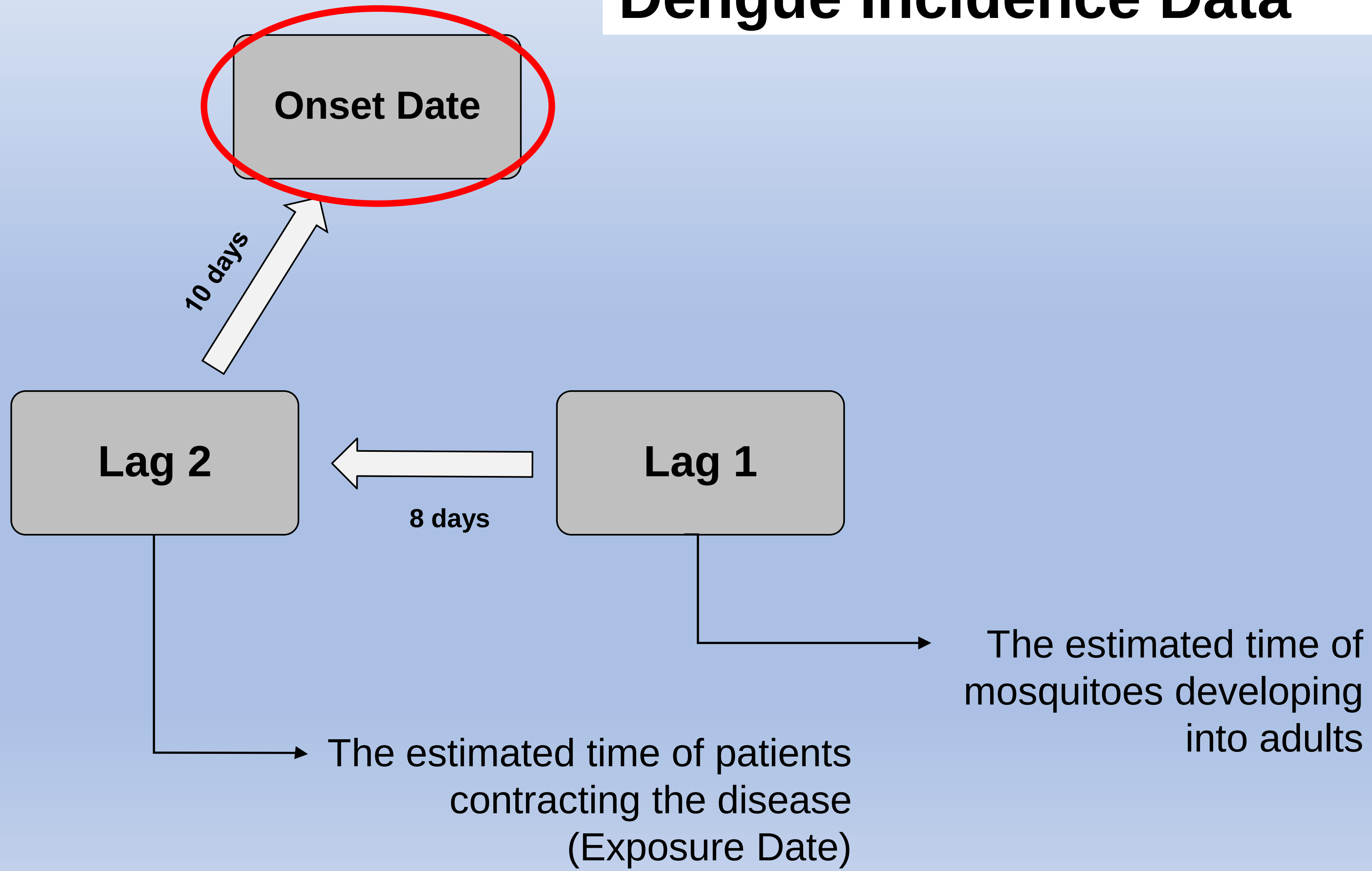
Data Preparation

Image datasets used in this study

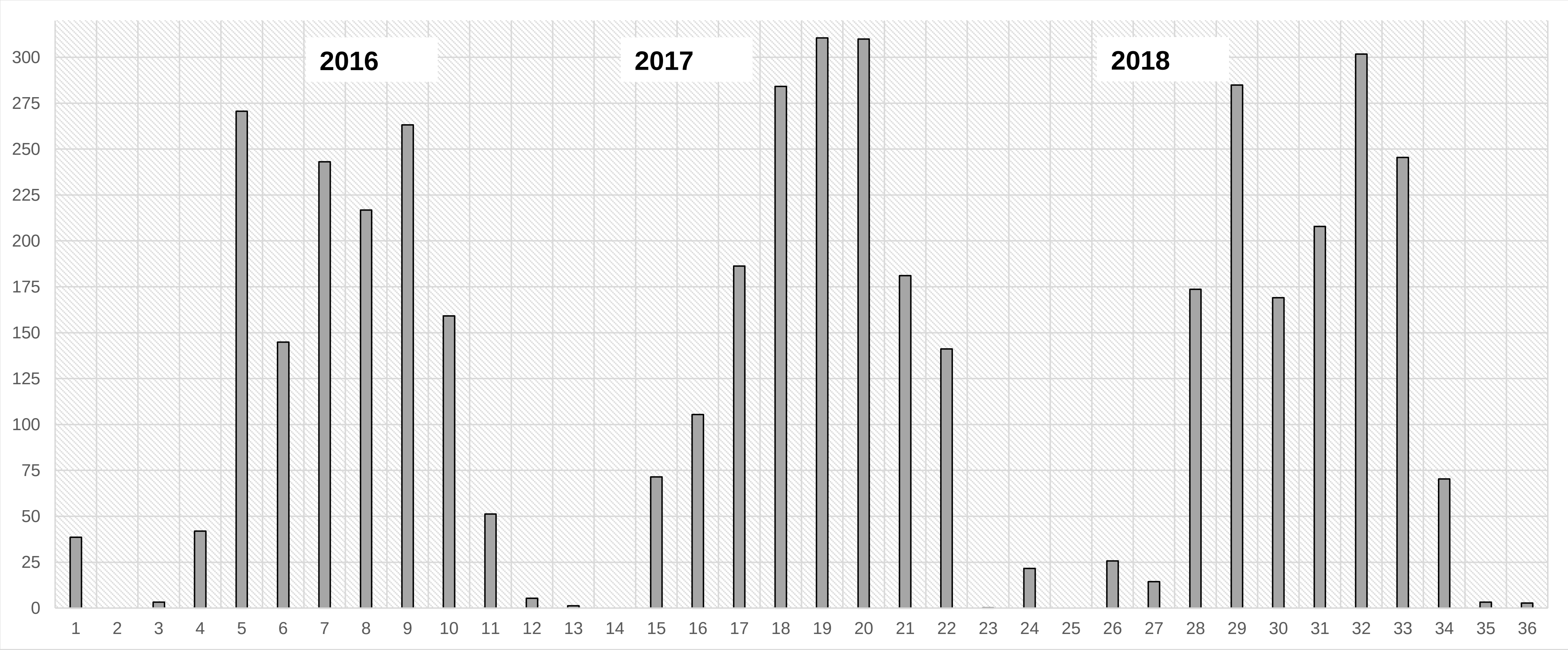
Satellite Images	Dates	Number of Tiles
PlanetScope	04 January 16 January 17 February 04 April 10 May June July 23 August September 17 October 14 November 24 December	4 4 3 4 4 - - 6 - 8 5 7
RapidEye	13 March	4

Data Preparation

Dengue Incidence Data



Data Preparation

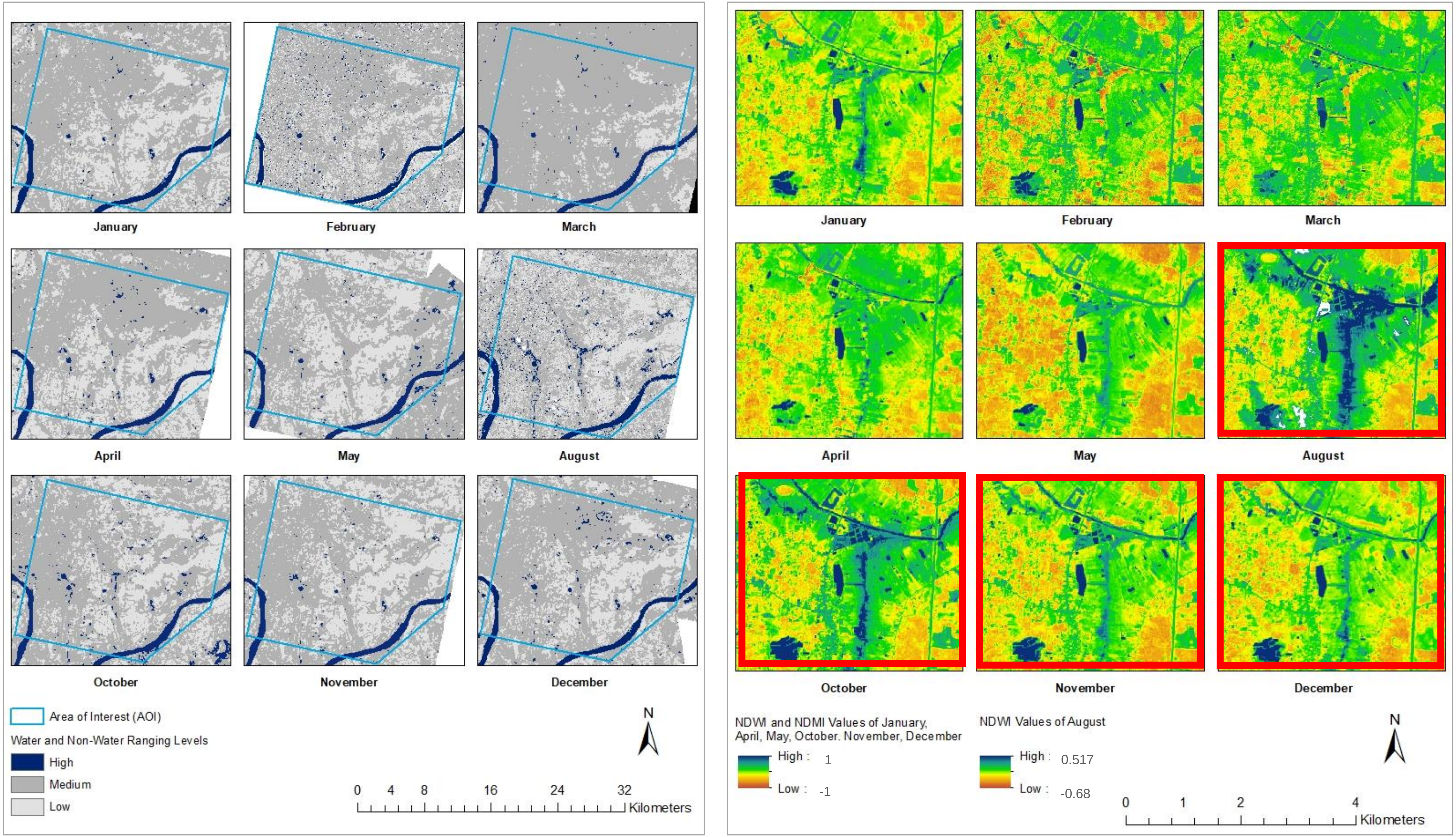


Precipitation Data from 2016-2018

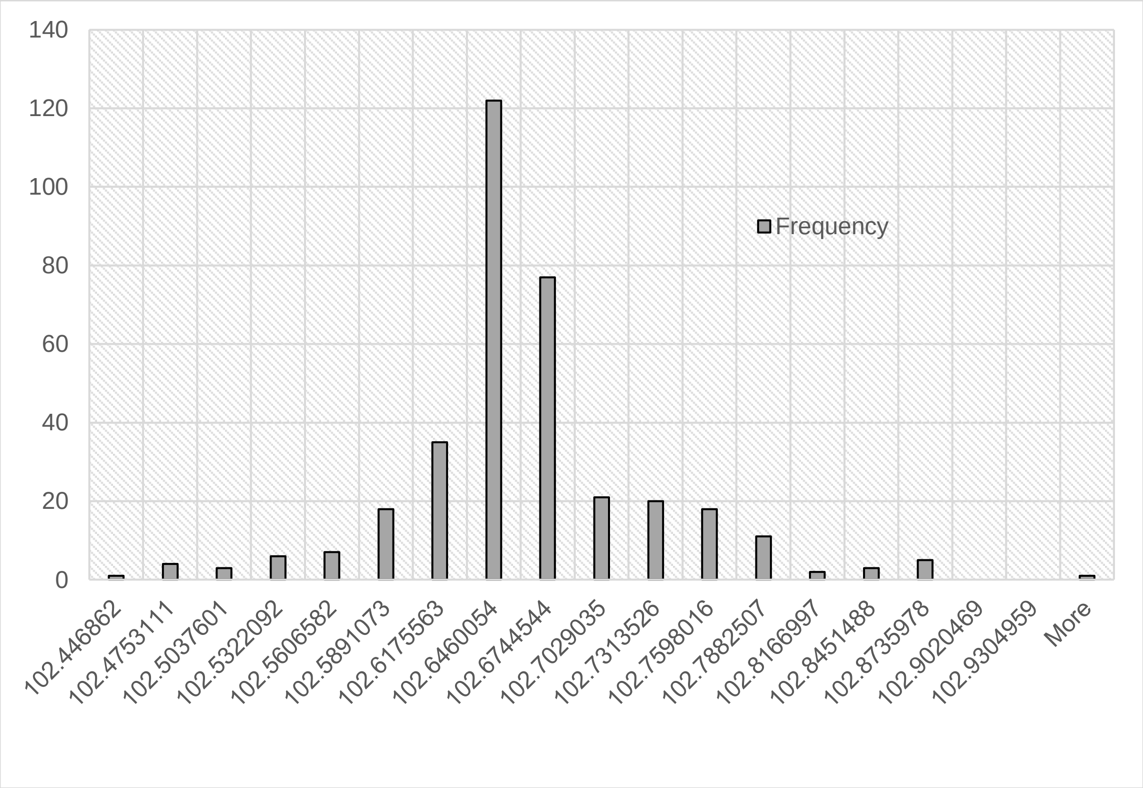
Key findings

A. Surface Water Extraction

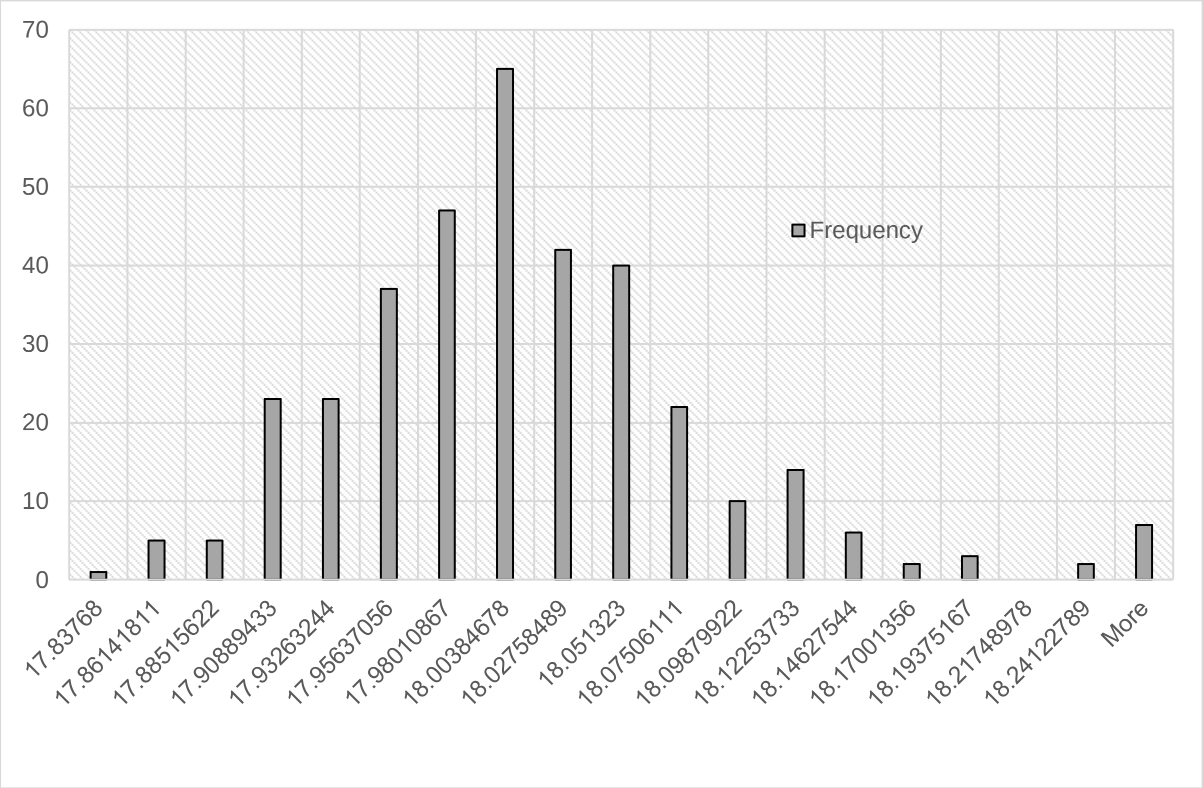
- It was found that **NDWI** and **NDMI** performed better in different time throughout the year.
- **NDWI** could detect surface water where there is a vast amount of surface water, while NDMI was found to perform better in the area where there is less amount of surface water.


January
February
March
April
May
August
October
November
December
Area of Interest (AOI)
Water and Non-Water Ranging Levels
High
Medium
Low
0 4 8 16 24 32 Kilometers
N
January
February
March
April
May
August
October
November
December
NDWI and NDMI Values of January, April, May, October. November, December
High : 1
Low : -1
NDWI Values of August
High : 0.517
Low : -0.68
0 1 2 4 Kilometers
N

Spatial distribution of Dengue fever



Frequency of dengue incidence spread in Easting

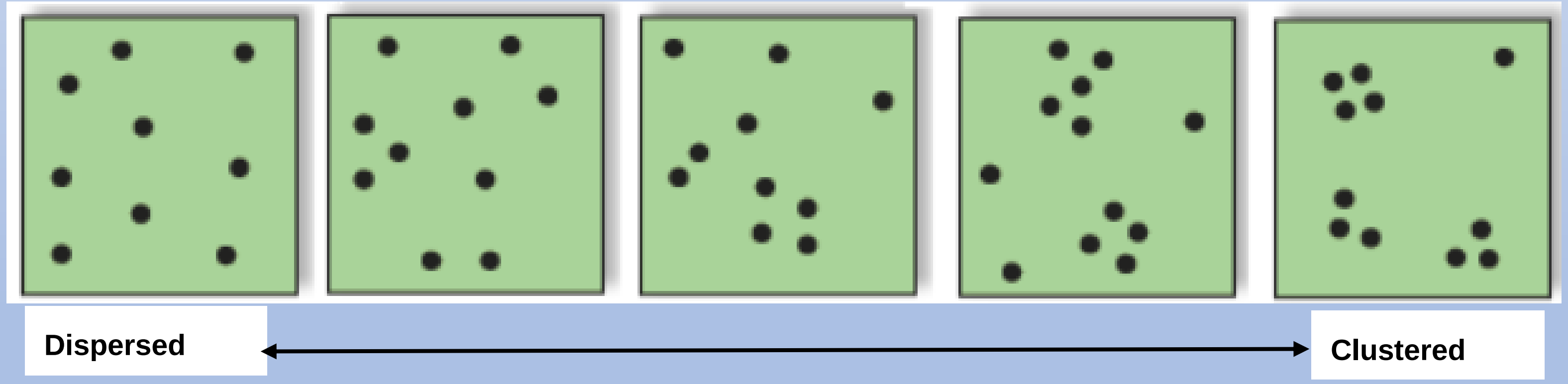


Frequency of dengue incidence spread in Northing

Cont. Spatial Distribution

Nearest Neighbour (NN) was applied to determine the dispersion of the data as it is normally used to investigate the quantitative analysis spread of data.

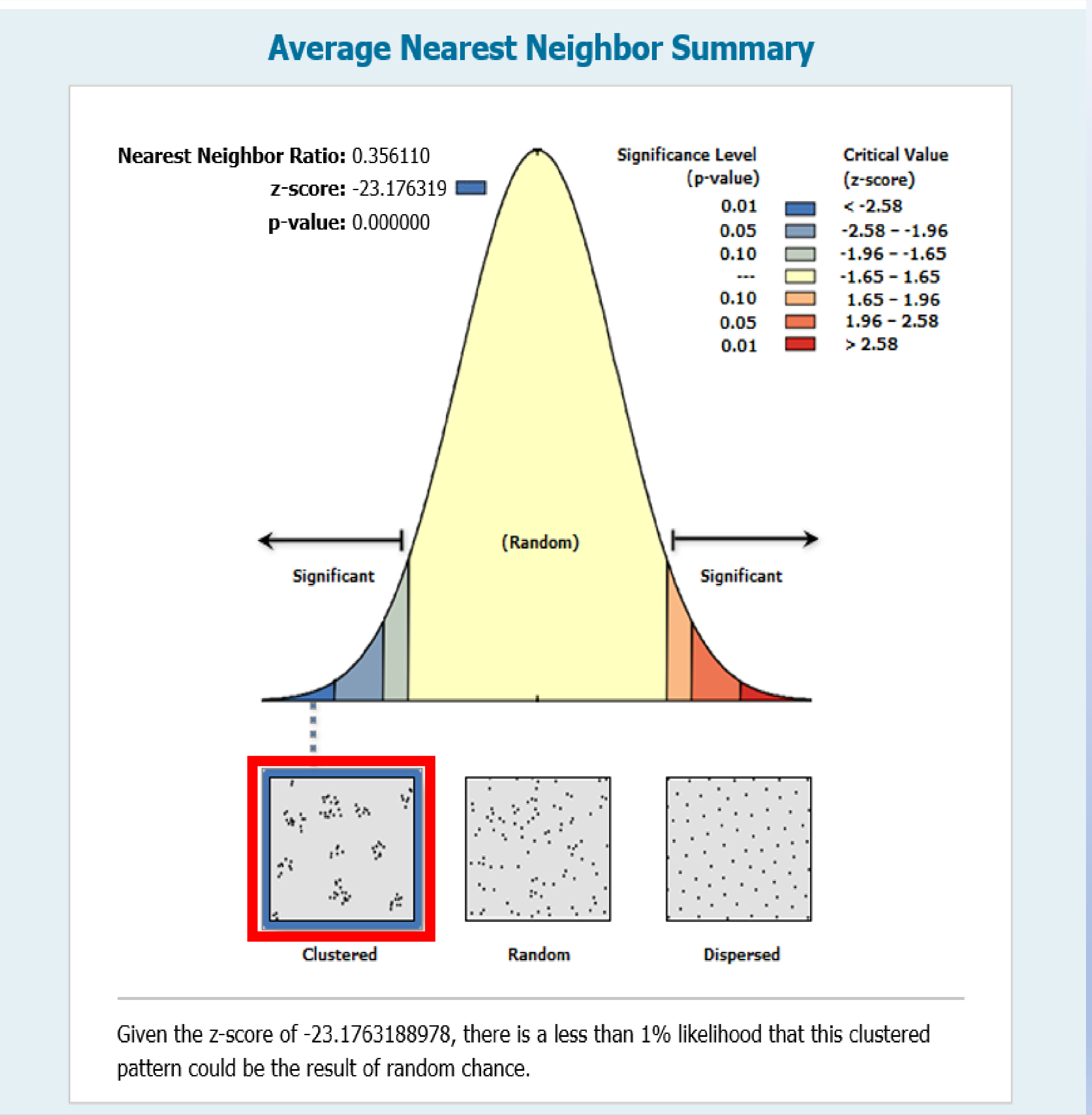
- D_O = Observed Distance between the given features and their nearest neighbour
- D_E = Expected distance of the given features random pattern

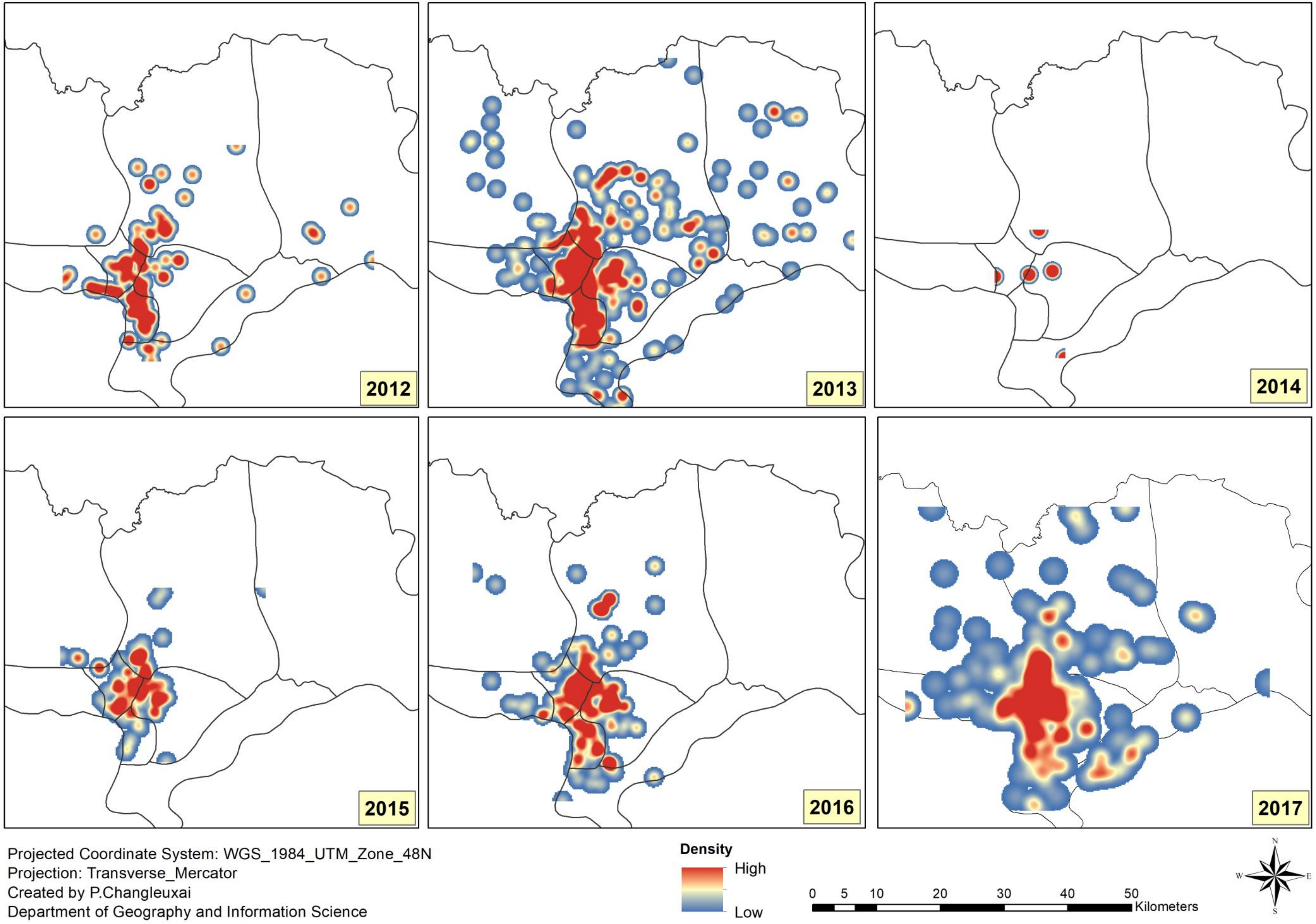


Average Nearest Neighbour Analysis Information

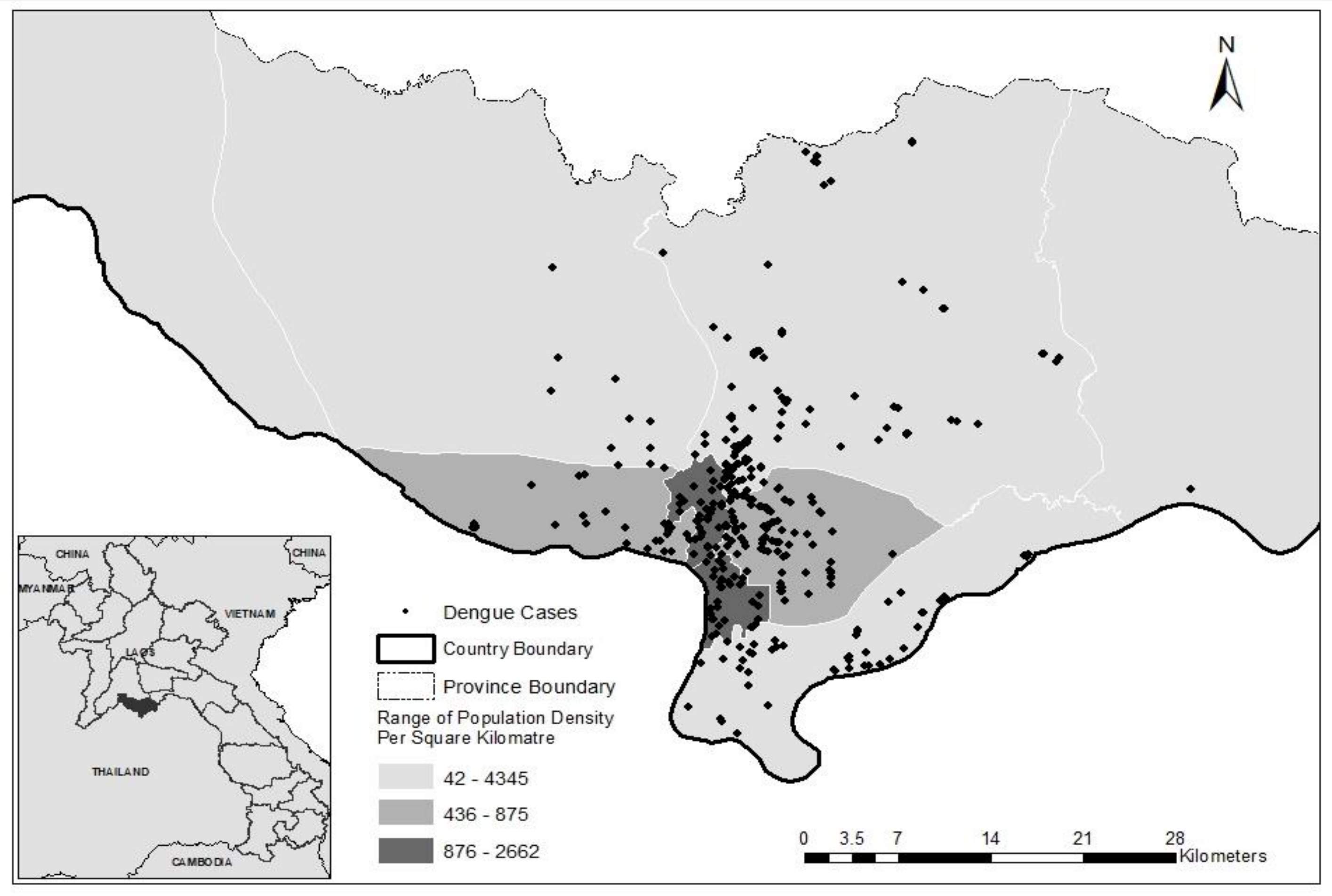
	Index Values
Nearest Neighbour Ratio	0.35611
Nearest Neighbour Expected	1603.37221
Nearest Neighbour Observed	570.976251
P Value	0
Nearest Neighbour Z Score	-23.176319

NN Ratio < 1 indicates the pastern of clustering




2012
2013
2014
2015
2016
2017
Projected Coordinate System: WGS_1984_UTM_Zone_48N
Projection: Transverse_Mercator
Created by P.Changleuxai
Department of Geography and Information Science
Density
High
Low
0 5 10 20 30 40 50
Kilometers
N
S
W
E

- The **trend of dengue** occurrence was likely to be influenced by the spatial distribution of population.
- However, there was a lack of data at the village level, which is necessary for the **spatial evaluation to analyse** whether the clustering pattern of dengue distribution is significantly correlated to **population and urban development**.



Comparing Dengue Incidence with Population Density

B. Correlation Coefficient

- **Surface water** showed positive relationship with **dengue incidence** at significant point (r=0.7, p= 0.025), but there was **NO association** between the **lag1** and **lag2.**
- **Rainfall and dengue incidence** appeared a **positive correlation** with dengue incidence **but not** at a significant level (r=0.53, p=0.071), whereas it had positive relationship with **lag1** and **lag2** at a level of significance.
- ***Linear Regression:***

	Lag1			Lag2		
	Standardized Coefficients Beta	R Square	p	Standardized Coefficients Beta	R Square	p
Surface Water	**0.6**	**0.39**	**0.07**	**0.6**	**0.4**	**0.049**
Rainfall	**0.8**	**0.7**	**0.001**	**0.7**	**0.6**	**0.03**

Conclusion

Water bodies extraction

- Indices methods like NDWI and NDMI could generate water features at the accepted level of accuracy, however,
- Other aspects that should be considered include the fact that the surface water can be affected from run-off, organic matter, climate, vegetation and soil types, as well as geographical characteristics.

Analysis of the correlation of Water bodies and dengue incidence

- The distribution of dengue case in this year at this study site is likely to spatially influence by the spatial distribution of population.
- There was low trend of correlation between surface water and dengue incidence
- Rainfall appeared to highly associate with lag1 and lag2, thus, it might be used to project the occurrence of the disease.

Further studies

- If a study area is in tropical region where the presence of cloud is a significant challenge to extracting ground feature information, therefore **integrating SAR (**Synthetic Aperture Radar) **images** which can penetrate cloud cover with **optical images** should be examined.
- Further study might need to include
  - ✓ distance between the dengue incidence and the location of water.
  - ✓ average flight distance of dengue vectors will help define approximate distance between water bodies and the disease incidence.
- **In terms of health policy intervention**, controlling factors and activities including small scale water bodies and accumulation of water on surfaces **should be implemented** not only in the **rainy season**, but also in the **dry season** as how rainfall correlates with the disease incidence was clearly identified.


Thank you!