Application of Remote Sensing Technology for the Classification of Malaria Risk Areas in A Thai-Myanmar Border Province

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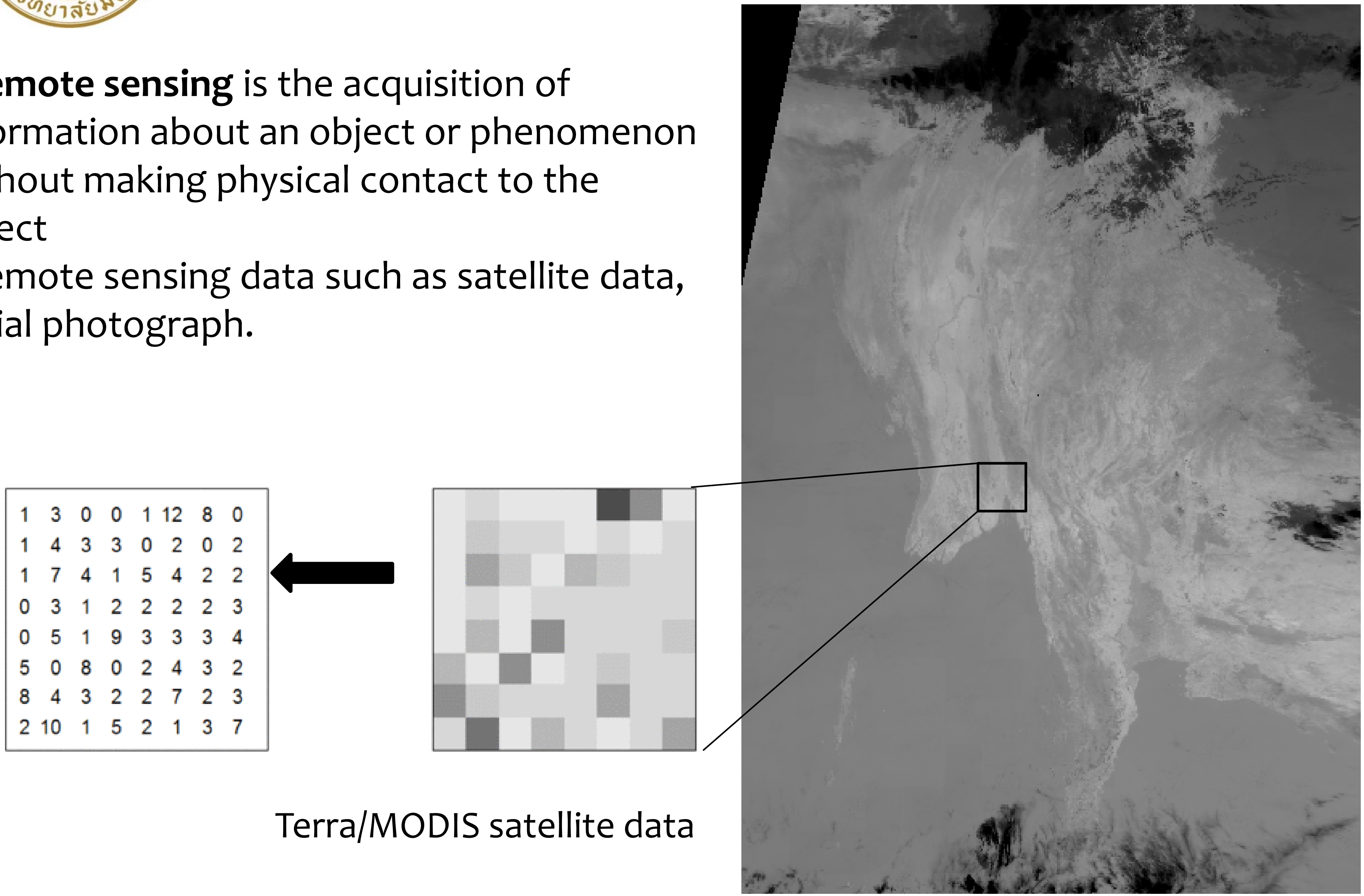
Outlines

- Introduction
- Objective
- Material and Method (data collection, data processing)
- Result
- Discussion

Introduction

Remote Sensing

- **Remote sensing** is the acquisition of information about an object or phenomenon without making physical contact to the object
- Remote sensing data such as satellite data, aerial photograph.



Terra/MODIS satellite data

Applications of Remote sensing in Malaria

- **Identify the risk area:** classified land cover that match malaria risk factor
- **Find bleeding place:** find a potential areas for mosquito bleeding
- **Make early warning system:** monitoring environmental changes over times

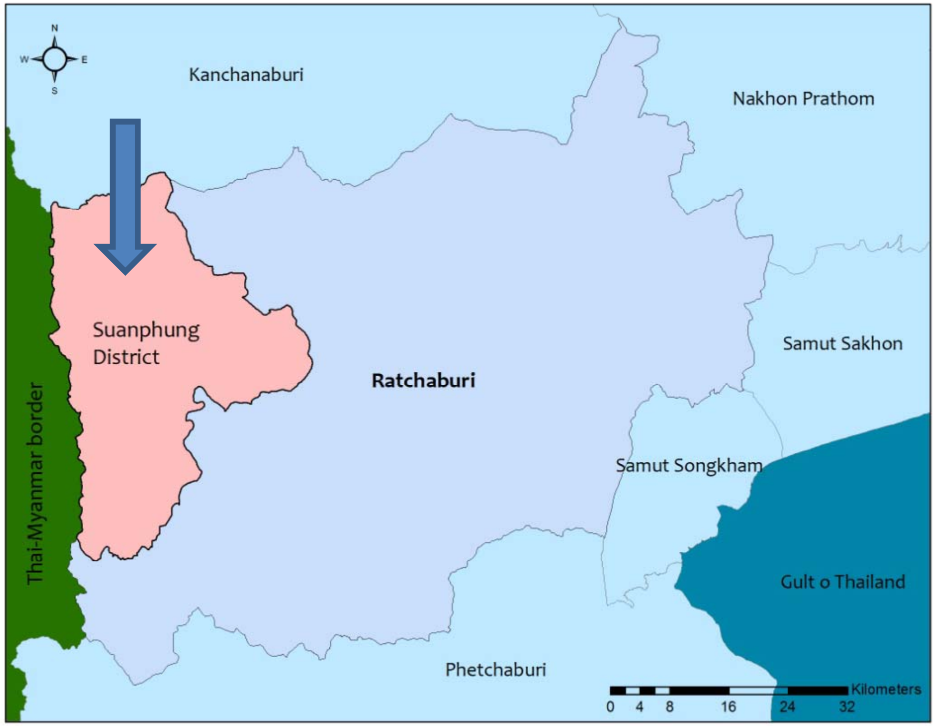
Objective

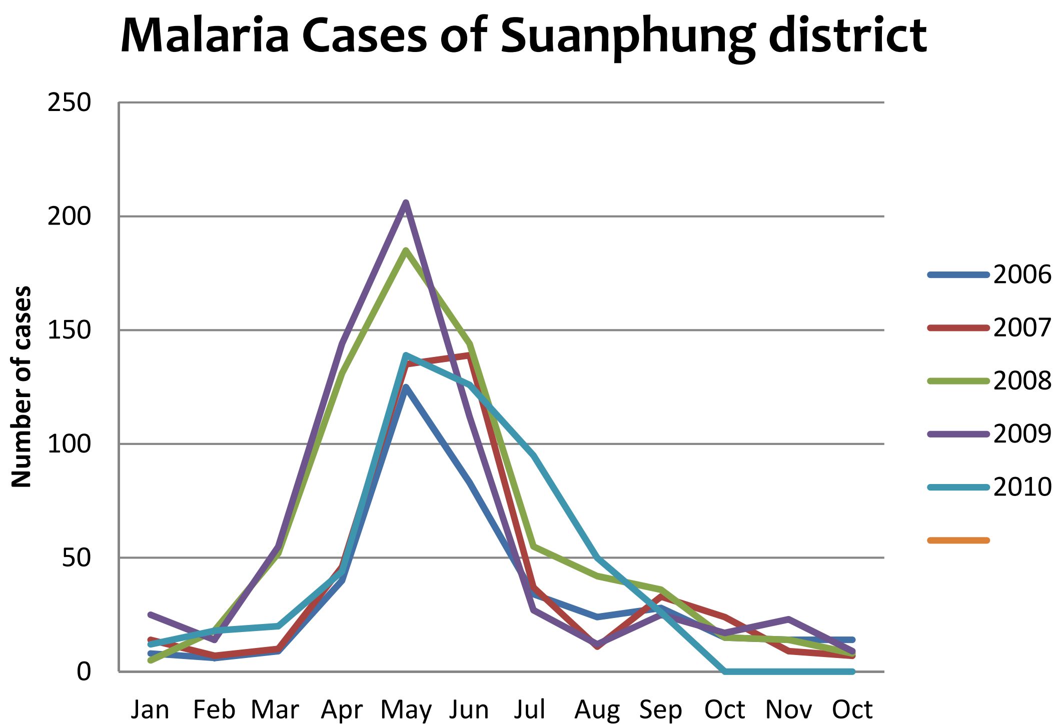
To establish a spatial model to predict malaria risk areas based on statistical modeling and remote sensing technology.

Materials and Methods

Study Site

- Suanphung district, Ratchaburi province along Thai-Myanmar border
- Endemic area for malaria





Environmental Factors

The 4 environmental factors considered in the study:

- Humidity (Atmospheric Water Vapor-AWV)
- Temperature (Land Surface Temperature-LST)
- Density of vegetation (Normalized Difference Vegetation Index-NDVI)

Terra/MODIS satellite data

- Rainfall data source: http://www.thaiwater.net

Data collection

- **Monthly malaria incidence cases by sub-district** acquired from Vector-borne Disease Control Unit, Ratchaburi Province

- **Monthly LST, NDVI, and AWV by sub-district** extracted from Terra/MODIS satellite images

- **Rainfall data** from 7 meteorological stations around the study areas and interpolated to get average monthly rainfall by sub-district.

- Observation period: January to April (2006 - 2010)

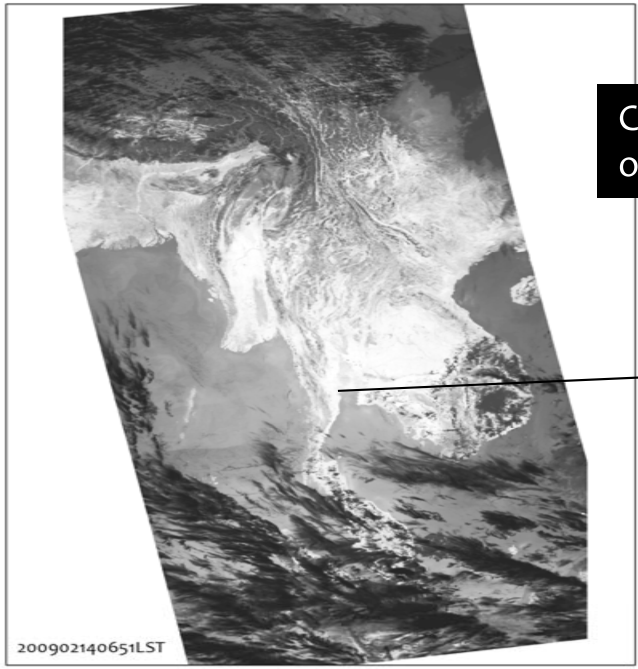
- The factors are processed as monthly average by sub-district from 2006-2010. The 2006-2009 were used to obtain the statistical model. Data in 2010 were used for model validation.

Factors from Terra/MODIS satellite

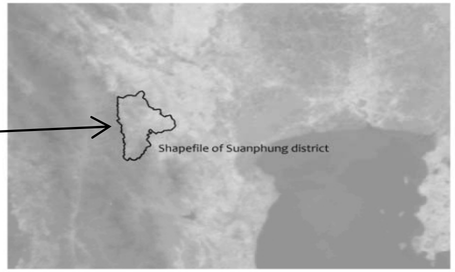
- **Normalized Difference Vegetation Index (NDVI) -** measures the abundance of vegetation
- **Land Surface Temperature (LST)** is the temperature that measure at the earth surface in degree Celsius
- **Atmospheric Water Vapor (AWV) -** or humidity is amount of water dissolved in the air measure in mm.

Satellite image processing for NDVI, LST, and AWV

All satellite data are downloaded from www.iis.u-tokyo.ac.jp



Cropped image with shapefile of Suanphung district

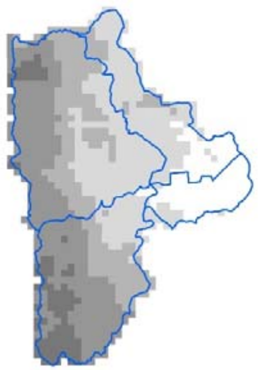


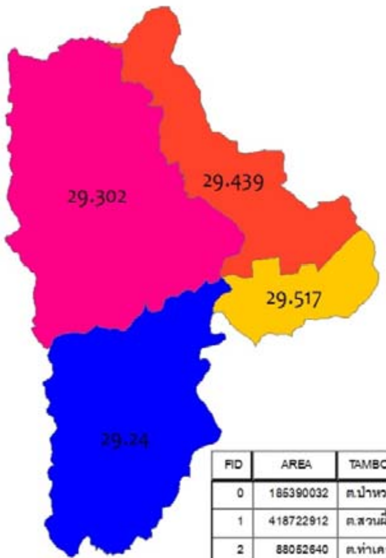
Set of LST data on 02/2009

30 days composite processed

Monthly average of LST data on 02/2009

Zonal operation (Average f^n) with Shapefile of Suanphung sub-district





FID	AREA	TAMBON_T	COUNT	MEAN
0	185390032	ต.ป่าหวาย	184	29.439
1	418722912	ต.สวนผึ้ง	421	29.302
2	88052640	ต.ท่าเคย	86	29.517
3	305127648	ต.ตะนาวศรี	309	29.24

Rainfall data processing

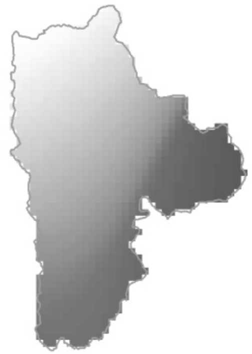
Monthly rainfall data from the website

Station name	Jan	Feb	Mar	Apr
Ratchaburi	0.04	0.00	0.03	3.02
Hua hin	0.02	0.00	0.63	5.69
U-Thong	0.51	0.00	0.11	2.47
Kanchanaburi	0.45	0.00	0.06	5.69
Kamphaengsan	0.23	0.00	0.55	5.04
Phetchaburi	0.00	0.00	0.01	1.54

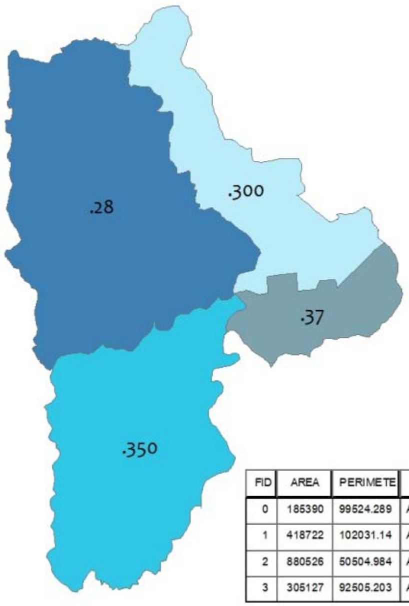
Converted the 7 station with monthly rainfall data to shapefile

Rainfall data interpolated

Cropped image with shapefile of Suanphung district



Zonal operation (Average f^n) with Shapefile of Suanphung sub-district



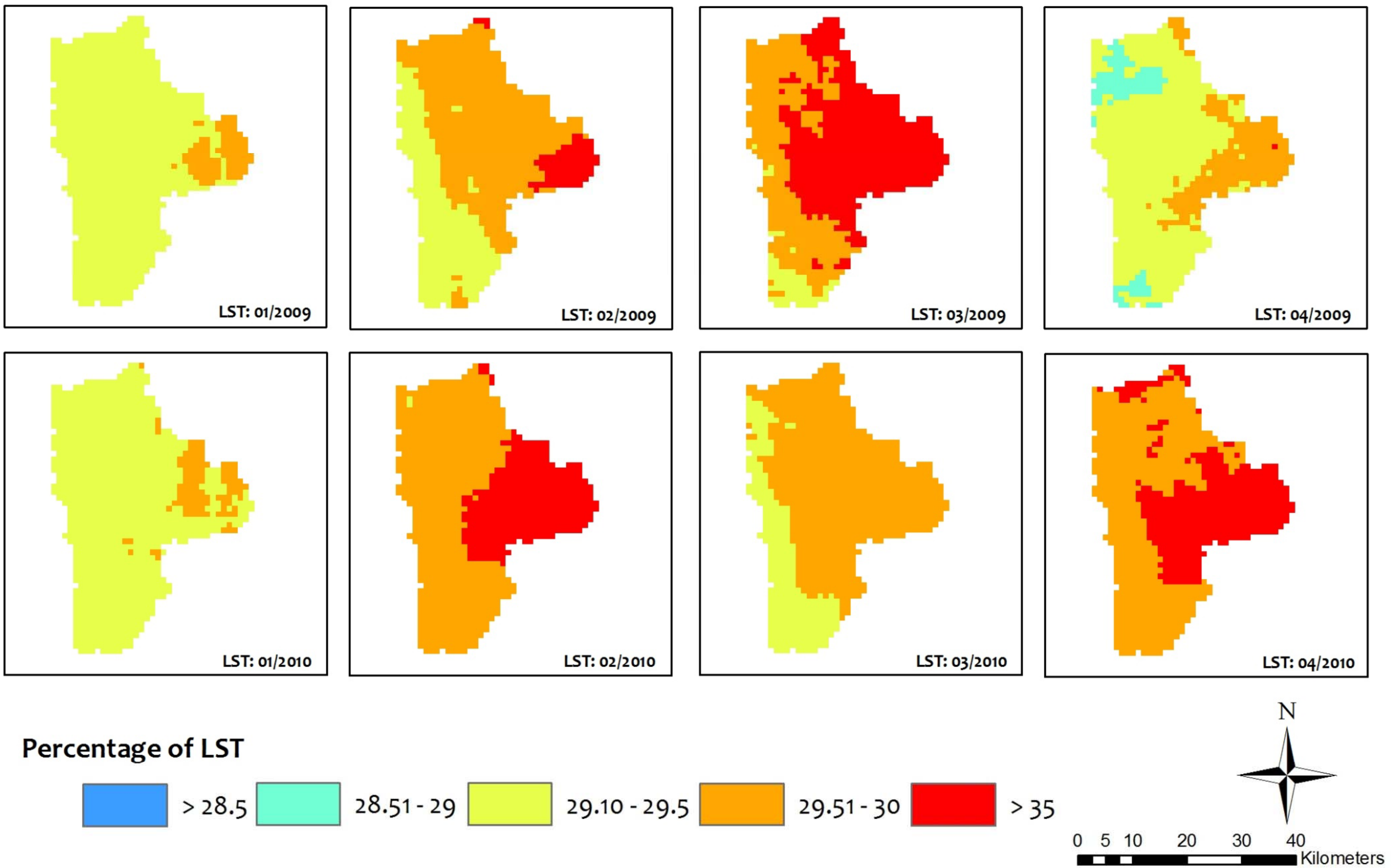
FID	AREA	PERIMETE	AMPHOE_E	TAMBON_	Mean
0	185390	99524.289	Amphoe Suan Phung	ต.ป่าหวาย	.300
1	418722	102031.14	Amphoe Suan Phung	ต.สวนผึ้ง	.28
2	880526	50504.984	Amphoe Suan Phung	ต.ท่าเคย	.37
3	305127	92505.203	Amphoe Suan Phung	ต.ตะนาวศ	.350

Regression model

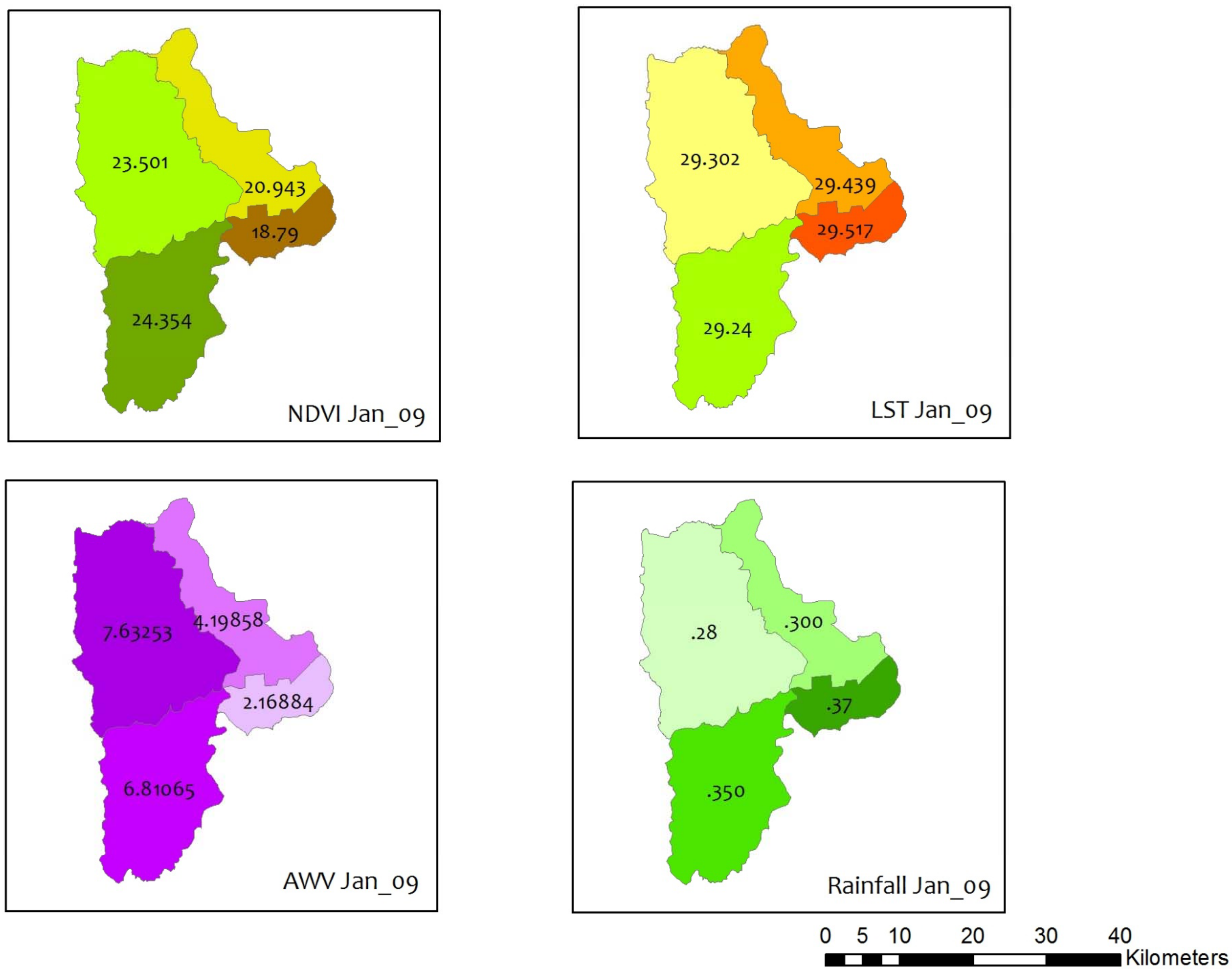
- Negative binomial regression (STATA 12) with 5% level of significance.
- Variables used
  - Outcome: observed malaria cases
  - Denominator: populations at sub-district level
  - Predictors: NDVI, LST, AWV, and rainfall
- Prediction of malaria incidence rates from the final model

Results

Land Surface Temperture



Example results



Final Model

$$\hat{IR} = \exp^{[-33.627 + 0.889(x_{LST}) - 0.102(x_{NDVI}) + 0.102(x_{AWV})]}$$

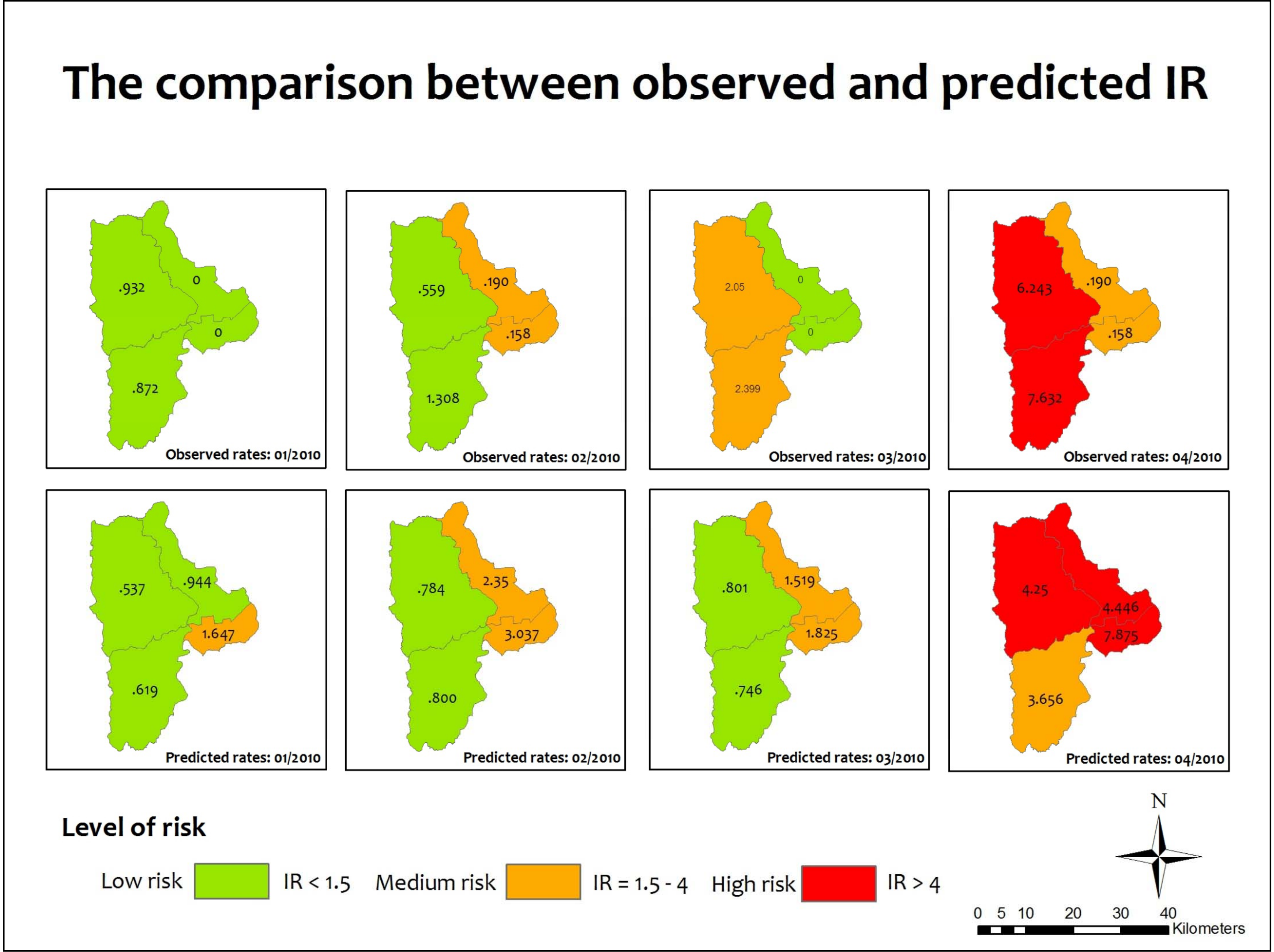
Note: rainfall is not significant (p>0.05)

$\hat{IR}$ = Estimated malaria incidence rate (per 1,000)

x_{NDVI} = Normalized Difference Vegetation Index at location x

x_{LST} = Land surface temperature at location x

x_{AWV} = Atmospheric water vapor at location x


The comparison between observed and predicted IR
.932
0
0
.872
Observed rates: 01/2010
.559
.190
.158
1.308
Observed rates: 02/2010
2.05
0
0
2.399
Observed rates: 03/2010
6.243
.190
.158
7.632
Observed rates: 04/2010
.537
.944
1.647
.619
Predicted rates: 01/2010
.784
2.35
3.037
.800
Predicted rates: 02/2010
.801
1.519
1.825
.746
Predicted rates: 03/2010
4.25
4.446
7.875
3.656
Predicted rates: 04/2010
Level of risk
Low risk
IR < 1.5
Medium risk
IR = 1.5 - 4
High risk
IR > 4
N
0 5 10 20 30 40
Kilometers

Conclusions

1) From this study, we have identified some potential environmental factors related to incidence of malaria.
2) There is limitation of data from satellite images due to some weather conditions.
3) Preliminary results suggest that there are some relationships between malaria incidence and these environmental factors, however, the current model must be further adjusted for accurate spatially predicting of malaria risk.

Thank you
for your kind attention