

MONOCENTRIC URBANIZATION IN THAILAND

Key Issues and Recent Development in Urban Studies

EE 460: Thai Economy
Semester 1 / 2019
Thammasat University

Main topics

- (1)** The development of cities as engines of growth: status and challenges
- (2)** Policy issues of major concerns
- (3)** Availability and accessibility of micro-level data for analysis
- (4)** How to use the available data to address issues

Topic 1: The development of cities as engines of growth: status and challenges

(1) The development of cities as engines of growth: status and challenges

(1.1) Rapid expansion of area and population

Core & Suburban Population: 1947-2010
BANGKOK REGION

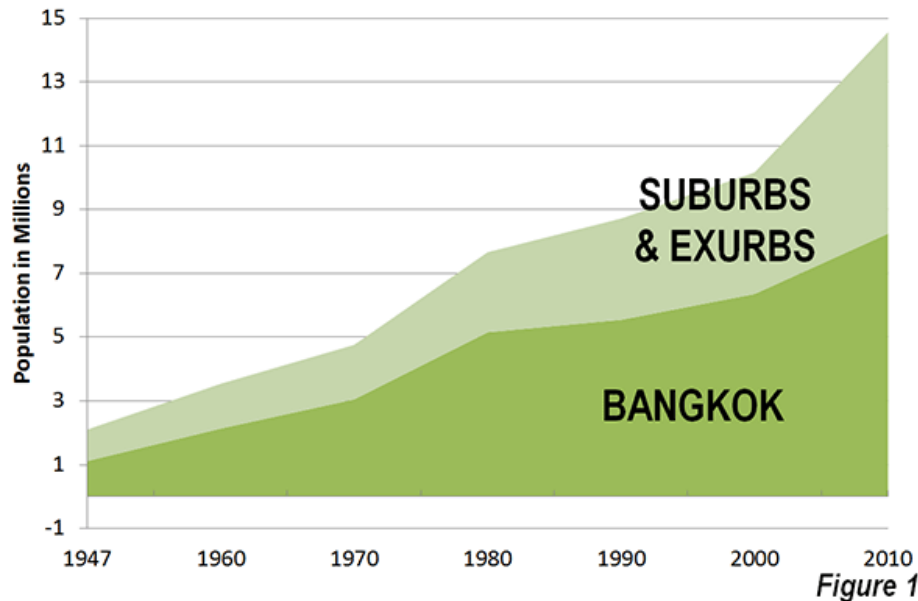


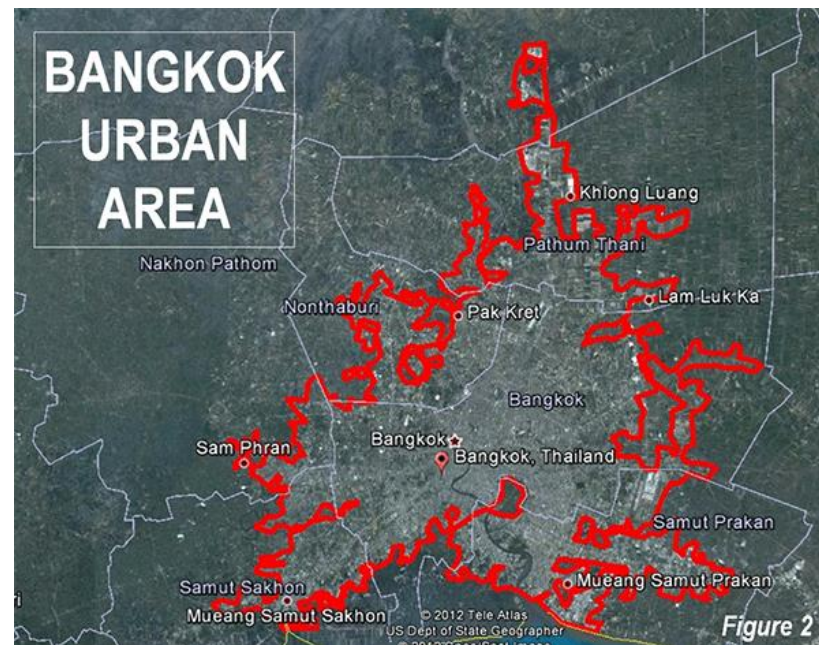
Figure 1

Cox(2012) states the following key issues of urbanization of Bangkok and its suburban areas as follows.

- **After 2000**, the **annual population growth** of Bangkok has been **2.5 times that of 1980-2000**.
- The Bangkok region – which includes the provincial level city of Bangkok and the provinces of Samat Prakan, Samut Sakhon, Pathum Thani, Nonthaburi and Nakhon Pathom – had a **population of 15 million in 2010**.
- Interestingly the growth has arisen in suburban areas. During 2000 and 2010, the **city expanded by 30%**, while the **suburban provinces grew by 66%**.

(1) The development of cities as engines of growth: status and challenges

(1.1) Rapid expansion of area and population (continued)



Cox(2012) also indicates the following main characteristics of Bangkok and its suburban areas .

- The urban area covers approximately 900 square miles (2,330 square kilometers).
- It has a population density of the urban area of 16,200 per square mile (6,200 per square kilometer).
- It is noted that this density is **1.5 times** that of the **Paris urban areas** and more than **2.5 times** that of **the Los Angeles**.

(1) The development of cities as engines of growth: status and challenges

(1.1) Rapid expansion of area and population (continued)

In addition, Cox(2012) identifies key economic outcomes influenced by Bangkok's rapid expansion as follows.

- According to Brookings Global Metro Monitor (2012), the **GDP per capita** of Bangkok is **\$23,400 annually** (based on purchasing power), which is **higher than that of main Latin America's metropolitan economies** (Brasilia, Monterrey, Buenos Aires and Sao Paulo).
- The increasing affluence of Bangkok area has induced the real estate investment, especially **inexpensive residences in suburban areas**, and also influenced the **rising private ownership of vehicles** (e.g. automobiles and motorcycles).

Although conventional views on Bangkok's rapid expansion attracting the higher density of business and residential areas, **the industrialization has been clustering in the surrounding provinces**, which are Samat Prakan, Samut Sakhon, Pathum Thani, and Nakhon Pathom.

(1) The development of cities as engines of growth: status and challenges

(1.2) Concentration of industrialization surrounding Bangkok

- Retrospectively, the clustering pattern of industrial activities around Bangkok has been occurring since 1980s. Phisit (1988) stated that it was because **Bangkok had the largest demand for manufactured products**.
- Therefore, in the first phase of industrial development, the **largest financial return on manufacturing activities** and related services was mainly from **the concentration within Bangkok's suburban areas**.
- Consequently the higher concentration has progressively **induced the economies of scale and comparative advantages**. Also this process has **continuously influenced migration from rural areas**.

(1) The development of cities as engines of growth: status and challenges

(1.3) Urban-rural migration and remittance

- As previously stated in (1.1) and (1.2), disparities in income and living condition **have been continuously induced relocation** of labor **from rural provinces to Bangkok** and its suburban areas.
- The urban-rural migration does not only incur the expansion of Bangkok and its suburban areas, but it does **indirectly influence the rural development through remittances**.
- Many studies indicate that internal **remittances have been contributing a positive consequence on income distribution** (e.g. Boonyamanond and Punpuing (2009), Paris et al. (2009) and Guest (1998)).
- Boonyamanond and Punpuing (2009), using data from the Migration Survey conducted by the National Statistical Office in 2007, identified that most of remittances were sent to the following recipients:
 - **Parents (74.6%),**
 - **Children (15.4%)**
 - Spouses (6.6%)
 - Other relatives (2.6%).

(1) The development of cities as engines of growth: status and challenges

(1.3) Urban-rural migration and remittance (continued)

- Paris et al. (2009) used a survey of 1,874 rice farming households in the Northeast, and found that **40% of their household incomes were from remittances**.
- Guest (1988) did the similar study and estimated that **remittances** could contribute around **25% of rural households' incomes**.
- Piriyaikul (2010) indicated that internal remittances were used as **daily expenses, including food purchases, investment in farms and supporting children's schooling**. These evidences clearly show the **effect on poverty alleviation**.

Topic 2: Policy issues of major concerns

(2) Policy issues of major concerns

(2.1) What have been key factors driving Bangkok as the monocentric growth pole?

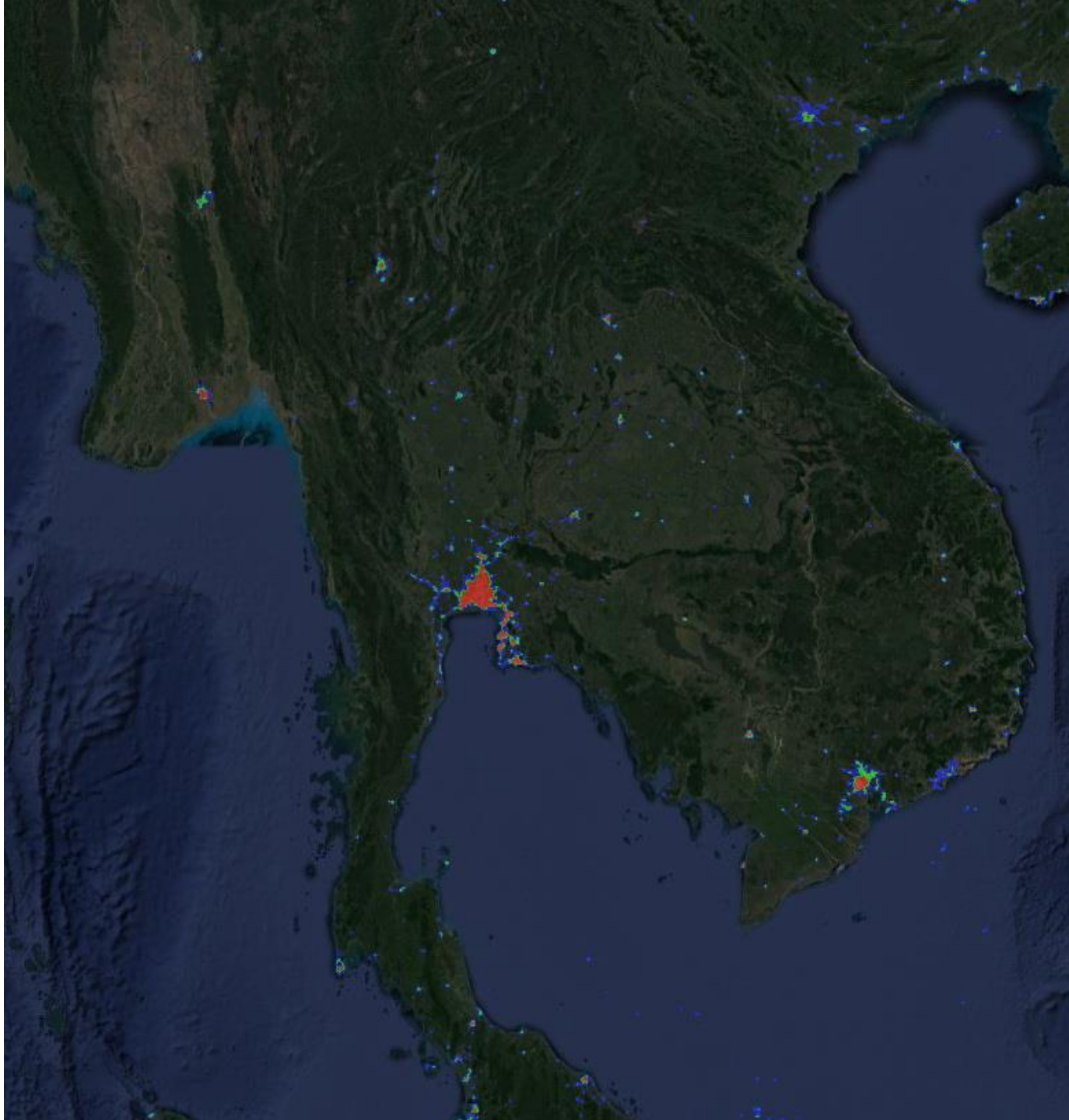
[The combination of development policies and behaviors of firms and workers]

(2.2) Will Bangkok still be the single growth pole in the future?

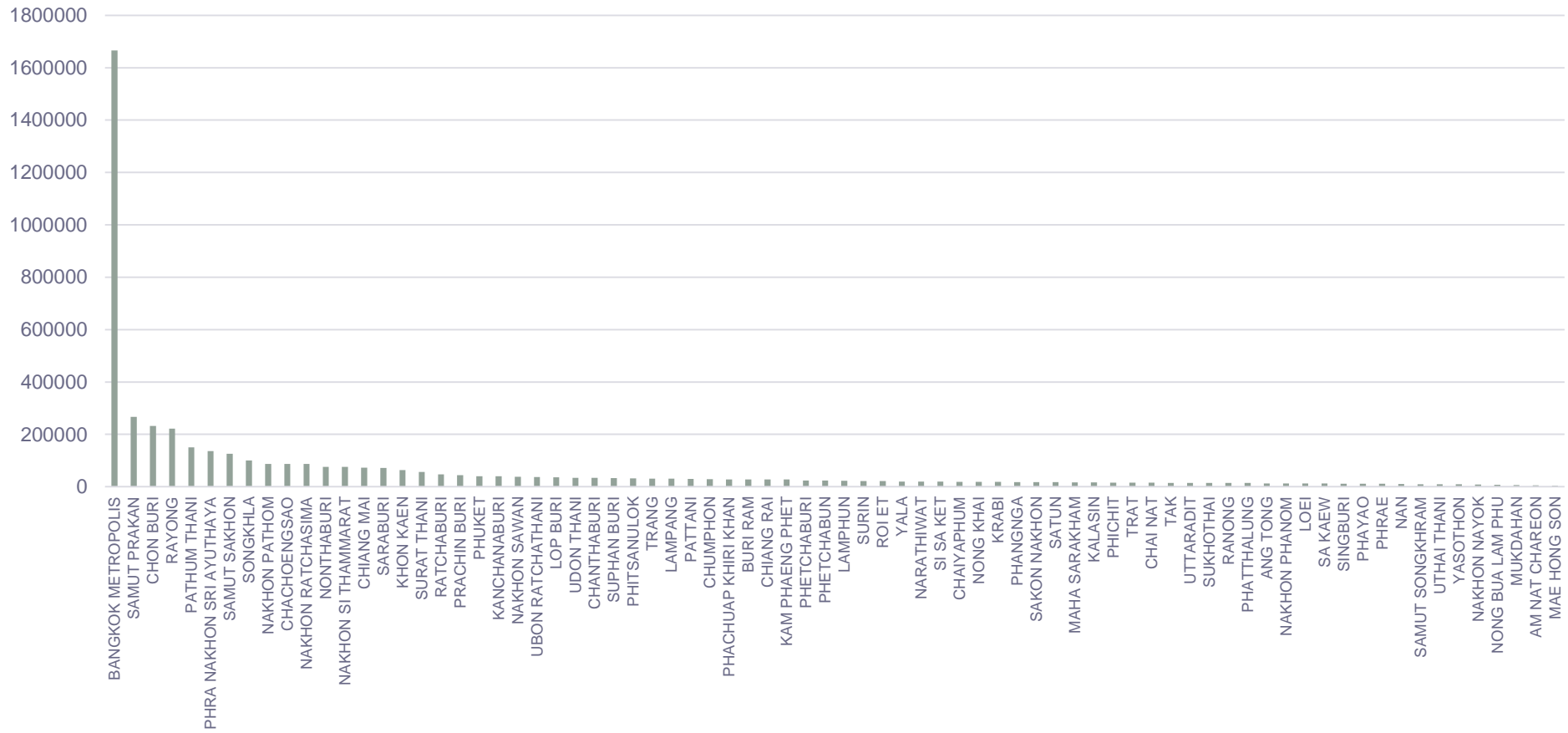
[Technology, ageing society and AEC integration may change the spatial pattern of growth and employment]

(2.3) Will the monocentric pattern of Bangkok be replicated to create other growth poles in Thailand?

[A pattern of industrial concentration of surrounding areas and service-oriented in the central zone]

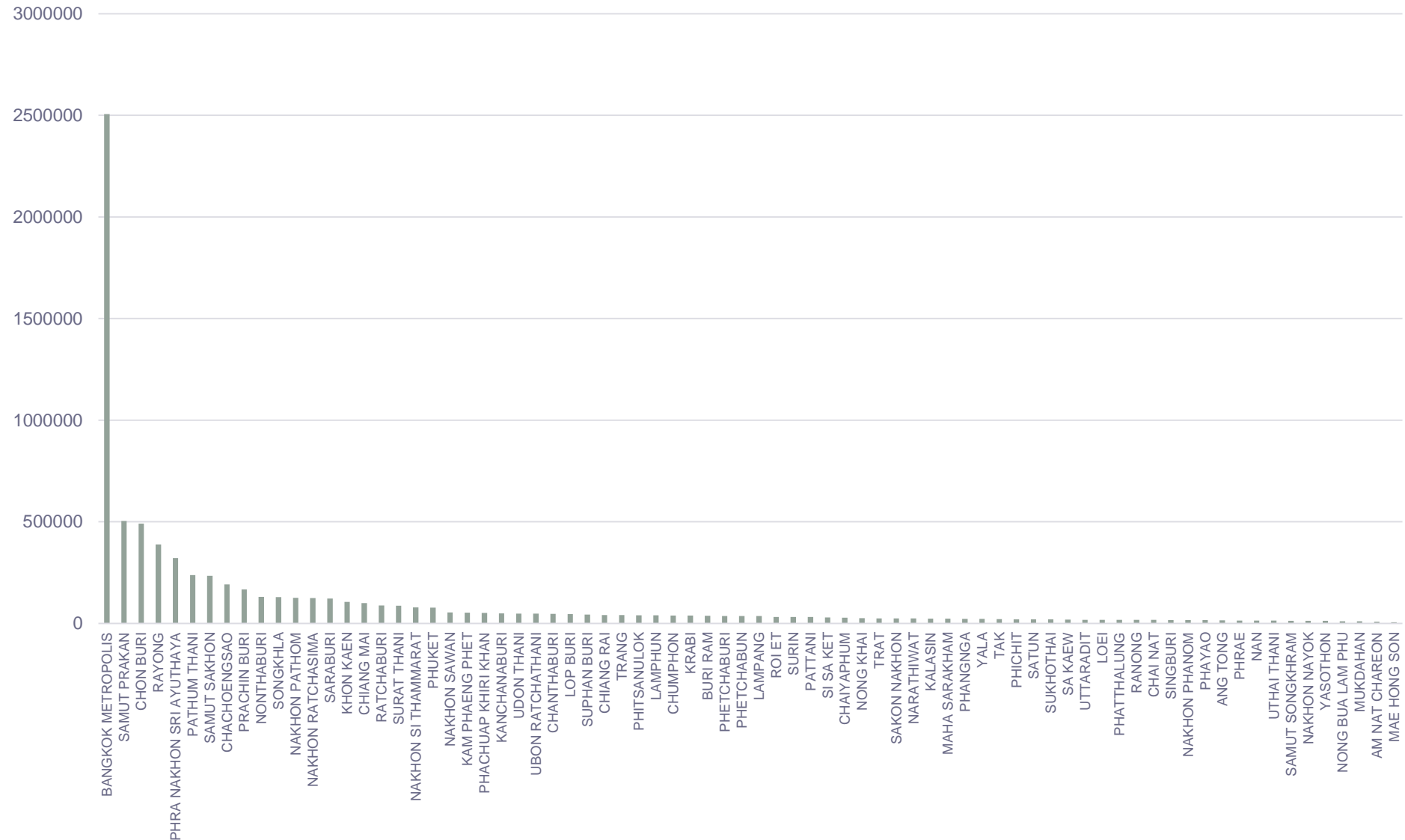


Provincial GDP (GPP) 1998



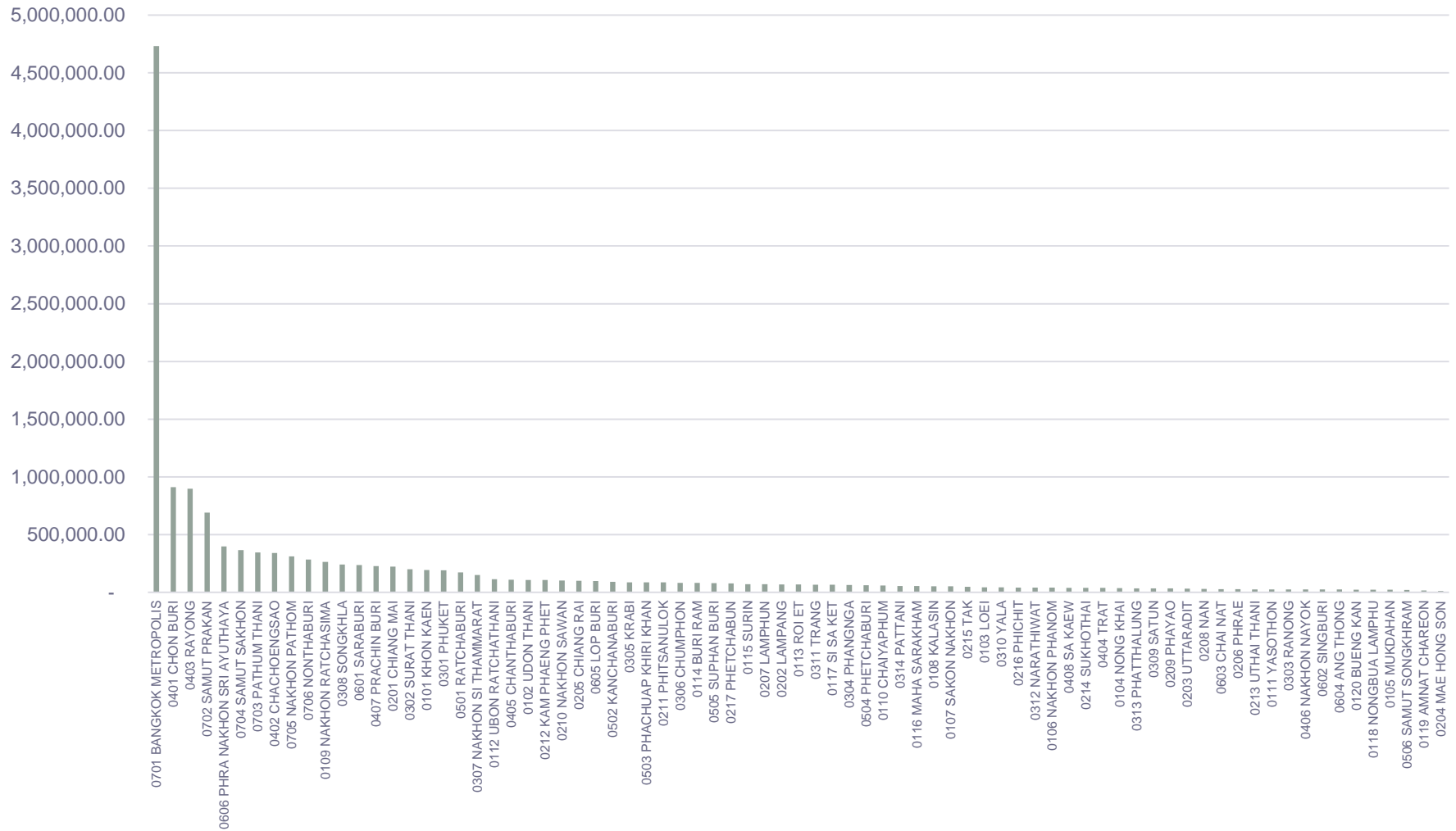
Source: NESDB

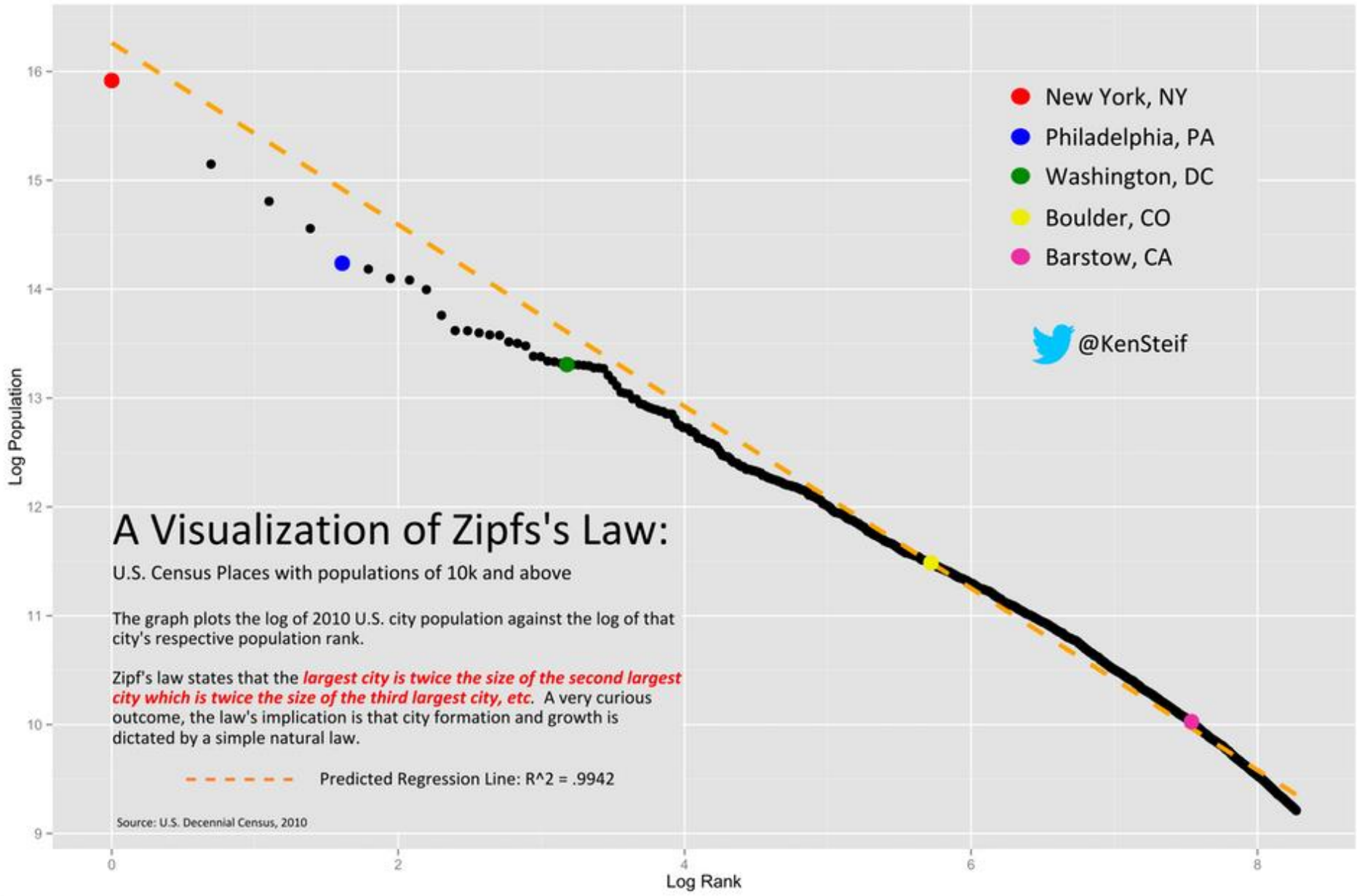
Provincial GDP (GPP) 2008



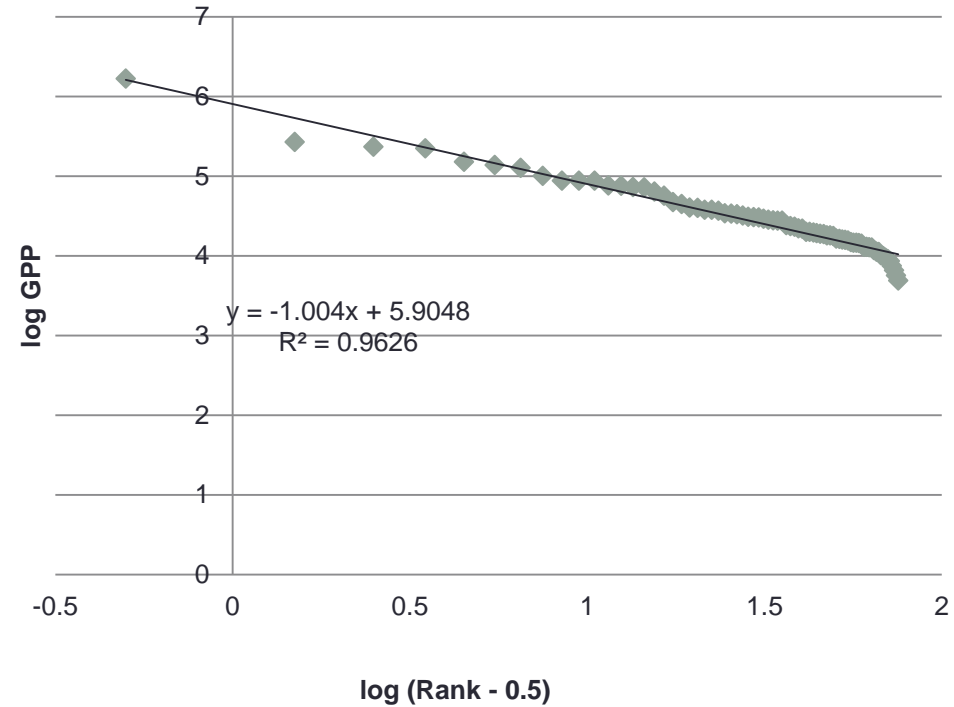
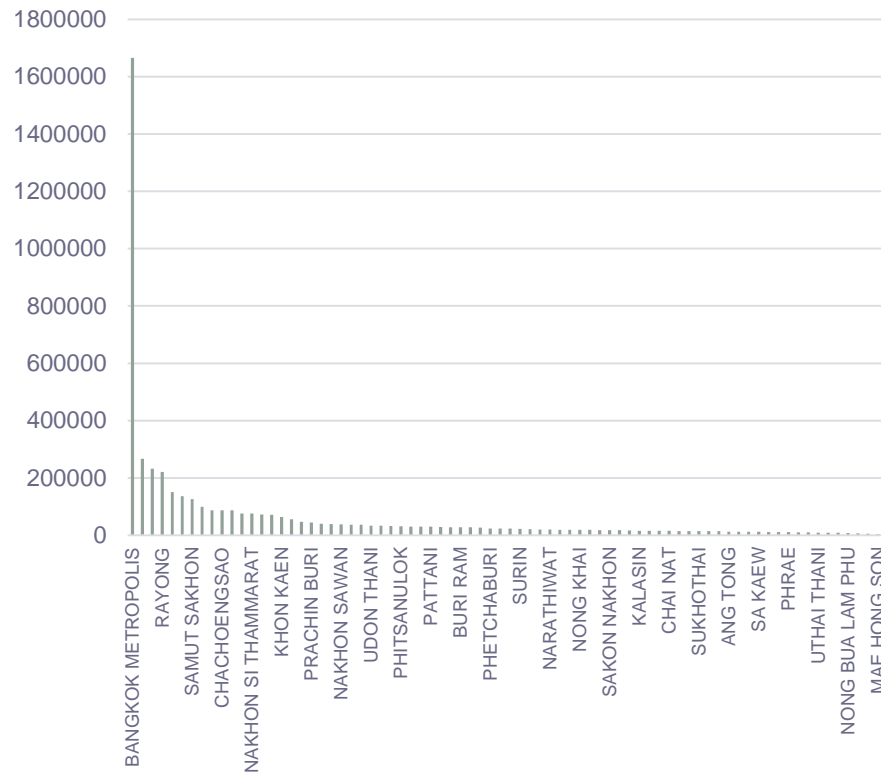
Source: NESDB

Provincial GDP (GPP) 2017



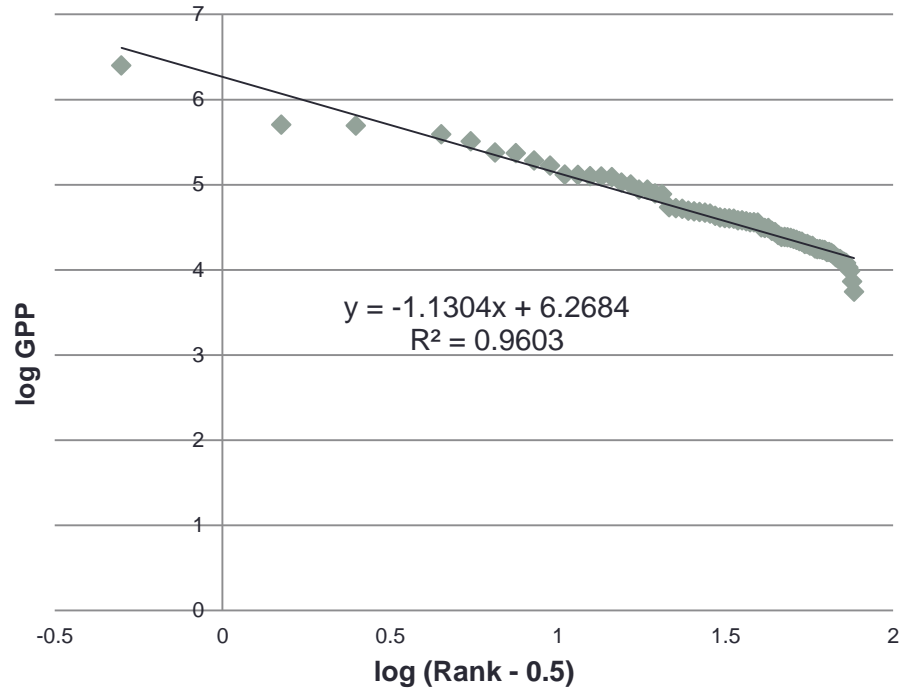
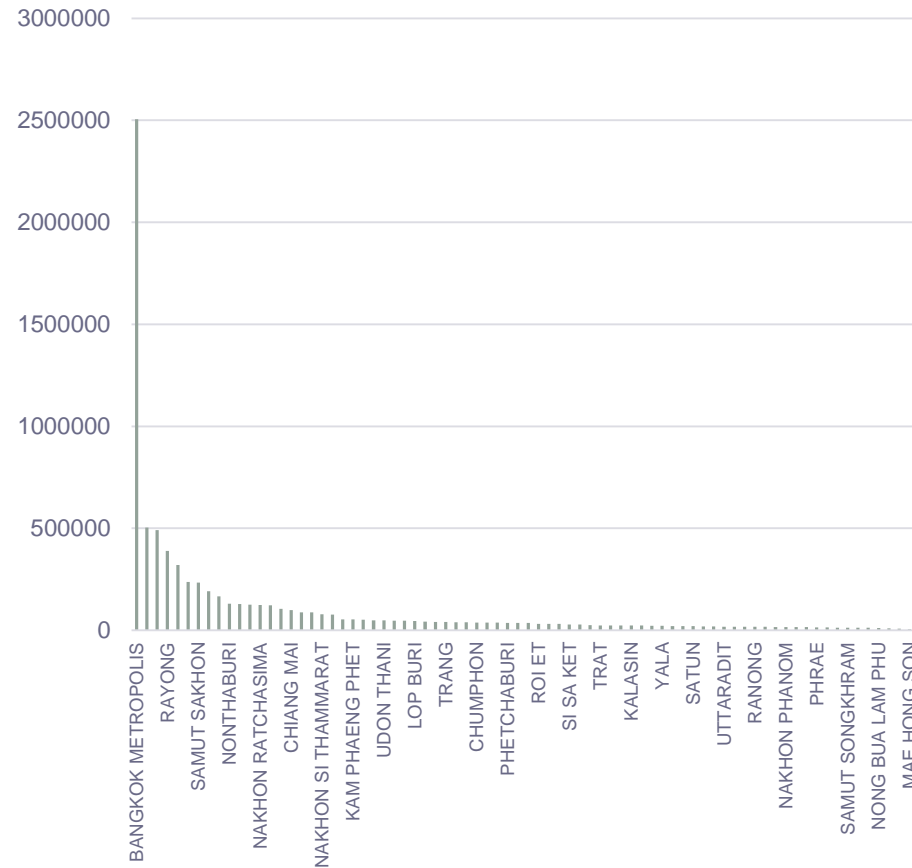


Provincial GDP (GPP) 1998



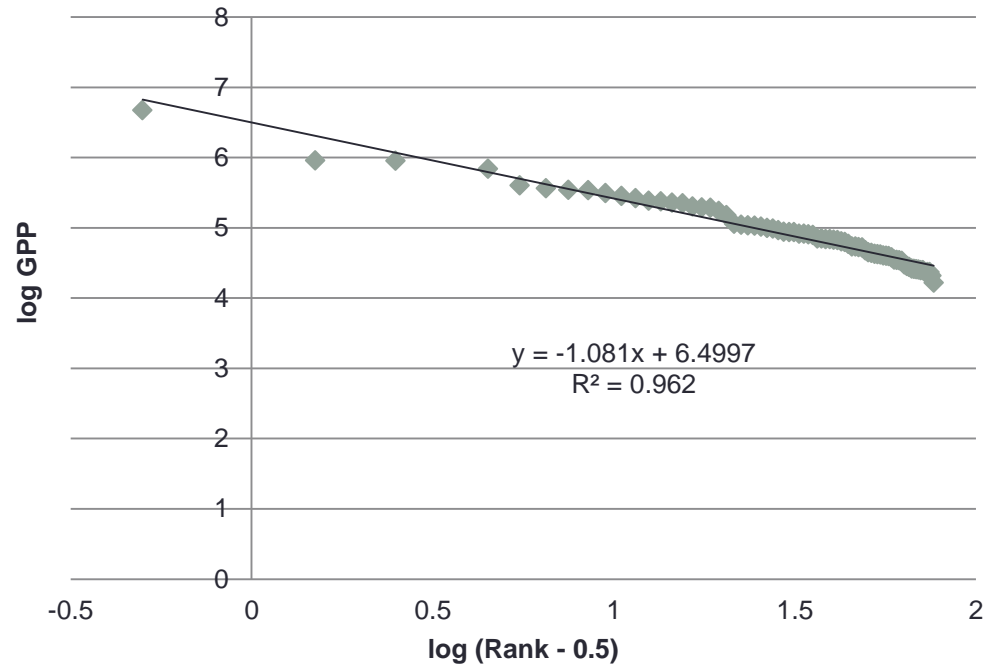
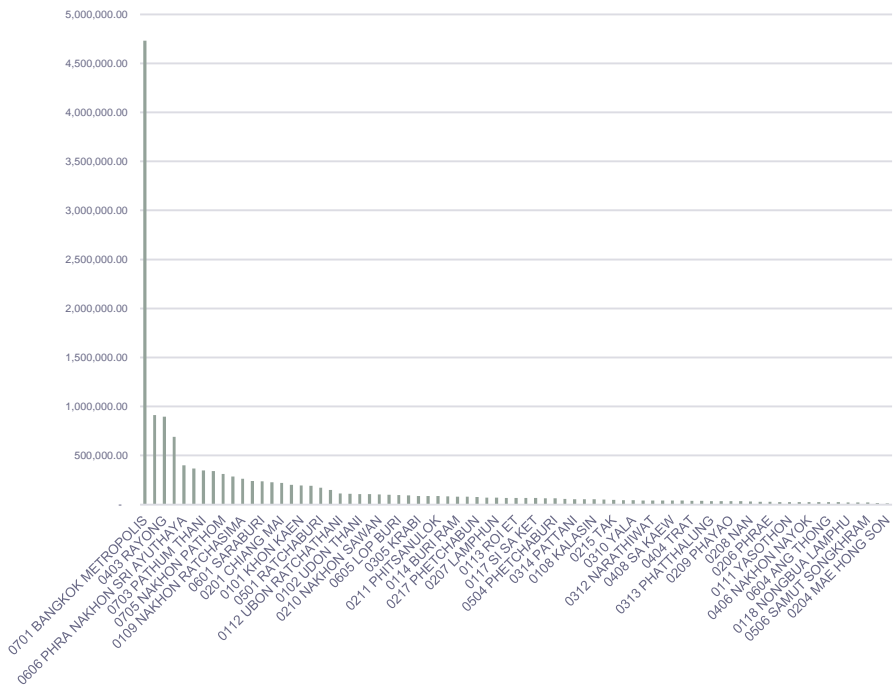
Source: NESDB

Provincial GDP (GPP) 2008

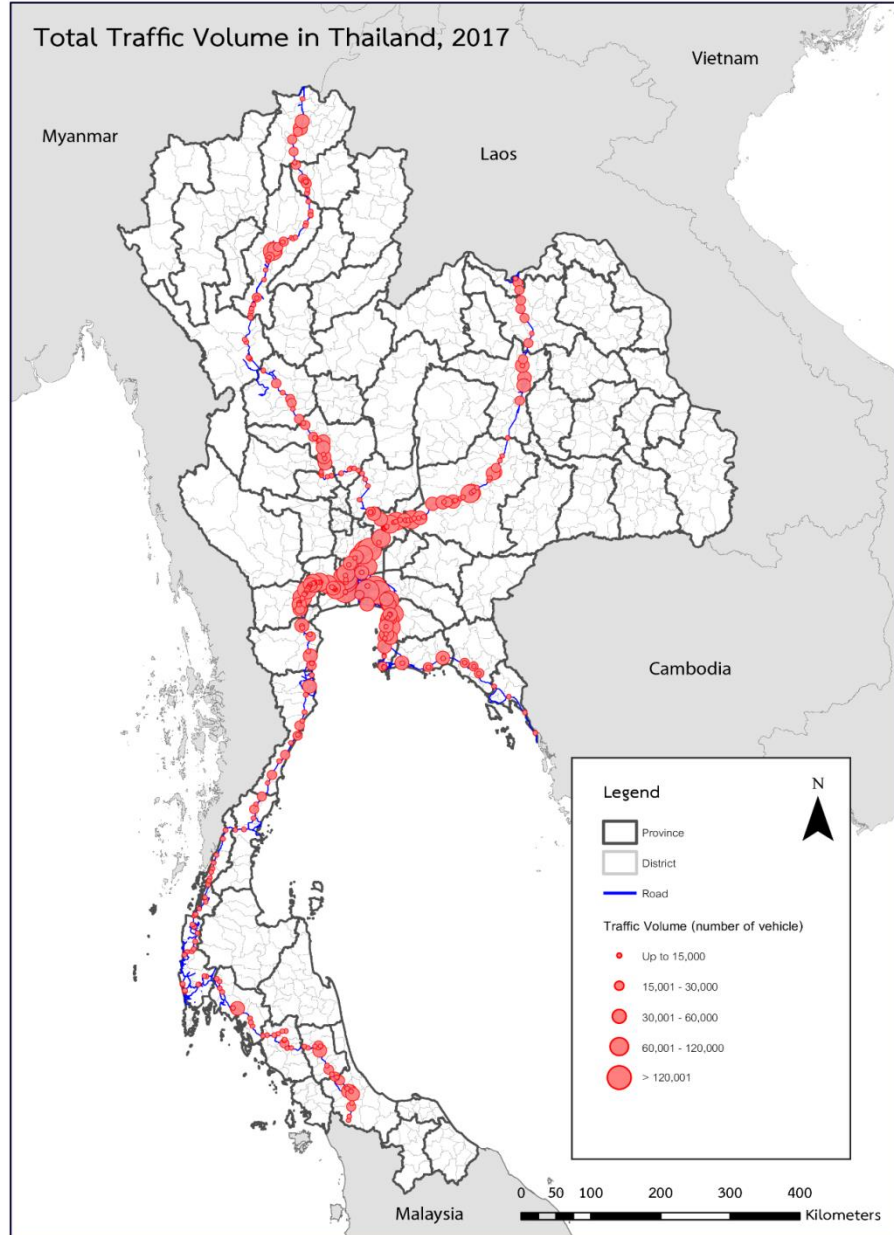
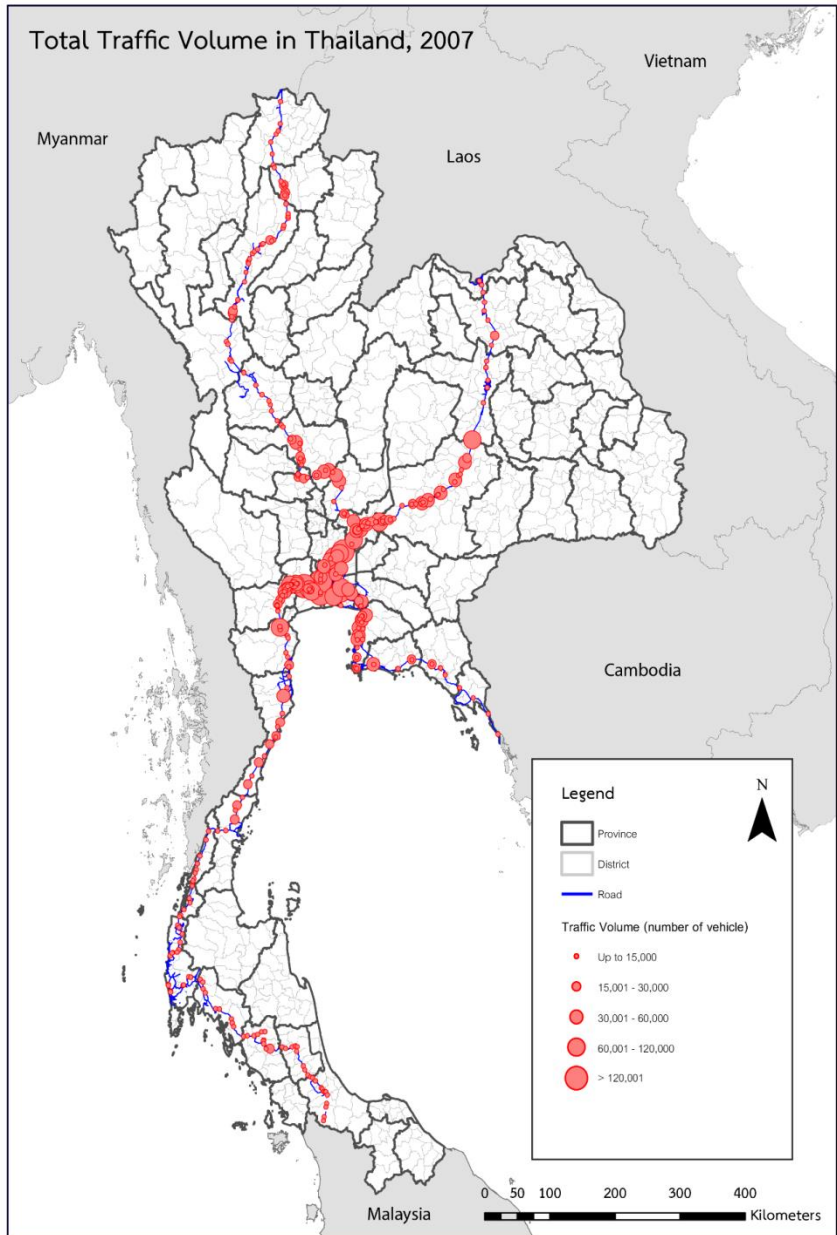


Source: NESDB and Puttanapong (2018)

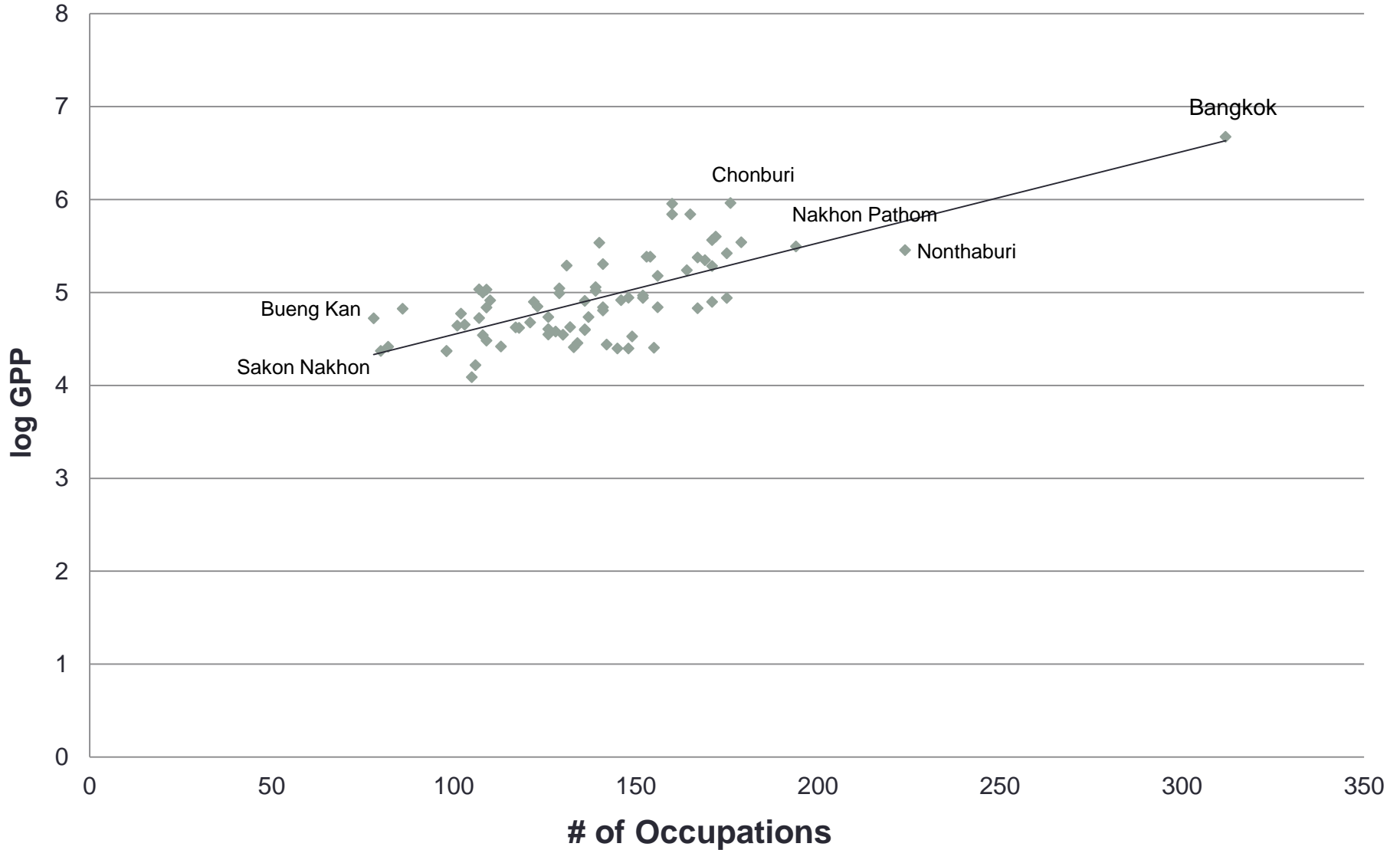
Provincial GDP (GPP) 2017



Source: NESDB and Puttanapong (2018)



Variety of Occupations and GPP (2016)



Topic 3:

Availability and accessibility of micro-level data for analysis

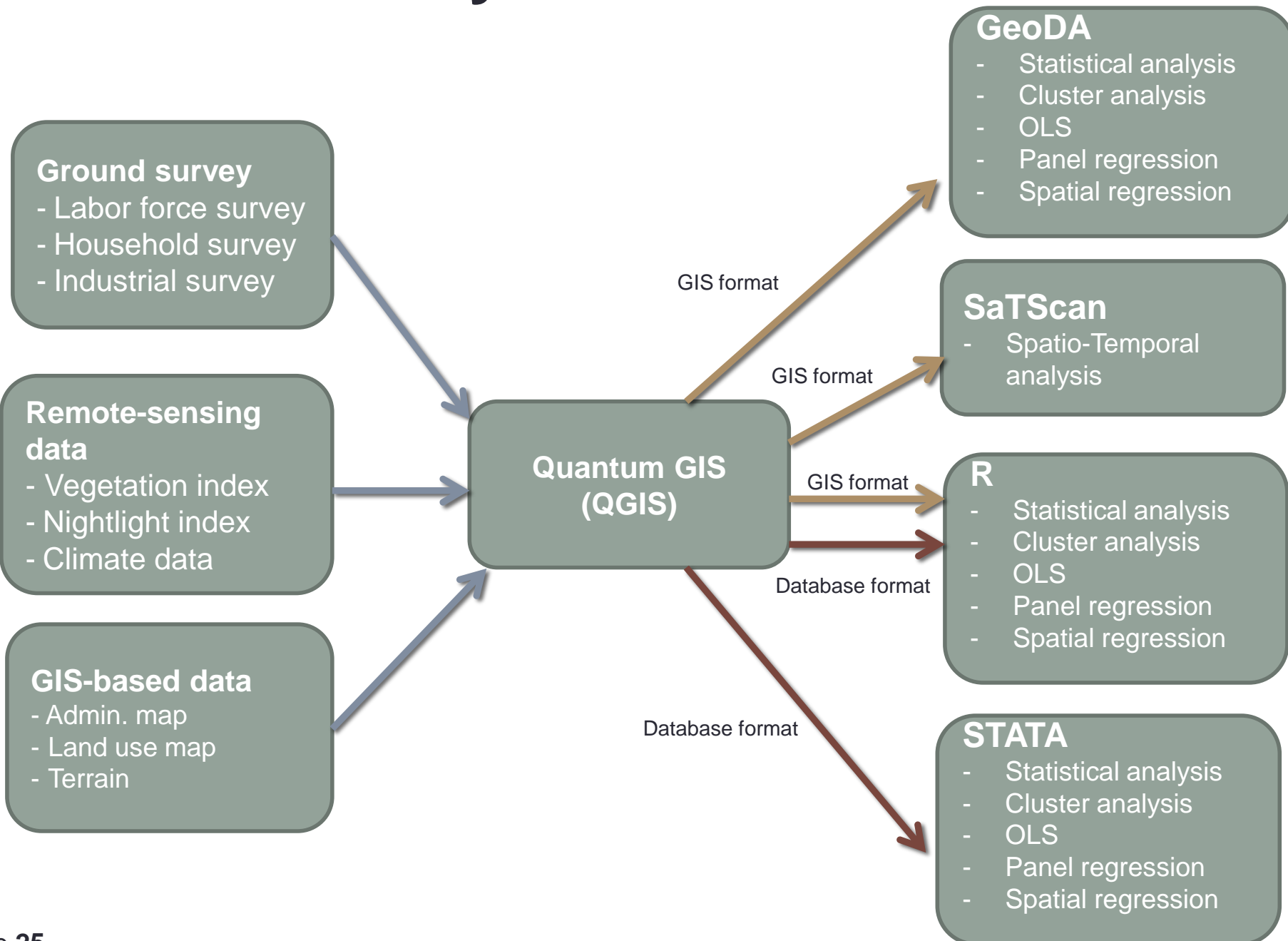
(3) Availability and accessibility of micro-level data

There are 3 categories of data

- **Ground surveys:** mostly produced by NSO (formal request/purchase is required).
- **Remote sensing data:** most vegetation and nightlight data are publicly available.
- **GIS-based maps:** specifically produced by government's agencies (formal request/purchase is required).

Topic 4: How to use the available data to address policy issues

Overview of Analytical Framework



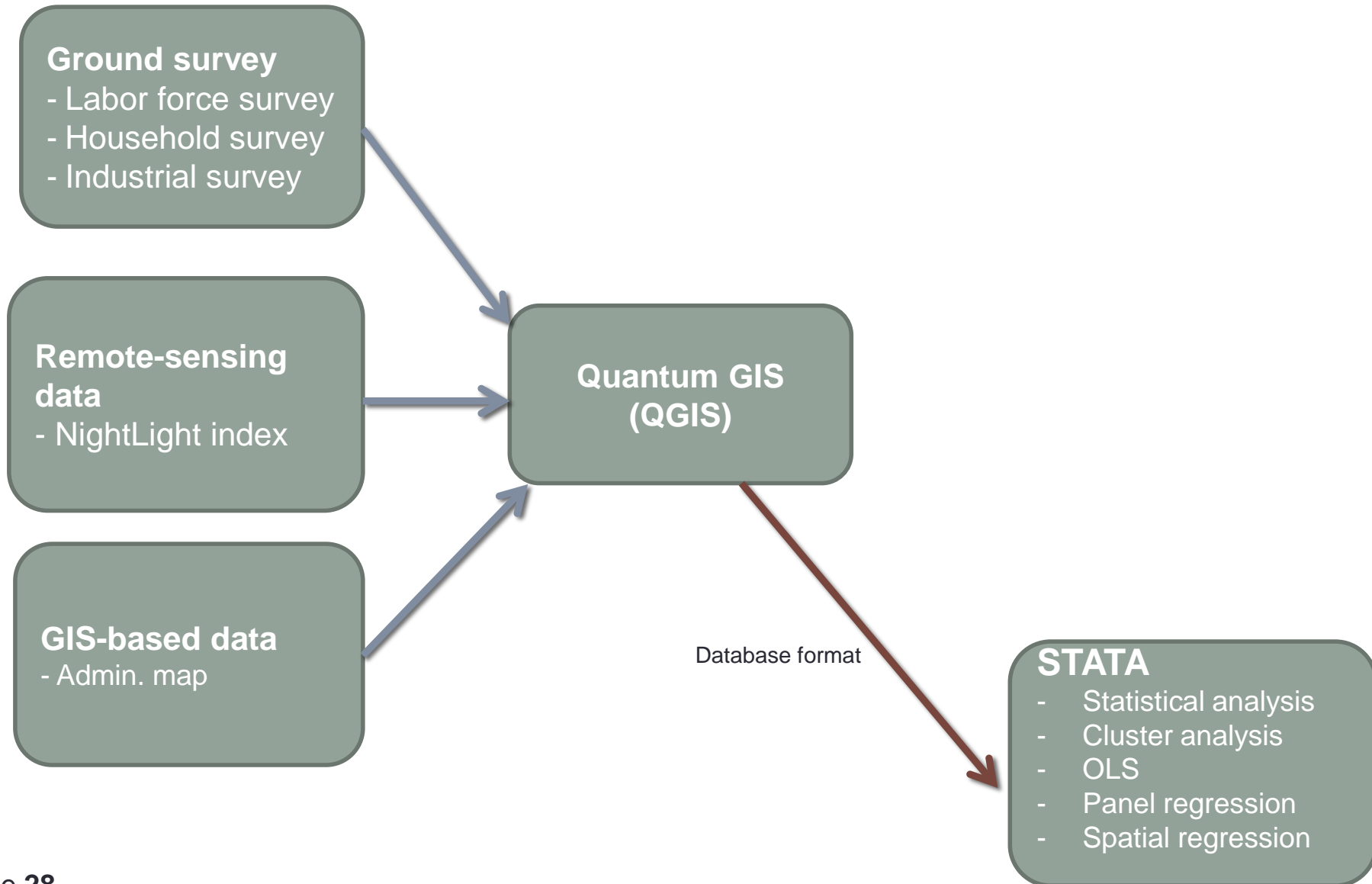
Example #1: Nightlight Index

Example #1: Nightlight Index

Spatial Economic Analysis of Thailand using Satellite Data on Lights at Night

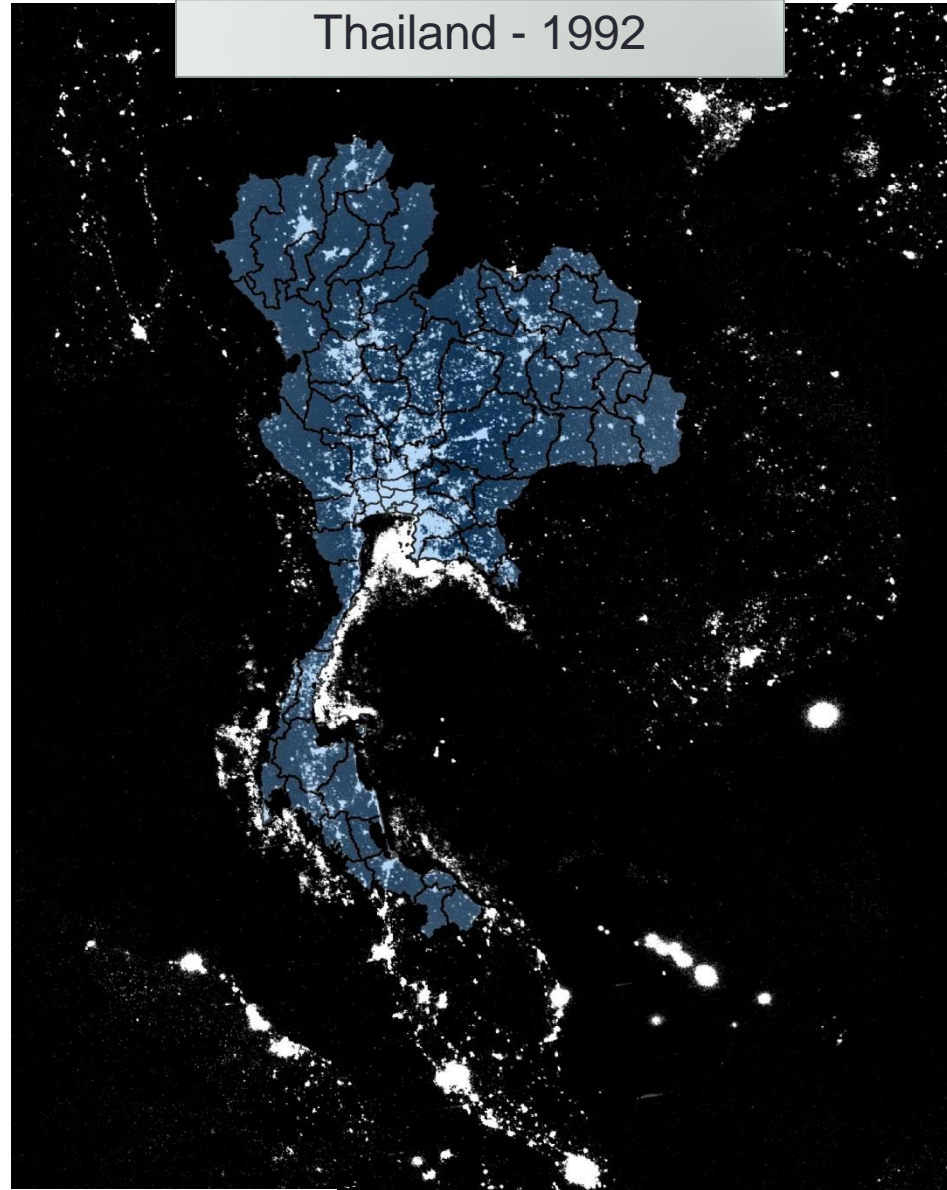
- With the public availability of **Defense Meteorological Satellite Program Operational Line Scanner (DMSP/OLS)** nighttime light data, many analyses have been using this satellite dataset to monitor and examine spatial dynamics of economic expansions. This study explores the **application of this nightlight data to the case of Thailand**, covering annual spatio-temporal data of **1992-present**.
- Results from econometrical analyses show that the values of provincial nightlight indexes are **significantly correlated with** many survey data such as the **annual provincial GDP**, the **spatial density of labor** classified by occupation and the **spatial density of industrial production**.

Analytical Framework

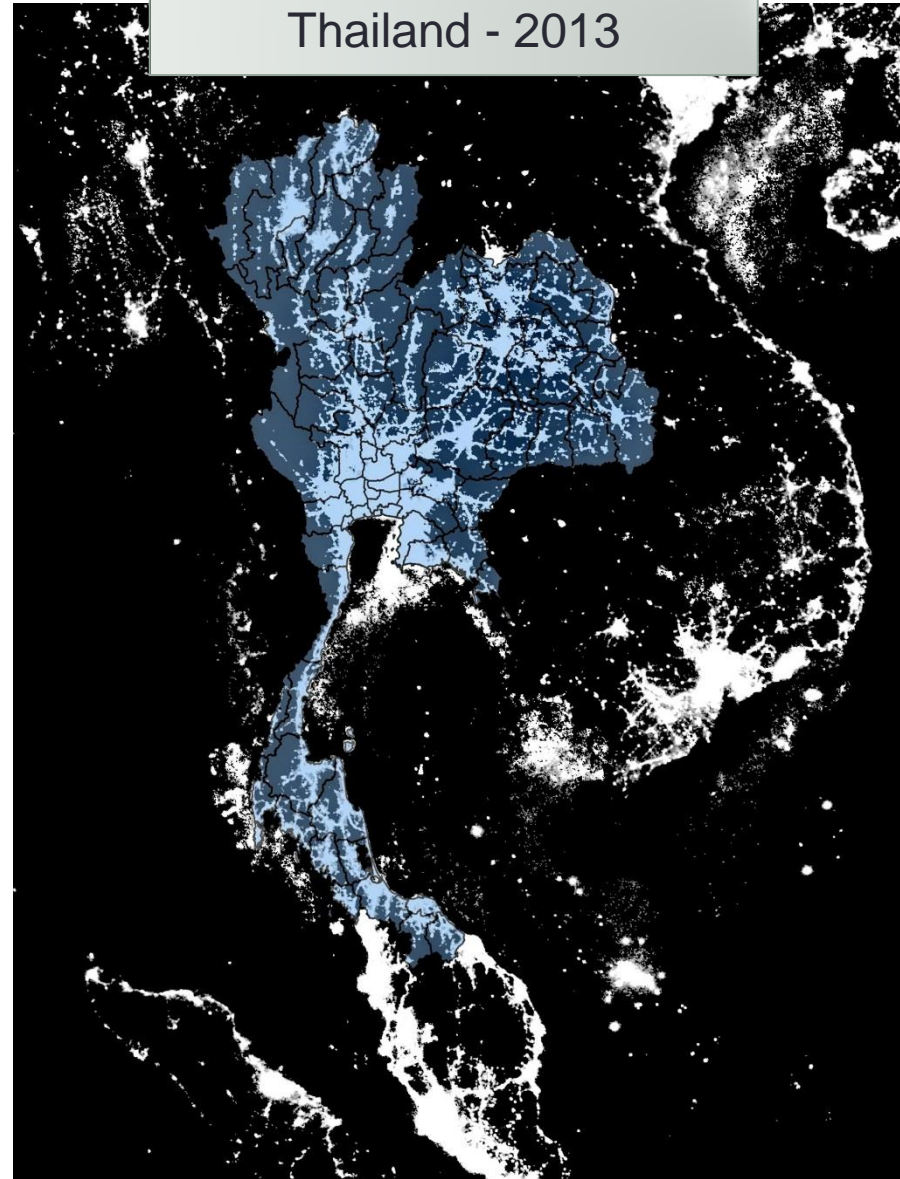


Example #1: Nightlight Index

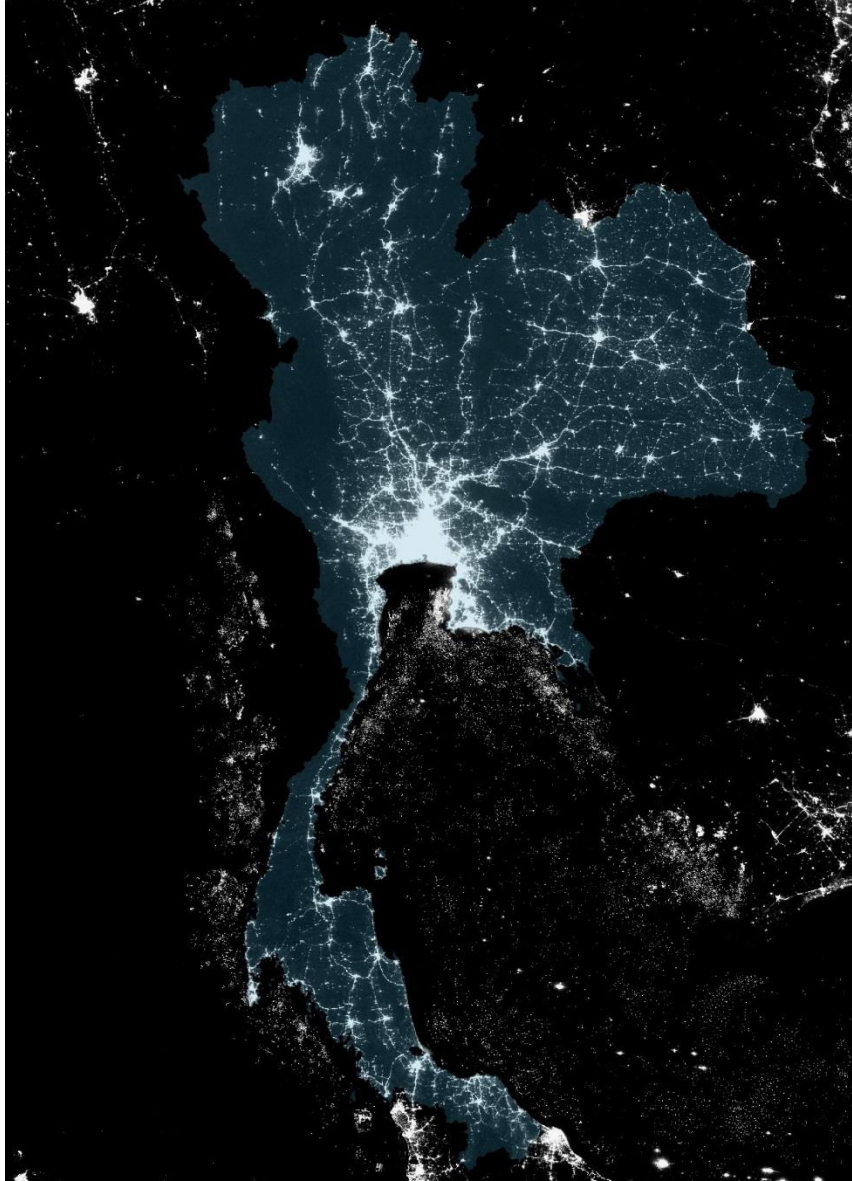
Thailand - 1992



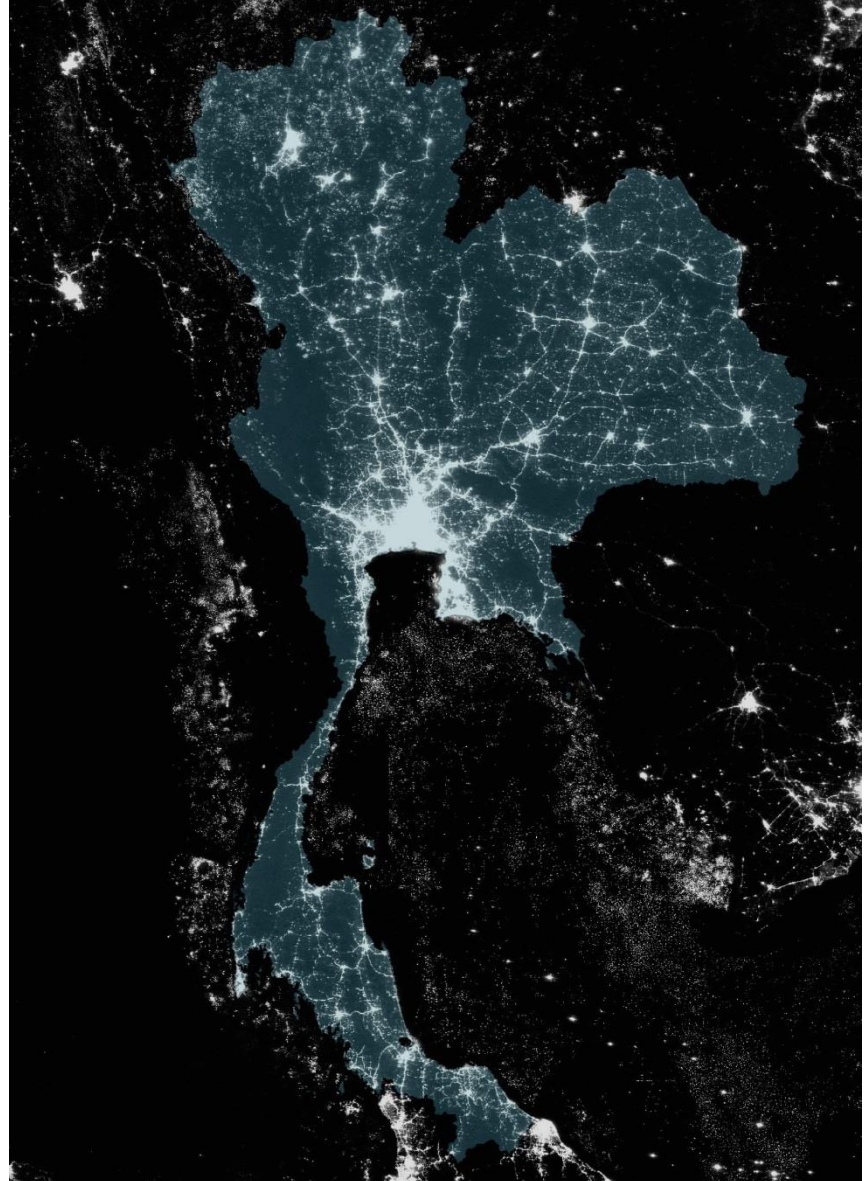
Thailand - 2013



Thailand - 2015

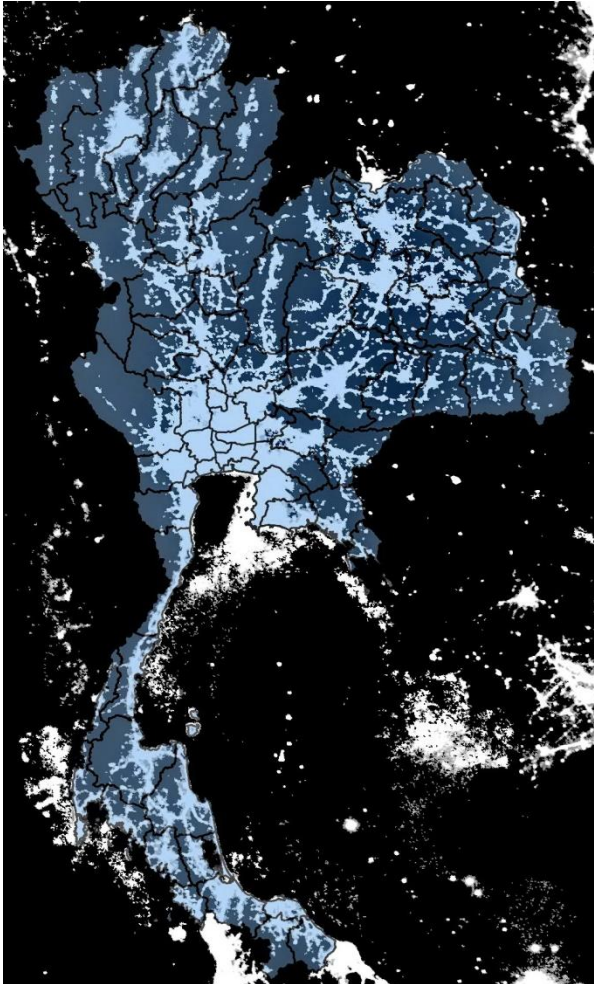


Thailand - 2019

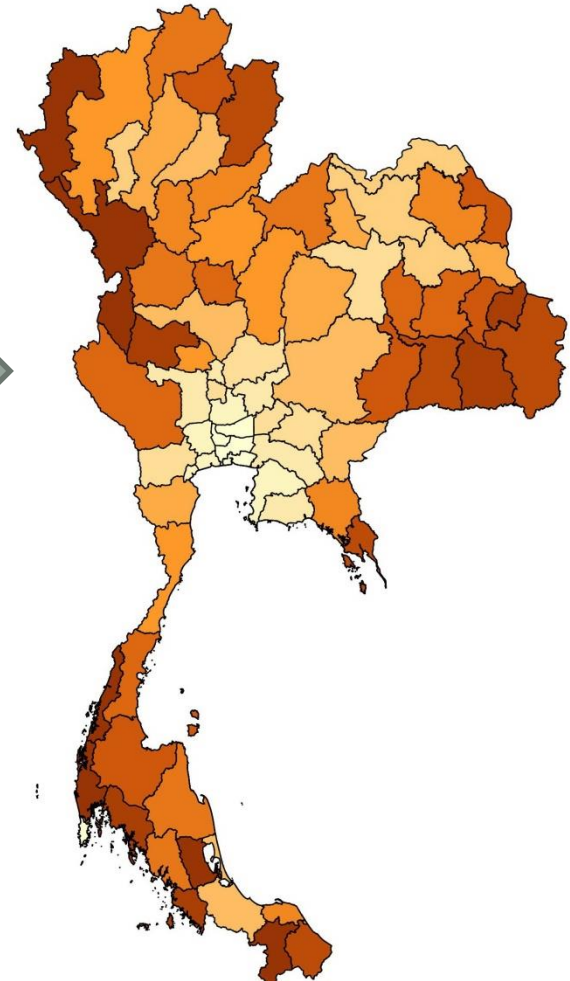


Example #1: Nightlight Index

Raw data from DMSP/OLS satellite



Provincial Nightlight Index



Transforming
Raster data
into GIS map
(using QGIS)

Example #1: Nightlight Index

Statistical and econometrical tests

Test #1: Correlation with provincial GDP

Test #2: Correlation with worker density

Test #3: Correlation with industrial density

Test #4: Correlation with consumption per capita

Test #5: Correlation with an average electricity bill per household

Test #6: Panel regression (with provincial GDP and visitors)

Example #1: Nightlight Index

Test #1: Correlation with provincial GDP

Province	Region	Correlation
BANGKOK METROPOLIS	Central	0.955

Province	Region	Correlation
SONGKHLA	South	0.958
NARATHIWAT	South	0.800
YALA	South	0.779
PATTANI	South	0.778
SATUN	South	0.678
PHUKET	South	0.968
SURAT THANI	South	0.936
KRABI	South	0.934
TRANG	South	0.823
CHUMPHON	South	0.800
PHANGNGA	South	0.771
PHATTHALUNG	South	0.752
RANONG	South	0.525
NAKHON SI THAMMARAT	South	0.513

Example #1: Nightlight Index

Test #1: Correlation with provincial GDP

Province	Region	Correlation
NAKHON RATCHASIMA	North East	0.925
UBON RATCHATHANI	North East	0.900
BURI RAM	North East	0.883
CHAIYAPHUM	North East	0.862
YASOTHON	North East	0.847
SI SA KET	North East	0.817
AM NAT CHAREON	North East	0.769
NONG KHAI	North East	0.202
MAHA SARAKHAM	North East	0.958
ROI ET	North East	0.916
NAKHON PHANOM	North East	0.907
KALASIN	North East	0.870
KHON KAEN	North East	0.862
UDON THANI	North East	0.825
MUKDAHAN	North East	0.757
SURIN	North East	0.739
SAKON NAKHON	North East	0.708
NONG BUA LAM PHU	North East	0.680
<i>LOEI</i>	<i>North East</i>	<i>0.205</i>

Example #1: Nightlight Index

Test #1: Correlation with provincial GDP

Province	Region	Correlation
RAYONG	Central	0.984
CHON BURI	Central	0.966
CHANTHABURI	Central	0.860
TRAT	Central	0.749
SAMUT SAKHON	Central	0.972
SAMUT PRAKAN	Central	0.942
NAKHON PATHOM	Central	0.927
SUPHAN BURI	Central	0.926
NAKHON NAYOK	Central	0.901
PHACHUAP KHIRI KHAN	Central	0.890
PHETCHABURI	Central	0.868
PRACHIN BURI	Central	0.867
RATCHABURI	Central	0.866
SA KAEW	Central	0.861
CHACHOENGSAO	Central	0.858
KANCHANABURI	Central	0.746
SAMUT SONGKHRAM	Central	0.733
NONTHABURI	Central	0.974
SARABURI	Central	0.949
SINGBURI	Central	0.906
PHRA NAKHON SRI AYUTHAYA	Central	0.902
ANG TONG	Central	0.817
LOP BURI	Central	0.775
PATHUM THANI	Central	0.654
CHAI NAT	Central	0.648

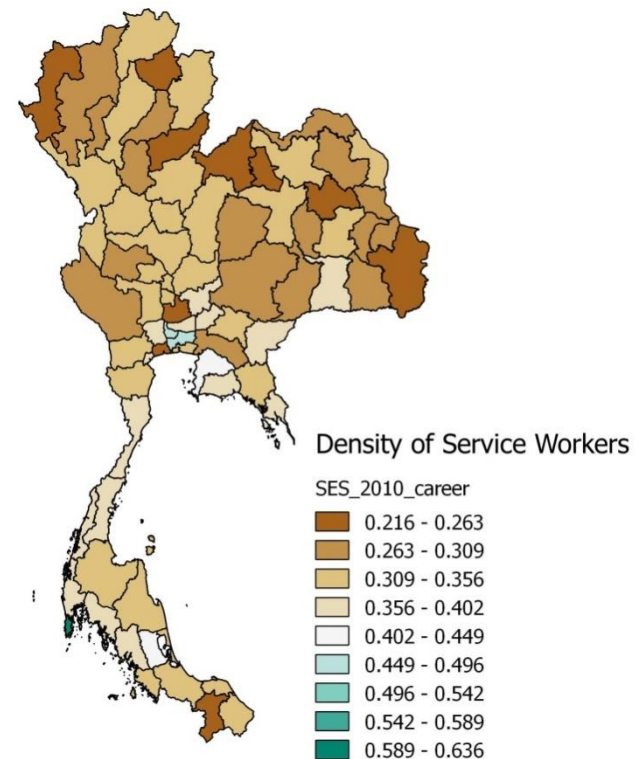
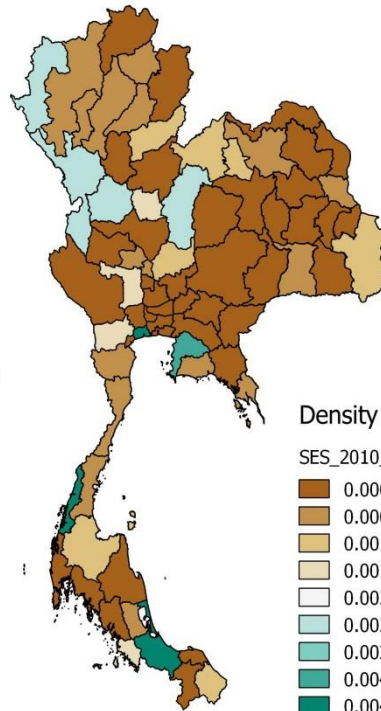
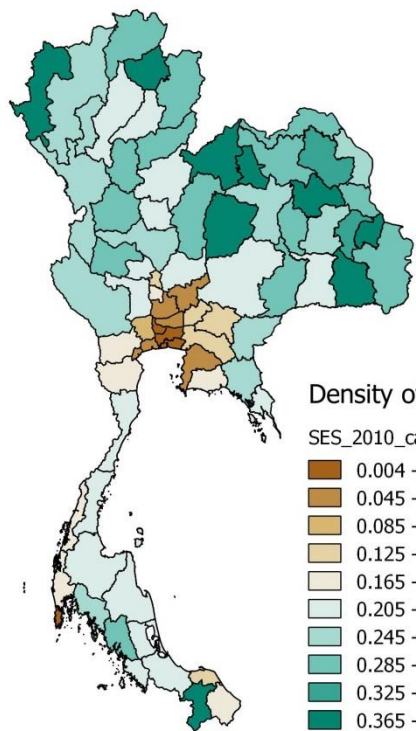
Example #1: Nightlight Index

Test #1: Correlation with provincial GDP

Province	Region	Correlation
PHICHIT	North	0.908
NAKHON SAWAN	North	0.905
PHETCHABUN	North	0.866
SUKHOTHAI	North	0.865
PHITSANULOK	North	0.815
KAM PHAENG PHET	North	0.754
UTHAI THANI	North	0.692
UTTARADIT	North	0.563
TAK	North	0.503
CHIANG MAI	North	0.868
CHIANG RAI	North	0.769
LAMPHUN	North	0.766
LAMPANG	North	0.567
PHAYAO	North	0.561
PHRAE	North	0.415
<i>NAN</i>	<i>North</i>	<i>(0.404)</i>
<i>MAE HONG SON</i>	<i>North</i>	<i>(0.605)</i>

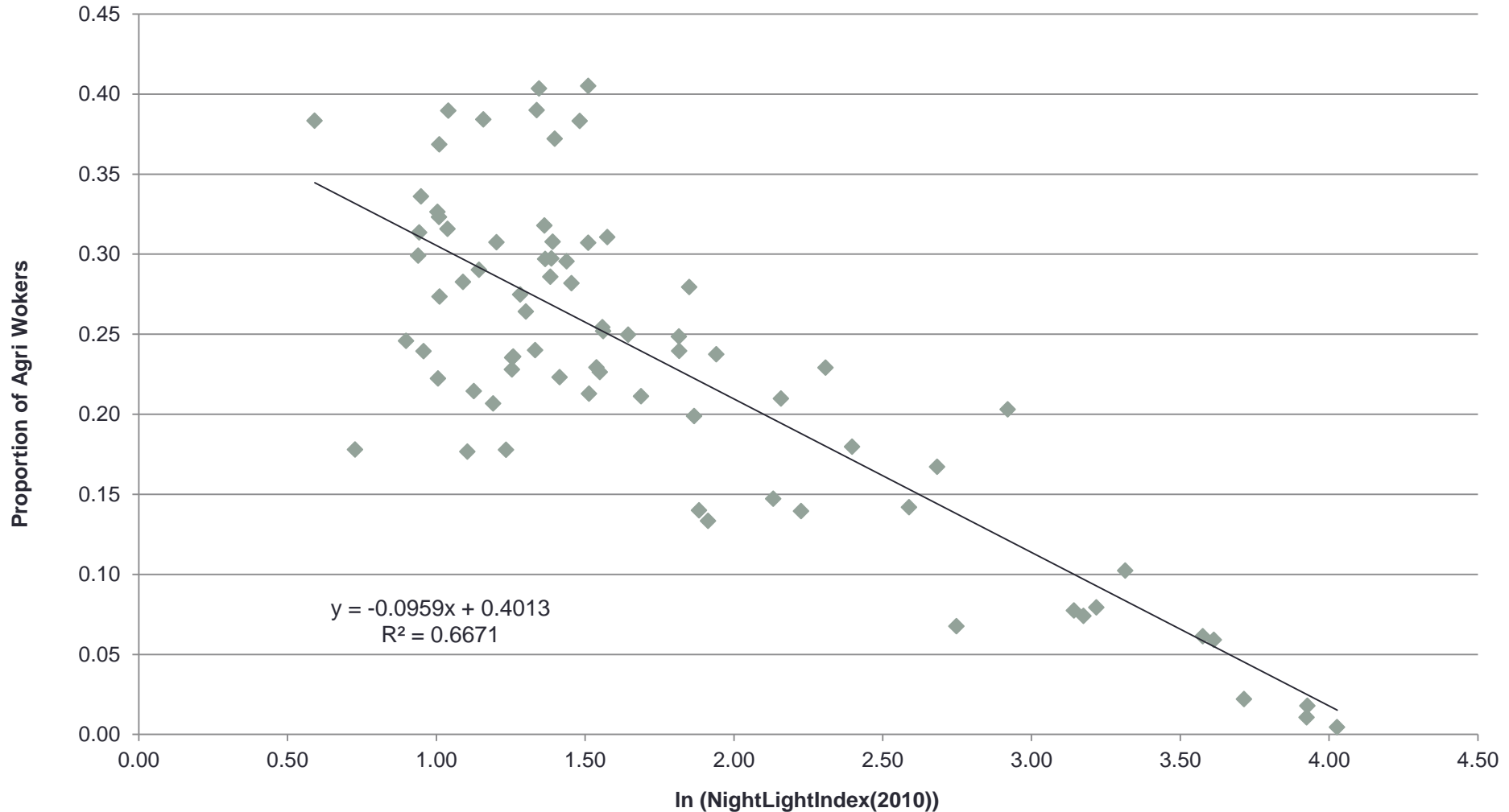
Example #1: Nightlight Index

Spatial density of workers classified by sectors (from SES 2010)



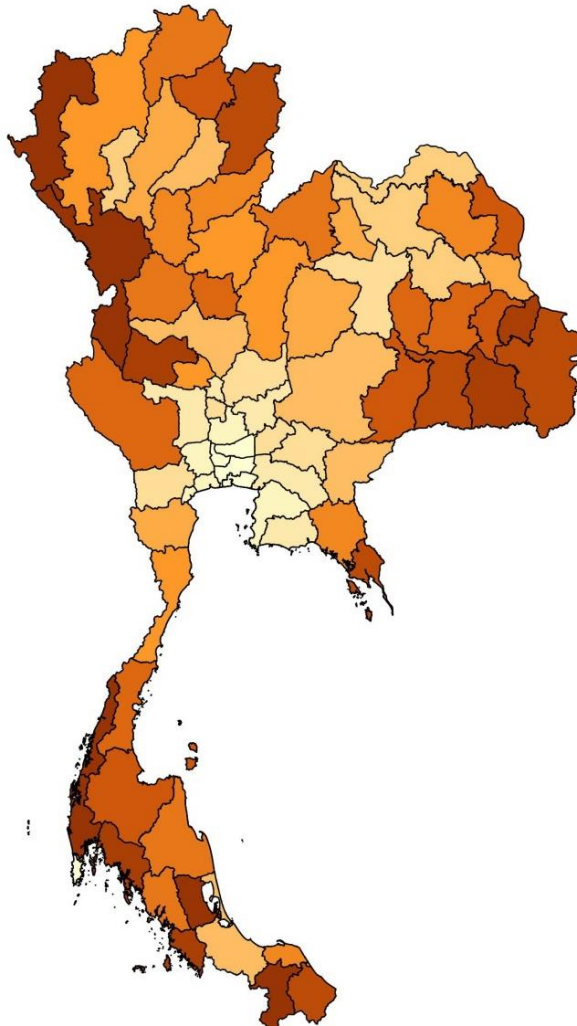
Example #1: Nightlight Index

Test #2: Correlation with worker density (agricultural sector)

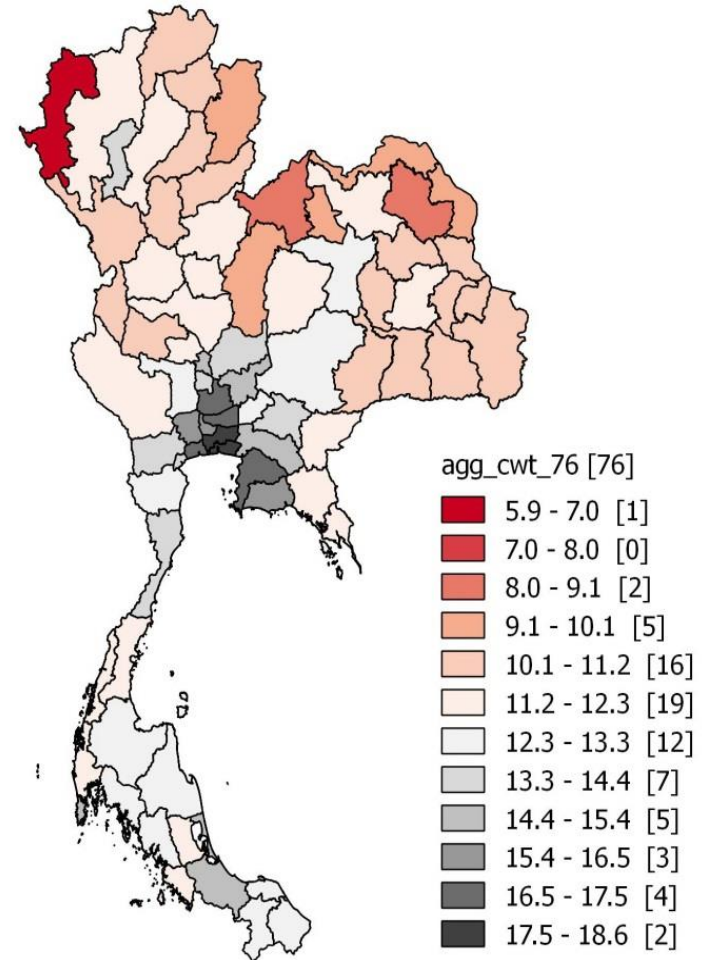


Example #1: Nightlight Index

Provincial Nightlight Index of 2010



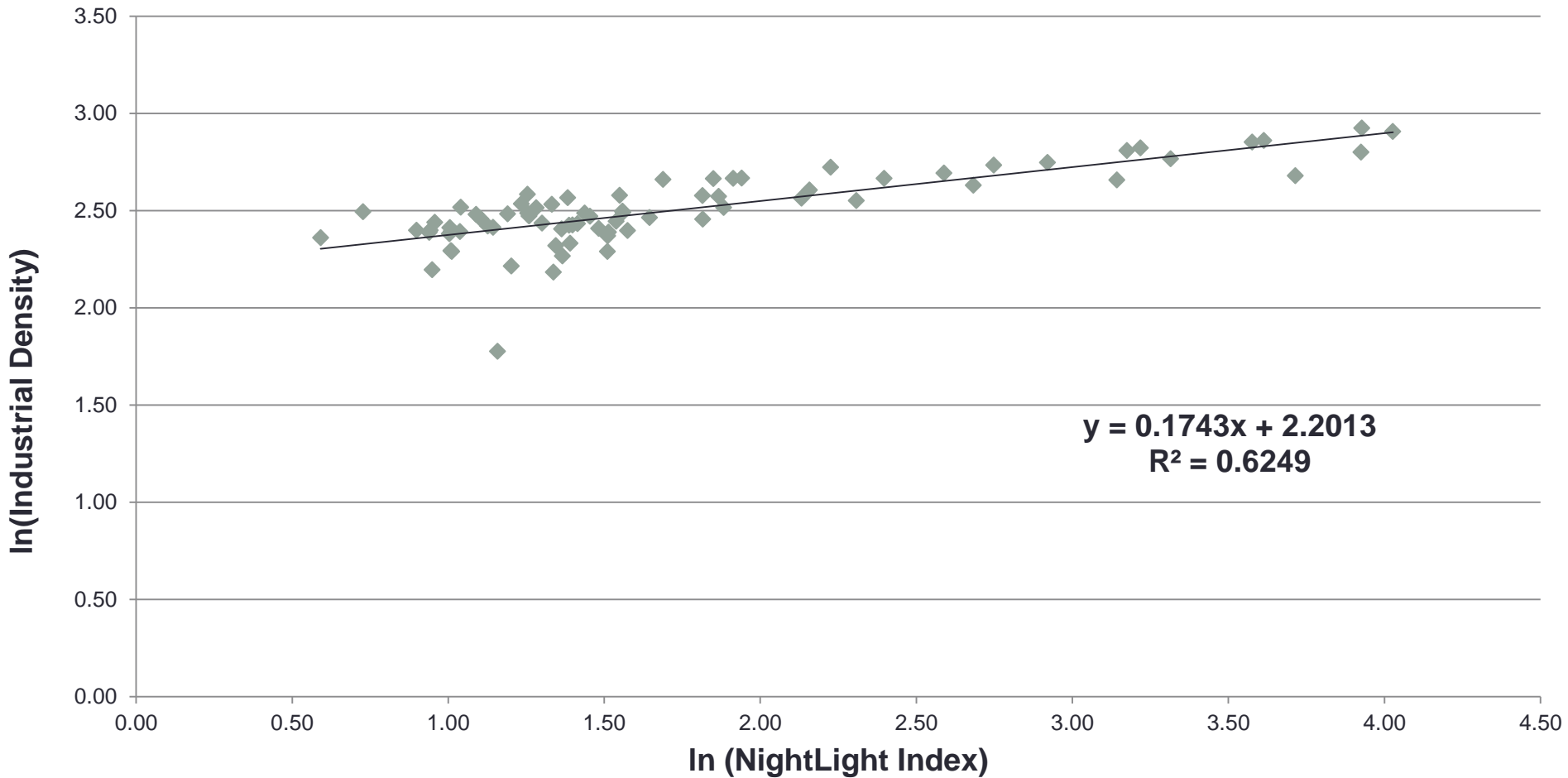
Industrial Density of 2010



Value of industrial output (baht) per square meter

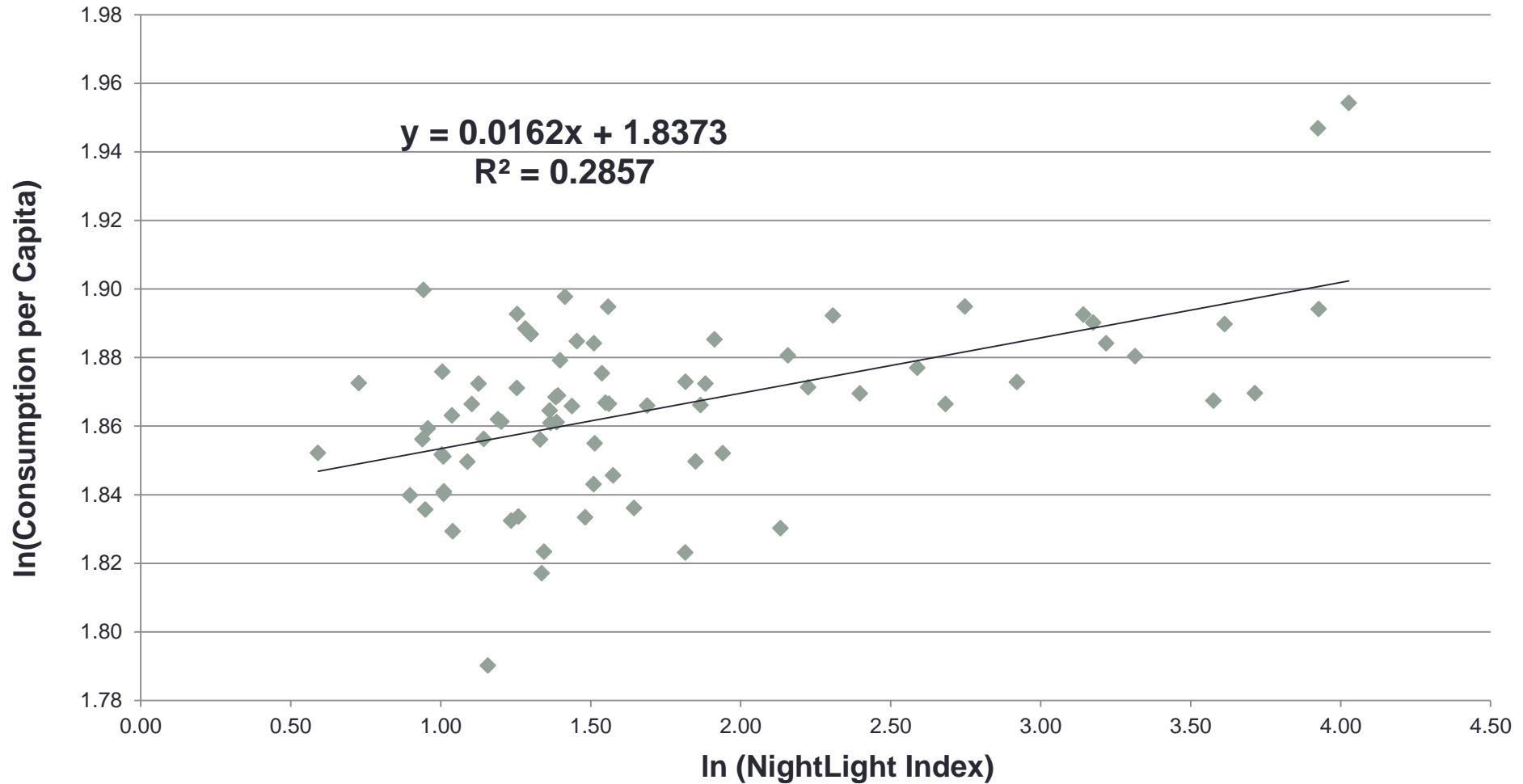
Example #1: Nightlight Index

Test #3: Correlation with industrial density



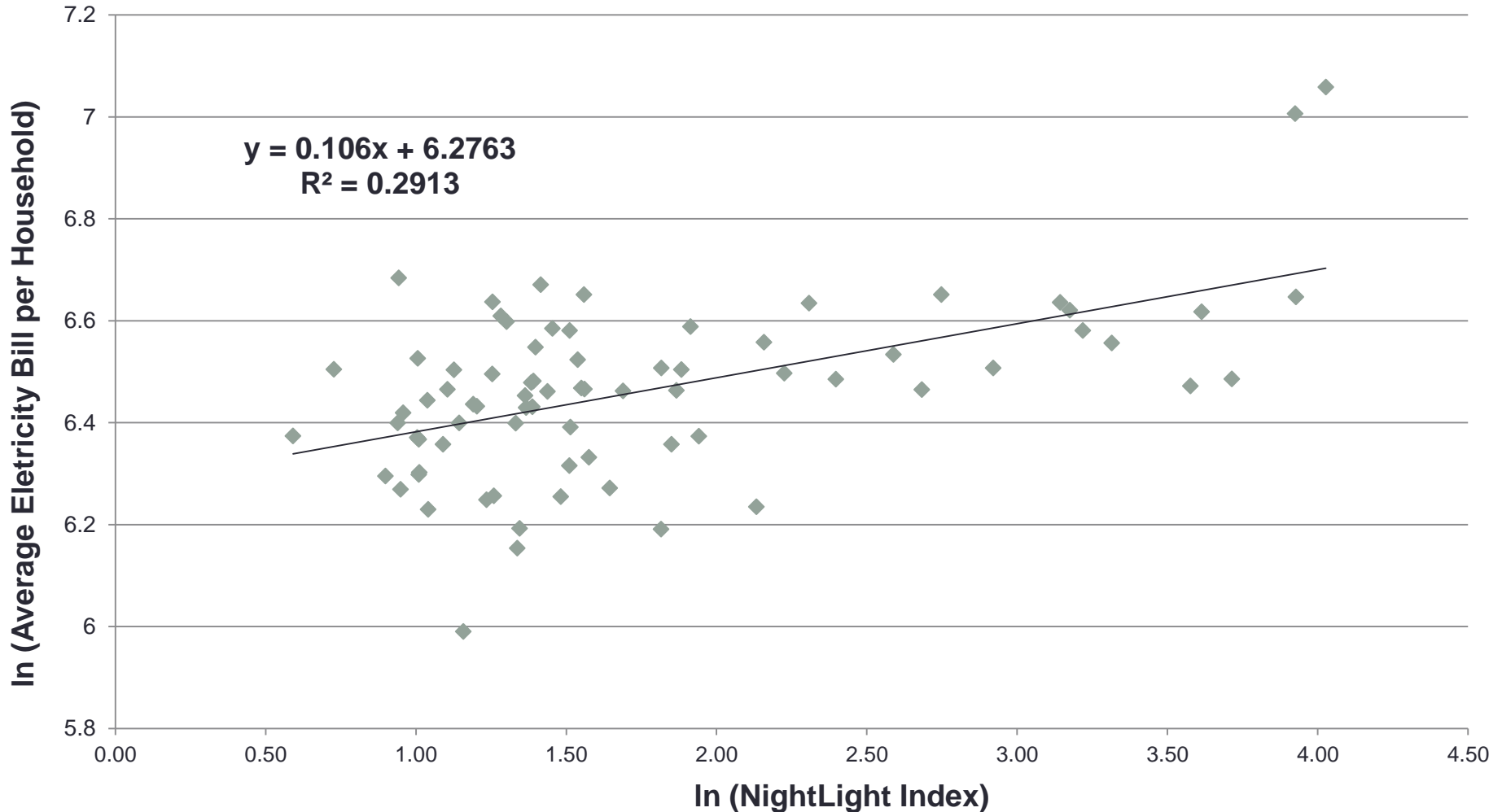
Example #1: Nightlight Index

Test #4: Correlation with consumption per capita



Example #1: Nightlight Index

Test #5: Correlation with an average electricity bill per household



Example #1: Nightlight Index

Test #6: Panel regression (with provincial GDP, no. of visitors and a dummy of flood 2011)

$$\ln NIGTLIGHT_{it} = c + \beta_1 \ln GPP_CVM_{it} + \beta_2 \ln VISITORS_{it} + \beta_3 FLOOD2011_{it} + \lambda_i + u_{it}$$

```
Fixed-effects (within) regression
Group variable: provcode2

R-sq:  within = 0.2531
      between = 0.4375
      overall = 0.4306

Number of obs   = 573
Number of groups = 72
Obs per group: min = 7
              avg  = 8.0
              max  = 8

F(3, 498) = 56.24
Prob > F   = 0.0000

corr(u_i, Xb) = -0.4127
```

nightlight	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
log_gpp_cvm	9.387998	.9231598	10.17	0.000	7.57423	11.20177
visitors	3.55e-07	8.76e-08	4.05	0.000	1.83e-07	5.27e-07
flood2011	-.5216289	.2430685	-2.15	0.032	-.9991949	-.0440628
_cons	-90.53666	9.821829	-9.22	0.000	-109.834	-71.23933
sigma_u	9.3013605					
sigma_e	1.8990488					
rho	.95998315	(fraction of variance due to u_i)				
F test that all u_i=0:			F(71, 498) =	156.96	Prob > F = 0.0000	

Example #1: Nightlight Index

- These outcomes suggest that with the limitation of most current survey data in term of their coverage and spatial resolution, the nightlight indexes can **be the alternative sources indicating the magnitude of economic activities** for many fields of studies interested in Thailand's dynamic adjustment of spatio-temporal dimensions.
- Also outcomes of these analyses provide **insights on Thailand's spatial pattern of economic transformation** which are important for future policy and planning formulations.

Example #2: Vegetation Index

Example #2: Vegetation Index

THE INTEGRATION OF REMOTE-SENSING DATA AND ECONOMIC ANALYSIS: THE CASE OF RICE CULTIVATION IN THE NORTHEASTERN REGION OF THAILAND

Nattapong Puttanapong¹, Preesan Rakwatin², Sutee Anantsuksomsri³, Nij Tontisirin⁴, Thanasin Tanompongphandh⁵

- This study aims at delivering two main contributions, which are (1) the process of undertaking **pre-treatment on remote-sensing data and constructing vegetation indexes**, and (2) the **validation of vegetation indexes with ground data**.
- Specifically, this study shows that vegetation indexes developed based on ASA's Moderate Resolution Imaging Spectroradiometer (MODIS) satellite have an **econometrically significant relationship** with the **provincial GDP in agricultural sector** and have the **negative correlation with crop loss statistics**.

¹ Faculty of Economics, Thammasat University, Bangkok, Thailand

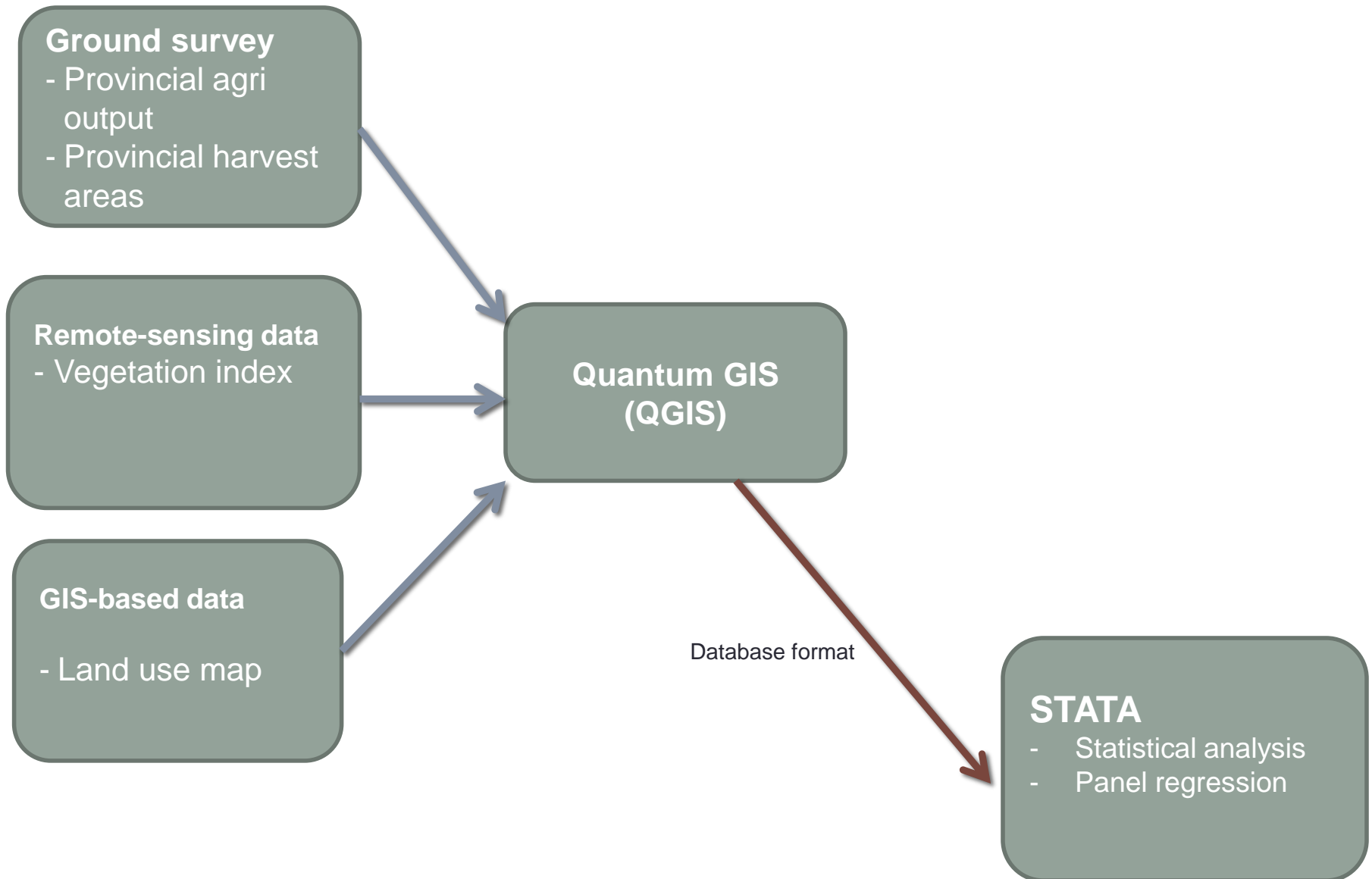
² Geo-Informatics and Space Technology Development Agency (GISTDA), Thailand

³ Faculty of Architecture, Chulalongkorn University, Bangkok, Thailand

⁴ Faculty of Architecture and Planning, Thammasat University, Thailand

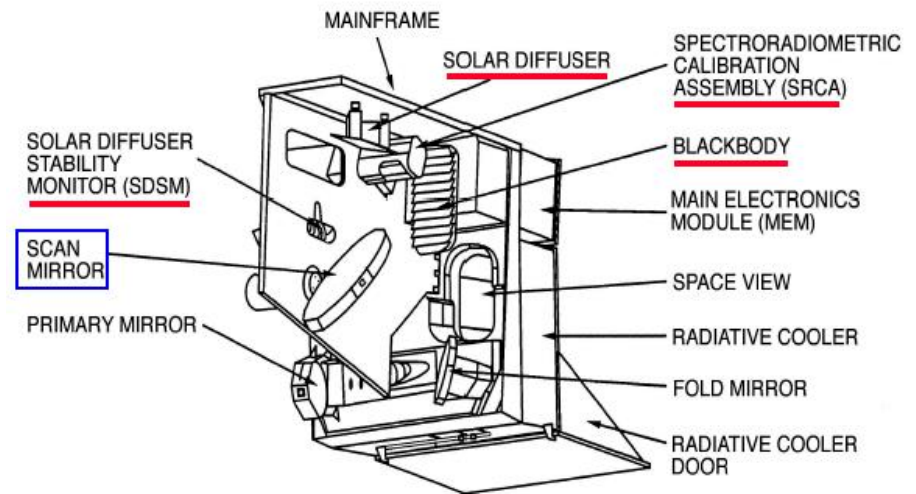
⁵ Faculty of Economics, Kasetsart University, Bangkok, Thailand

Example #2: Vegetation Index



Example #2: Vegetation Index

MODIS: System Characteristics



EOS-Terra Platform

- ❖ Sun-synchronous, near-polar, 705.3 km, 98.21° inclination
- ❖ 10:30 AM local solar equatorial crossing time (descending node)
- ❖ Launched December 18, 1999

Example #2: Vegetation Index

What is NDVI?

Normalized Difference Vegetation Index (NDVI)

**Heathy Vegetation
Reflectance**

50%
NIR

8%
Red



NDVI = 0.72

**Stressed Vegetation
Reflectance**

40%
NIR

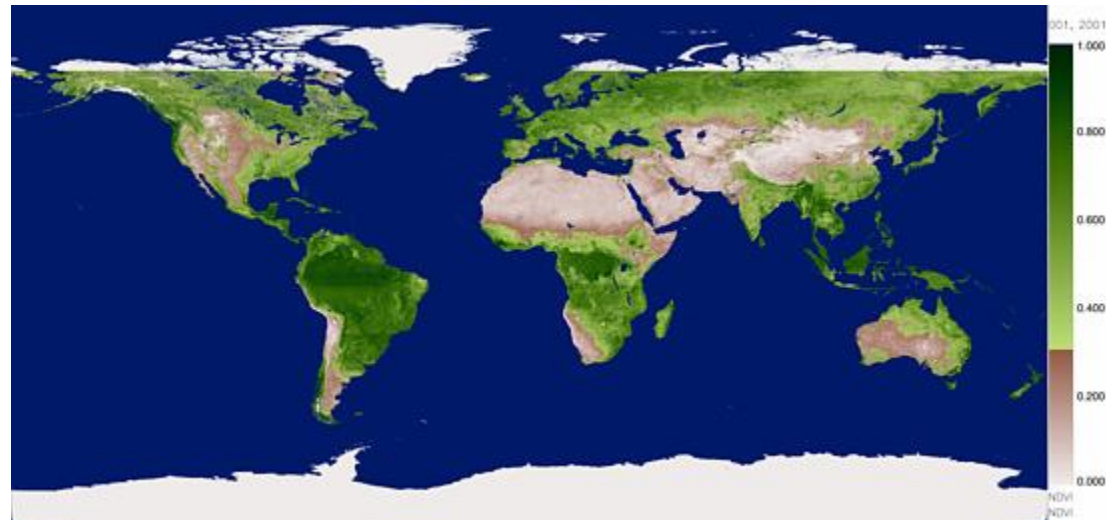
30%
Red



NDVI = 0.14

$$\text{NDVI} = \frac{\text{NIR} - \text{Red}}{\text{NIR} + \text{Red}}$$

PICTURE From: <http://odis.ca/ndvi.html>



PICTURE From: <http://modis-tmos.gsfc.nasa.gov/NDVI/Images/NDVI.FM.WS.2001.001.NDVI.thumb.jpg>

Example #2: Vegetation Index

Vegetation Index

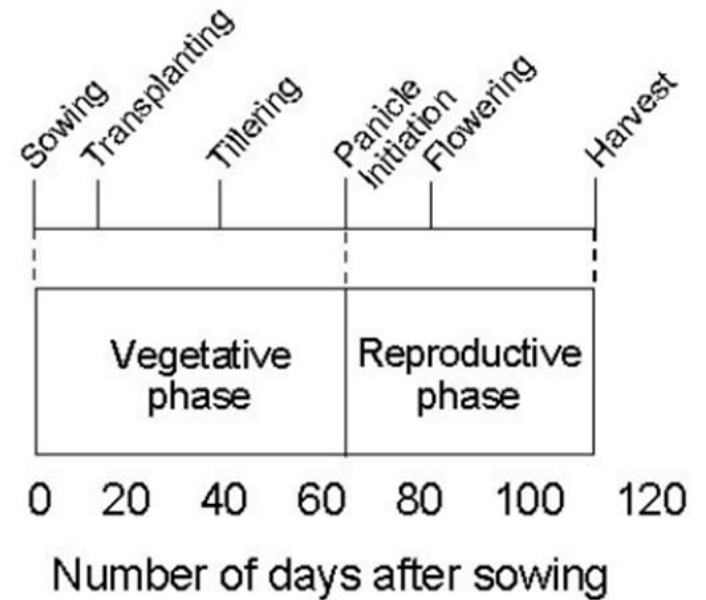
- **Normalized Difference Vegetation Index (NDVI)**

$$NDVI = \frac{NIR - RED}{NIR + RED} ,$$

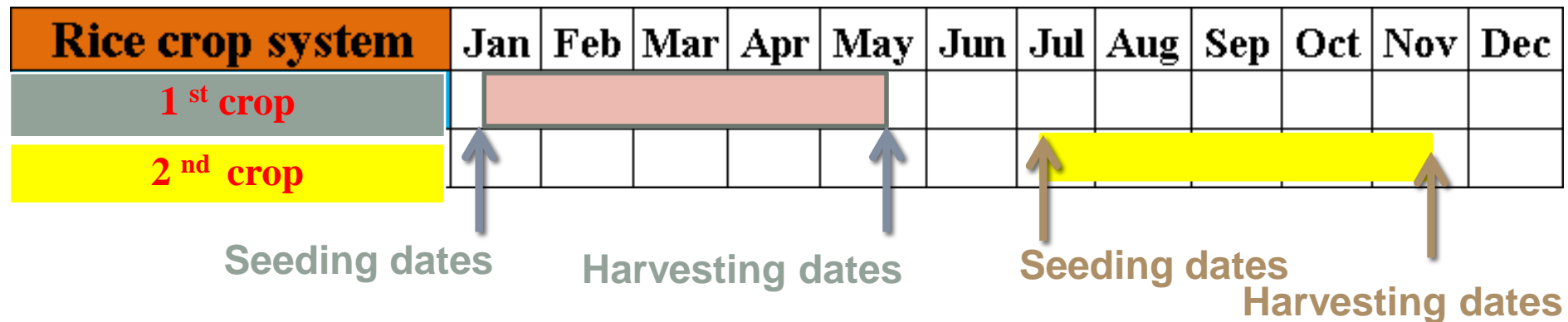
where NIR is near-infrared band and RED is red band.
Both available in MODIS 250m resolution (8-day average data).

Example #2: Vegetation Index

Rice growing stage (crop cycle length of 120-150 days)

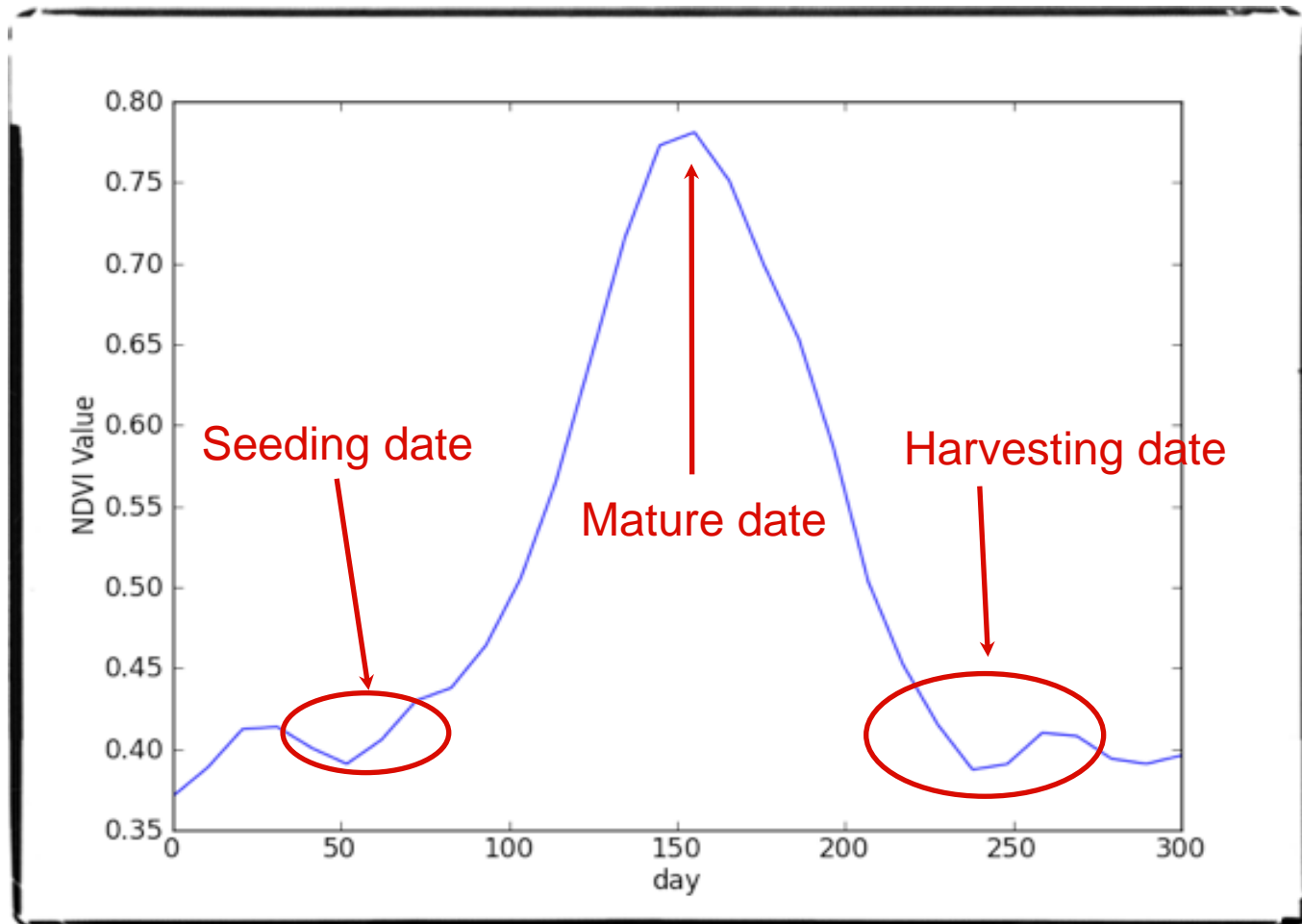


Source: Le-Toan et al. (2003)

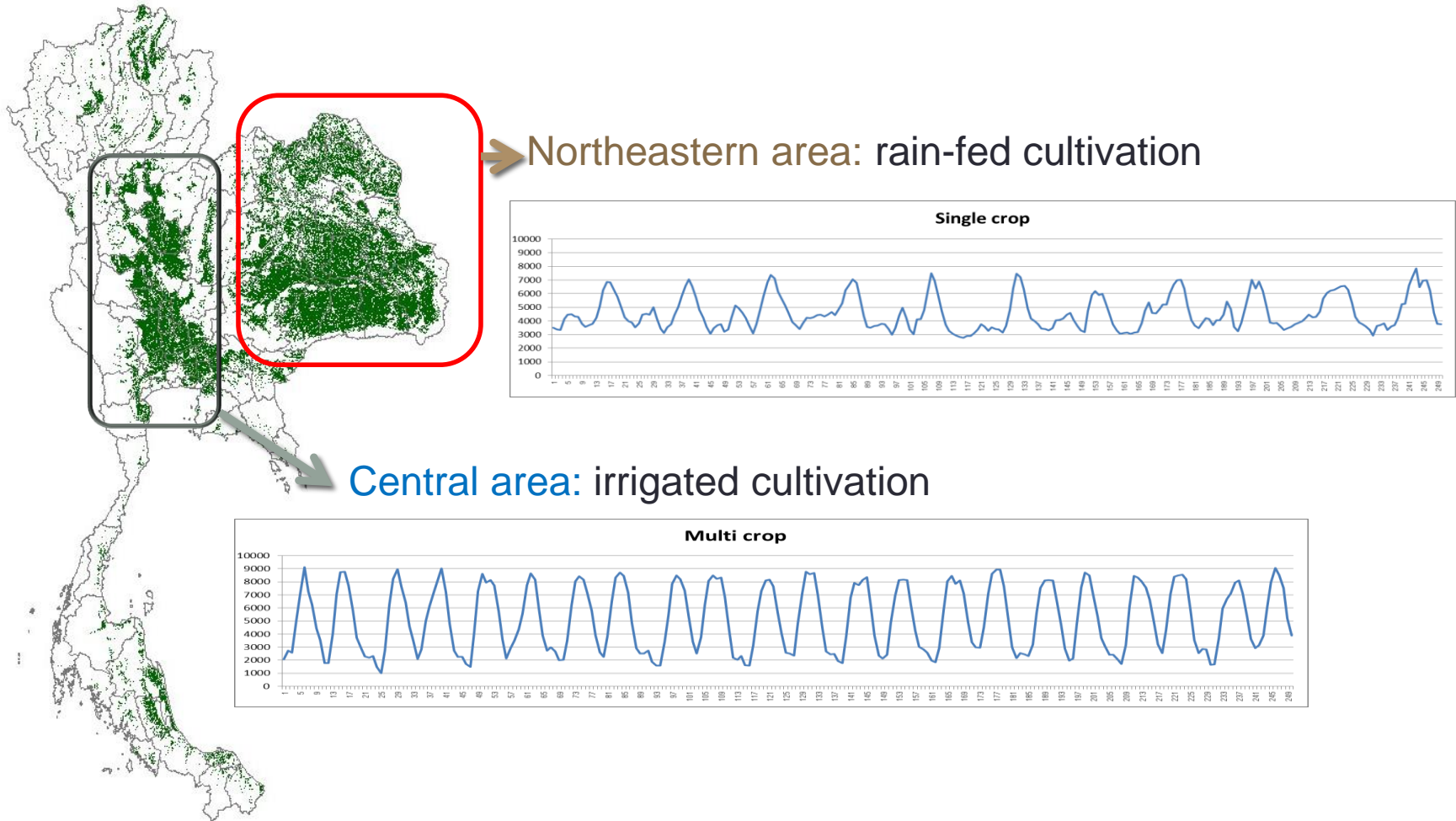


Example #2: Vegetation Index

Crop cycle of rice indicated by values of NDVI

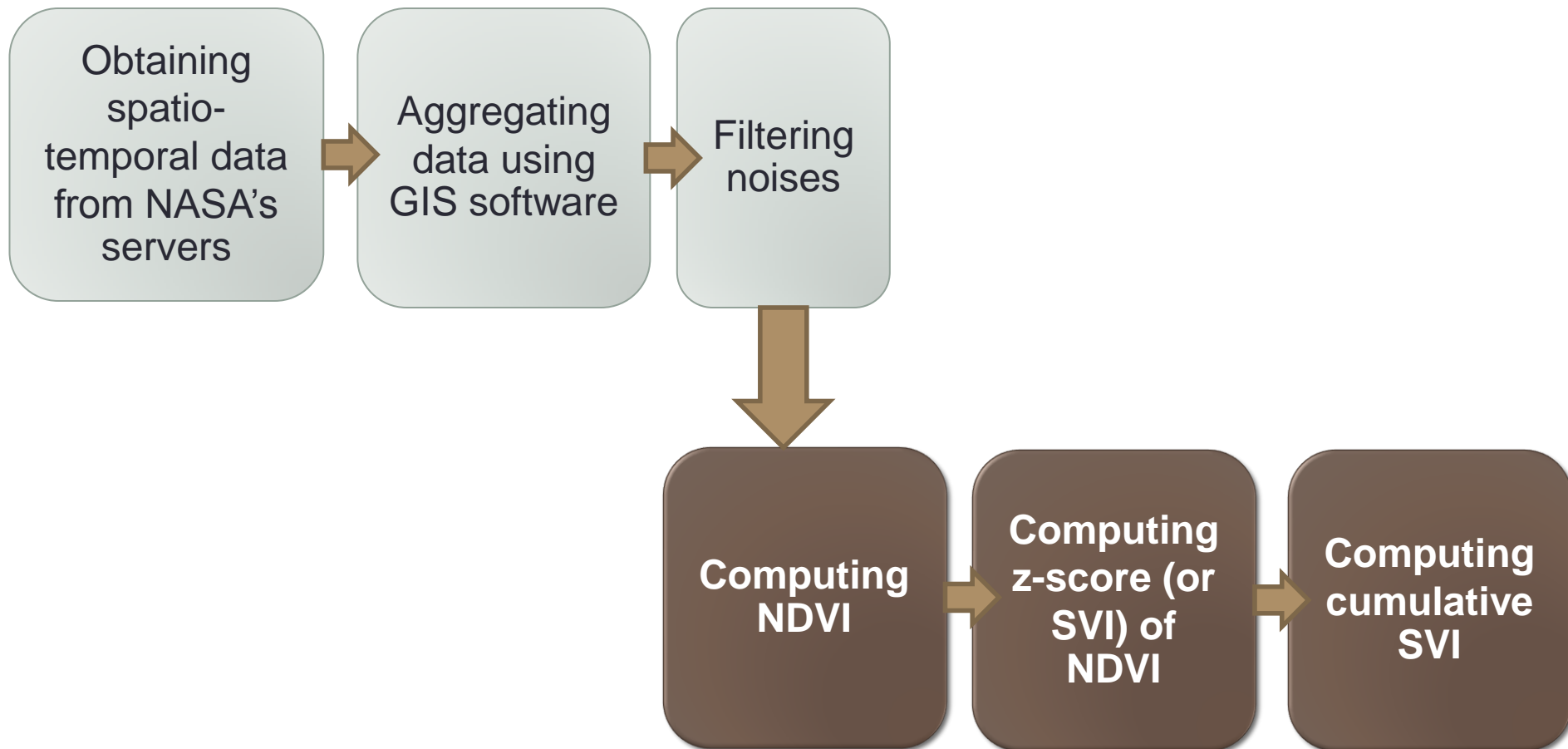


Example #2: Vegetation Index



Example #2: Vegetation Index

Steps of pre-processing of remote-sensing data and constructing vegetation index



SVI: Standardized Vegetation Index

Example #2: Vegetation Index

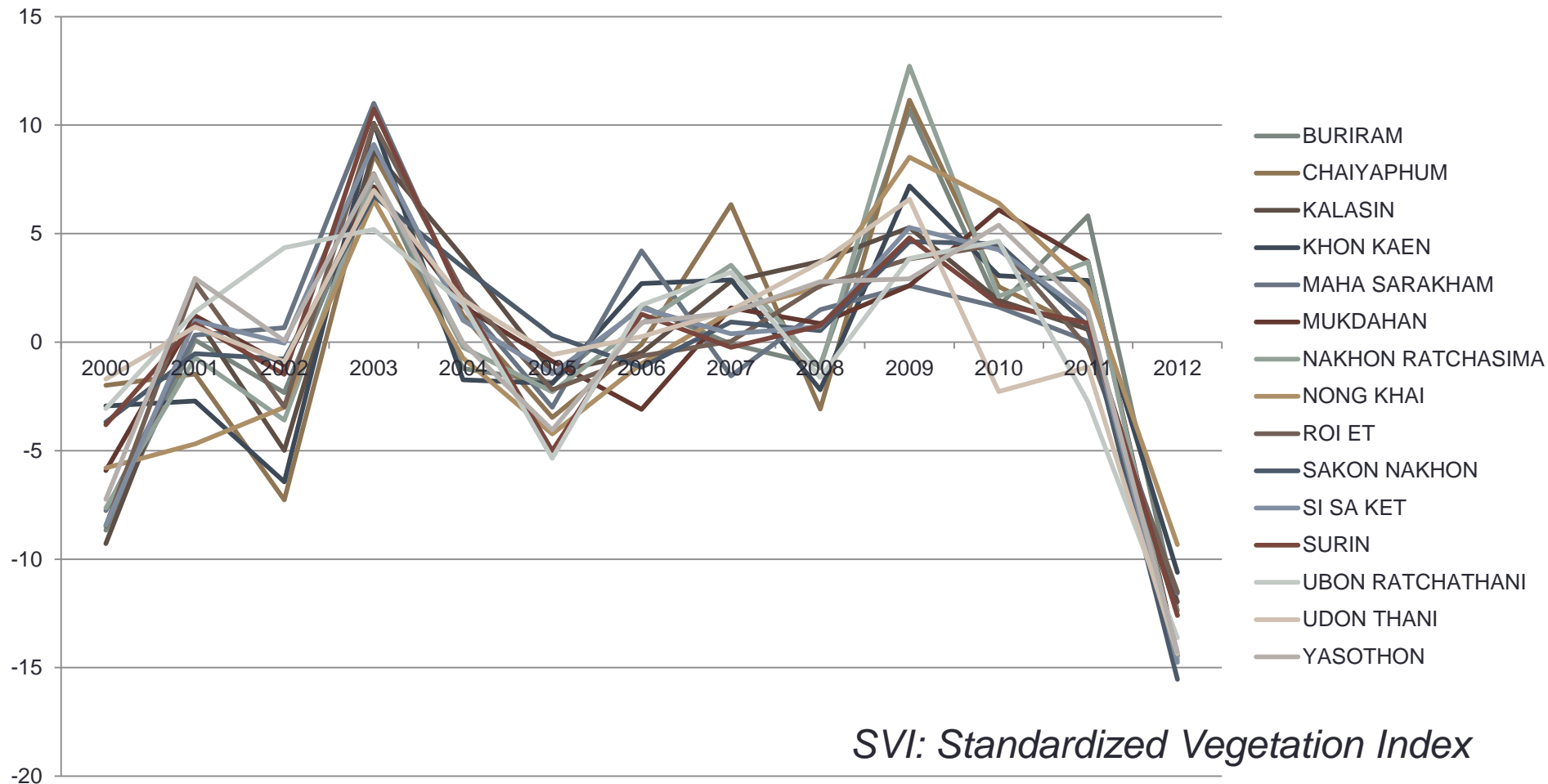
Statistical and econometrical tests

Test #1: Correlation with crop loss data

Test #2: Panel regression with provincial agricultural outputs and harvesting areas

Example #2: Vegetation Index

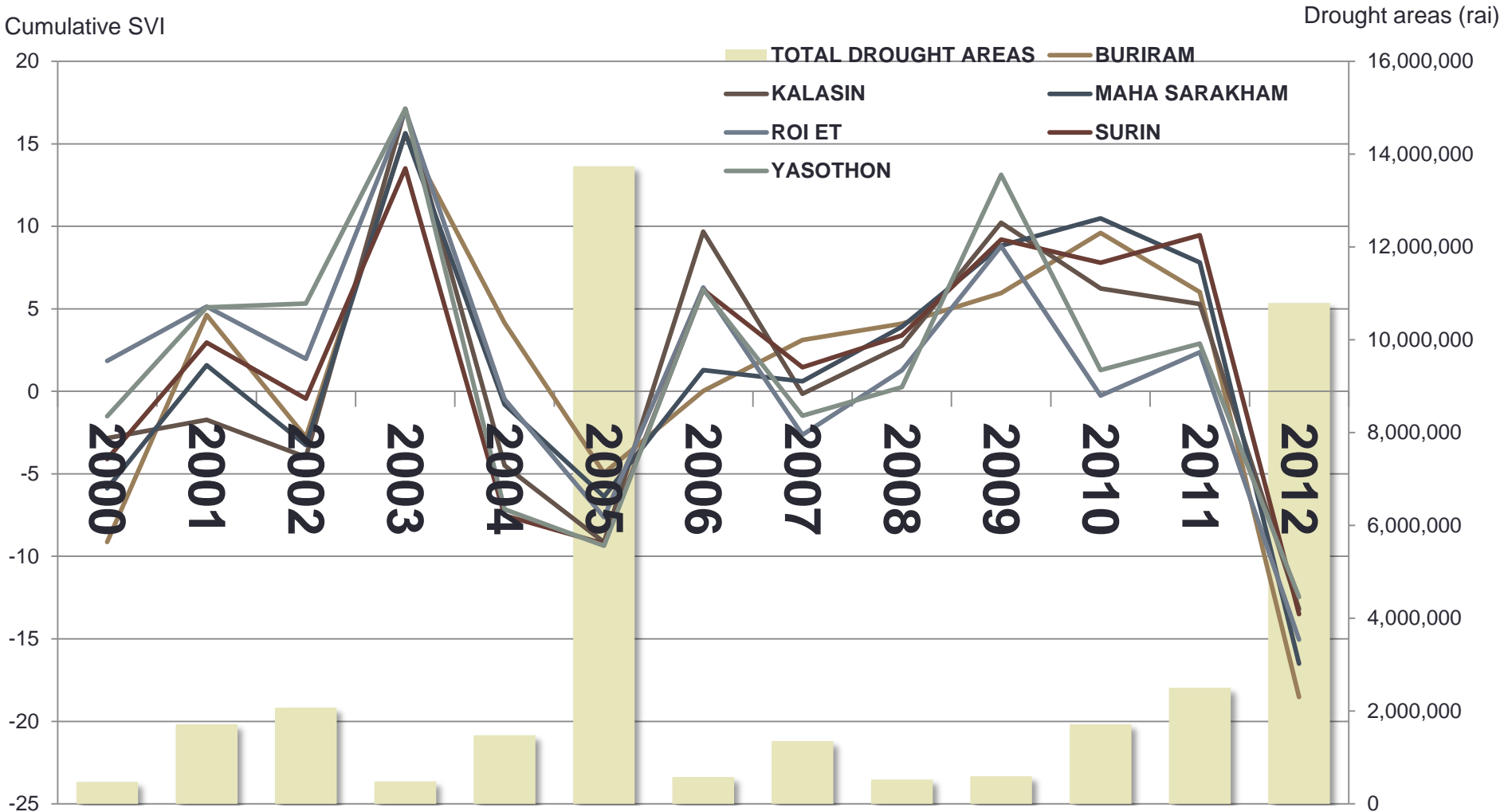
The constructed cumulative SVI (by province)



SVI: Standardized Vegetation Index

Example #2: Vegetation Index

Test #1: Correlation with crop loss data



Example #2: Vegetation Index

Test #1: Correlation with crop loss data

PROVINCE	CORRELATION WITH CROP LOSS
BURIRAM	-0.608
CHAIYAPHUM	-0.811
KALASIN	-0.783
KHON KAEN	-0.944
MAHA SARAKHAM	-0.842
MUKDAHAN	-0.882
NAKHON RATCHASIMA	-0.878
NONG KHAI	-0.800

PROVINCE	CORRELATION WITH CROP LOSS
ROI ET	-0.823
SAKON NAKHON	-0.895
SI SA KET	-0.924
SURIN	-0.879
UBON RATCHATHANI	-0.832
UDON THANI	-0.712
YASOTHON	-0.858

Example #2: Vegetation Index

Test #2: Panel regression with provincial agricultural outputs and harvesting areas

$$\Delta\%ProvincialAgriOutput_{it} = c + \beta_1 \Delta\%SVI_{it} + \beta_2 \Delta\%HarvestArea_{it} + \lambda_j + u_{it}$$

```
Fixed-effects (within) regression      Number of obs      =      192
Group variable: provcode              Number of groups   =       16
R-sq:  within = 0.2471                Obs per group: min =       12
      between = 0.1802                  avg              =      12.0
      overall  = 0.2451                  max              =       12
                                         F(2, 174)         =      28.56
corr(u_i, Xb) = 0.0019                 Prob > F           =      0.0000
```

	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
gpp_agri_const_gr~h					
growth_svi	.2560079	.0543998	4.71	0.000	.1486395 .3633764
growth_harvest_area	.3869245	.070286	5.51	0.000	.2482016 .5256473
_cons	.0420295	.0068434	6.14	0.000	.0285227 .0555362

```
-----+-----
sigma_u | .0171715
sigma_e | .09399939
rho     | .03229315 (fraction of variance due to u_i)
```

```
-----+-----
F test that all u_i=0:      F(15, 174) =      0.40      Prob > F = 0.9776
```

Example #2: Vegetation Index

Future applications

- These findings suggest the possibility of using remote-sensing data for **timely monitoring the economic situation of rice farmers**, which would subsequently improve insights on the **connection between the agricultural output and urban-rural migration**.
- Suttiwichienchot and Puttanapong (2014) indicate that the seasonal migration is the important mechanism of Thai economy. Specifically **switching between farm and non-farm jobs signifies the flexibility of Thai labor market**.
- This switching mechanism can be represented by **Harris-Todaro's expected-wage equation**.

Example #2: Vegetation Index

Million persons

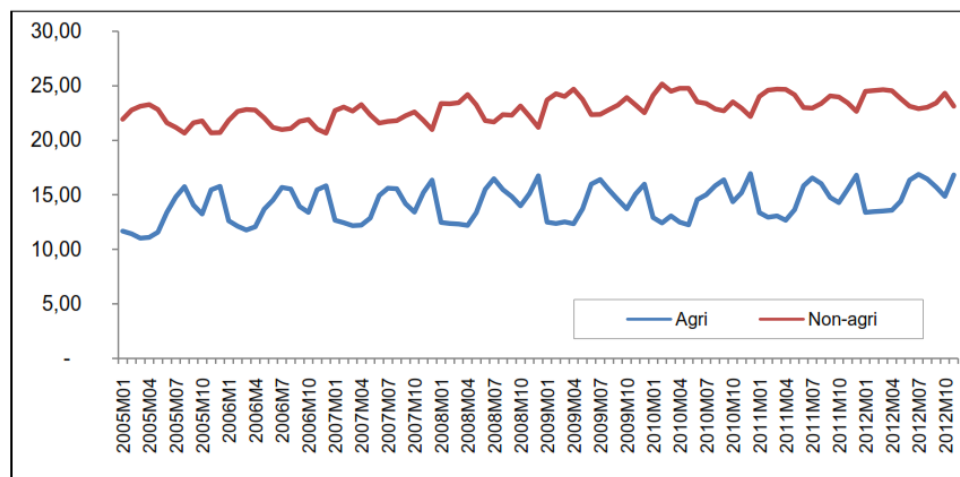


Figure 1. Seasonal employment in agricultural and non-agricultural sectors in Thailand during 2005 – 2012.

Source: The Labor Force Survey, Ministry of Labor, Thailand

Unit: Baht

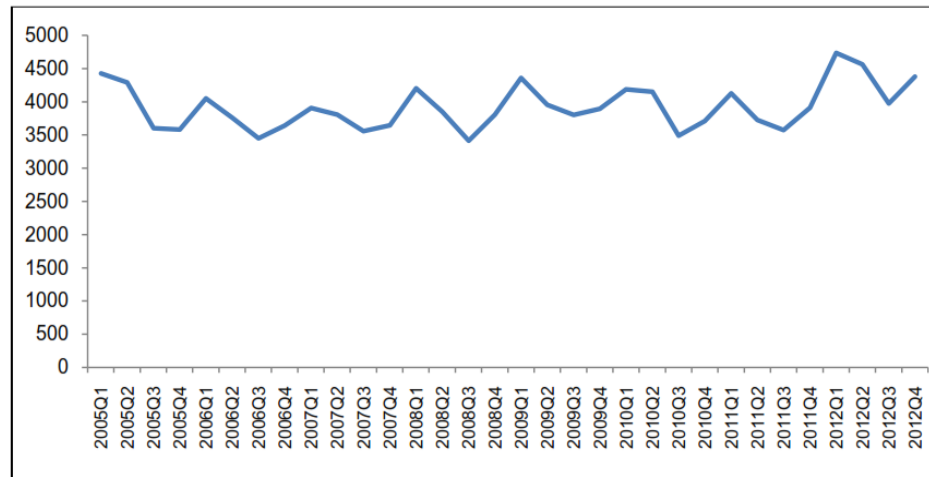


Figure 2. The time series of the deflated switching cost during 2005 - 2012

Source: Authors' calculation based on the data obtained from the Labor Force Survey, Ministry of Labor, Thailand.

Following **Harris-Todaro's concept**, the behavior of internal migration between agricultural and non-agricultural sectors can be mathematically represented by the expected wage equilibrium as shown in Eq. 1.

$$\begin{aligned}
 & \text{prob}(\text{employment}_{\text{agri}}) \cdot \text{wage}_{\text{agri}} = \\
 & \sum_{\text{nagri}} (\text{prob}(\text{employment}_{\text{nagri}}) \cdot \text{wage}_{\text{nagri}}) - \text{switching cost} \quad (1) \\
 & \text{where } \text{prob}(\text{employment}_{\text{agri}}) = \frac{\text{employment}_{\text{agri}}}{\text{total labor supply}}, \\
 & \text{and } \text{prob}(\text{employment}_{\text{nagri}}) = \frac{\text{employment}_{\text{nagri}}}{\text{total labor supply}}
 \end{aligned}$$

Source: Suttiwichienchot and Puttanapong (2014)