

A GIS-based Kriging Approach for exploring air pollution and asthma

Author:

*Ta-Chien Chan, National Health Research Institutes
Po-Huang Chiang, National Health Research Institutes
Jen-Hsiang Chuang, CDC, Taiwan
Mei-Lien Chen, National Yang Ming University
I-Fang Mao, National Yang Ming University

Ta-Chien Chan, Taiwan



Outline

- Background
- Goal
- Method
- Result
- Discussion
- Conclusion



Background



Ta-Chien Chan, Taiwan

Background

- Air pollutants' effect on respiratory illness
- **Higher** traffic load → **Higher** concentration of air pollutants
- Asthma accounts for an estimated **3 million** lost workdays for adults and **10.1 million** lost school days in children annually. (The American Lung Association)
- Asthma's prevalence rate in Taipei city → **13%**

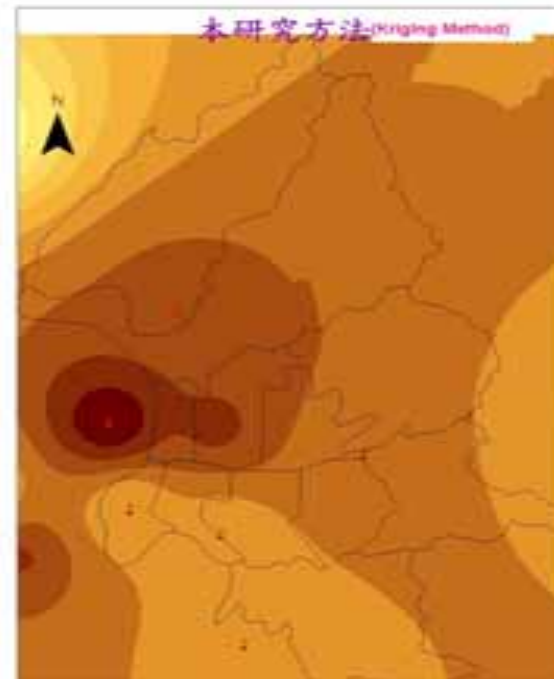
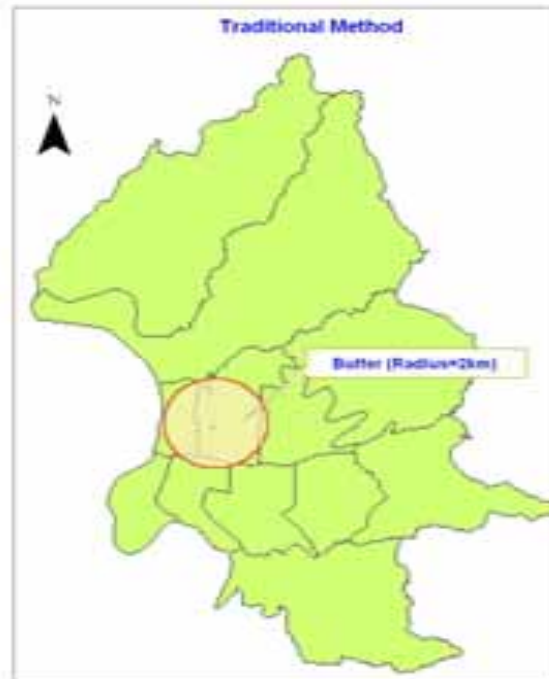


Ta-Chien Chan, Taiwan



Problems We Faced!!

- Cases which are limited **surrounding the air monitoring station.**
- **Long-term and large-scale** exposure's estimation.



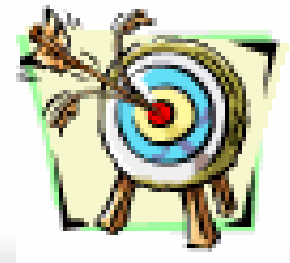
Goal

Ta-Chien Chan, Taiwan



Goal

1. To evaluate four air pollutants' ($\text{NO}_2, \text{SO}_2, \text{O}_3, \text{PM}_{10}$) impact on asthma's outpatient and ER admission.
2. To observe the spatial and temporal pattern of asthma's admission and air pollutants' concentration.

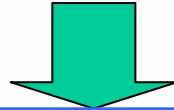


Method

Ta-Chien Chan, Taiwan

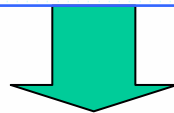
Method

Pre-processing raw data

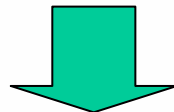


Exposure's estimation
(By ArcView and its extensions)

Geocoding cases ' location



General Additive Model (GAM)
(By SAS software)

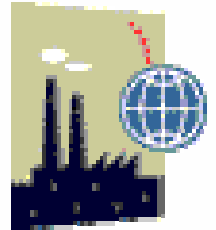


Overall Effect's Estimation
(By ArcView and its extensions)





Data source



• Case data

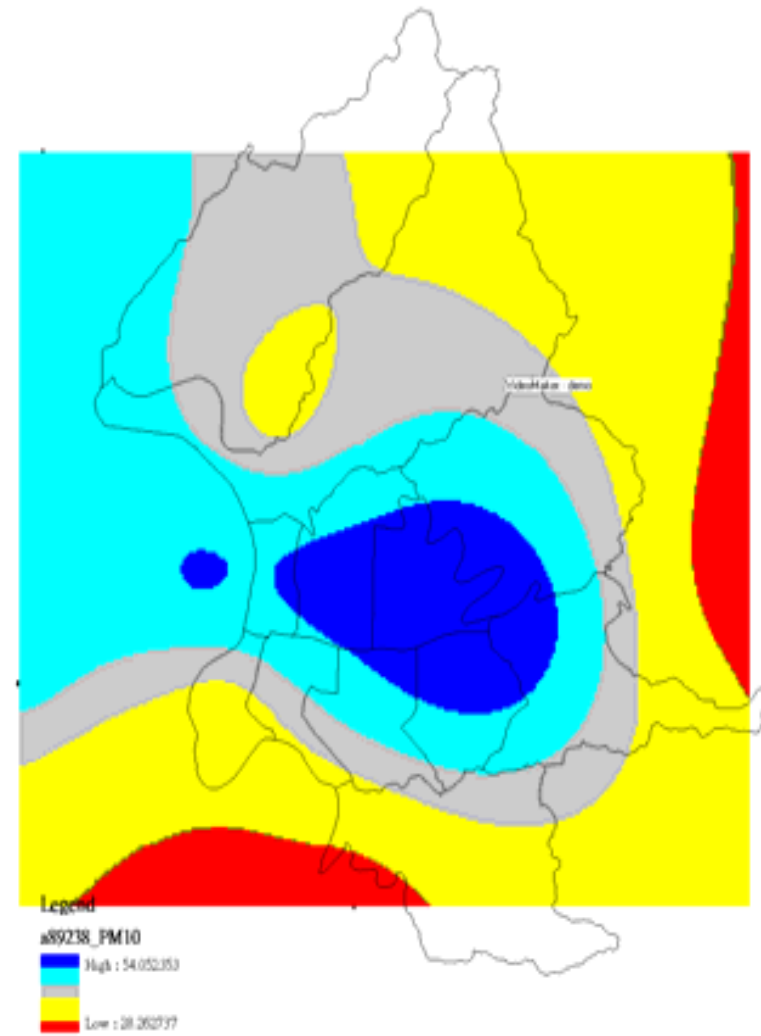
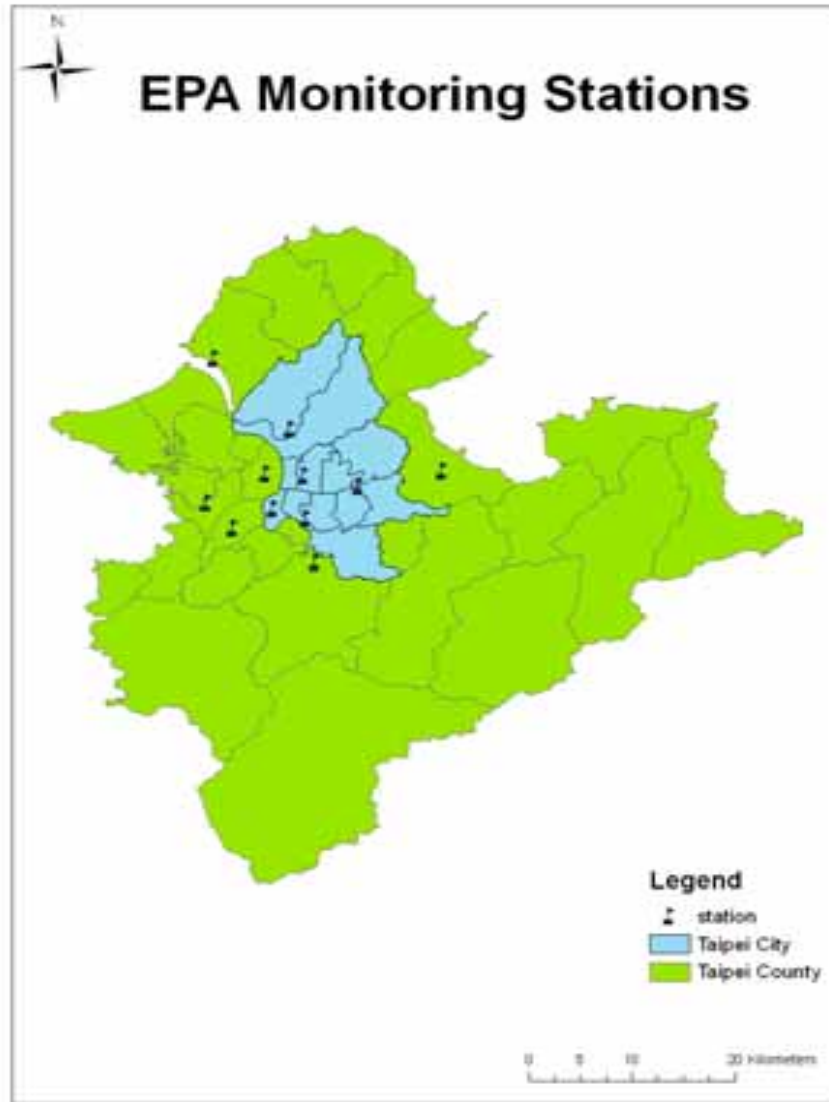
- Source : 3 years' claims data in outpatient and emergency settings
- Definition :
 - Code : ICD 9-CM =493(Asthma)

• Exposure data

- Source : air pollution's data
- Air pollutants : SO_2 、 O_3 、 PM_{10} 、 NO_2
- Number of air monitoring stations : 11
- Interpolation's method : Kriging Method

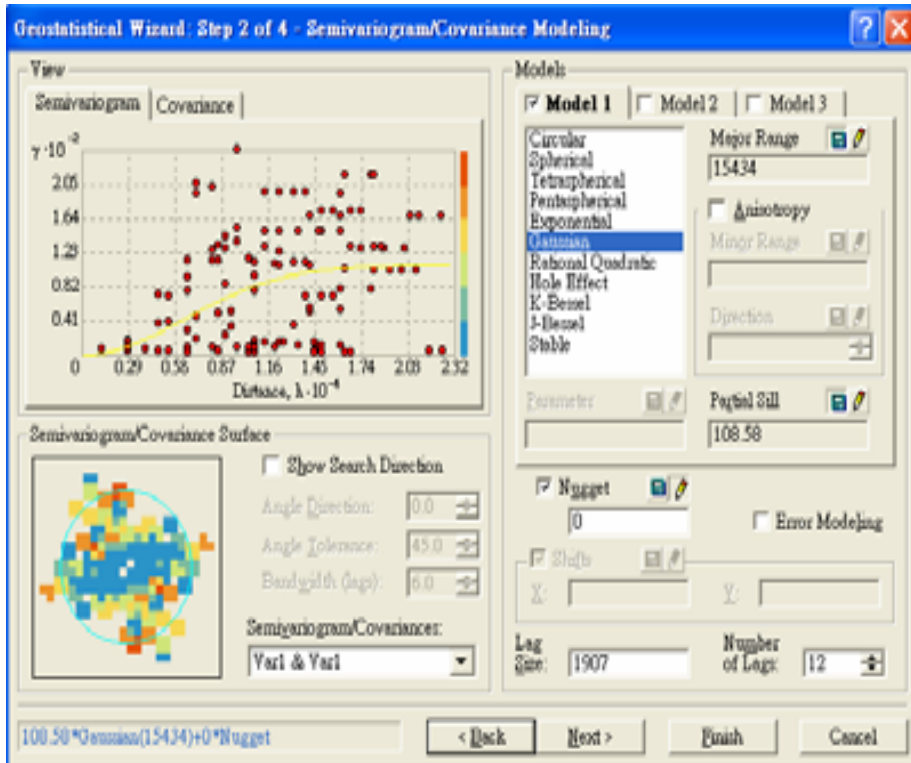


Air monitoring station's distribution

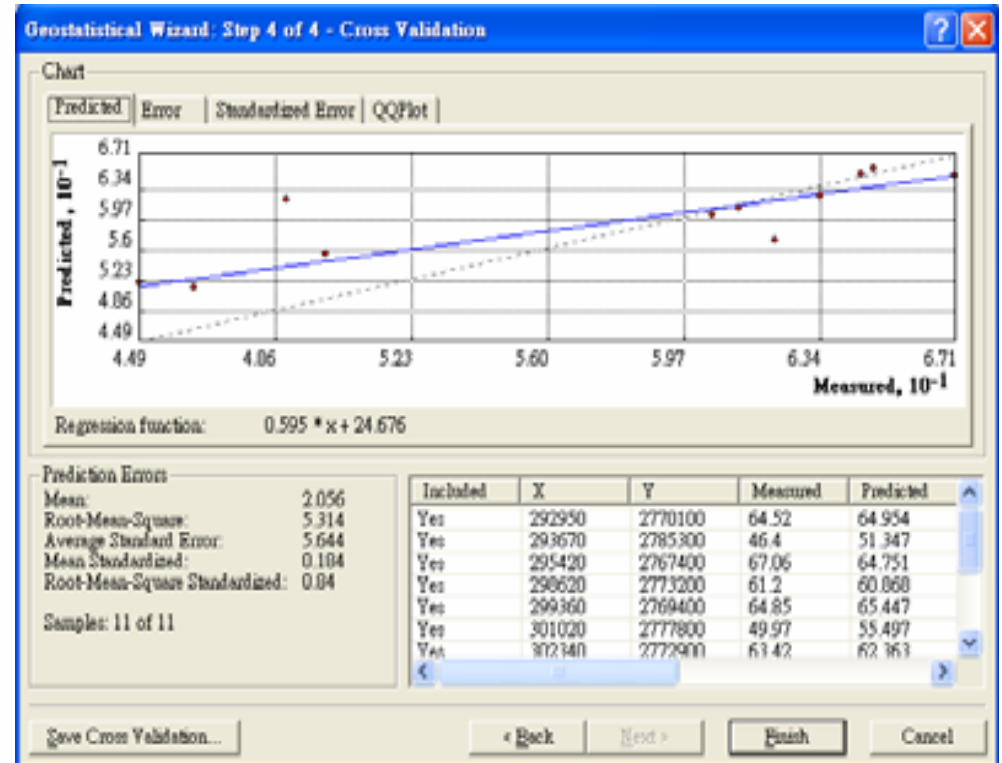


Ta-Chien Chan, Taiwan

Selecting Model's Parameters



Semivariogram Modeling

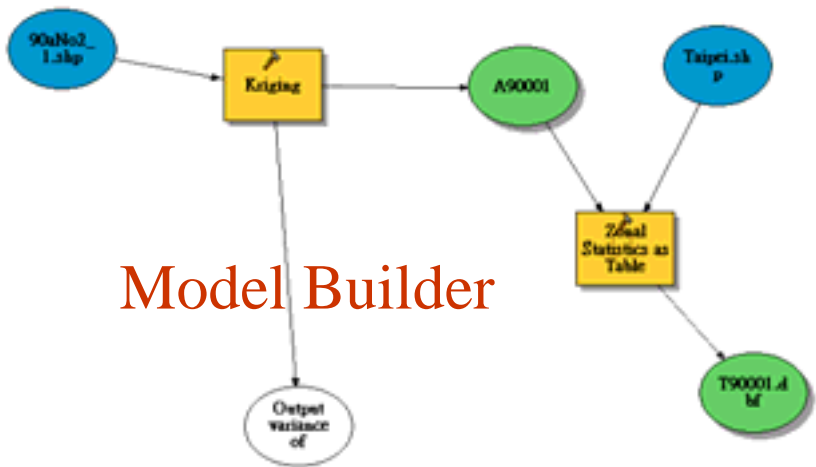


Prediction Errors



Take NO₂ AS Example

Ta-Chien Chan, Taiwan



Model Builder

```

File Edit Format View Options Window Help
-----
# -----
# dachian.py
# by NYHU Chan Ts-chien
# Created on: 星期三 六月 01 2005 02:54:10 下午
# (generated by ArcGIS/ModelBuilder)
# -----

# Import system modules
import sys, string, os, win32com.client

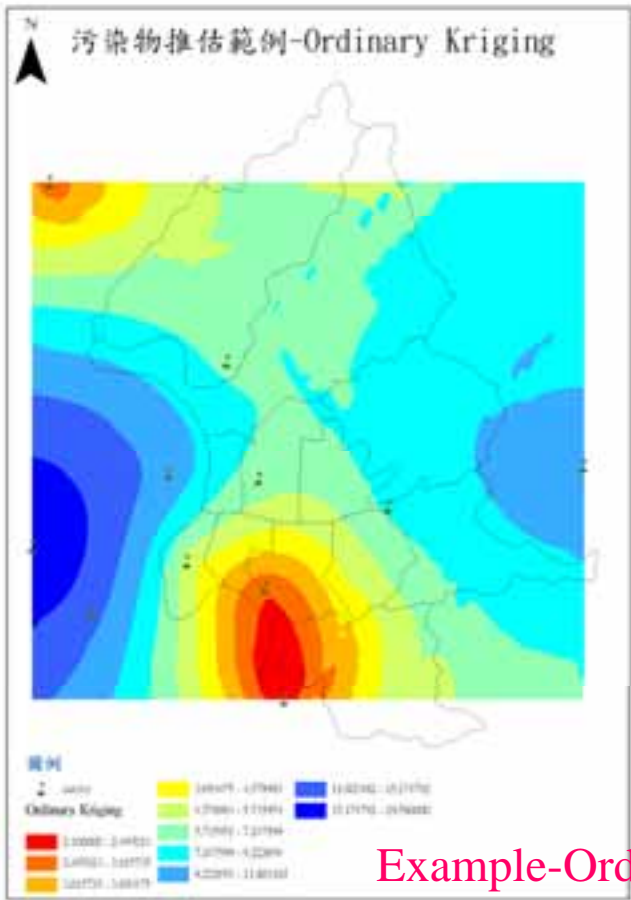
# Create the Geoprocessor object
gp = win32com.client.Dispatch("esriGeoprocessing.GpDispatch.1")

# Check out any necessary licenses
gp.CheckOutExtension("spatial")

# Load required toolboxes...
gp.AddToolbox("C:/Program Files/ArcGIS/ArcToolbox/Toolboxes/Spatial Analyst

# Local variables...
#control tansal
  
```

Python Dialog



Example-Ordinary Kriging

NO	A	B	C	D	E	F	G	H	I
1	EMO_TOWNSHIP	ZONE	COGHT	AREA	MIN	MAX	RANGE	MEAN	STD
2	Dachian Township	1	2142	17302300	33,819	38,896	5,078	36,748	1,060
3	Suh Township	2	794	2882960	36,394	38,881	2,487	36,081	6,550
4	Lufsh City	3	1051	7753600	32,409	36,150	3,642	34,382	6,911
5	Shenzong City	4	2825	17962800	30,092	34,440	4,356	31,832	1,014
6	Shiding Township	5	1433	10626600	21,251	30,813	9,562	26,379	2,206
7	Shaoan City	6	2808	19033100	24,168	34,527	10,359	30,295	2,814
8	Shenzong Township	7	2600	19280000	15,001	29,010	13,009	22,345	2,581
9	Yongde City	8	829	6147540	11,616	26,430	14,814	20,590	3,591
10	Rongde City	9	2113	12669200	7,262	27,004	19,742	16,890	4,694
11	Shaoan City	10	539	3973010	0,001	18,797	18,796	5,589	2,491
12	Turkey City	11	773	5732260	19,244	28,602	9,358	24,815	3,222
13	Shih City	12	6064	44968200	30,177	37,043	6,866	34,715	1,497
14	Wash Township	13	3338	25793300	53,073	25,028	1,954	34,003	6,442
15	Shenzong City	14	1650	12554000	21,170	28,195	7,026	25,404	1,241
16	Turkey Township	15	362	2694450	36,441	38,159	1,719	37,588	6,260
17	Waga Township	16	2264	16788900	13,896	38,397	4,501	36,005	6,901
18	Shaoan Township	17	129	1175600	32,960	33,340	3,380	33,154	6,077
19	Shaoan District	18	6388	47370000	30,504	36,540	6,136	33,078	1,272
20	Shaoan District	19	7024	42824000	30,504	36,540	6,136	33,078	1,272

Average concentration in each district

Ta-Chien Chan, Taiwan

Statistical Analysis--GAM

- Cubic Smoothing Function
- **Y**: daily admission in Outpatient and ER setting
- **X**: four kind of pollutants (fit separately) and possible confounders. (temperature, dewpoint)



Health Effect

- When air pollutant's concentration elevated 10% , the percentage change of admission

$$100 \{ \exp(0.1 * \bar{C} * \hat{S}_1) - 1 \}$$

\bar{C} : average concentration of the districts

\hat{S}_1 : smoothing parameter of the pollutants (close to poisson regression)



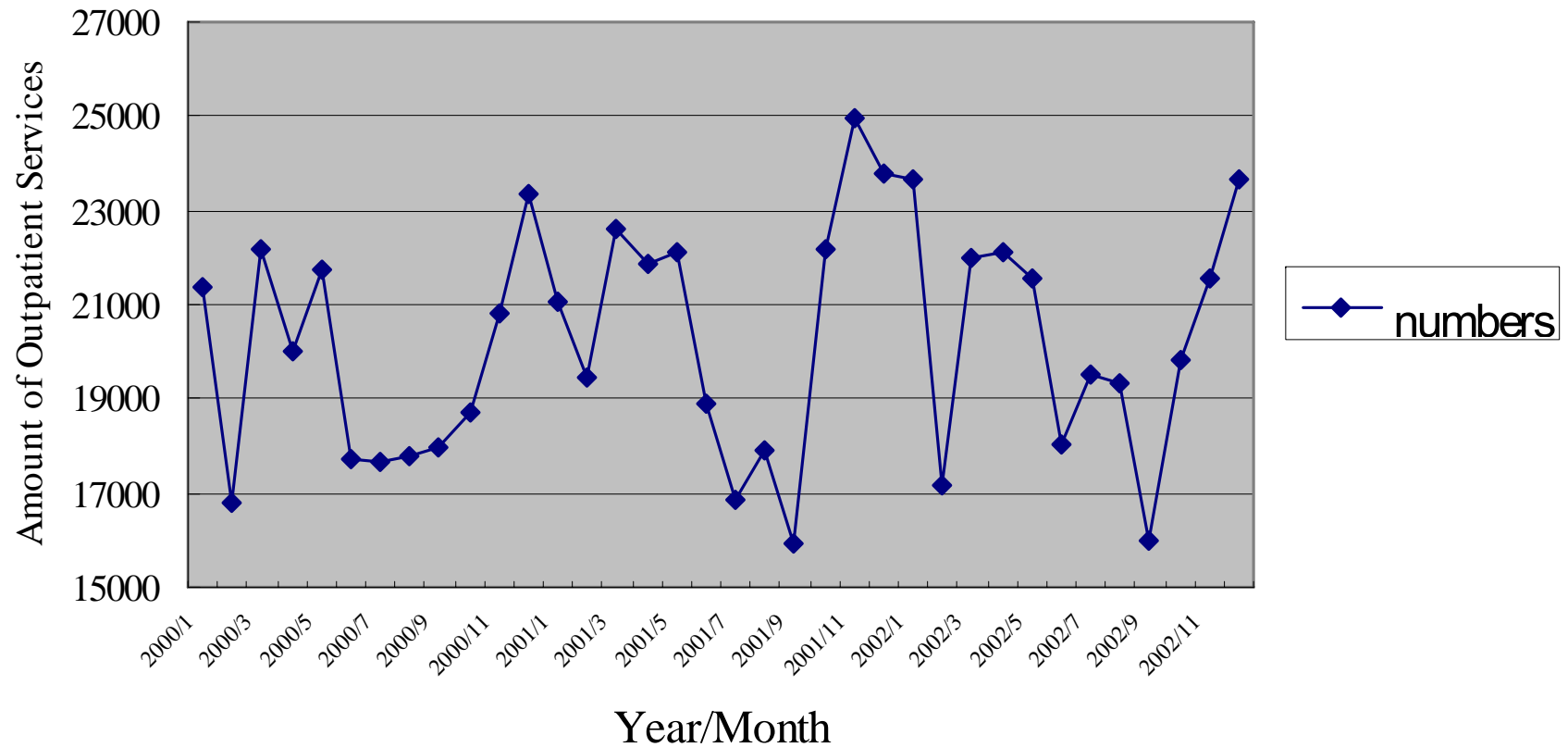
Result

Ta-Chien Chan, Taiwan



Result- Temporal Pattern 1

Asthma's Outpatient Services in Taipei City (2000~2002)

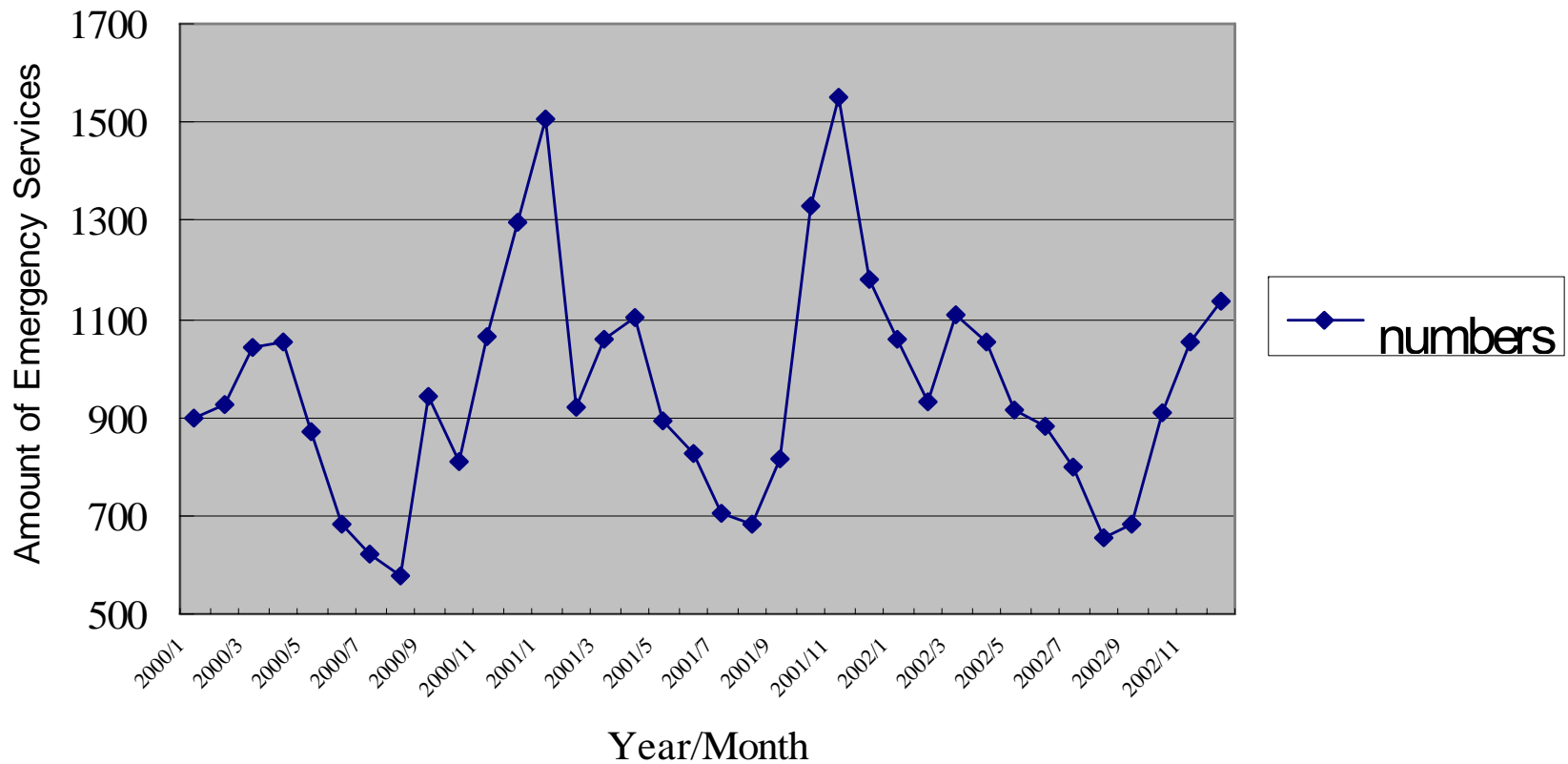


Ta-Chien Chan, Taiwan



Result- Temporal Pattern 2

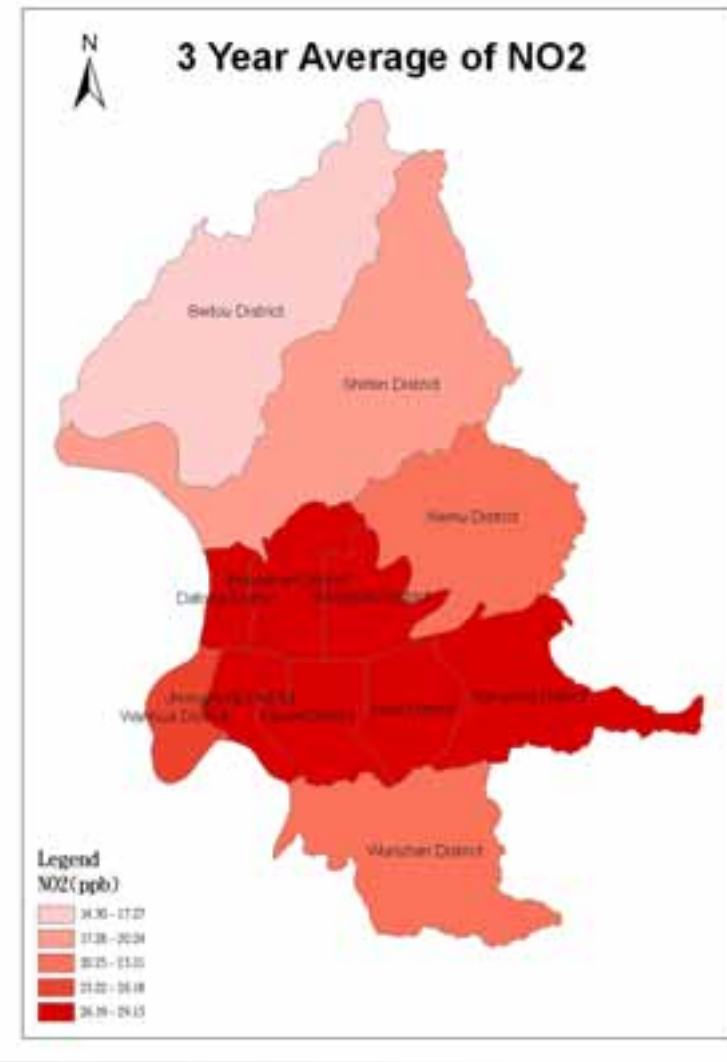
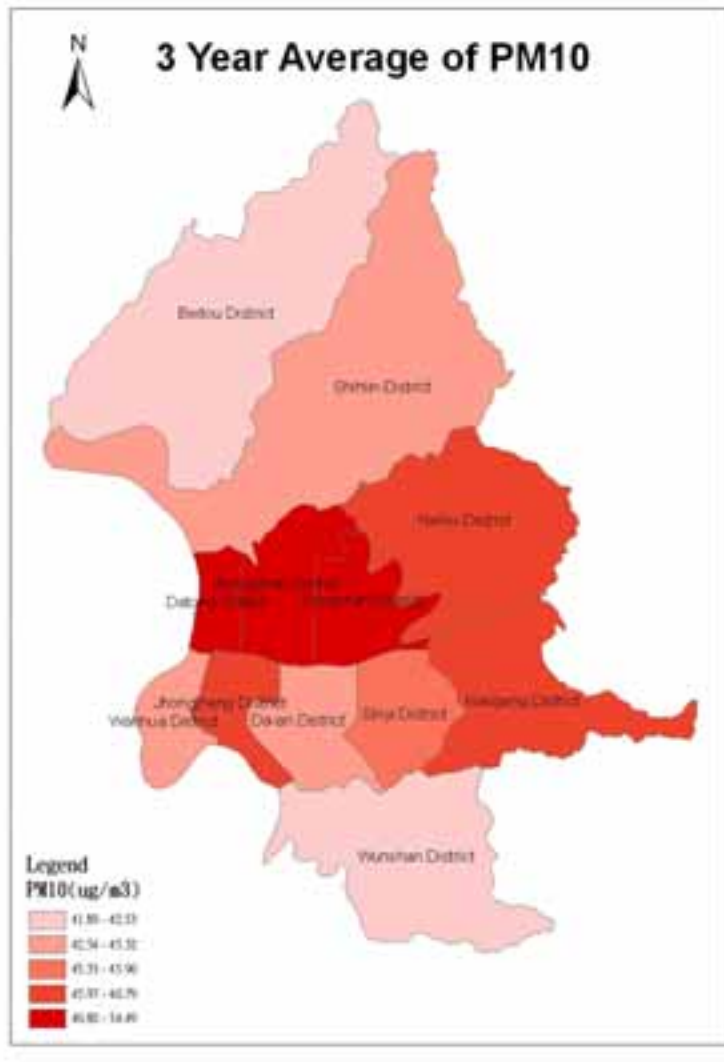
Asthma's Emergency Services in Taipei City (2000~2002)



Ta-Chien Chan, Taiwan



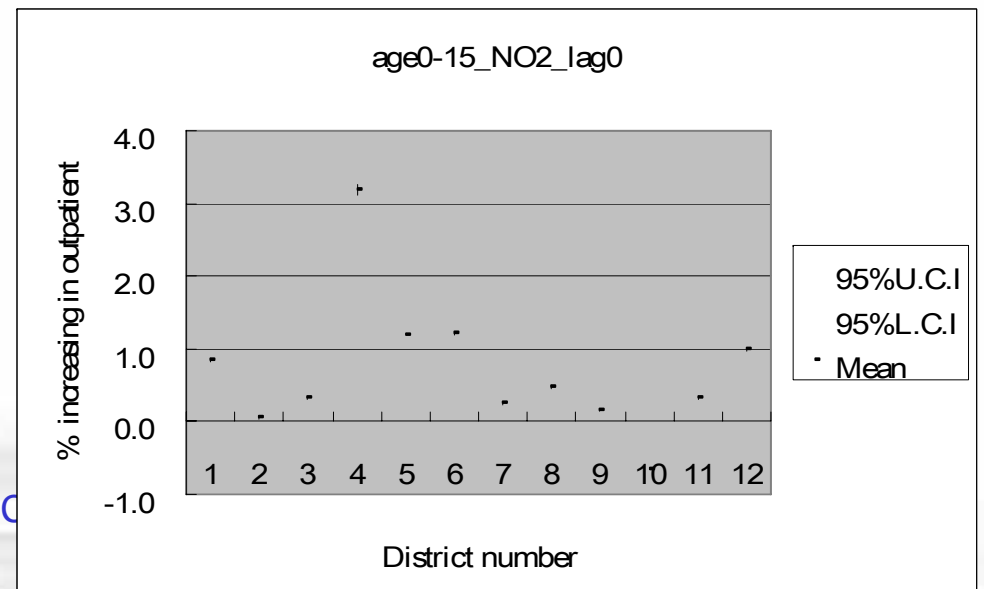
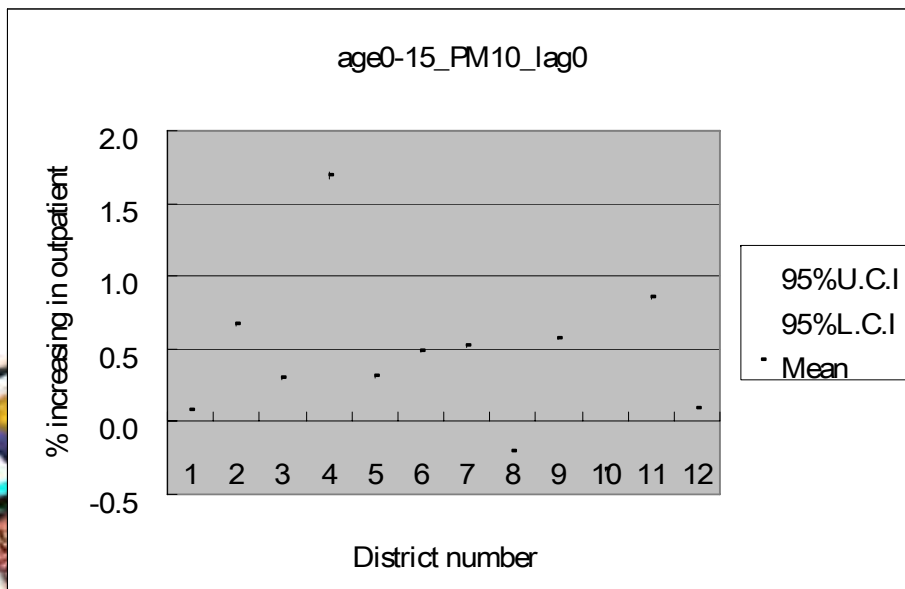
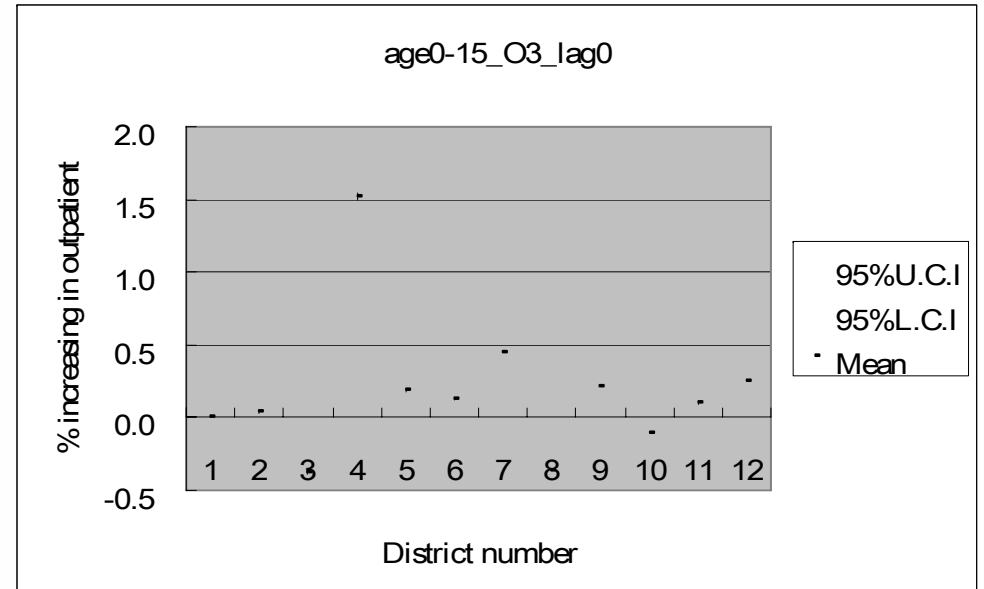
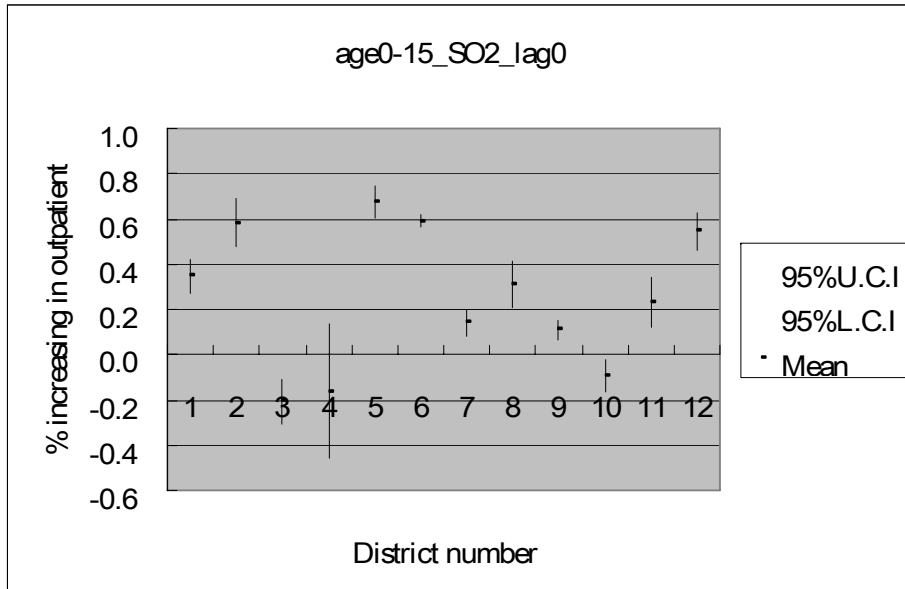
Pollution's Distribution (3 years' average)



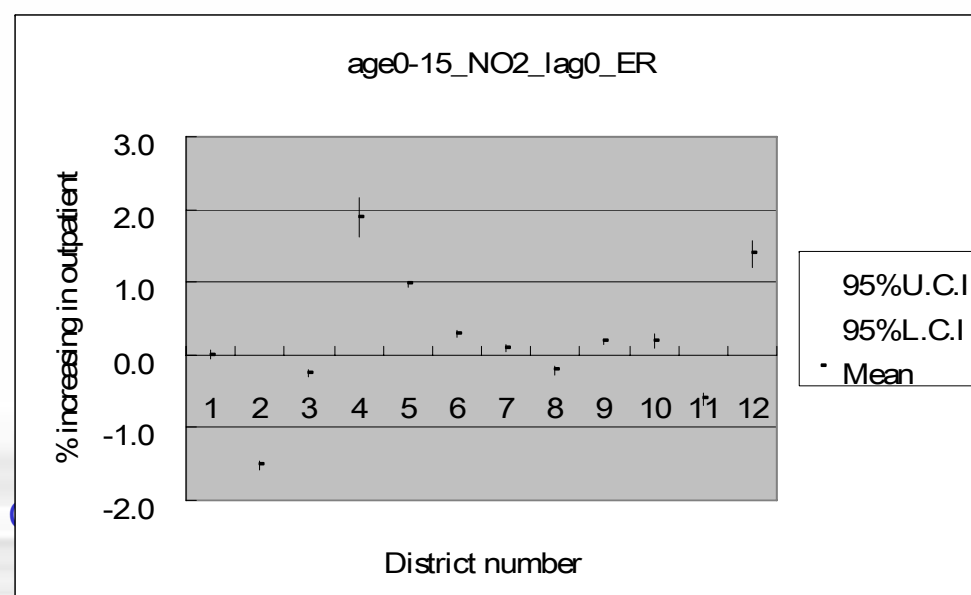
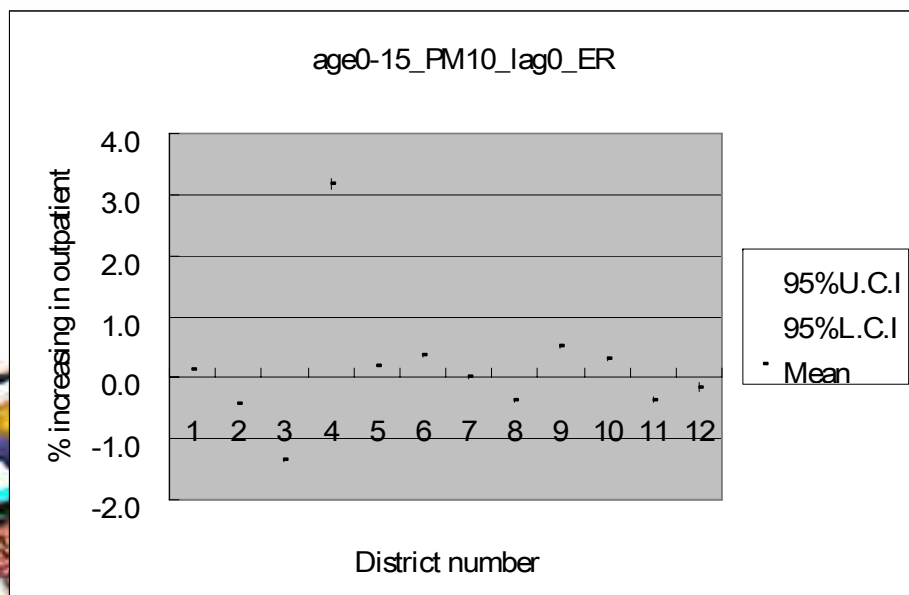
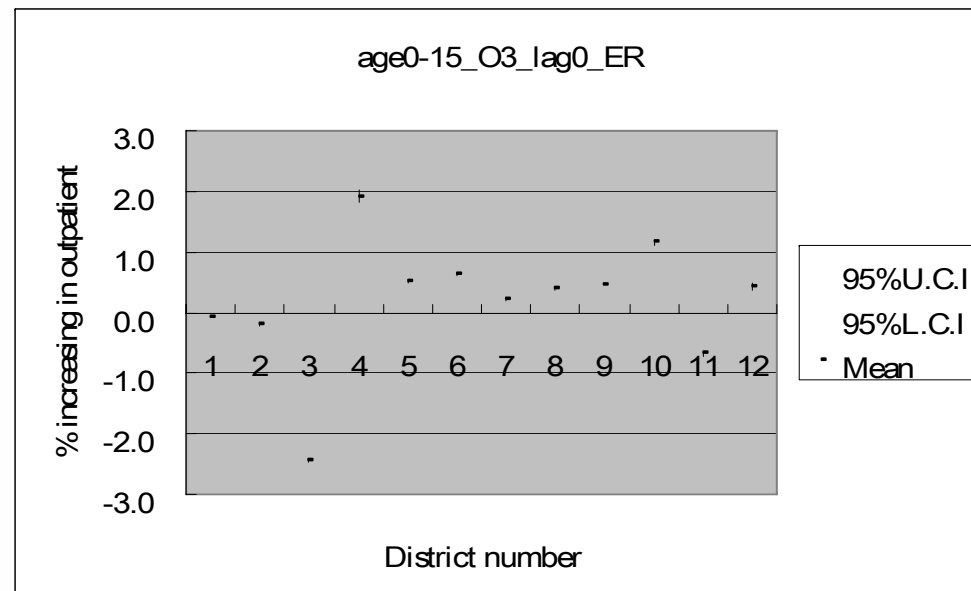
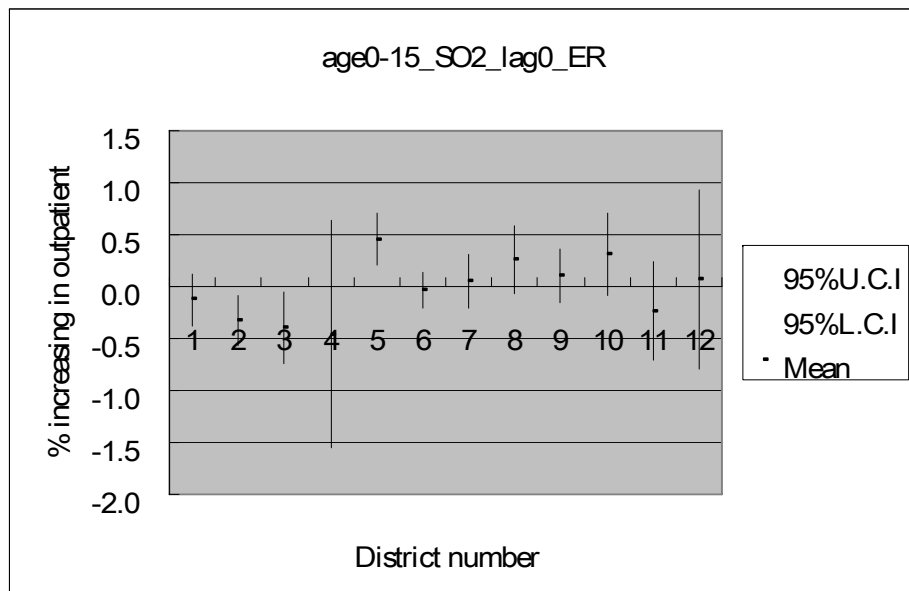
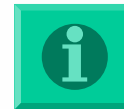
Ta-Chien Chan, Taiwan



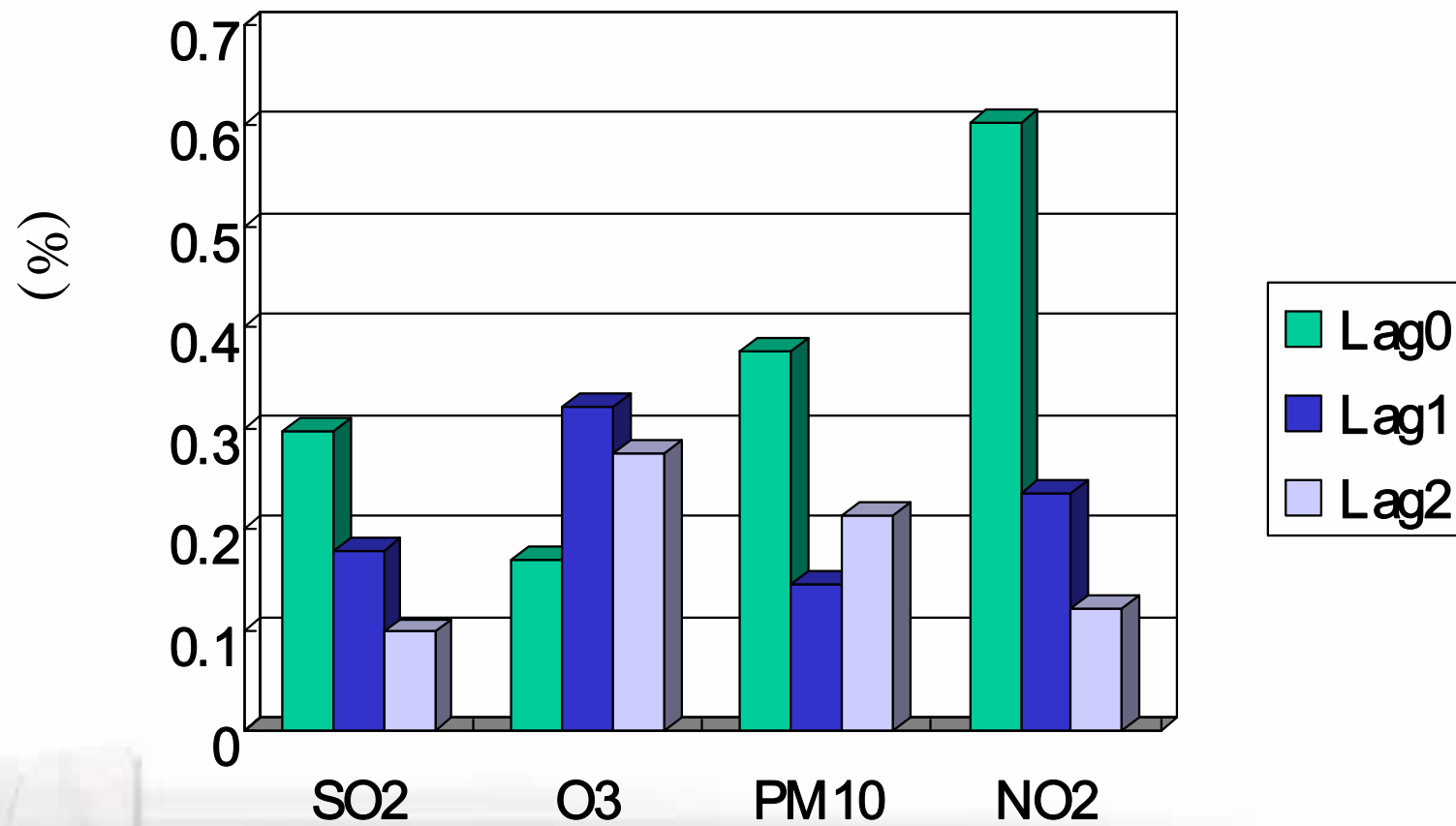
Four pollutants' effect (Outpatient, Age 0-15, lag0)



Four pollutants' effect (ER , Age 0-15, lag0)



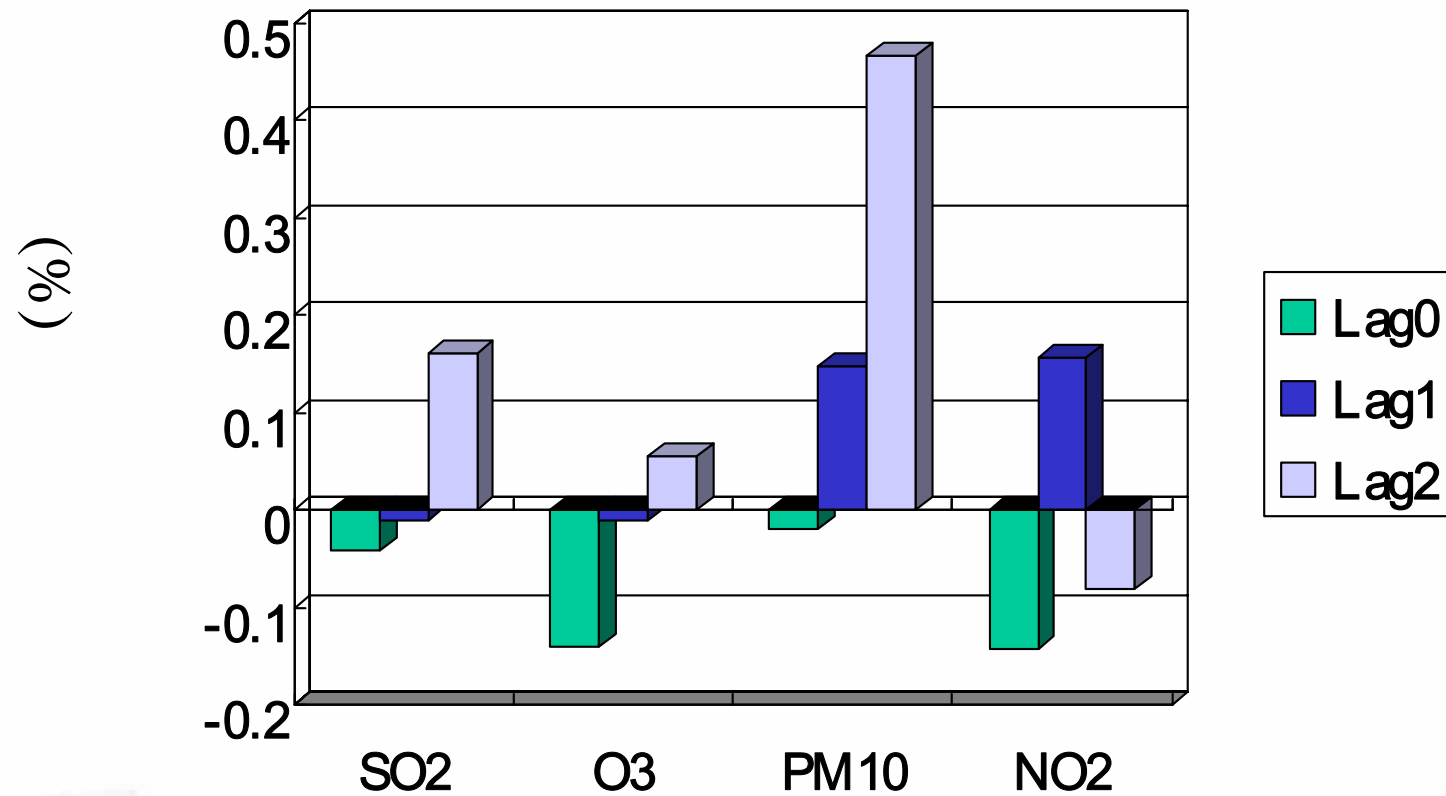
Pooled Estimation of Outpatient in Taipei City



Ta-Chien Chan, Taiwan



Pooled Estimation of ER in Taipei City



Ta-Chien Chan, Taiwan



Discussion & Conclusion

Ta-Chien Chan, Taiwan



Discussion

- Temporal Pattern
- Spatial Patten
- Air pollutants' impact on asthma
- Others' research
- How GIS work in this research
- Limitation



Conclusion

- Under short-term exposure of air pollution, it will have **positive influence** on asthma's Outpatient and ER admission rate.
- Air pollution's influence on outpatient admission is **decreasing** while the increase of lag time was measured.
- Air pollution's influence on emergency admission is **increasing** while the increase of lag time was measured.



Thanks for your attention

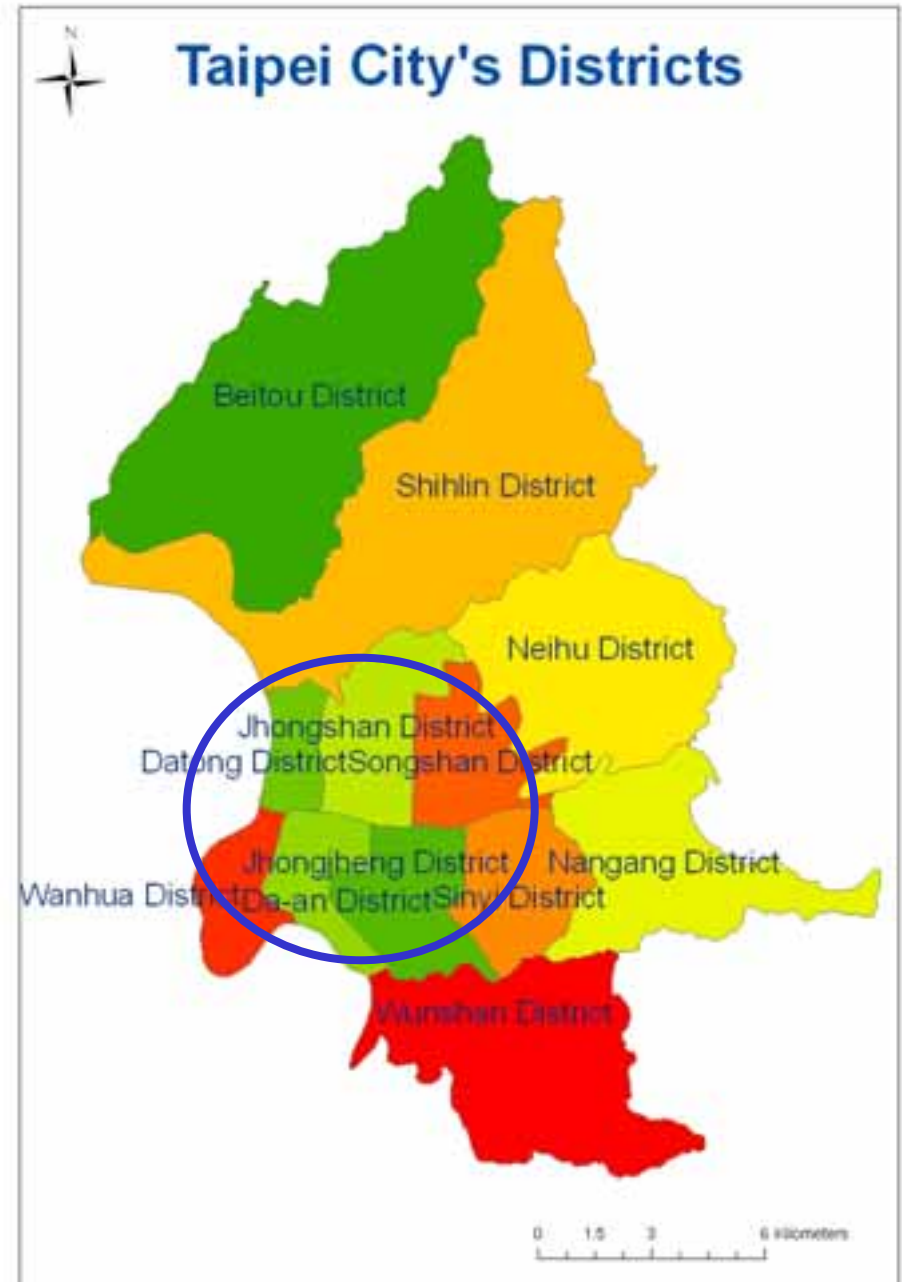
GIS Lab in NHRI



Ta-Chien Chan, Taiwan



District Number	District Name
1	Jhongjheng District
2	Nangang District
3	Shihlin District
4	Datong District
5	Da-an District
6	Jhongshan District
7	Neihu District
8	Wunshan District
9	Beitou District
10	Songshan District
11	Sinyi District
12	Wanhua District



Ta-Chien Chan, Taiwan

