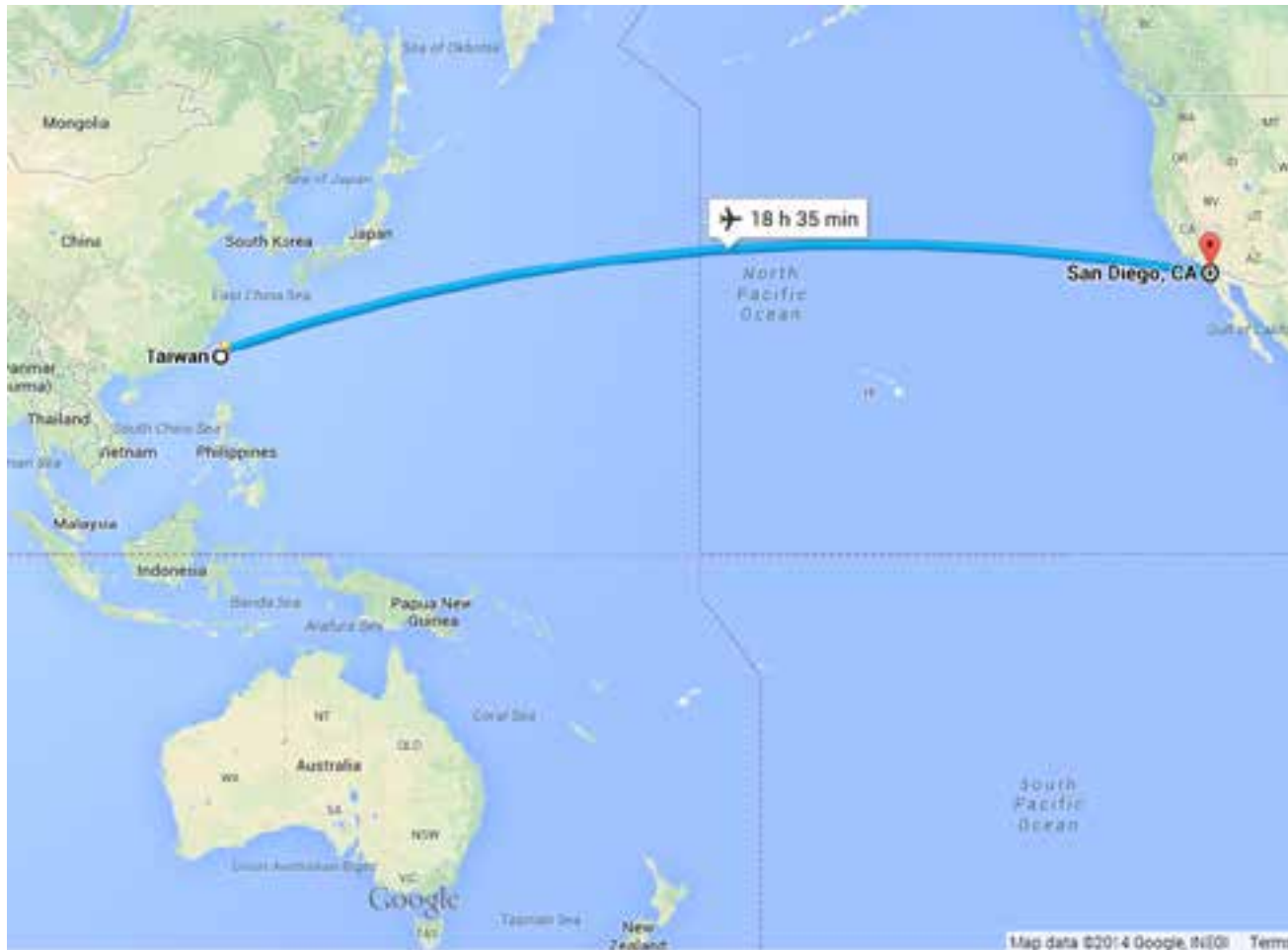


*Geographical differences in prevalences
and mortality rates of COPD*

Ta-Chien Chan (Ph.D.)

Where is Taiwan ?

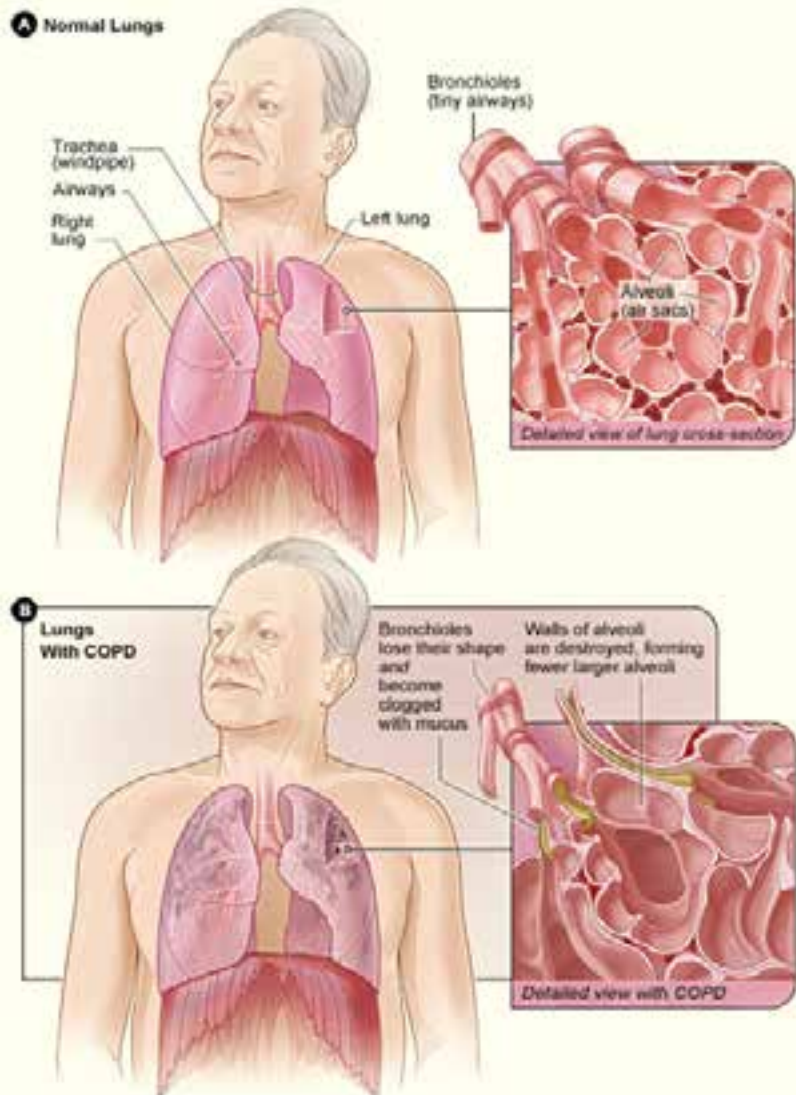


San Diego is Taiwan's neighbor on the map.
In reality, it takes 18 hours to arrive...

Outline

- Brief introduction of COPD
- What are our research questions?
- Materials and Methods
- Results
- Discussion and Suggestion

Brief introduction of COPD



- Chronic obstructive pulmonary disease (COPD) is a progressive disease that makes it hard to breathe.
- COPD can cause coughing that produces large amounts of mucus (a slimy substance), wheezing, shortness of breath, chest tightness, and other symptoms.

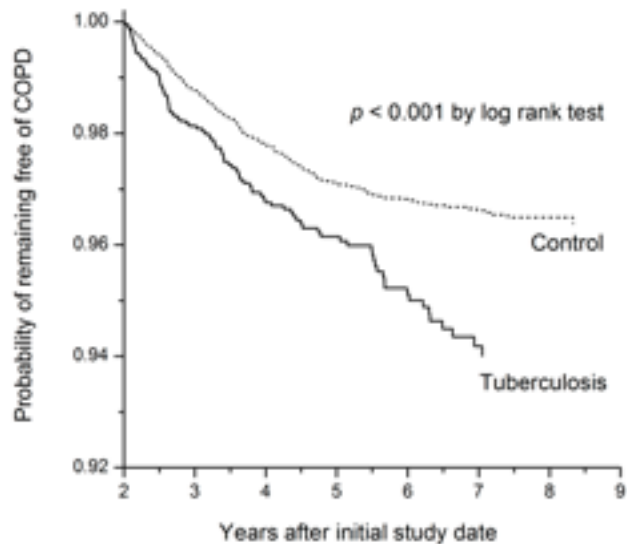
Disease Burden of COPD

- World:
 - According to WHO estimates, 65 million people have moderate to severe chronic obstructive pulmonary disease (COPD).
 - More than 3 million people died of COPD in 2005, which corresponds to 5% of all deaths globally.
 - In 2002 COPD was the fifth leading cause of death.
 - Estimates show that COPD becomes in 2030 the third leading cause of death worldwide.
- Taiwan:
 - Prevalence in 2011: 16.2/100,000 persons
 - 7th leading cause of deaths

Possible Risk Factors

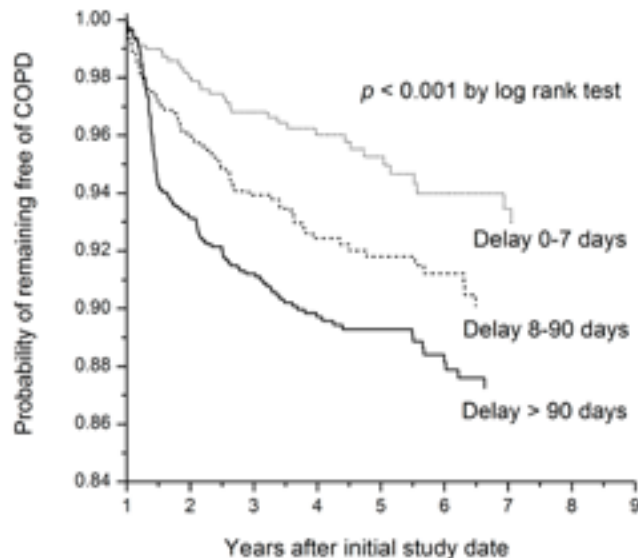
- **Smoking**
- Occupational exposure
- Air pollution
- Elderly
- Gender
- SES
- **TB**
- Altitude

Delayed TB treatment is a risk factor for COPD



	p value	Hazard ratio (95% CI)
Age	<0.001	1.047 (1.043–1.052)
Male	<0.001	2.001 (1.687–2.373)
Tuberculosis	<0.001	2.054 (1.768–2.387)
Diabetes mellitus	0.003	0.730 (0.591–0.902)
Low income	0.048	1.549 (1.004–2.390)

doi:10.1371/journal.pone.0037978.t002



	p value	Hazard ratio (95% CI)
Age	<0.001	1.036 (1.028–1.044)
Male	<0.001	1.812 (1.333–2.462)
Diabetes mellitus	0.003	0.587 (0.411–0.838)
Delay in anti-TB treatment (days)	<0.001	1.005 (1.003–1.007)

doi:10.1371/journal.pone.0037978.t005

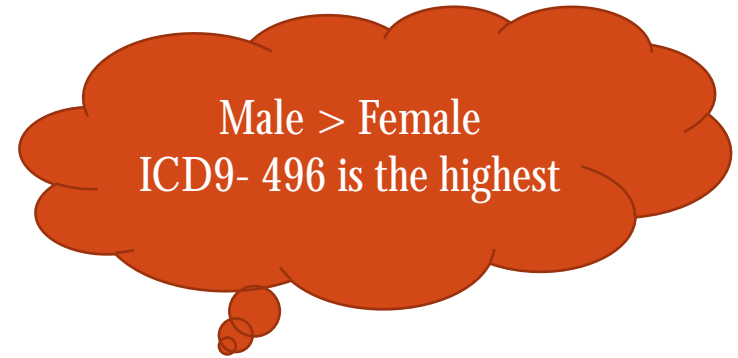
Citation: Lee C-H, Lee M-C, Lin H-H, Shu C-C, Wang J-Y, et al. (2012) PLoS ONE 7(5): e37978.

What are our research questions?

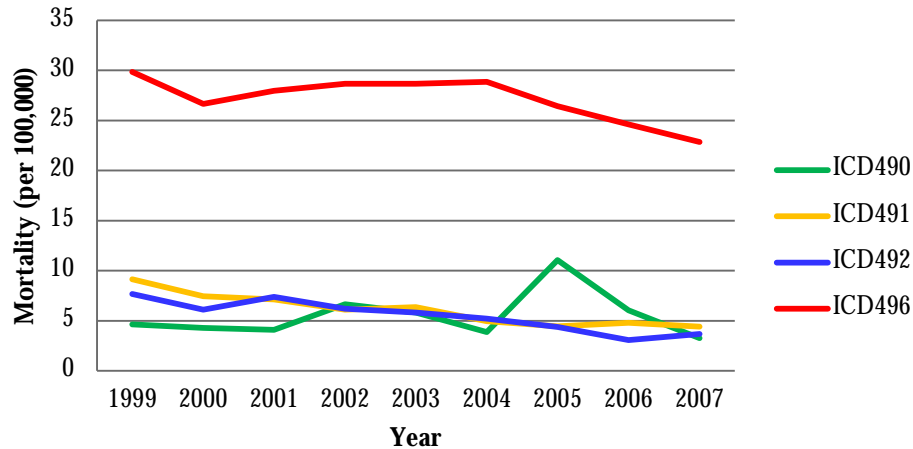
- Are there any COPD clusters in Taiwan ?
- What are the possible risk factors for causing the clusters ?
- What is the spatial distribution of the prevalence ?

Disease Definition

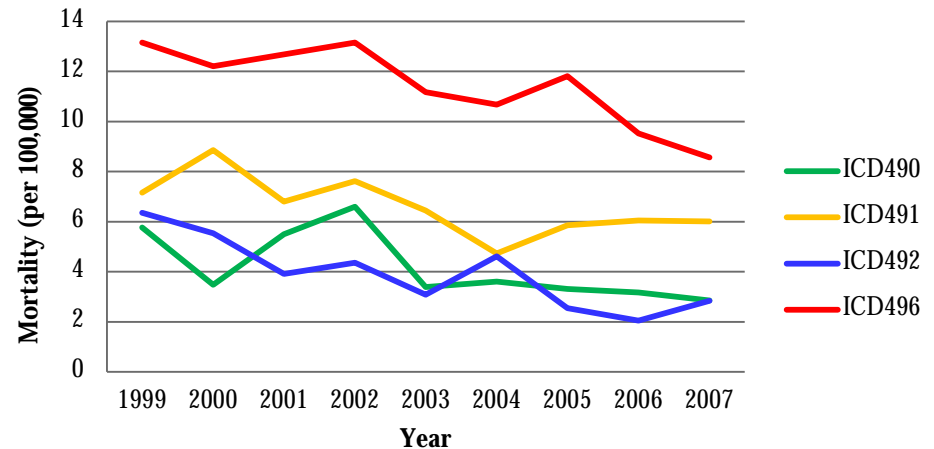
- ICD 9:
 - Bronchitis(490,491)
 - Emphysema(492)
 - Chronic airway obstruction, not elsewhere classified (496)



Male Crude Mortality



Female Crude Mortality



Materials

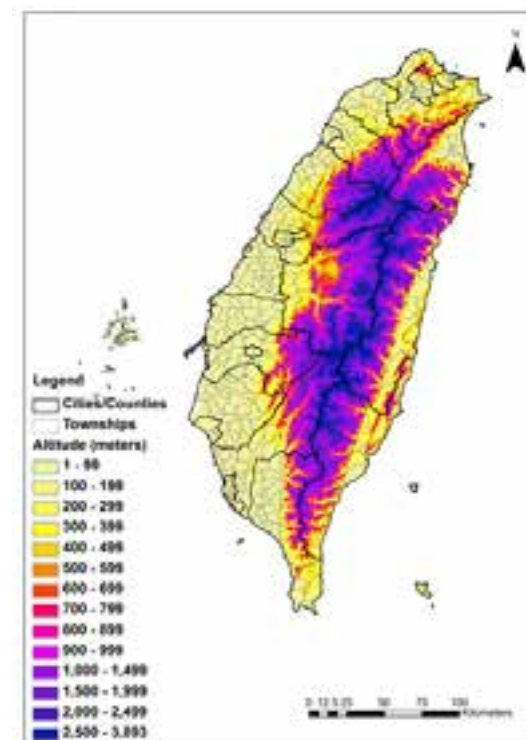
- Materials
 - Age-adjusted Mortality Rates
 - Sources: Causes of Deaths Database
 - Time period: 1999-2007
 - By Township
 - By Gender
 - Reference population: 2000 Taiwan Population
 - Smoking Rates
 - Sources: 2001 NHIS
 - Time Period: 2001
 - By **City/County**
 - By Gender

Materials – cont.

- Materials
 - Air pollution
 - Source: EPA Database
 - Time: 1994-1999
 - PM10, SO2, NO2, CO
 - Estimation by township
 - Prevalence rate
 - Source: National Health Insurance Database
 - Time Period: 2000-2007
 - By township
 - By gender
 - Area Deprivation Index (ADI)
 - Source: 2000 Population and Housing Census
 - Time: 2000
 - By township
 - ADI= Standardized (Proportion of Elementary Occupations)+Standardized (students aged 15~17 drop-out rate from schooling)

Materials – cont.

- TB Mortality Rate (Proxy of TB exposure)
 - Sources: Causes of Deaths Database
 - Time period: 1999-2007
 - By Township
 - By Gender
 - Reference population: 2000 Taiwan Population
- Aborigines percentage
 - Source: 2000 Population and Housing Census
 - Time: 2000
 - By township
 - Number of aborigines/township population
- Density of health care facilities
- Altitude
 - ASTER GDEM website

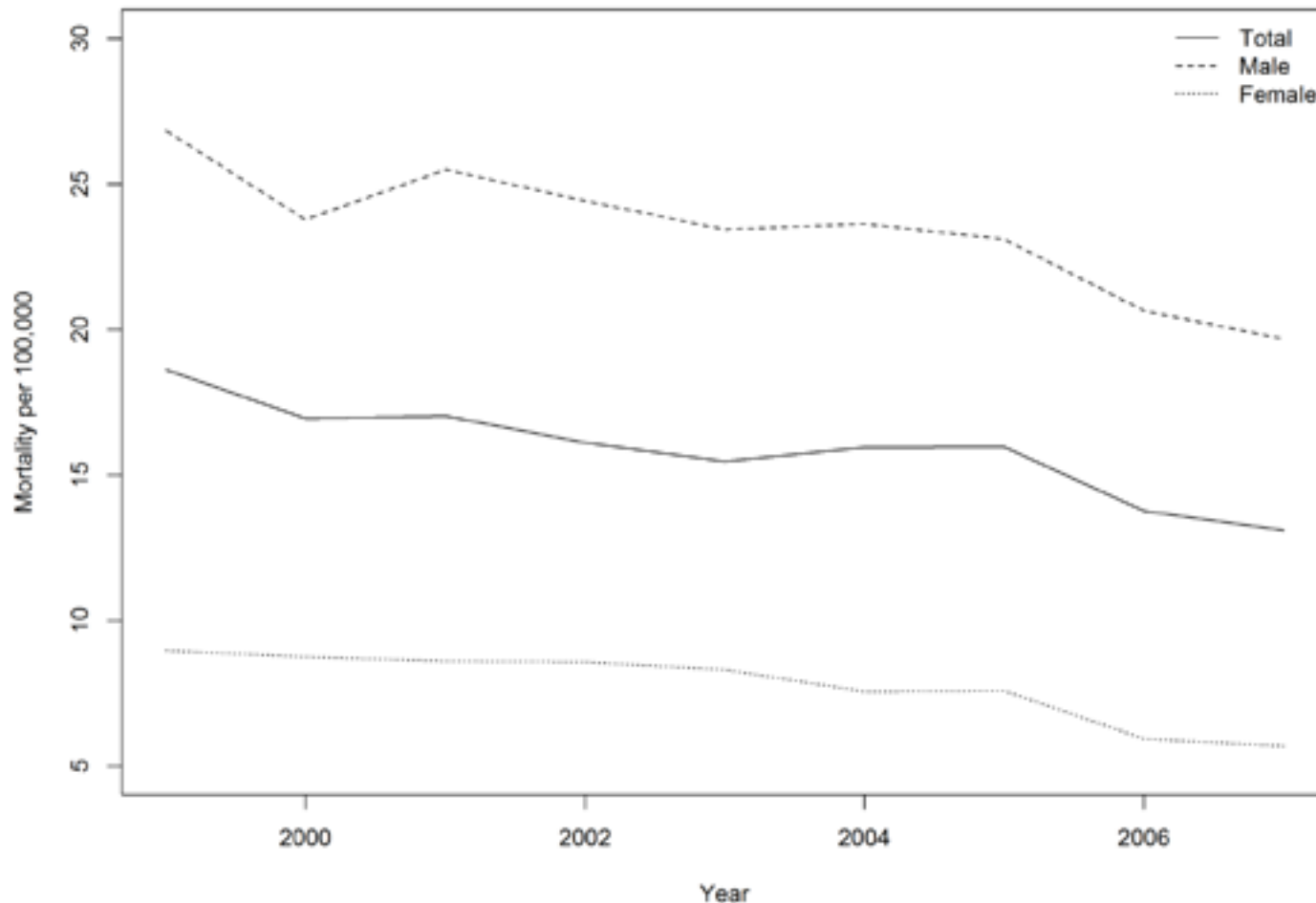


Methods

- SaTScan
 - Spatio-temporal Scan Statistics
 - Identify the COPD Mortality Clusters
- ArcGIS
 - Geographically Weight Regression (GWR) and linear regression for statistical modeling
 - Empirical Bayes Kriging for interpolation the air pollutants
 - Zonal Statistics to estimate the average **air pollution concentration and altitude** in each township
- SAS
 - Calculate the age-adjusted mortality rates, prevalence, area deprivation index, aborigines

Results

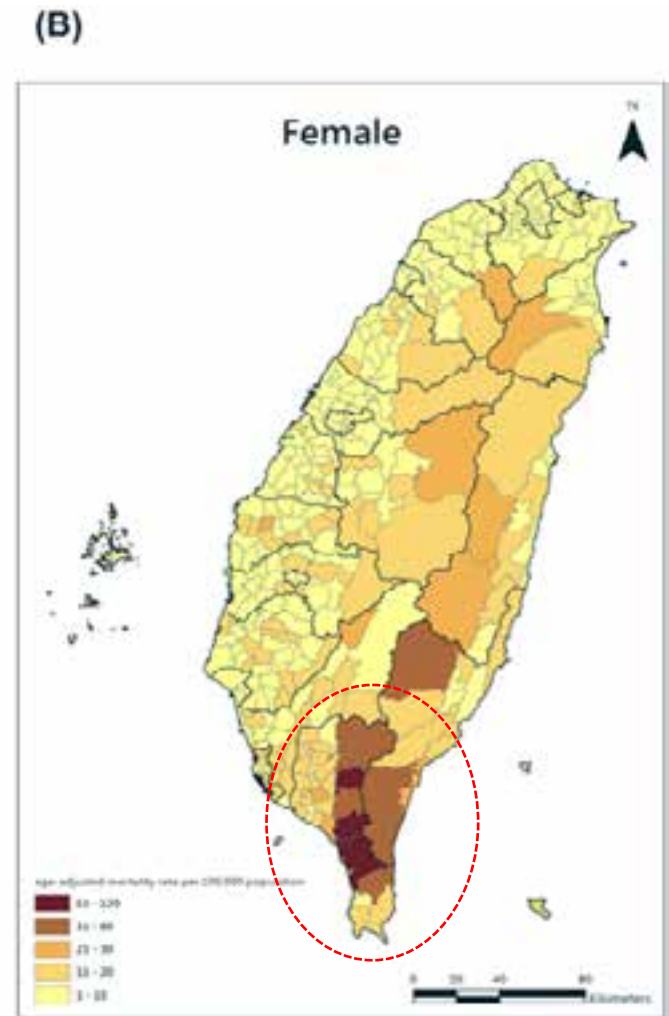
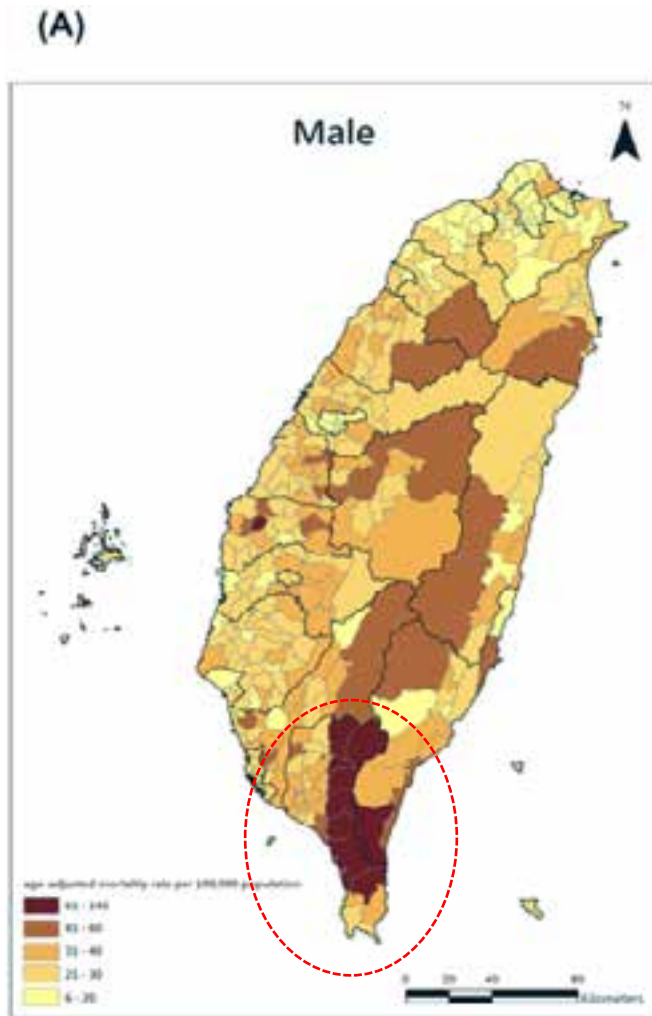
Temporal trend of age-adjusted mortality of chronic obstructive pulmonary disease in Taiwan, 1999–2007.



Chan T-C, Chiang P-H, Su M-D, Wang H-W, et al. (2014) Geographic Disparity in Chronic Obstructive Pulmonary Disease (COPD) Mortality Rates among the Taiwan Population. PLoS ONE 9(5): e98170. doi:10.1371/journal.pone.0098170

<http://www.plosone.org/article/info:doi/10.1371/journal.pone.0098170>

COPD age-adjusted mortality(1999-2007)



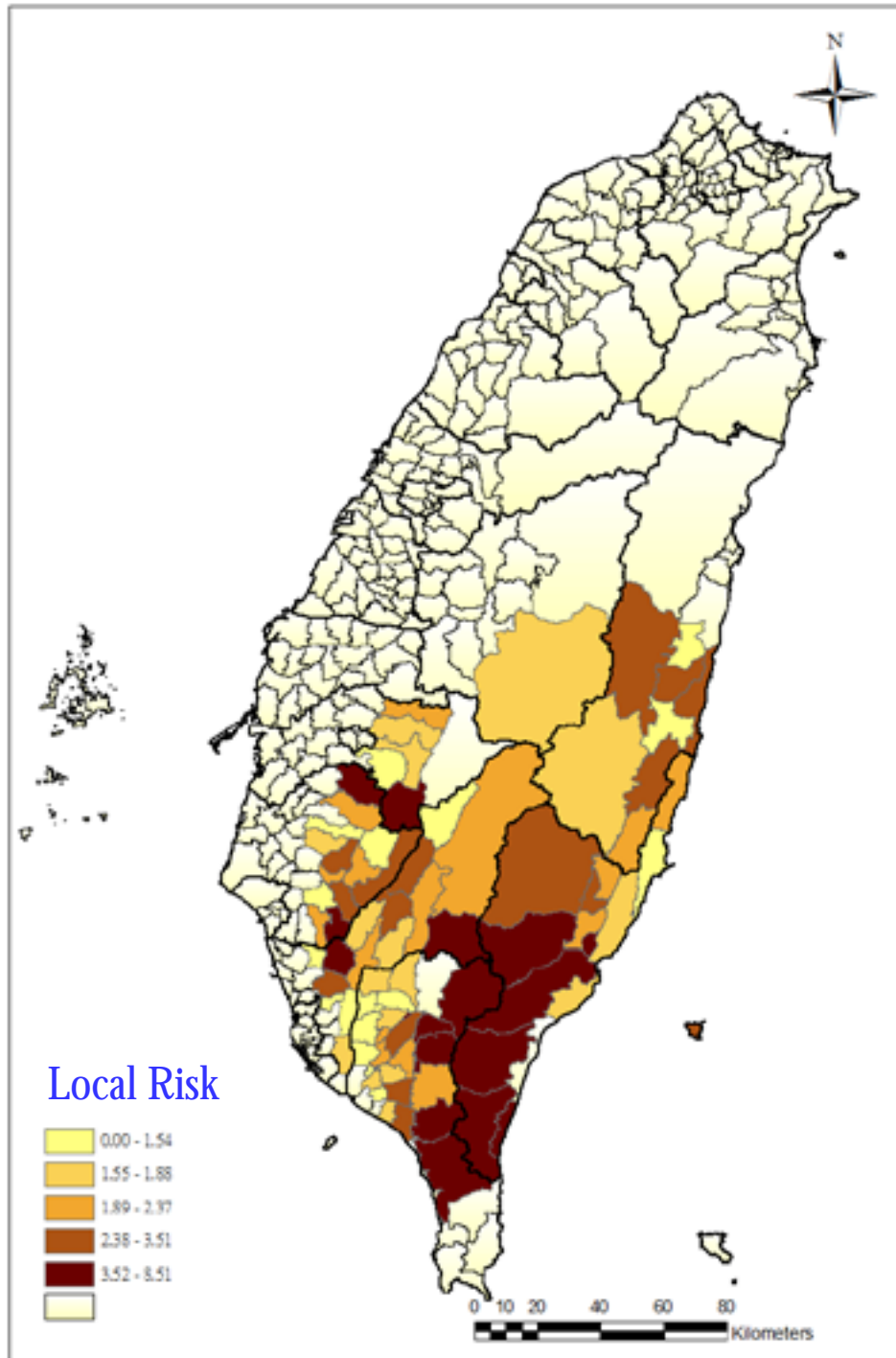
Chan T-C, Chiang P-H, Su M-D, Wang H-W, et al. (2014) Geographic Disparity in Chronic Obstructive Pulmonary Disease (COPD) Mortality Rates among the Taiwan Population. PLoS ONE 9(5): e98170. doi:10.1371/journal.pone.0098170

<http://www.plosone.org/article/info:doi/10.1371/journal.pone.0098170>

COPD Mortality Risk (M) w

Most likely S-T Clusters:

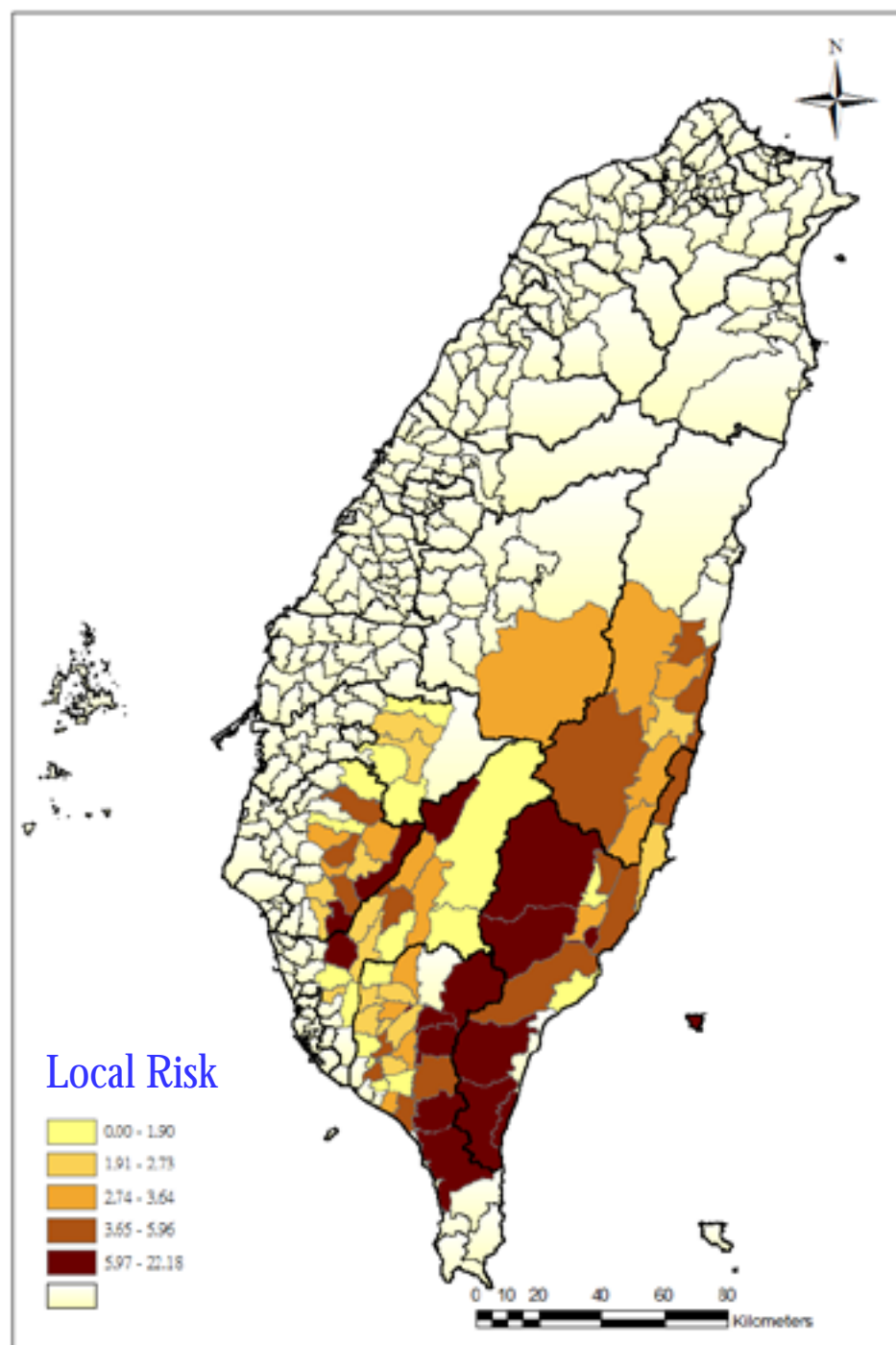
1. Spatial w 79 Townships
2. Temporal w 2004-2007



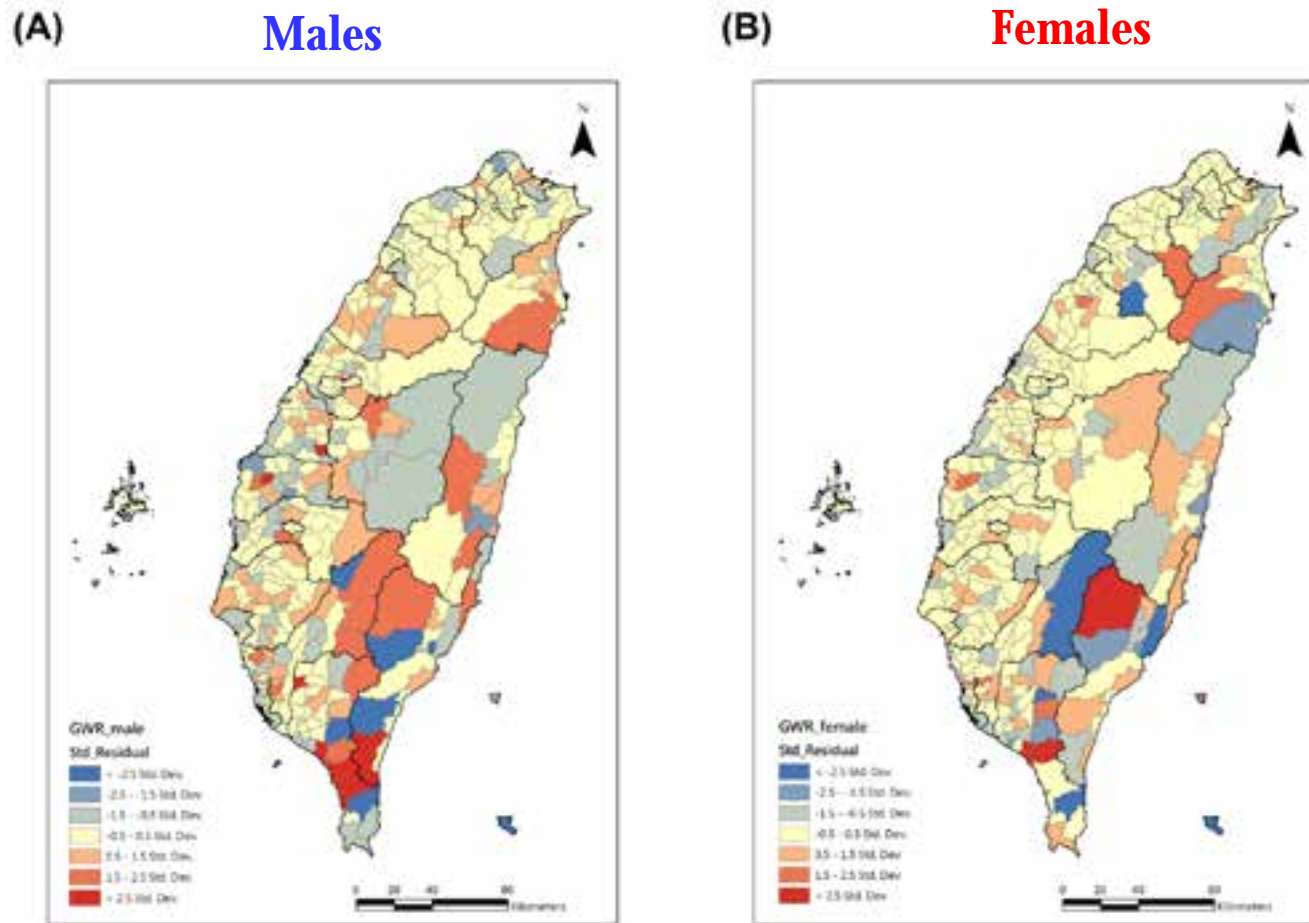
COPD Mortality Risk (F) w

Most likely S-T Clusters:

1. Spatial w 77 Townships
2. Temporal w 2002-2005

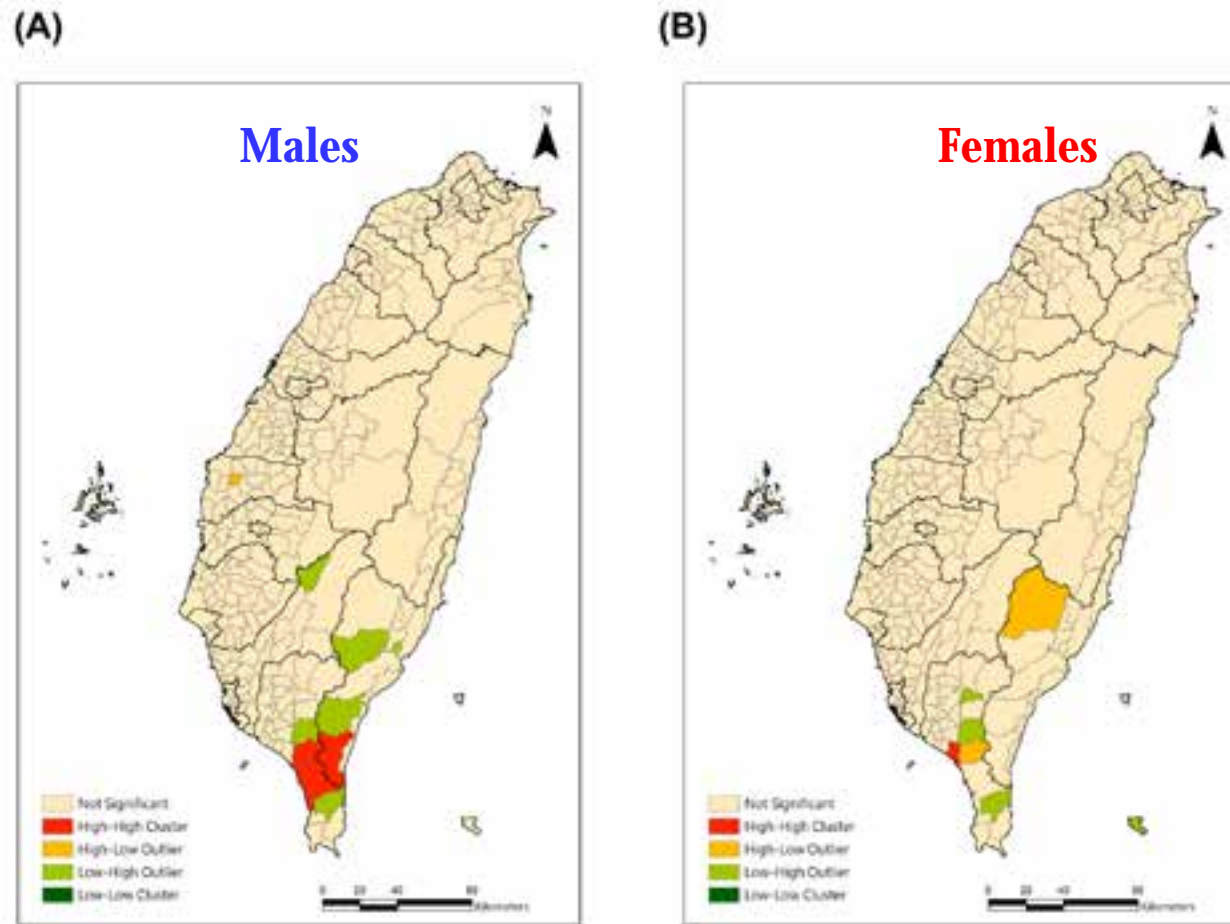


The residual map after GWR



Chan T-C, Chiang P-H, Su M-D, Wang H-W, et al. (2014) Geographic Disparity in Chronic Obstructive Pulmonary Disease (COPD) Mortality Rates among the Taiwan Population. PLoS ONE 9(5): e98170. doi:10.1371/journal.pone.0098170

Local Moran's I of residual map



Global Moran's I was not significant and close to zero.

Chan T-C, Chiang P-H, Su M-D, Wang H-W, et al. (2014) Geographic Disparity in Chronic Obstructive Pulmonary Disease (COPD) Mortality Rates among the Taiwan Population. PLoS ONE 9(5): e98170. doi:10.1371/journal.pone.0098170

<http://www.plosone.org/article/info:doi/10.1371/journal.pone.0098170>

R-square improvement OLS à GWR

Males

49.4% à
72.2%

Females

60.9% à
77.9%

Coefficients (GWR)– Males

Variables	N	1 st Quartile	Median	3 rd Quartile	Robust STD.
Male Smoking	358	-0.512	1.428	2.618	2.320
Area Deprivation Index	358	-0.284	1.288	3.646	2.914
Male Tuberculosis Mortality	358	-1.540	0.195	6.533	5.984
Percentage of Male Aborigines	358	-4.955	2.322	8.017	9.616
Density of Health Care Facilities	358	-2.532	-1.908	-1.128	1.041
CO	358	-0.241	1.952	11.762	8.898
NO2	358	-1.514	1.581	5.041	4.859
SO2	358	-4.956	-0.209	2.117	5.243
PM10	358	-1.327	2.684	5.665	5.183
Altitude	358	-2.276	0.281	2.177	3.301

Chan T-C, Chiang P-H, Su M-D, Wang H-W, et al. (2014) Geographic Disparity in Chronic Obstructive Pulmonary Disease (COPD) Mortality Rates among the Taiwan Population. PLoS ONE 9(5): e98170. doi:10.1371/journal.pone.0098170

<http://www.plosone.org/article/info:doi/10.1371/journal.pone.0098170>

Coefficients (GWR)– Females

Variables	N	1 st Quartile	Median	3 rd Quartile	Robust STD.
Female Smoking	358	-1.748	0.152	1.252	2.224
Area Deprivation Index	358	-2.833	-1.351	0.232	2.272
Female Tuberculosis Mortality	358	-2.686	-1.374	-0.344	1.736
Percentage of Female Aborigines	358	3.584	5.656	12.191	6.380
Density of Health Care Facilities	358	-0.516	-0.287	-0.169	0.257
CO	358	-3.633	-0.492	1.607	3.884
NO ₂	358	-2.784	-1.014	0.165	2.186
SO ₂	358	-0.988	0.014	1.731	2.015
PM ₁₀	358	1.119	2.385	3.920	2.077
Altitude	358	-1.889	0.834	1.608	2.593

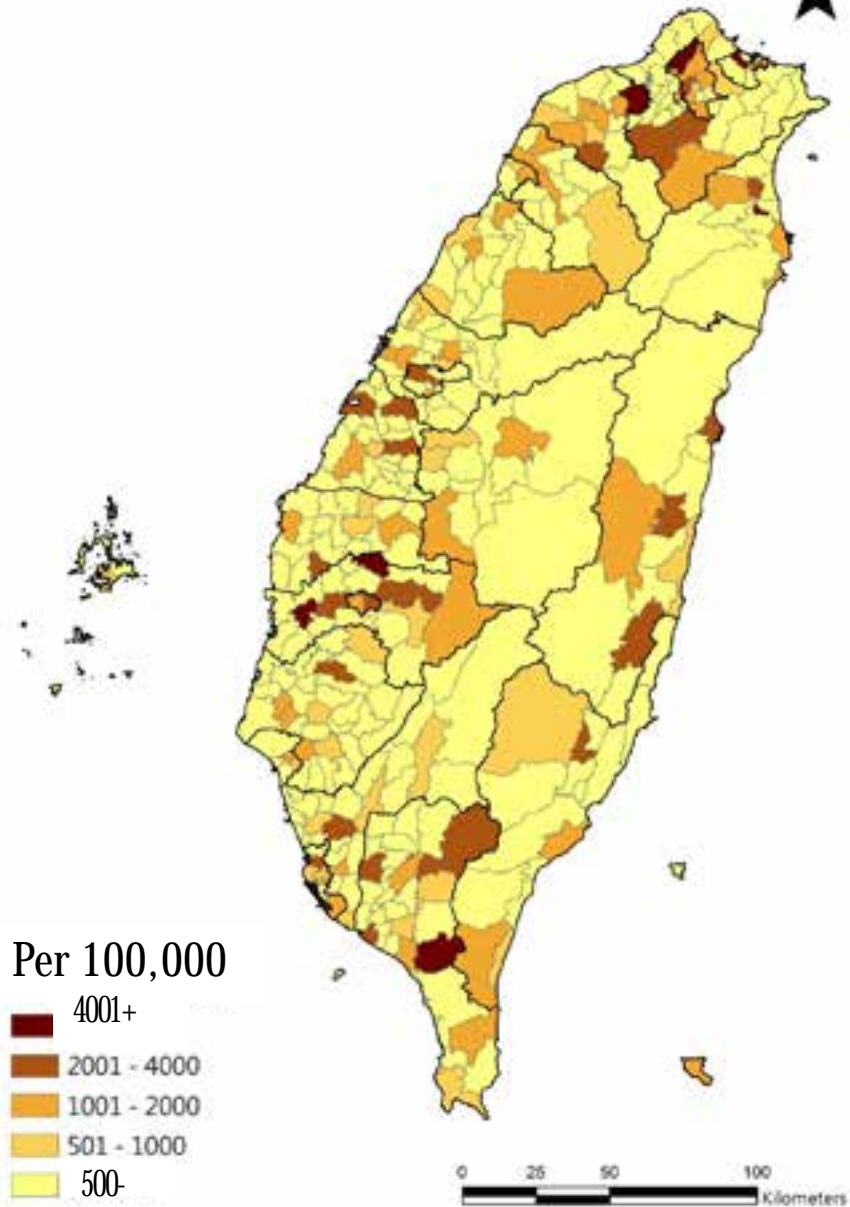
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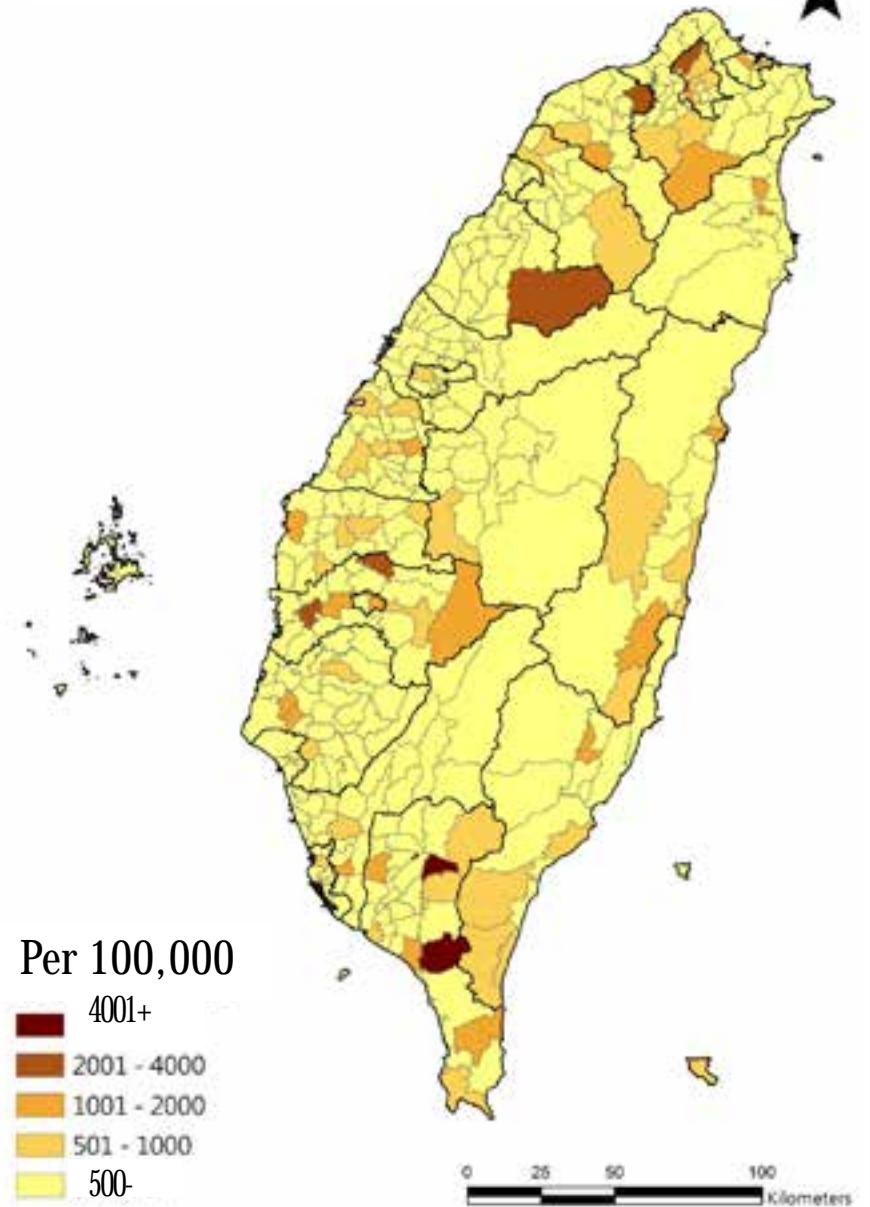
Consistent variables

- Smoking
- Aborigines
- PM10
- Altitude

2007 Male COPD prevalence rate



2007 Female COPD prevalence rate



Discussion and Suggestion

- **Major research Questions:**
- Are there any COPD clusters in Taiwan ?
- What are the possible risk factors for causing the clusters ?

Discussion and Suggestion

- Use **GIS techniques** to demonstrate correlations between spatial and temporal effect with some health and social parameters
- Identify the mortality clusters with Space-Time Poisson Scan Statistics
- Spatial regression can explain the spatial distribution of the disease and improve the model's power
- Smoking, air pollution and aborigines are the major explanatory factors of COPD in ecological study
- Altitude's effect can not be concluded here because most townships (316/358, 88.3%) are located at altitudes less than 500 m
- Prevalence will be biased by the health care facilities
- There are still some limitations of this study:
 - Unknown risk factors of COPD, such as burning biofuels in the house
 - Smoking rate by township is still under estimated
- **The epidemiological investigation is currently ongoing on those high risk areas.**

Thank you for your attention

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Geographic Disparity in Chronic Obstructive Pulmonary Disease (COPD) Mortality Rates among the Taiwan Population

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[Details in the published papers \(May 2014\)](#)