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Explore the Effect of Urban Flood with the Integration of Spatial Analysis Technique

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National Cheng Kung University

Presenter: Chang Hsueh-Sheng

Department of Urban Planning, National Cheng Kung University, 70101 Tainan, Taiwan.

Planning failure or Adjustment failure?

Tainan, Taiwan, in the floods of Auguster 2009
(source: http://www.flickr.com/photos/kyo4890x115/3807860280/)

Outline

- Introduction
- Methodology
- Research Design
- Analysis and Result
- Conclusion

Introduction

- In 2005, the World Bank issued "Natural Disaster Hotspots" – A Global Risk Analysis, which indicted that Taiwan may be the place on Earth most vulnerable to natural hazards, with 73 percent of its land and population exposed to three or more hazards.
  - ✓ Typhoon: With the annual average of 3.6 typhoon, the loss is about USD $589 million/year.
  - ✓ Water: Shortage and distribution of water worsen gradually.
  - ✓ Earthquake: Large scale earthquake make the serious impacts.

Land use is possibly the most significant aspect of disaster risk management, hence it is essential to ensure that this is an integrated.

Introduction

- Floods, together with wind related storms, are considered the major natural hazard in Taiwan in terms of risk to people and assets.
- How to analysis flood pattern and increasing urban resilience of protected buildings and critical and assess the expected flood disaster intensity reduction from these measures?

Resource:http://www.google.com.tw/imgres?q=%E5%8F%B0%E7%81%A3%E8%8E%AB%E6%8B%89%E5%85%8B%E9%A2%A8%E7%81%BD&um=1&hl=zh-TW&sa=N&rlz=1T4GGHP_zh-TWTW449TW449&tbm=isch&tbnid=5w7R9wCY3KrryM:&imgrefurl=http://yblog.org/archive/index.php/10523&docid=NcWT6We7NQv1nM&imgurl=http://inapcache.boston.com/universal/site_graphics/blogs/bigpicture/morakot_08_10/m24_19953247.jpg&w=990&h=579&ei=3beUT_zH6iImQXpsYz9AQ&zoom=1&biw=1366&bih=529&iact=rc&dur=360&sig=108854361612295

Methodology

■ Definition of flood intensity

- The direct economic loss of damaged bridge collapses, and damage to embankments, transportation infrastructure, and agriculture loss is caused by floods themselves; however, the indirect economic loss is caused by factory shutdowns, railway outages and the discontinuation of cultivation due to the floods (Jonkman, 2005; Feng and Luo, 2010).
- In order to calculate the disaster intensity of flood, it thus uses human deaths and direct economic loss, information about which can be easily acquired and used as characteristic values.

Methodology

■ Definition of flood intensity

- Defining the disaster intensity of a flood involves establishing the flood magnitude and following the two above-mentioned principles(Feng and Luo, 2010). A similar method was applied based on Feng et al. (2010) in the study.

$$FG = a \lg D \times E - b$$

Where:

- FG is the index expressing the flood disaster grade namely disaster intensity (degree)
- D is the human deaths (persons)
- E is direct economic loss
- a and b are undefined parameters.

Methodology

■ Spatial Autocorrelation

- Similar objects in proximity to one another are positively spatially auto correlated, and vice versa, zero autocorrelation occurs when attributes are distributed independently in space.

$$I(d) = \sum_{i} \sum_{1} w_{il} z_i z_l / S_0 m_2$$

Where

$$S_0 = \sum_{i} \sum_{l} w_{il} \quad , \quad m_2 = \sum_{i} z_i^2 / I \qquad z_i = x_i - \bar{x}$$

Where:

•A weight matrix W has elements X_i representing the connections in a set of spatial unit i.

•The X_i may assume any value, but in this paper we shall confine to a binary weight matrix of ones (connected) and zeros (not connected).

•The diagonal elements of W are zero. The variable X is mapped onto the I spatial units. The spatial autocorrelation analysis coefficient, Moran's I, Z_i is the value of equity for each zone. i=1,2…,I.

Methodology

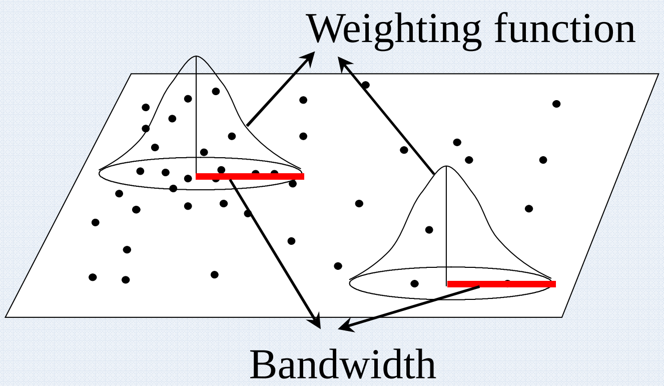
■ Geographically Weighted Regression

- ☐ If the residual has spatial autocorrelation, then GWR can be utilized to modify the OLS regression to solve the problem.
- ☐ If the spatially varied characteristics in flood are taken into account, the equation can be modified as:

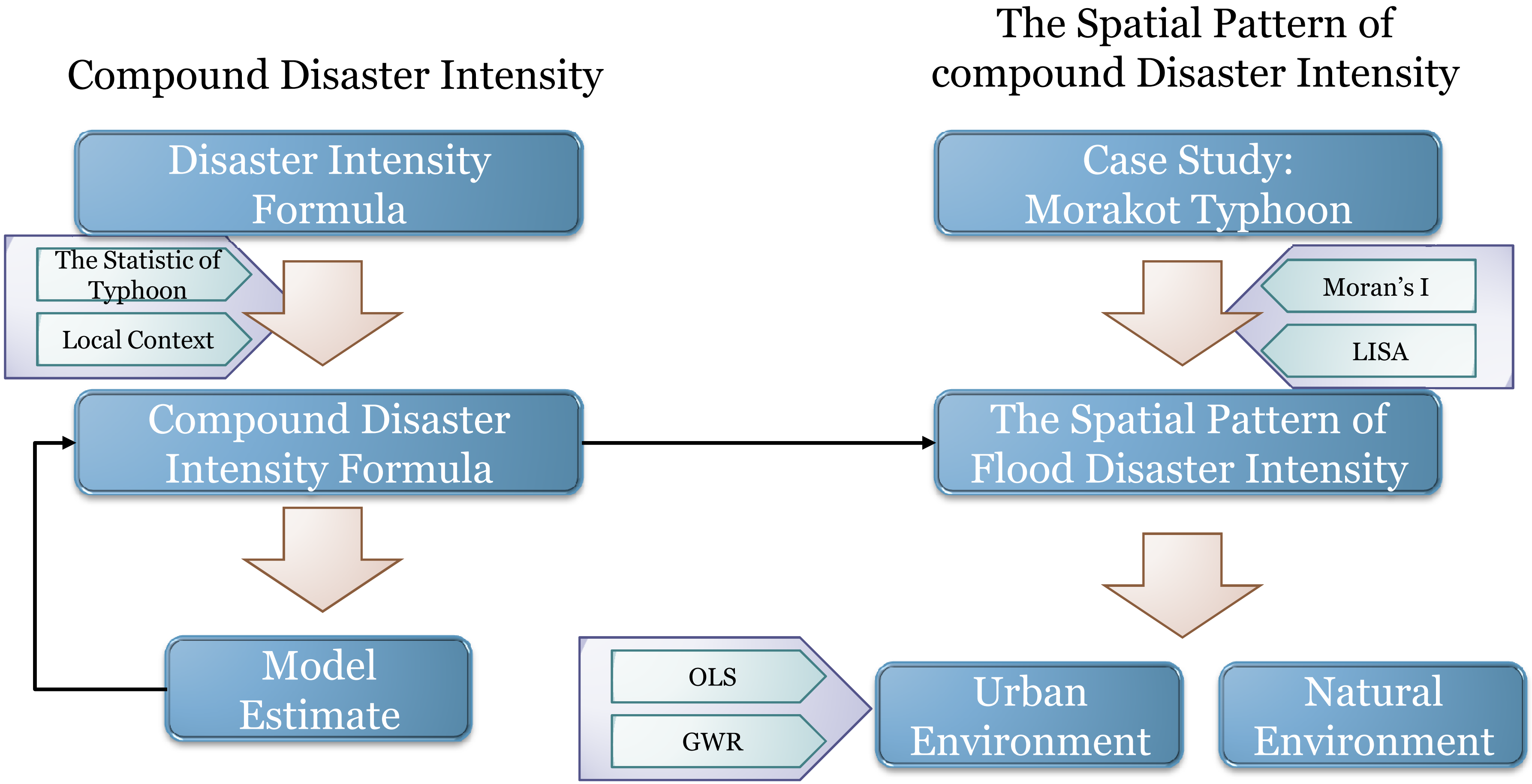
$$y_i = b_0(\mathrm{u}_i, \mathrm{v}_i) + \sum_{k=1}^{n} b_k(u_{i,} v_i) \cdot X_{ik} + \varepsilon_i$$

Where:

- y_i is the flood of point i;
- x_i is the flood shape area of point i;
- $u_i v_i$ is the coordinates if the i point is a space;
- $b_o(u_i v_i)$, $b_k(u_i v_i)$ is the realization of the continuous function at point i;
- ε_1 is the residual of point $(u_i v_i)$



Research Design



Analysis and Result

■ Data and study area

- The study area is selected according to the degree of compound disaster intensity, and this study will further proceed Morans'I and LISA to investigate the spatial features.

Tabel The flood disaster intensity of Morako Typhoon

City and County	Degree	City and County	Degree
Kaohsiung County	7.09	Miaoli County	2.94
Pingtung County	6.15	Penghu County	2.34
Tainan County	5.73	Chiayi City	2.27
Chiayi County	5.42	Yilan County	2.01
Taitung County	4.83	Hsinchu County	1.85
Nantou County	4.77	Taichung City	1.76
Changhua County	4.06	Kaohsiung City	1.31
Yunlin County	4.03	Taipei County	0.9
Tainan City	3.56	Taoyuan County	0.82
Taichung County	3.43	Hsinchu City	0.76
Hualien County	3.12	Taipei City	-0.78

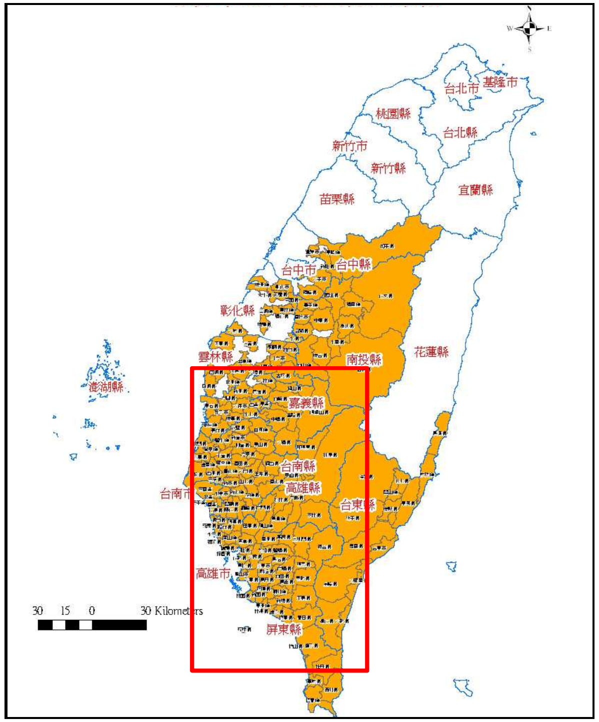


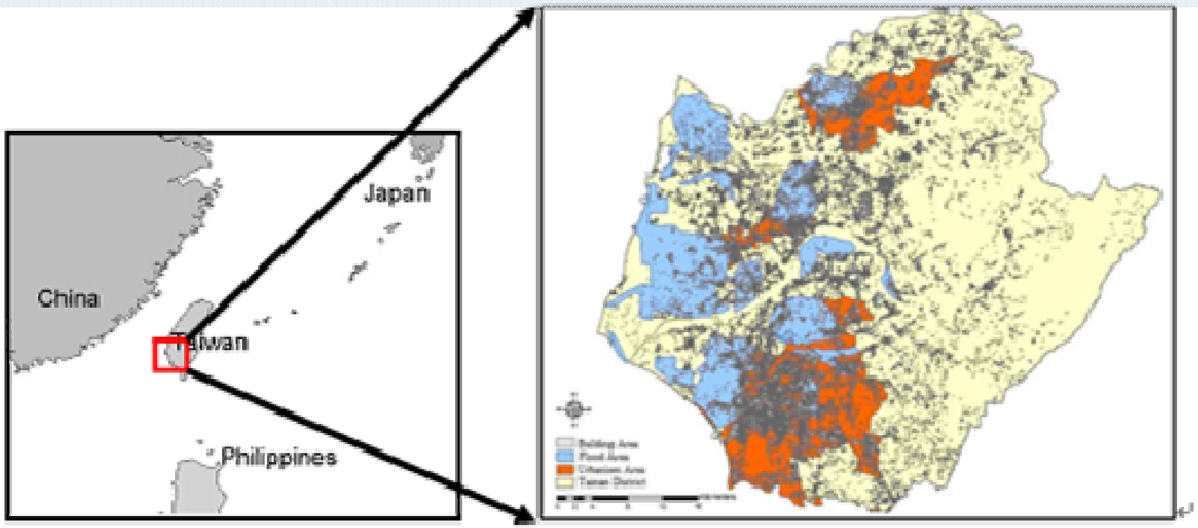
Fig. The damage area of Morako Typhoon

Resource: http://map2.ncdr.nat.gov.tw/morakot/index.htm

Analysis and Result

■ Data and study area

- This study establish the flood disaster intensity and magnitude for Tainan.
- The Central Emergency Operation Center (CEOC) addressed 619 people were killed, 76 were missing and 35 were injured, over 200 bridges were damaged, and the amount of personal property loss and failure of flood control facilities was yet to be estimated during the typhoon Morakot.



Analysis and Result

■ Relationship Diagnose

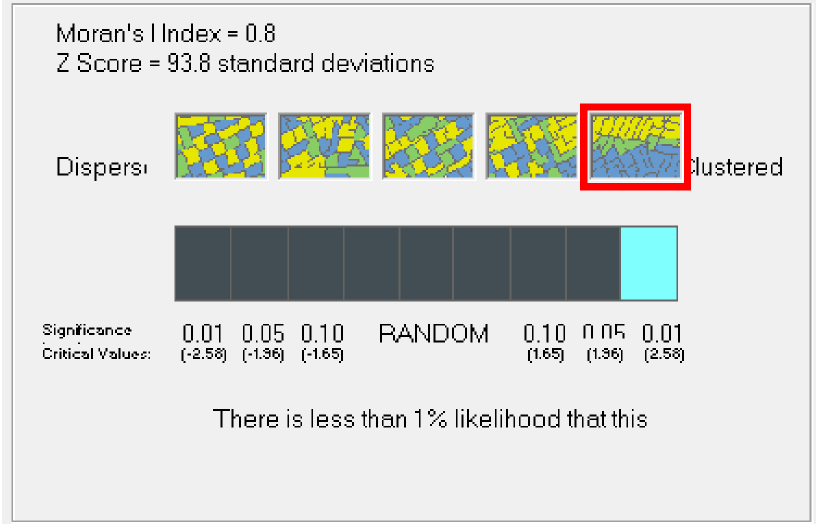
- A significant positive correlation is found between population density and compound disaster.
- The Pearson correlation coefficient is equal to .929 and is highly significant.

		g	Density
g	Pearson Correlation	1	0.929*
	Sig. (2-tailed)		0.022
	N	5	5
Density	Pearson Correlation	0.929*	1
	Sig. (2-tailed)	0.022	
	N	5	5

**: Significance with a 99% confidence interval
* : Significance with a 95% confidence interval

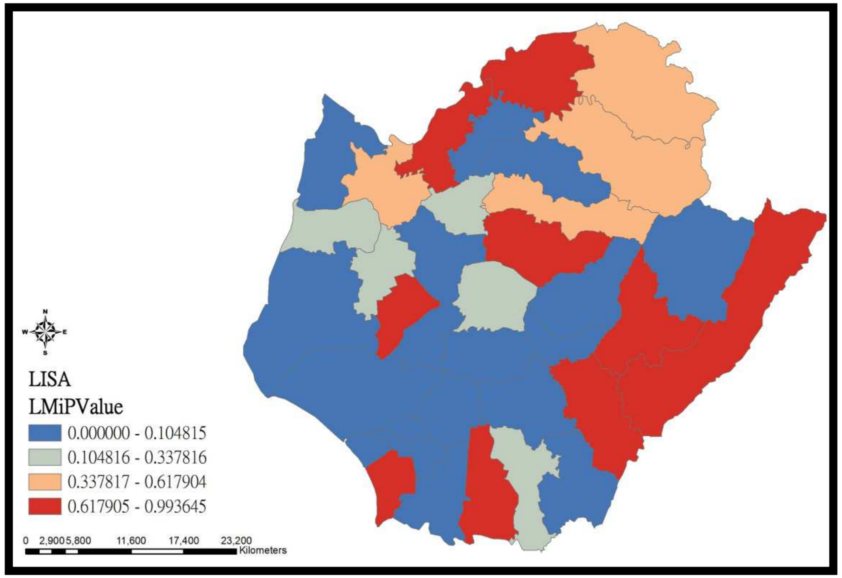
Analysis and Result

■ Spatial Autocorrelation



- The result of the SAA analysis on Tainan the value of Moran's I is positive 0.8, and refers to the random and independent distribution in region.

■ Local Indicators of Spatial Association



- Compound disaster intensity has spatial aggregated phenomenon.
- High value (above the mean) is associated with high risk values and refers to high–high pattern (the red color).

Analysis and Result

Table Local Regression Parameter Descriptive Statistics: n:913

Variable	Minimum	Lwr Quartile	Median	Upr Quartile	Maximum
URBAN	-0.00264	-0.00078	-0.00013	0.00028	0.00429
INDUST	-0.0329	-0.00354	-0.00088	0.00365	0.01304
SOIL	-0.00117	0.00006	0.0003	0.00054	0.0054
SLOPE	-0.31203	-0.04906	-0.0139	0.0177	0.22665

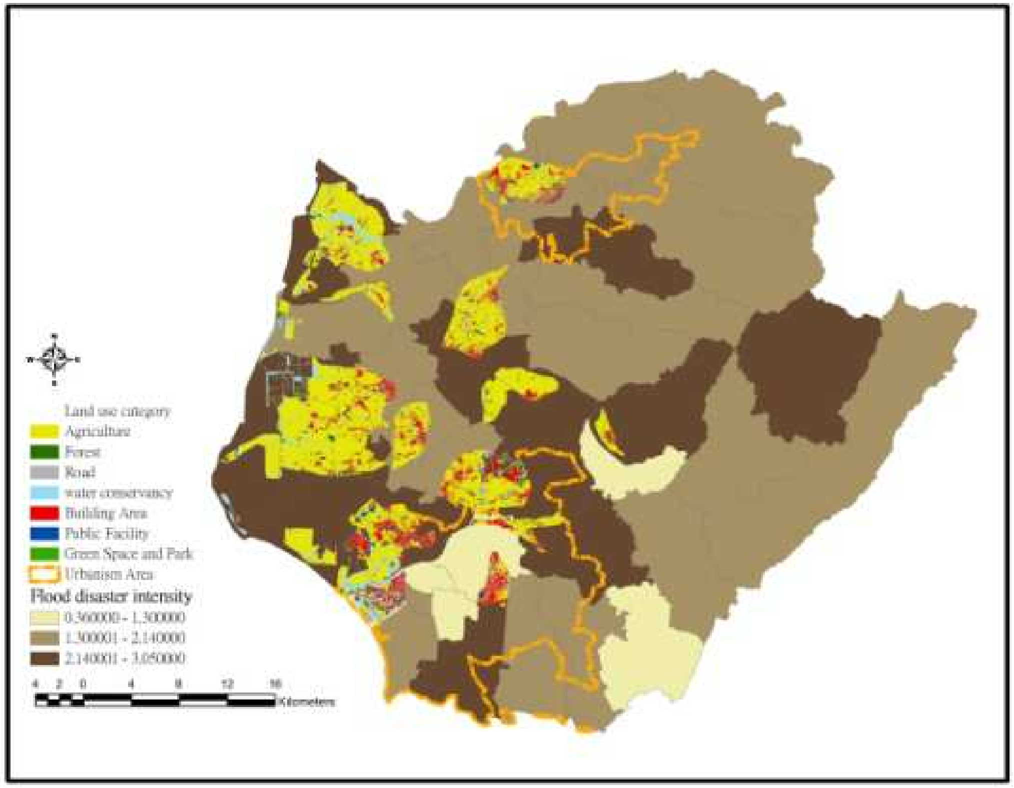
Table OLS and GWR n:913

	Akaike Information Criterion (AICc)	Correlation Coefficient (r):	Coefficient of Determination (r^2)	Adjusted r-square (r^2 Adj):	F (r^2):	P-value (r^2): (OLS: <.001)
OLS	1686.56	0.184	0.034	0.031	7.988	<.001
GWR	1396.481	0.633	0.401	0.353	8.22	0

Analysis and Result

■ Land use and flood disaster intensity analysis

- In the past, land use and flood disaster intensity analysis have been used to represent the size, qualities of land use category.
- The land use and flood disaster intensity are affected by population, land use type, and local features etc.
- The construction of land use is often related to the natural environment and urban development that mainly influences urban compound disaster intensity.



Conclusion

- Traditional regression models overlook the spatial variations with flooding loss characteristics.
- This study propose a approach to establish the flood functions based on the smallest numbers of explained variables and take spatial variations with flooding loss characteristics into account.
- The GWR model improves the coefficient of determination to 0.353 from the original OLS value, 0.031.
- The improvement of green space, urban park area and land use capacity supplements urban environment safety and sustainable development.

The eco-city will include both high and low-density developments that shoot off from a central transportation spine connecting main sites.

Thanks your attention