Explore urban flood vulnerability based on spatial pattern in Taiwan ecological city viewpoint

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Outline

• INTRODUCTION

• ‘ECO-CITY’ VISION: THE DEVELOPMENT PERSPECTIVE

• METHODOLOGY

• ANALYSIS AND RESULT

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INTRODUCTION
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.
INTRODUCTION

- With the annual average of 3.6 typhoon, the loss is about USD $589 million/year.

- Shortage and distribution of water worsen gradually.

- Large-scale earthquake make the serious impacts on society.
INTRODUCTION

Purpose

• Understanding urban flood situations and spatial pattern.

• Understanding the land use vulnerability area or levels from different situations.

• Rethinking ecological city viewpoint with land use plan.
‘ECO-CITY’ VISION: THE DEVELOPMENT PERSPECTIVE
‘ECO-CITY’ VISION: THE DEVELOPMENT PERSPECTIVE

In the ECOCITY project, the structure adopted for analysis and evaluation was based on the following elements:

- Urban structure
- Land use
- Transport
- Energy
- Material flows
- Socio-economy.

Developed countries’ aspirations for an eco-city
(source: http://www.ecocityprojects.net/index_public.php)
‘ECO-CITY’ VISION: THE DEVELOPMENT PERSPECTIVE

The urban flood issues between ecological city and compact city discuss complicated dialectical perspective from channelizing spatial plan and dike spatial plan.
METHODOLOGY

• Study area

These study area Tainan is the forth-grade city in Taiwan, but it's the oldest city which has abundant cultural heritage, as the cultural style presented. The methodology will now be described in greater detail, taking as an example its pilot application for Tainan in Taiwan, which is a town in which there is present risk from flood hazard.
METHODOLOGY

- Flood governing equations

(1) The two-dimensional constitutive equations include the continuity equation:

\[
\frac{\partial h}{\partial t} + \frac{\partial h V_x}{\partial x} + \frac{\partial h V_y}{\partial y} = i \quad (1)
\]

(2) The two-dimensional equations of motion:

\[
S_{fx} = S_{ox} - \frac{\partial h}{\partial x} \frac{V_x}{g} \frac{\partial h V_x}{\partial x} - \frac{V_y}{g} \frac{\partial h V_y}{\partial y} - I \frac{\partial V_x}{\partial t} \quad (2)
\]

\[
S_{fy} = S_{oy} - \frac{\partial h}{\partial y} \frac{V_y}{g} \frac{\partial h V_y}{\partial y} - \frac{V_x}{g} \frac{\partial h V_y}{\partial y} - I \frac{\partial V_y}{\partial t} \quad (3)
\]

<table>
<thead>
<tr>
<th>Category</th>
<th>Code</th>
<th>Classification</th>
<th>Unit</th>
<th>Illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>D</td>
<td>1、2</td>
<td>Date</td>
<td>Explain rainfall duration</td>
</tr>
<tr>
<td>Return period</td>
<td>I</td>
<td>1、2、5、25、50、100、200</td>
<td>Year</td>
<td>Known as a recurrence interval is an estimate of the interval of time between events certain intensity or size.</td>
</tr>
<tr>
<td>Rainfall intensity</td>
<td>R</td>
<td>150、300、450、600</td>
<td>mm</td>
<td>Explain rainfall duration rainfall amount.</td>
</tr>
</tbody>
</table>
METHODOLOGY

- Utilizing explore spatial data analysis
  - Spatial autocorrelation analysis

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

\[ S_0 = \sum_{i} \sum_{l} w_{il} \]  
(2)

\[ m_2 = \sum_{i} z_i^2 / I \]

\[ z_i = x_i - \bar{x} \]
ANALYSIS AND RESULT
ANALYSIS AND RESULT

- Urban flood situations and spatial pattern.
ANALYSIS AND RESULT

- Explore spatial data analysis of flood area

<table>
<thead>
<tr>
<th>Flood Area</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explore spatial data analysis.</td>
<td>![Image A]</td>
<td>![Image B]</td>
<td>![Image C]</td>
<td>![Image D]</td>
<td>![Image E]</td>
</tr>
</tbody>
</table>

- The result of the SAA analysis on Tainan the value of Moran’s I is positive 0.52, and refers to the gather and independent distribution in region.

- In the future, the land use planning suggests strengthening prevention such as Yong Kang district, Sinying district and Madou district.
ANALYSIS AND RESULT

- Land use vulnerability assessment of flood area

<table>
<thead>
<tr>
<th>Jiangjiyun land use vulnerability area</th>
<th>Yanshuei land use vulnerability area</th>
<th>Yong Kang land use vulnerability area</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Map of Jiangjiyun land use vulnerability area" /></td>
<td><img src="image2" alt="Map of Yanshuei land use vulnerability area" /></td>
<td><img src="image3" alt="Map of Yong Kang land use vulnerability area" /></td>
</tr>
</tbody>
</table>

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<tr>
<th>Jiangjiyun current status of land use vulnerability area</th>
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<th>Yong Kang current status of land use vulnerability area</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image4" alt="Map of Jiangjiyun current status of land use vulnerability area" /></td>
<td><img src="image5" alt="Map of Yanshuei current status of land use vulnerability area" /></td>
<td><img src="image6" alt="Map of Yong Kang current status of land use vulnerability area" /></td>
</tr>
</tbody>
</table>
## ANALYSIS AND RESULT

Results indicate that Tainan area will be vulnerability by flooding at minimum and maximum inundation 4 to 13 levels, respectively. The most severely impacted sectors are expected to be the residential areas, agricultural land. The urban flood issues were discussing water retention by land use from ecological city.

<table>
<thead>
<tr>
<th>Land use planning type</th>
<th>The simulation of flood</th>
<th>Vulnerability level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>Residential</td>
<td>27(2)</td>
<td>21(3)</td>
</tr>
<tr>
<td>Agriculture</td>
<td>88(4)</td>
<td>71(4)</td>
</tr>
<tr>
<td>Open space</td>
<td>59(3)</td>
<td>2.8(1)</td>
</tr>
<tr>
<td>Wetland</td>
<td>13(1)</td>
<td>4(2)</td>
</tr>
<tr>
<td>Current Status of Land Use type</td>
<td>The simulation of flood</td>
<td>Vulnerability level</td>
</tr>
<tr>
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<td>77(4)</td>
<td>82(4)</td>
</tr>
<tr>
<td>Agriculture</td>
<td>33(2)</td>
<td>21(3)</td>
</tr>
<tr>
<td>Open space</td>
<td>20(1)</td>
<td>0.7(1)</td>
</tr>
<tr>
<td>Wetland</td>
<td>46(3)</td>
<td>2(2)</td>
</tr>
</tbody>
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CONCLUSION
CONCLUSION

• First, urban flood might have different spatial distribution. How to declare and categorize a factor based on its identity and effectiveness is a quite important and skillful work.

• Second, this paper use FLO-2D, SAA and vulnerability analysis provide adjustment of urban flood and land use.

• Finally, it is important to involve the to balance the impact of water retention by land use include: wetland preservation; open space build storm water planter; and the afforestation of dunes.
REFERENCE

• Natural Disaster Hotspots, A Global Risk Analysis. World Bank. 2005
• Central Weather Bureau (http://www.cwb.gov.tw/V4e/, CWB)
• fig3. source: http://www.flickr.com/photos/kyo4890x115/3807860280
• fig2. source: http://www.ecocityprojects.net/ index_public.php
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

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