Water Infrastructure as Inter-scale Design Tool for Spatial Strategy Making

• The Dike system in Pearl River Delta

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urban deltas

(Meyer, Nijhuis, 2010)
Introduction
Method
Result
Conclusion
Deltas Scale

Pearl River Delta (China)

Rhine – Meuse Delta (Netherlands)
Pearl River
1 country
1 province
Basin 425,700 km²
Length 2,055 km
Discharge 302 km³/y,

Rhine River
9 countries
? Provinces
Basin 170,000 km²
Length 1,233 km
Discharge 63 km³/y,
type of deltas

River dominated
- Mississippi, USA

Wave dominated
- São Francisco, Brazil

Tide dominated
- Rhine-Meuse, Netherlands

Pearl River Delta:
- Area 42,831.5 km²
- Inhabitant 47.9 Million
- 11 municipalities: 69% urbanized
Urbanization phenomena

Rural Urbanization: Industrialization and urbanization focused in rural areas. (Lin, 1997).

Land use and cover change between 1989 and 1997 in PRD
Pearl River Delta

30 years

Inhabitants 1.5 millions /yr

Buildup area 82.1 km² /yr

The population of PRD in 1990, 2000 and 2010
Flooding & Climate Change

Large affected area
Fast urban expansion
Huge immigrants

Territory below sea level in PRD
Source: NASA
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Research Question

How to use water infrastructure to understand the spatial pattern and prepare for the future challenges in a fast urbanizing delta like PRD?

Key Words: Water Infrastructure, Pearl River Delta, Design Research, Scale study, Spatial Pattern
Introduction
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Scale study

An attributor or descriptor of empirical phenomena (Sayre 2005).

• 1. proper scales(s) to examine the process(es)
• 2. an integrated and unified ecology can only be achieved by addressing inter-scalar and inter-disciplinary phenomena
• 3. thresholds of phenomena change exists in certain scale (characteristic scale)
Scale: extent, grain and hierarchy
Temporal scale and Spatial scale

• spatial and temporal scales are fundamentally linked so that complex systems can be decomposed in time and space simultaneously (Courtois 1985; Wu 1999).
Layer Approach

- Occupation
- Infrastructure
- Landscape

(Meyer, Nijhuis, 2010)
Scale: extent, grain and hierarchy

<table>
<thead>
<tr>
<th>FRAME</th>
<th>NOMINAL RADIUS</th>
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<tr>
<td>Sub-continental</td>
<td>1000</td>
</tr>
<tr>
<td>National</td>
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</tr>
<tr>
<td>Sub-national</td>
<td>100</td>
</tr>
<tr>
<td>Regional</td>
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</tr>
<tr>
<td>Sub-regional</td>
<td>10</td>
</tr>
<tr>
<td>Local</td>
<td>District</td>
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<tr>
<td>Area</td>
<td>Village</td>
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<tr>
<td>Ensemble</td>
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<tr>
<td>Building complex</td>
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<tr>
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<tr>
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<tr>
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</tr>
<tr>
<td>Submaterial</td>
<td>&lt;1 mm</td>
</tr>
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</table>

- Jong & Rosemann 2002
- Variable of composition in the scale recognition, Jong 2012
• Characteristic Scale:

Extreme homogeneity exist in the content of grain
China Historical GIS, Harvard University, 2007,
The Historical Atlas of China, Tan 1996
Local Chronicles of Agriculture in Pearl River Delta(first version) ,1976
Google map, 2011
Spatial scales:

<table>
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<tr>
<th>Level of scale</th>
<th>Extent</th>
<th>Grain</th>
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</thead>
<tbody>
<tr>
<td>Province</td>
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<td>100 km</td>
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<tr>
<td>Delta</td>
<td>100 km</td>
<td>30 km</td>
</tr>
<tr>
<td>Region</td>
<td>30 km</td>
<td>10 km</td>
</tr>
<tr>
<td>Sub-region</td>
<td>10 km</td>
<td>3 km</td>
</tr>
<tr>
<td>Local</td>
<td>3 km</td>
<td>1 km</td>
</tr>
<tr>
<td>Area</td>
<td>1000 m</td>
<td>300 m</td>
</tr>
<tr>
<td>Neighborhood</td>
<td>300 m</td>
<td>100 m</td>
</tr>
</tbody>
</table>

Temporal scale:
Extent: - 2010 ,
Grain: Varies, Based on the available data sets

Characteristic Scale: Extreme homogeneity in content
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Dike system: characteristic scale in Local scale
Occasion: characteristic scale in Local and Delta scale
Dike system: characteristic scale in Region scale

\[ R = 30 \text{km} \]
Dike administration in village scale because of the increasing difficulty of reclamation along river.

Occupation: characteristic scale in Local, Region and Delta scale
Dike system: characteristic scale in Sub-region and Region scale
Occupation: characteristic scale in Region and Delta scale
Dike system: characteristic scale in Local and Delta scale
Occupation: characteristic scale in Local and Region scale
The change in characteristic scales of the dike system (in solid circle) and the occupation (in dot circle) shows a trend where the homogeneity of dike system pass over the urban system.
Tanzhou County, Zhongshan Municipality
Settlement and farmland all located in natural highland. Only few farmland required dike to protect during high tide.
Landscape adapted: Dike to reclaim farmland (1279-1644)

Dike was used as tools to reclaim land into sea. Reclamation started in estuary and people begin to settle along dikes. Dike managed among villages in local level.
Sea dike construction enabled more farmland reclamation, more settlement along dike. Large families controlled the dike rings in sub-region scale.
Infrastructure dominated: Dike to guard cities, settlement in polder (1911-2010)

unlimited urbanization in the floodable area inside dikes. Dike is managed in Region scale
Introduction
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1. The dominated administrative scale in the dike system (solid circle) become larger than it is in the occupation (dotted circle) in 2010.

2. Such scale change in these two layers leads to less consideration in landscape constrain, increasing flood threaten and spreading occupation pattern.

3. Scale cohesion in dike system and occupation is essential in a more sustainable spatial pattern in the Pearl River Delta.