Space based information service for flood mapping _ case study of Malaysia

LI Jing
College of Disaster Reduction and Emergency Management, Beijing Normal University

lijing@bnu.edu.cn;  lijing21@sina.com

2013.10.25  Zhongmin Building, Beijing
Global Disaster number (1986-2006)

It shows: flood frequency increase more fast than other disaster.
Total Fatalities of Flood Related Disaster: 1986-2006

It shows that Asia is the region where has most serious flood
Remote sensing technology is very useful tool for flood disaster management.
Disaster management based on remote sensing

Disaster preparedness
- Disaster early warning
- Hazard monitoring
- Database construction
- Logistics preparation for disaster relief

Disaster mitigation
- Vulnerability assessment
- Hazard assessment
- Risk investigation and assessment
- Disaster characteristic factor monitoring
- Disaster reduction planning support

Disaster
- Disaster information quick processing and analysis
- Disaster mapping
- Scenario simulation
- Disaster trend forecasting
- Emergency response decision support

Reconstruction
- Disaster loss assessment
- Requirement assessment for disaster recovery and reconstruction
- Recovery and reconstruction monitoring

Disaster relief
- Information integration and analysis
- Disaster monitoring
- Dynamic disaster loss assessment
- Scenario simulation recurrence
- Disaster relief decision making support
Spatial Model Base System

Spatial Model Base System (SMBS) is a computer software system which classify and maintain a great number of spatial models, and support generation, storage, query, running and analysis of the spatial models.
Expresion Test Model

```
# Define Overlay Coverage:
# dfAoiMinX = 390015.000000
# dfAoiMinY = 359985.000000
# dfAoiMaxX = 420015.000000
# dfAoiMaxY = 389985.000000
#
# Define Map Size and Pixel Size for Output Raster File:
# dwAoiCol = 1000
# dwAoiRow = 1000
# dfAoiPs = 30.000000
#
# Set Processing Environment Variables:
# SETAOI dfAoiMinX dfAoiMinY dfAoiMaxX dfAoiMaxY MAPSIZE
dwAoiCol dwAoiRow PIXELSIZE dfAoiPs
#
# Define Data Variables:
# R1 = "D:\DataSEL\arf3758.rdf"
# R2 = "D:\DataSEL\bsc3758.rdf"
# R3 = "D:\DataSEL\ttt.rdf"
#
# Operations:
# RunComID 5
# MAOP [R1+R2*2]/2 NEWMAP &R3 DATATYPE uschar
# SHOWMAP D:\DataSEL\ttt.rdf
```

### LANDSLIDE HAZARD CLASSES

**LOW TO VERY LOW HAZARD**
Low probability of occurrence of landslides is very low even with existence of strong triggering factors, such as drastic landuse change and intense rainfall.
(Environmentally non sensitive – development can take place with standard conservation practices)

**MODERATE HAZARD**
Some landslides will occur under the influence of strong triggering factors.
(Environmentally moderately sensitive – limited development activities may take place provided strong conservation measures are implemented)

**HIGH TO VERY HIGH HAZARD**
A considerable number of landslides will occur even with the presence of weak triggering factors.
(Environmentally very sensitive – no development activities should be considered)
Flood Disaster Mapping

Study area is located north of the Kelantan
Flooding Area Extraction using remote sensing

1. Noise Reduction
2. Geometric Correction
3. Projection
4. Threshold value

Preprocessed SAR image

GCPs dataset

Mountain Shadow dataset

Normal water extent dataset

Boundary dataset

5. Water Extent Extraction
6. Flooded Area Extraction
7. Map Production

Flooded Area map
Attribute of flooded area (*.dbf)
Gray value of shadow is close with that of water in the Radarsat images. Shadow and water have low gray value while other has high gray value. So shadow extraction is very difficult from Radarsat image directly.
Shadow extraction of Radarsat image (cont...)
Simulate image based on DEM

S6_20041208

Simulate image
Water+shadow

water
Flooding area extraction

Flow chart

1. RADARSAT SAR image
2. Water extent extraction
3. Masking
4. Subtract
5. Flooded Area (Raster)
6. Convert to Vector
7. Overlay
   - District Boundary
   - Mountain shadow
   - District Boundary
   - Mukim Boundary

Flooding area map
Attribute of flooded area (*.dbf)
The flooded Area extraction model (FAEM) has been created by using ArcGIS ModelBuilder.

The model includes 11 processes, 5 dataset, 11 results. The whole run time is less than 5 minutes.
Flooded Area in District of Kelantan 11 Dec 2004

Legend
- Red: Flooded Area
- Yellow: District
- Blue: Normal Water

<table>
<thead>
<tr>
<th>Code</th>
<th>Name</th>
<th>Flooded Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C3001</td>
<td>BACHOK</td>
<td>840.87</td>
</tr>
<tr>
<td>C3002</td>
<td>KOTA BHARU</td>
<td>2,235.44</td>
</tr>
<tr>
<td>C3003</td>
<td>MACHANG</td>
<td>513.59</td>
</tr>
<tr>
<td>C3004</td>
<td>PASIR MAS</td>
<td>2,798.78</td>
</tr>
<tr>
<td>C3005</td>
<td>PASIR PUTEH</td>
<td>2,121.84</td>
</tr>
<tr>
<td>C3006</td>
<td>TANAH MERAH</td>
<td>494.84</td>
</tr>
<tr>
<td>C3007</td>
<td>TUMPAT</td>
<td>713.35</td>
</tr>
</tbody>
</table>

Total: 9,724.71
Flooded Area in different year

1998

2003

2004
Remote sensing + field work
Landuse map

<table>
<thead>
<tr>
<th>Name</th>
<th>Area (ha.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coconut</td>
<td>1288.26</td>
</tr>
<tr>
<td>Forest</td>
<td>46167.03</td>
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<tr>
<td>Lake</td>
<td>1431.45</td>
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<tr>
<td>Mangrove</td>
<td>3551.94</td>
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<tr>
<td>Mixed horticulture</td>
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<tr>
<td>Oil palm</td>
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<tr>
<td>Paddy</td>
<td>77983.2</td>
</tr>
<tr>
<td>River</td>
<td>4798.44</td>
</tr>
<tr>
<td>Rubber</td>
<td>104794.65</td>
</tr>
<tr>
<td>Urban</td>
<td>23072.13</td>
</tr>
</tbody>
</table>
Population Density Mapping

Cell size: 2.5M * 2.5M
Population Density Simulation Model

Census data with Zone Boundary

Vector to Raster

Zone Boundary Map (Vector)

Zonal Statistics

Zone Weight Map

Mathematical Statistics

Population Density Map (Raster) Series

Zone_Bachok.shp

Feature to Raster

Resident_Bachok.im

Rclassify

tmp_model2_feat2rast

tmp_model2_Reclassi

tmp_model 2_Reclassi

Zonal Statistics

tmp_model 2_Zonal1.i

 Divide

tmp_model2_times1.i

Times

Zone_Modell2.img
Disaster Assessment Model

- Land cover
- Population
- Built-up area

- Flooded Area

- Overlay & Statistic

- Inundated land cover map
- Affected Population map
- Affected Built-up area map
## Disaster Assessment - Inundated land cover area

<table>
<thead>
<tr>
<th>Name</th>
<th>Area (ha.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coconut</td>
<td>0.00</td>
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<tr>
<td>Forest</td>
<td>0.00</td>
</tr>
<tr>
<td>Lake</td>
<td>0.74</td>
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<tr>
<td>Mangrove</td>
<td>1.06</td>
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<tr>
<td>Mixed horticulture</td>
<td>776.59</td>
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<tr>
<td>Oil palm</td>
<td>224.57</td>
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<tr>
<td>Paddy</td>
<td>1475.71</td>
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<tr>
<td>River</td>
<td>323.39</td>
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<tr>
<td>Rubber</td>
<td>144.70</td>
</tr>
<tr>
<td>Urban</td>
<td>402.82</td>
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</tbody>
</table>
Flood risk depends on more than hazard and vulnerability

Flood risk = a spatial, multi-parameter problem
Flood risk: A multi-criteria issue

Source: Dr. Cees Van Westen and Alkema
Multi-Criteria Analysis

Hazard Index

\[ HI(x) = \sum_{j=1}^{9} \left[ W_j \times HI_{ji}(x) \right] \]

Vulnerability Index

\[ VI(x) = \sum_{j=1}^{2} \left[ W_j \times VI_{ji}(x) \right] \]

Risk Index

\[ RI(x) = W_{HI} \times HI(x) + W_{VI} \times VI(x) \]

Where:

\[ W_1 \ldots W_j = \text{the WEIGHT assigned to each criterion} \]
Flood Risk Mapping

Risk index map

Risk class map
Flood Disaster Model Base (FDMB)
Thank You!