EO Data for climate resilience and disaster management city plans

Hervis GHOMSI, SIRS
Outline of the Presentation

• what are the elements that can be measured from earth observation data to support climate resilience and disaster management city plans?

• Example of Terrain motion management

• Example of Flood risks management
UNDP SDG Goal 11: Make cities inclusive, safe, resilient and sustainable

Target 5:
“By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations”
Outline of the Presentation

• SDG Goal 11 Target 5:

Indicators to monitor over time:
- Estimation of people living in high risk areas
- Estimation of people living in slums or inadequate housing within high risk areas
How can EO support?

The following parameters can be generated with EO data / remote sensing methods:

- **Population distribution** (based on census and EO data)
- **Risk areas** (floods, terrain motion, landslides)
- **Civil security**: (prevention, assistance during crises and post-crisis assessment)
- **Land use information** (residential, industrial)
- **Location of individual Buildings** (footprints, heights)
- **Transport Infrastructure** (roads, railway)
Risk areas (floods, terrain motion, landslides)

Terrain and Infrastructure motion

*What is terrain motion?*

Upheaval or sinking of land
Risk areas (floods, terrain motion, landslides)

**Terrain and Infrastructure motion**

*Various causes of terrain motion:*
  - Increased pressure on the surface due to concentrated building activities in combination with
  - Geological disposition
  - Groundwater extraction or mining

Subsidence can cause Cracks/ damages on buildings/infrastructure
Collapsing of buildings
- Natural factor (earthquake, more frequent flooding, etc.)
Terrain and Infrastructure motion, How to map them?

Example of Radar Interferometry method:
Radar interferometry can be broadly defined by use of phase measurements to precisely measure the relative distance to an object when imaged by synthetic aperture radar from two or more observations separated either in time or space.
Terrain and Infrastructure motion, How to map them?

Interferometric coherence analysis for terrain motion mapping:

Comparaison of two coherence maps to assess damage caused by an earthquake or landslide (The coherence value)

Example of Sentinel-1 data measurement
Risk areas: floods events in Dhaka

Mapping of Flood Risk area
Risk areas: floods events in Dhaka

- 2004 flooding event as worst case reference
- August 2017 event

|------|-------|---------------------------|-----------------------------|-----------------------------|-----------------------------|

August 2017
## Risk areas: Floods risk in Dhaka

### Flood frequency

<table>
<thead>
<tr>
<th>Flood hazard level</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td><strong>Damage classes</strong></td>
<td><strong>1A</strong></td>
<td><strong>1B</strong></td>
<td><strong>1C</strong></td>
</tr>
<tr>
<td><strong>2A</strong></td>
<td><strong>2B</strong></td>
<td><strong>2C</strong></td>
<td><strong>2D</strong></td>
</tr>
<tr>
<td><strong>3A</strong></td>
<td><strong>3B</strong></td>
<td><strong>3C</strong></td>
<td><strong>3D</strong></td>
</tr>
</tbody>
</table>

*Potential Damage Assessment*
### Floods Hierarchisation

#### Table 9 Flood risk matrix

<table>
<thead>
<tr>
<th>Flood hazard level</th>
<th>Damage cost on land use</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>1</td>
<td>1A</td>
<td>1B</td>
<td>1C</td>
<td>1D</td>
</tr>
<tr>
<td>2</td>
<td>2A</td>
<td>2B</td>
<td>2C</td>
<td>2D</td>
</tr>
<tr>
<td>3</td>
<td>3A</td>
<td>3B</td>
<td>3C</td>
<td>3D</td>
</tr>
</tbody>
</table>

#### Flood Risk classification

- **Low risk**: 1A, 1B, 2A
- **Medium risk**: 1C, 1D, 2B, 2C
- **High risk**: 2D, 3C
- **Very high risk**: 3D
Risk areas: Floods risk in Dhaka

Peri-urban
- HighRisk: 5.5%
- MediumRisk: 39.1%
- LowRisk: 37.6%
- Non-flooded: 17.4%
- Waterbody: 0.4%

Urban
- HighRisk: 8.0%
- MediumRisk: 27.4%
- LowRisk: 15.9%
- Non-flooded: 48.4%
- Waterbody: 0.4%

Agriculture only

Urban
- Flooded
- Non-Flooded

Peri-urban
- Flooded
- Non-Flooded

Urban
- Flooded
- Non-Flooded
## Risk areas: Floods risk

### Exemple of Flood risk evaluation table

<table>
<thead>
<tr>
<th>LU Classes</th>
<th>Damage</th>
<th>Total</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Economic Costs</td>
<td>Social Damage</td>
<td>Physical Damage</td>
</tr>
<tr>
<td>Agricultural Land</td>
<td>1.5</td>
<td>0.5</td>
<td>0</td>
</tr>
<tr>
<td>Commercial and Industrial Units</td>
<td>2</td>
<td>0.5</td>
<td>1</td>
</tr>
<tr>
<td>Dump site</td>
<td>0</td>
<td>1.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Construction Sites</td>
<td>1</td>
<td>0.5</td>
<td>0</td>
</tr>
<tr>
<td>Forests</td>
<td>0.5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Formal high density residential - Continuous urban fabric (Sealing level: 50%-100%)</td>
<td>1.5</td>
<td>1.5</td>
<td>2</td>
</tr>
<tr>
<td>Formal low density residential - Discontinuous urban fabric (Sealing level: 10%-50%)</td>
<td>1.5</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Land Without Current Use</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mineral Extraction site</td>
<td>1</td>
<td>0</td>
<td>0.5</td>
</tr>
<tr>
<td>Non-Residential Urban Fabric</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>Other Natural and Semi-Natural Areas including Wetlands</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roads and associated land</td>
<td>1.5</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Sports and leisure facilities</td>
<td>0.5</td>
<td>0.5</td>
<td>0</td>
</tr>
<tr>
<td>Other Urban / Artificial Area</td>
<td>1.5</td>
<td>1.5</td>
<td>1</td>
</tr>
<tr>
<td>Urban Greenery</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Village Settlements (Sealing level 1-10%)</td>
<td>1.5</td>
<td>1.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Water Bodies</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Risk areas: Floods risk in Dhaka
Risk areas: Floods risk in Saint-Louis

- Floods
- Flood risk hazard of Saint-Louis, status 2017

Subset of Flood Hazard Map of Saint Louis (Ile Saint Louis, northern part of Island of Sor, Khor) (Background Image: Sentinel 2, recorded on 10/09/2017)
Risk areas: Floods risk in Saint-Louis

- Floods
- Flood risk map of Saint-Louis, status 2017

Subset of Flood Risk Map of Saint Louis (Ile Saint Louis, northern part of Island of Sor, Khor) (Background Image: Sentinel 2, recorded on 10/09/2017)
Risk areas: Floods risk in Lima

- Floods

- Flood risk map of LIMA, status 2017

Flood Subset of Flood Risk Map for Callao – La Punta and Central Lima considering Tsunamis and flooding from River Rímac (Background Image: Sentinel2A 20170220)
Risk areas: Floods risk in Phnom Penh

Floods history:
Phnom Penh from S1

Phnom Penh; Cambodia:
Flood Monitoring with Sentinel-1
Thank you for your attention!

SIRS
Dr Christophe Sannier
Hervis Ghomsi
Sebastien Delbour
27 Rue du Carrousel, 59650
Villeneuve-d'Ascq
France

christophe.sannier@sirs-fr.com
hervis.ghomsi@sirs-fr.com
sebastien.delbour@sirs-fr.com
contact@sirs-fr.com
info.gaf.de