Remote Sensing for flood monitoring and disaster management in local communities in the Nile Basin and coastal areas in Egypt

Second Expert Forum for Producers and Users of Disaster-related Statistics
6-7-8 Sept 2022 from 12:00 to 4:00 PM Beirut Time
ESCWA -UN House, Beirut, Lebanon

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Social Economic and environmental challenges in Arab Countries

Challenges in order to protect human lives, their health, their assets, and the environment and achieve the targets of the United Nations (UN)’s 2030 Agenda for Sustainable Development (SDGs):

- Rapid population growth
- Income Inequality and high unemployment rate
- Unplanned rapid urbanization
- Need for adequate infrastructure, access to water and sanitation, reliable housing, public transportation,
- Millions of migrated populations caused by conflicts and wars
- Environmental pollution, drought, floods, water scarcity, resources exploitation

Disasters are obstacles in the way of progress towards achieving the SDGs
<table>
<thead>
<tr>
<th>Monitoring and reporting for the Sendai Framework and SDGs disasters related indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>The UN Committee of Experts on Global Geospatial Information Management (UN-GGIM)-Strategic Framework on Geospatial Information and Services for Disasters Working Group on Geospatial Information and Services for Disasters (WG-GISD)</td>
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<td>Establishment of an Inter-Agency and Expert Group on Disaster-related Statistics (IAEG-DRS) in 2020 as per the recommendation of the UN Statistical Commission UNSC which meets regularly</td>
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<tr>
<td>First Expert Forum for Producers and Users of Disaster-related Statistics, 07 - 10 June 2021 online and by UNESCWA in September 2022 (Hybrid, 6-7-8 Sept 2022 Beirut 2022)</td>
</tr>
</tbody>
</table>
Data Sources for DRR and SDGs

A. Traditional Data Sources such as Census and Surveys on population and households, Administrative records such as civil registration and cadastres

B. New data sources on using geospatial technologies, remote sensing Earth Observations (EO) and social media

C. Integrating data coming can produce more timely, frequent, and disaggregated SDGs indicators for more information for monitoring and analysis for remote areas, and more timely and efficient response

Special Issue "EO Solutions to Support Countries Implementing the SDGs"
SDGs Data gaps on Disasters in Arab Countries
SDGs 1.5.1, 1.5.2, 11.5.1, 11.5.2, 13.1.1, 13.1.2

• Disaster occurrences, disaggregation by hazards types, etc...

• On-Going Review of the hazard terminology and classification

• Scale, and geographic region: Geo Region 1 Large Medium Small (Local scale)

https://data.unescwa.org
Earth Observation (EO) and Remote Sensing (RS)
Free, high-quality satellite imagery

- USGS Earth Explorer
- NASA's Earthdata Search
- ESA's Copernicus open
- NOAA's Digital Coast
Partnership and Cooperation

• At the National levels between NSOs & NMAs and DRR Agencies;

• With UN, Regional Organizations and Other Partners:
  • GEO (Group on Earth Observation in Geneva) Plan to set a GEO for Arab Countries
  • UNGGIM and UN-GGIM Arab states
  • UNSD, UN regional Commissions, UK Statistical Office
  • OCHA, UNDRR on disaster risk management
  • UNFPA on Population and Housing Census
  • FAO on Crop mapping and land Cover
  • UNHabitat, on neighborhoods and informal areas
  • Qatar Computing Research Institute (QCRI)
Earth Observations for Floods Monitoring-ESCWA Google Earth Engine (GEE) Project

Objectives

1. Exploring new data sources to integrate with official statistics with the aim to fill data gaps and better monitor and report on SDGs and Global agendas such as Sendai Framework

2. Testing the effectiveness of remote sensing for detecting disaster areas at local community levels

3. Estimate disaster areas, number of affected population, houses, land and infrastructure

4. Share Algorithms and Tools on GEE for Public Use
## Data Sources for the ESCWA- GEE Project

<table>
<thead>
<tr>
<th>Remote Sensing Data</th>
<th>Other Data Sources</th>
<th>GEE Community Datasets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sentinel-2 Multispectral Optical Imagery</td>
<td>GLIDE datasets – Asian Disaster Reduction Center (ADRC)</td>
<td>ESRI/Microsoft 2020 Global Land Use Land Cover from Sentinel-2</td>
</tr>
<tr>
<td>Copernicus Global Land Cover Layers: CGLS-LC100 Collection 3</td>
<td>World pop data 100 meter resolution population data (to be explored)</td>
<td></td>
</tr>
<tr>
<td>CHIRPS Daily: Climate Hazards Group InfraRed Precipitation with Station Data (version 2.0 final)</td>
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</tbody>
</table>
Methodology

**Identification of Possible Inundation**
Objective is to detect candidate area for deeper examination
Visual exploration of disasters using disaster databases, Sentinel sensors, CHIRPS precipitation layer
Cross referencing disasters with tweets and news articles to get background information

**Generating the Inundation Image**
Objective is to extract actual inundation extent from the images
Use of Sentinel-2 (2A/1C) and SAR Sentinel 1 to visually inspect damage using before and after images
Preprocessing Sentinel-2 (L1C) and Sentinel 1 using atmospheric correction and speckle filtering respectively
Delimiting inundated areas either using thresholding method or K means clustering
Validating delimited areas through visual inspection

**Quantifying Impact**
Objective is to estimate impact of inundated areas
Calculate the area of the intersection of inundated areas with the following:
Areas classified as urban
Areas classified as containing vegetation
Calculate intersection of inundated areas and spatially distributed population estimate datasets
Summary Results on Identified Floods

- **Time Period**: 2015 October-November, 2016, March 2020
- **Egypt Localities around Nile Basin, North Coast and Red Sea Coast**

<table>
<thead>
<tr>
<th>Area</th>
<th>Governorate</th>
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</thead>
<tbody>
<tr>
<td>Al Kawm Al Asmar Wadi Al Natroun 2015</td>
<td>El Beheira Governorate</td>
</tr>
<tr>
<td>Qarun Lake Al Natroun Ras Ghareb 2020</td>
<td>El Fayoum governorate, Red Sea Governorate</td>
</tr>
<tr>
<td>Rosetta Branch of the Nile River</td>
<td>Qaliubiah, Kafr El-Sheikh, El-Gharbia, El-Menofyia and El-Behira</td>
</tr>
<tr>
<td>Damietta Branch of the Nile River</td>
<td>Alexandria, Beheira, Dakahlia, Damietta, Sharqiayah, Port Said</td>
</tr>
</tbody>
</table>
2015 Flood and Analysis Approach

- 25 people died. 26 people injured³.
- Of the 25 people dead, 16 drowned in flood waters and 9 electrocuted⁴.
- “The October 2015 floods led to the resignation of Governor Hani El-Mesery after criticism of his administration’s lack of preparation and management of the city’s drainage system.” ⁴


Al Kawm Al Asmar and Al Natron Valley assessment
SAR Sentinel-1, 10-meter resolution, Time series comparison between before and after images. SAR image smoothing and speckle
### 2016 Flood

**Red Sea Governorate**

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
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<tbody>
<tr>
<td>Heavy rains, flooding and exceptionally high winds¹. Maximum daily</td>
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<tr>
<td>precipitation: 182 mm.</td>
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<tr>
<td>27-October-2016 till 13-November-2016.</td>
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<tr>
<td>26 people died. 72 people injured².</td>
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<tr>
<td>6500 families needed emergency food, shelter and water.¹</td>
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<tr>
<td>Main roads closed, telephone and power lines were cut and main ports were</td>
<td></td>
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<tr>
<td>shut off.¹</td>
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<tr>
<td>Red sea Provinces, Sohag, Assuit, Qena.</td>
<td></td>
</tr>
<tr>
<td>Torrential rain hits annually in late October and early November³.</td>
<td></td>
</tr>
<tr>
<td>Areas with particularly poor infrastructure¹.</td>
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</tbody>
</table>

¹ [https://reliefweb.int/disaster/fl-2016-000114-egy](https://reliefweb.int/disaster/fl-2016-000114-egy)

² GLIDE datasets – Asian Disaster Reduction Center (ADRC)
Results for Ras Ghareb, Red Sea Governorate 2016

Heavy rains, flooding and exceptionally high winds. Maximum daily precipitation: 182 mm.

https://code.earthengine.google.com/
2020 Floods

State of emergency declared

Airports and ports were shut

Heavy precipitation on March 12, 2020

Maximum estimated daily precipitation: 139 mm

Affected Areas

Al Natron Valley

Qarun Lake

Along the Nile river

2020 Flood Results: Qarun Lake

2020 Flood Results: Wadi El Natrun
Challenges and Opportunities

Challenges for implementation by governments

1. Mandate: Governments (NSOs) are not engaged in remote sensed data for disaster risk reduction because other entities have the mandate defense, national security etc.
2. Institutional: NSOs did not put in place coordination mechanisms with other national agencies
3. Capacity building: to enable their staff to use and produce new data sources and integrate with their regular data production

Opportunities for people and policy makers

1. More inclusive flood maps. Even small floods affect lives, livelihoods, health, assets and mobility
2. People can now find that their posts on social media are supporting disaster analysis, policy, and response
3. Our team is Developing a Flood Estimation Tool for Localized Floods for any user and a Guide for Flood Detection with EO and GEE
Thank You

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