

Explore The Use Of Remote Sensing For Disaster Monitoring And Impact Evaluation

UN ESCWA Team – Statistics, Technology and GIS for Climate Change

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Objectives

- Explore the effectiveness of remote sensing for detecting disaster areas
- Estimate disaster areas
- Estimate the area of affected land cover types (urban vs vegetation)
- Estimate the number of affected population



Study Area

- Egypt is characterized by vast deserts.
- Mediterranean and Red Sea.
- Vegetation landcover concentrated around the Nile river and the Nile delta.
- Focus: coastal Egypt and the Nile basin.



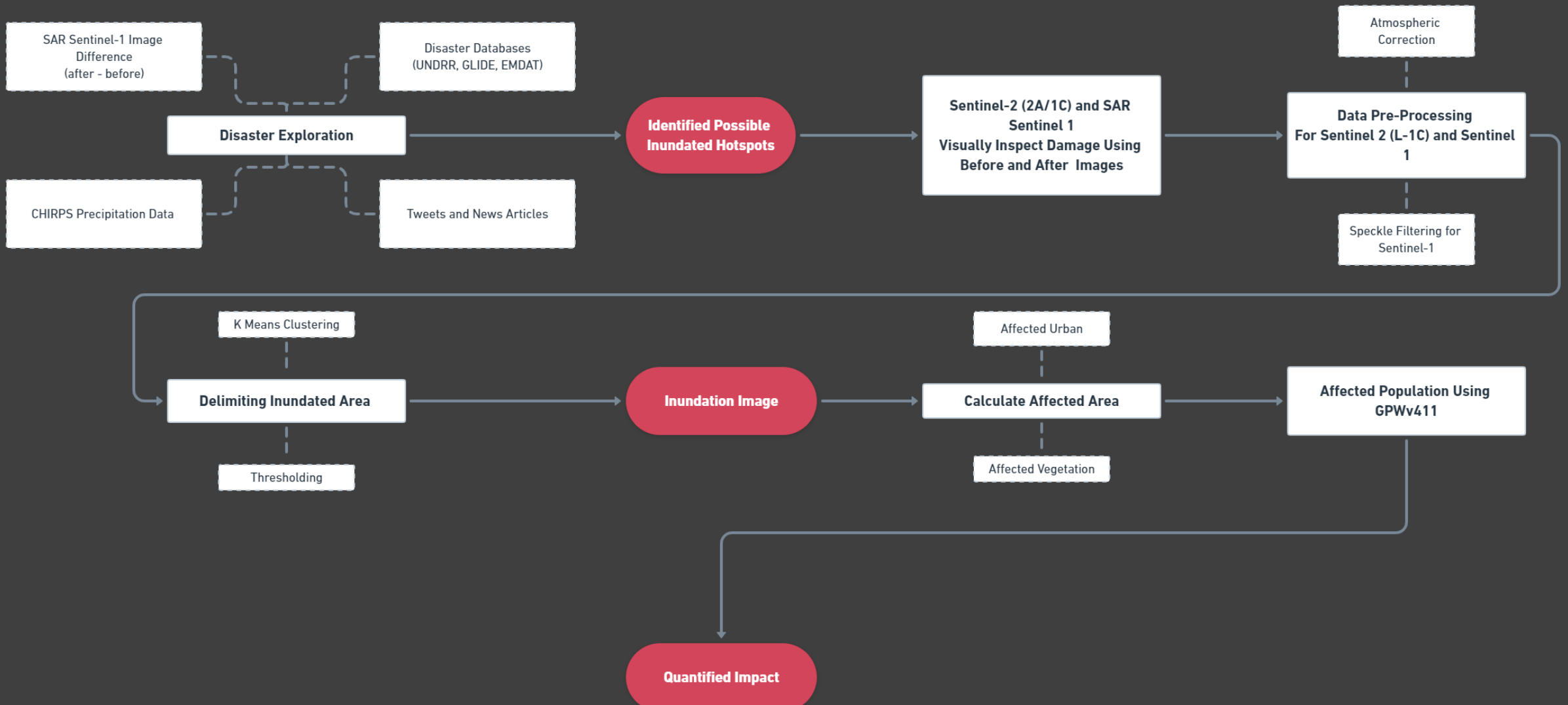
Data Sources

Remote Sensing Data	Other Data Sources	GEE Community Datasets
Sentinel-1 Synthetic Aperture Radar Imagery	Emergency Events Database (EM-DAT). Centre for Research on the Epidemiology of Disasters (CRED)	Facebook's High Resolution Settlement Layer
Sentinel-2 Multispectral Optical Imagery	GLIDE datasets – Asian Disaster Reduction Center (ADRC)	ESRI/Microsoft 2020 Global Land Use Land Cover from Sentinel-2
Gridded Population of the World, Version 4 (GPWv4): Population Count, Revision 11	UNDRR Disaster loss database	
Copernicus Global Land Cover Layers: CGLS-LC100 Collection 3		
CHIRPS Daily: Climate Hazards Group InfraRed Precipitation with Station Data (version 2.0 final)		

Center for International Earth Science Information Network - CIESIN - Columbia University. 2018. Gridded Population of the World, Version 4 (GPWv4): Population Count, Revision 11. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). <https://doi.org/10.7927/H4JW8BX5>.

Marcel Buchhorn, Bruno Smets, Luc Bertels, Bert De Roo, Myroslava Lesiv, Nandin-Erdene Tsendbazar, ... Agnieszka Tarko. (2020, September 8). Copernicus Global Land Service: Land Cover 100m: version 3 Globe 2015-2019: Product User Manual (Version Dataset v3.0, doc issue 3.3). Zenodo. <http://doi.org/10.5281/zenodo.3938963>

Methodology For Inundation Detection Using Google Earth Engine



2020 Floods Background

- Heavy rain and bad weather resulted in floods¹
- More than 40 people were killed¹
- More than 400 were injured¹
- Infrastructure's capacity to handle the rain was exceeded²



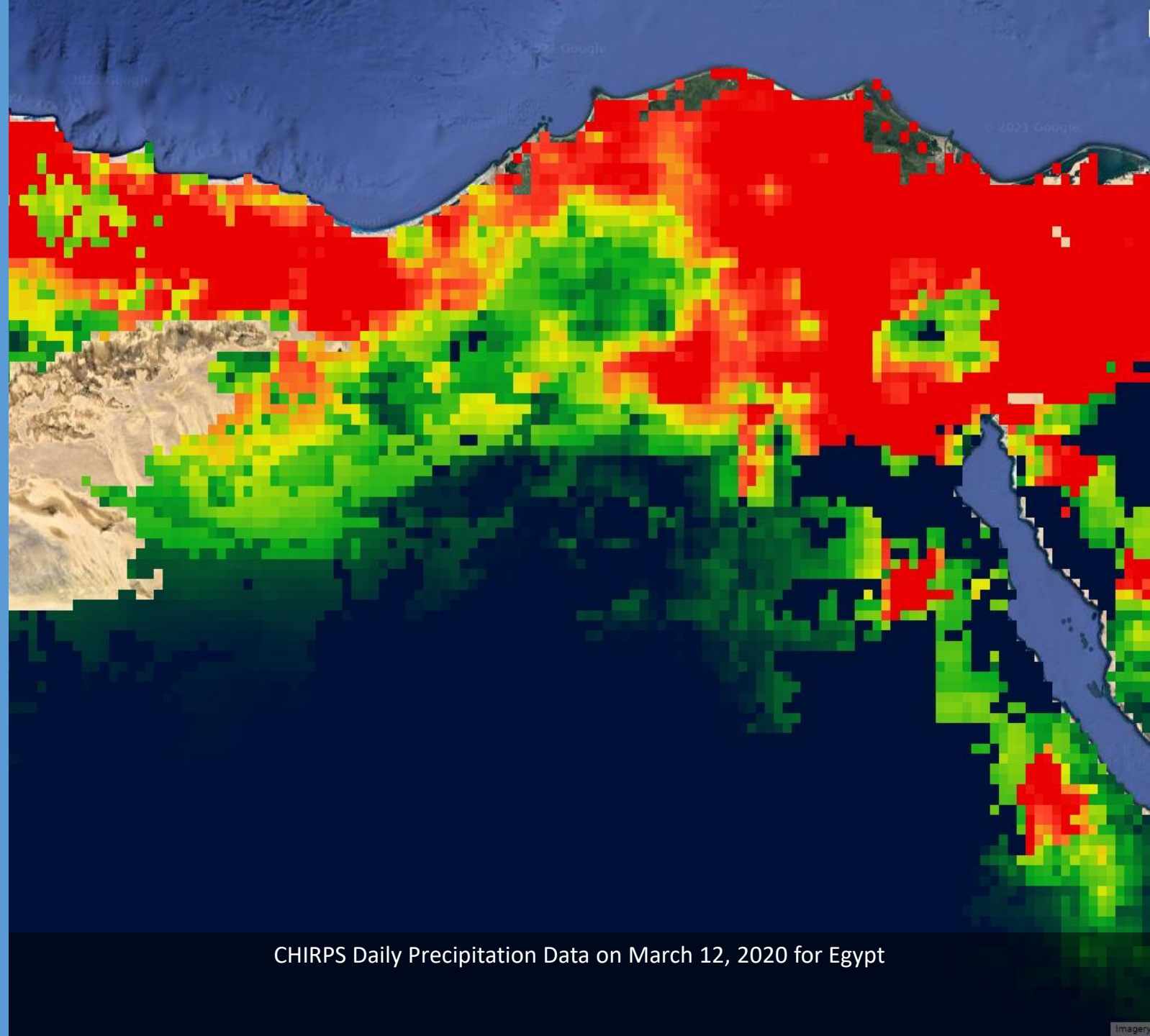
1. <https://reliefweb.int/report/egypt/egypt-flash-floods-emergency-plan-action-epoa-dref-operation-n-mdreg015>
2. <https://www.reuters.com/article/us-egypt-weather-idUSKBN2102OD>

Submerged cart in Cairo - Reuters²

2020 Floods Background

- State of emergency declared.
- Airports and ports were shut.
- Heavy precipitation between March 11 and March 12, 2020.
- Maximum estimated daily precipitation: 139 mm.

1. <https://reliefweb.int/report/egypt/egypt-flash-floods-emergency-plan-action-epoa-dref-operation-n-mdreg015>
2. <https://www.aljazeera.com/news/2020/3/13/storms-bring-widespread-floods-to-egypt-killing-5>



CHIRPS Daily Precipitation Data on March 12, 2020 for Egypt

2020 Flood Analysis Approach

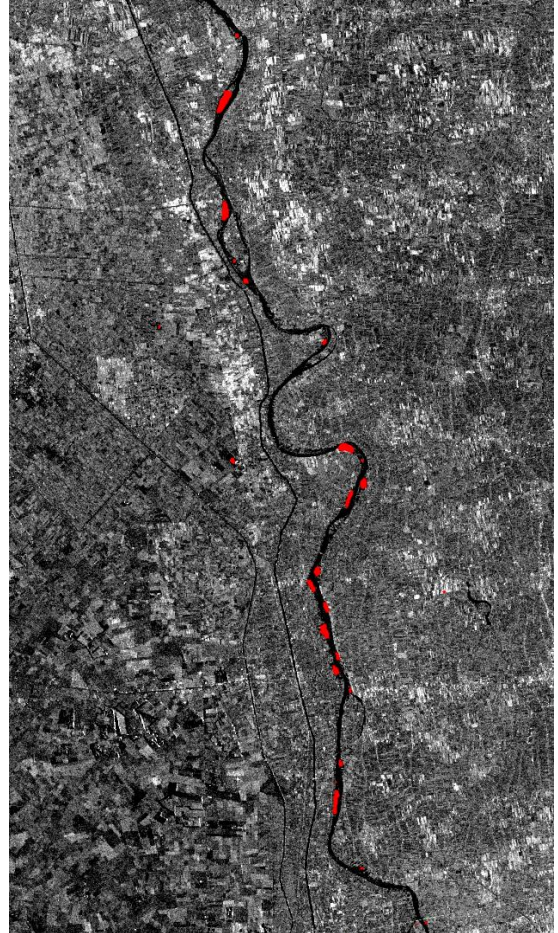
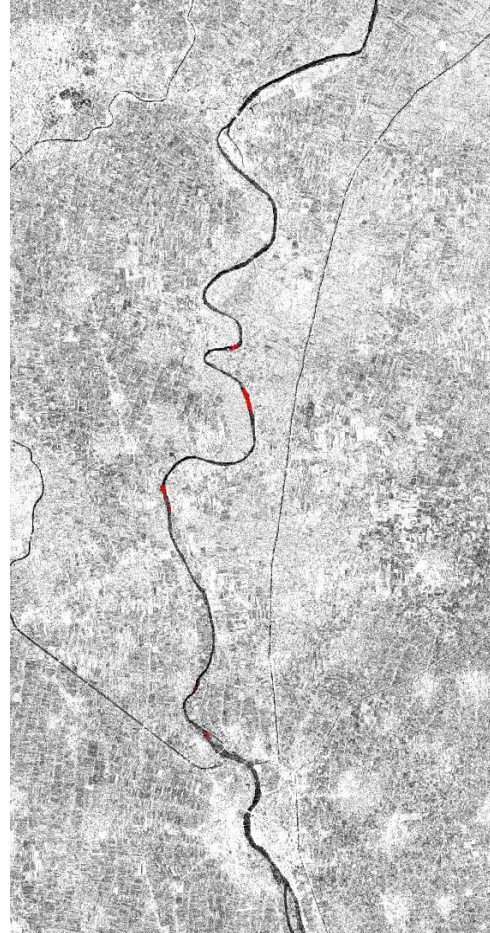
- Inspect SAR images before and after the flood
- Create a SAR difference image (after – before)
- Delimit the areas with detected inundation
- Use K-Means Clustering, an unsupervised machine learning algorithm, to extract the inundated areas
- Calculate the total area from the resulting image pixels
- Calculate the affected agricultural area and affected urban area
- Calculate the number of affected population

Affected Areas

- Al Natron Valley
- Qarun Lake
- Along the Nile river



2020 Flood Results: Nile



2020 Flood Results: Qarun Lake



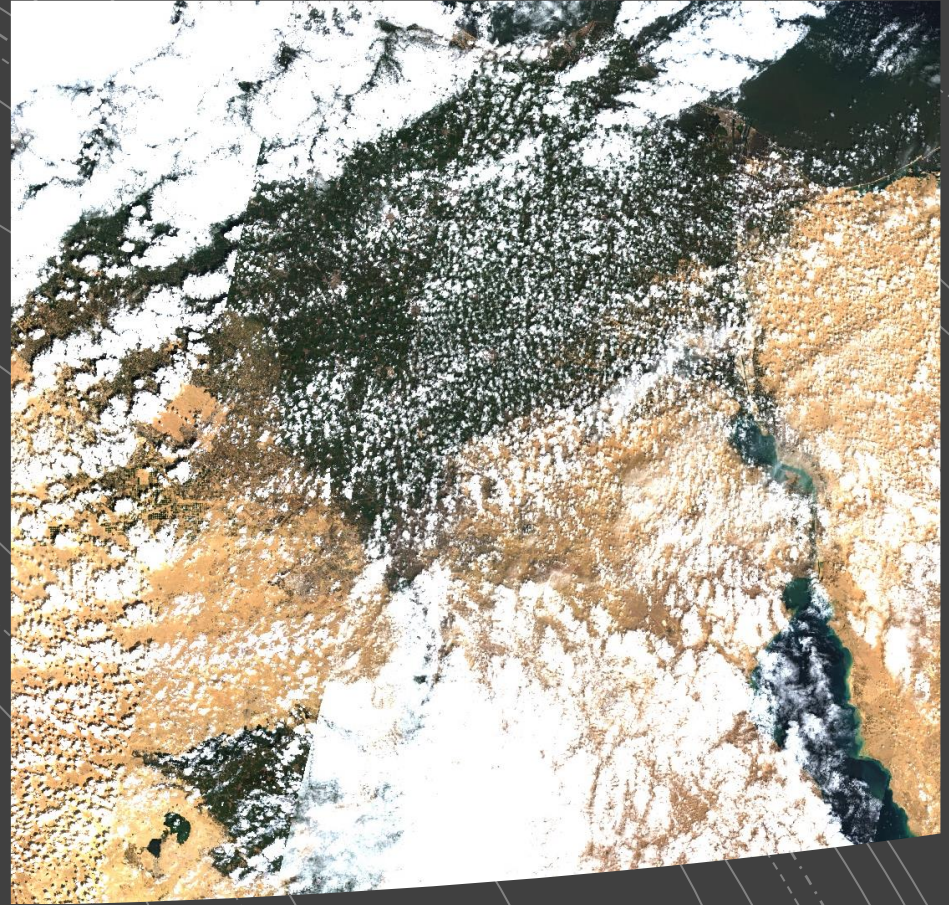
2020 Flood Results: Wadi El Natrun



2020 Flood Initial Estimates

Area	Area Inundated	Urban Area Affected	Agricultural Area Affected	Population Affected No Buffer	Population Affected 500 M Buffer	Population Affected 1 KM Buffer	Population Affected 2 KM Buffer
Total Area	5,862,047.324	26,892.259	1,913,248.888	4,180	129,810	363,268	1,060,152
Wadi Al Natroun	1,995,429.324	0	0	0	0	0	4,564
Qarun Lake	1,200,662.206	0	714.001	44	1,672	5,224	23,631
Rosetta Branch of the Nile River	2,346,929.986	7,818.978	1,843,913.388	3,502	106,764	288,571	726,304
Damietta Branch of the Nile River	312,643.799	19,073.282	68,621.499	635	20,124	62,450	175,918





2020 Flood: Challenges

- Cloud cover limited our ability to use multispectral optical images

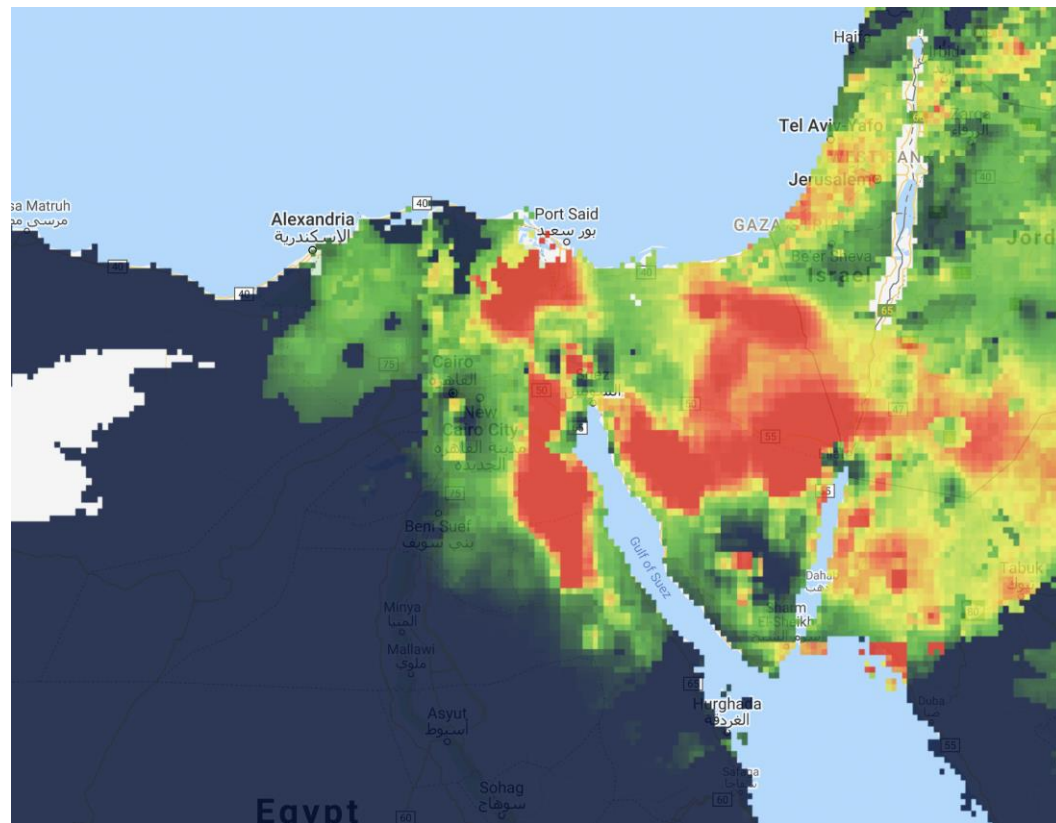


2020 Flood: Challenges

- Sentinel 1 resolution limits ability to detect urban floods
- Complexity of SAR urban analysis

2016 Flood, Red Sea Governorate

Chirps Precipitation Data, 27-October-2016



- Heavy rains, flooding and exceptionally high winds¹. Maximum daily precipitation: 182 mm.
- 27-October-2016 till 13-November-2016.
- 26 people died. 72 people injured².
- 6500 families needed emergency food, shelter and water.¹
- Main roads closed, telephone and power lines were cut and main ports were shut off.¹
- Red sea Provinces, Sohag, Assuit, Qena.
- Torrential rain hits annually in late October and early November¹.
- Areas with particularly poor infrastructure¹.

1 <https://reliefweb.int/disaster/fl-2016-000114-egy>

2 GLIDE datasets – Asian Disaster Reduction Center (ADRC)



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3:01 PM · Oct 28, 2016 · Twitter for iPhone

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سوبر سل والله الحمد

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برق العشاييا · Oct 28, 2016

الرجال مصر على محدودية الحالة 😂

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@hasanabdullah87

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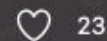
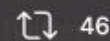
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1



11



4





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شوفو ارتفاع اثار
اللي كان بيهزر لما

اهلا يا مدثر. نتمنى
يمكننا استخدامها



4



23



8



Modasser Sebak
@modasser_sebak

المشهد الكارثي الآن في
#رأس_غارب
شوفو ارتفاع اثار المياه علي
البيوت ،
اللي كان بيهزر لما قولنا ان بيوت
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BBC New... · Oct 28, 2016

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التقطت هذه الصورة بعدستك؟ ومتى؟
وهل يمكننا استخدامها في تغطيتنا؟



1



@... · Oct 31, 2016

Replying to @modasser_sebak

الف سلامه على اهلنا في
#راس_غارب شده وتزول بأمر الله
@modasser_sebak



1

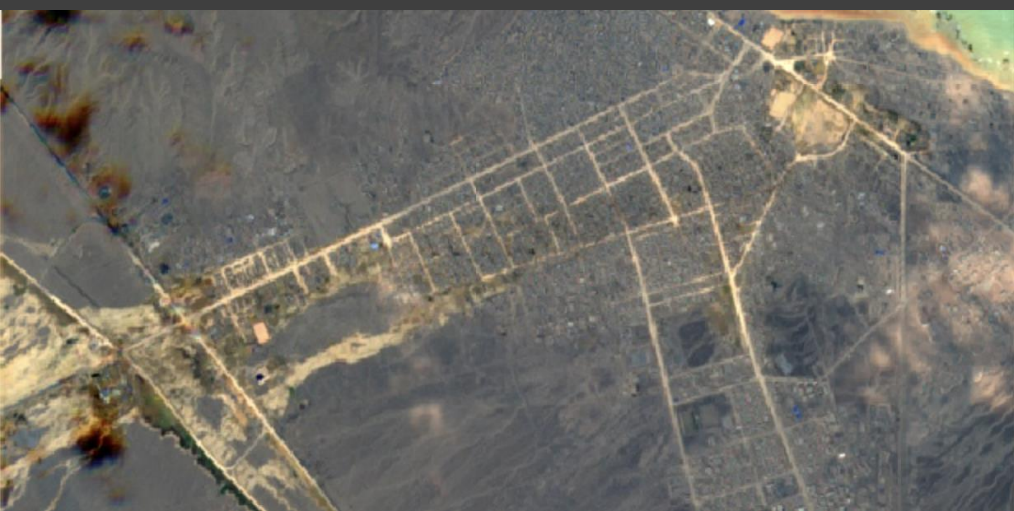


1



2016 Analysis Approach

- Ras Ghareb city damage assessment
- Sentinel-2 Level-1C satellite imagery
- Sensor-invariant atmospheric correction (SIAC) – Feng Yin, Department of Geography at UCL
- Time series comparison between before and after images
- RGB difference and thresholding to detect road damage and sand accumulation
- Quantifying area inundated and estimated population affected



Ras Ghareb, Red Sea Governorate

2016 Initial Damage Estimates

Damage to Ras Ghareb City (km ²)	Damage to roads (km ²)	Damage to Residential roads (km ²)	Damage to Trunk roads (km ²)	Damage to Secondary roads (km ²)	Damage to Unclassified roads (km ²)	Damage to Trunk Link roads (km ²)	Damage to Secondary Link roads (km ²)	Damage to Service roads (km ²)	Damage to Track roads (km ²)
2.29	8	0.43	5.157	0.331	1.562	0.05	0.003	0.34	0.436

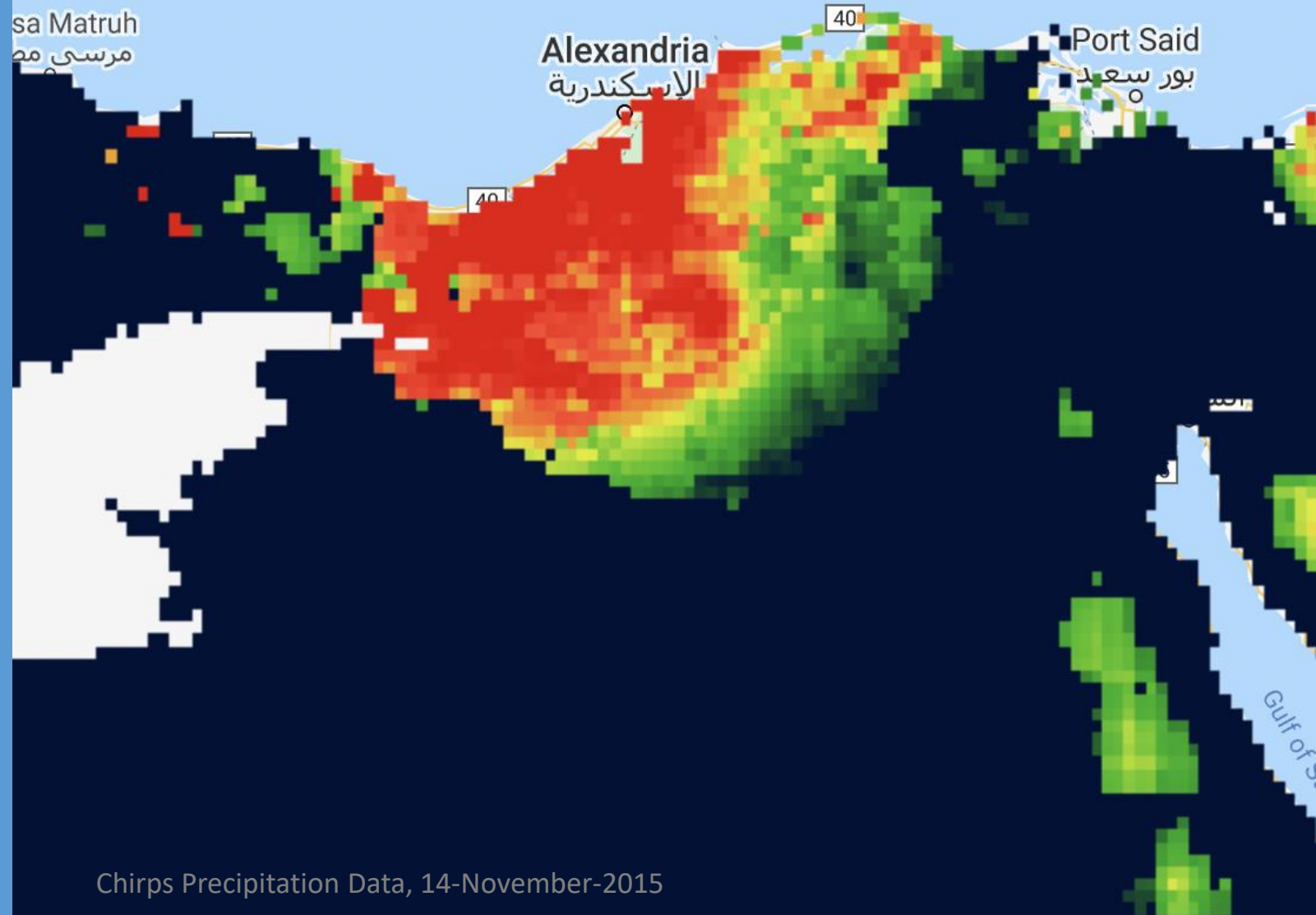
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2015 Flood

- 25-October-2015 till 13-November 2016.
- 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

³ Emergency Events Database (EM-DAT). Centre for Research on the Epidemiology of Disasters (CRED)

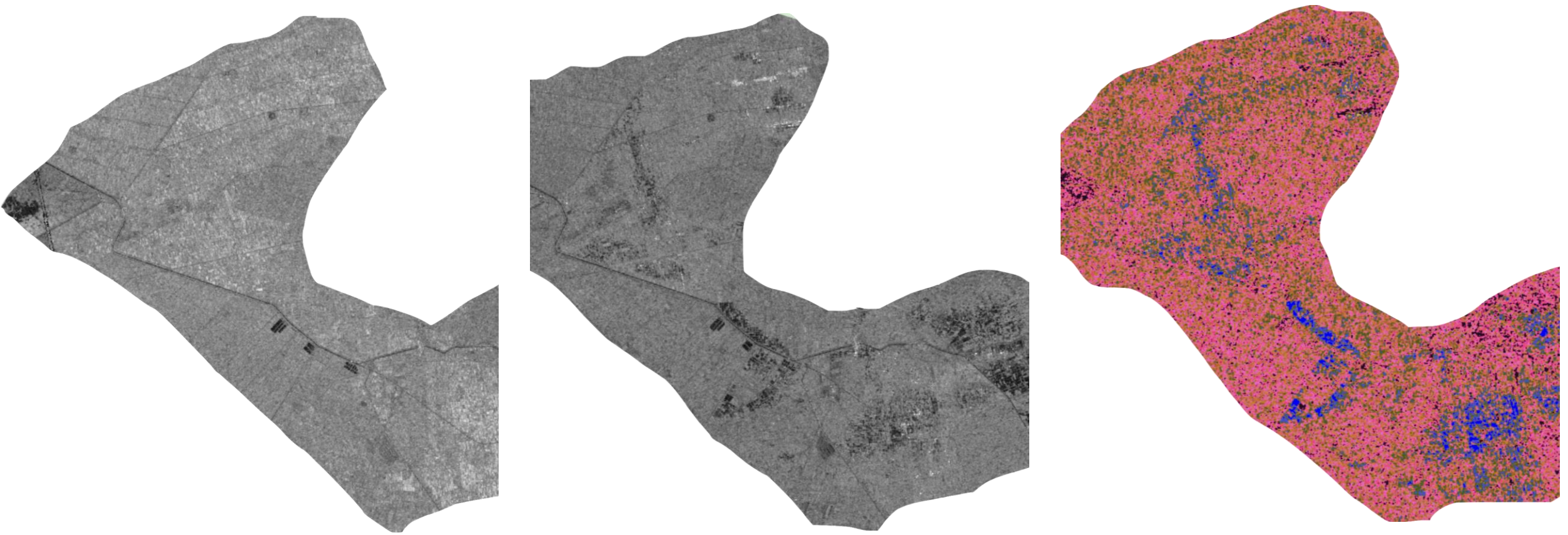
⁴ <http://floodlist.com/africa/egypt-floods-beheira-alexandria-november-2015>



Chirps Precipitation Data, 14-November-2015

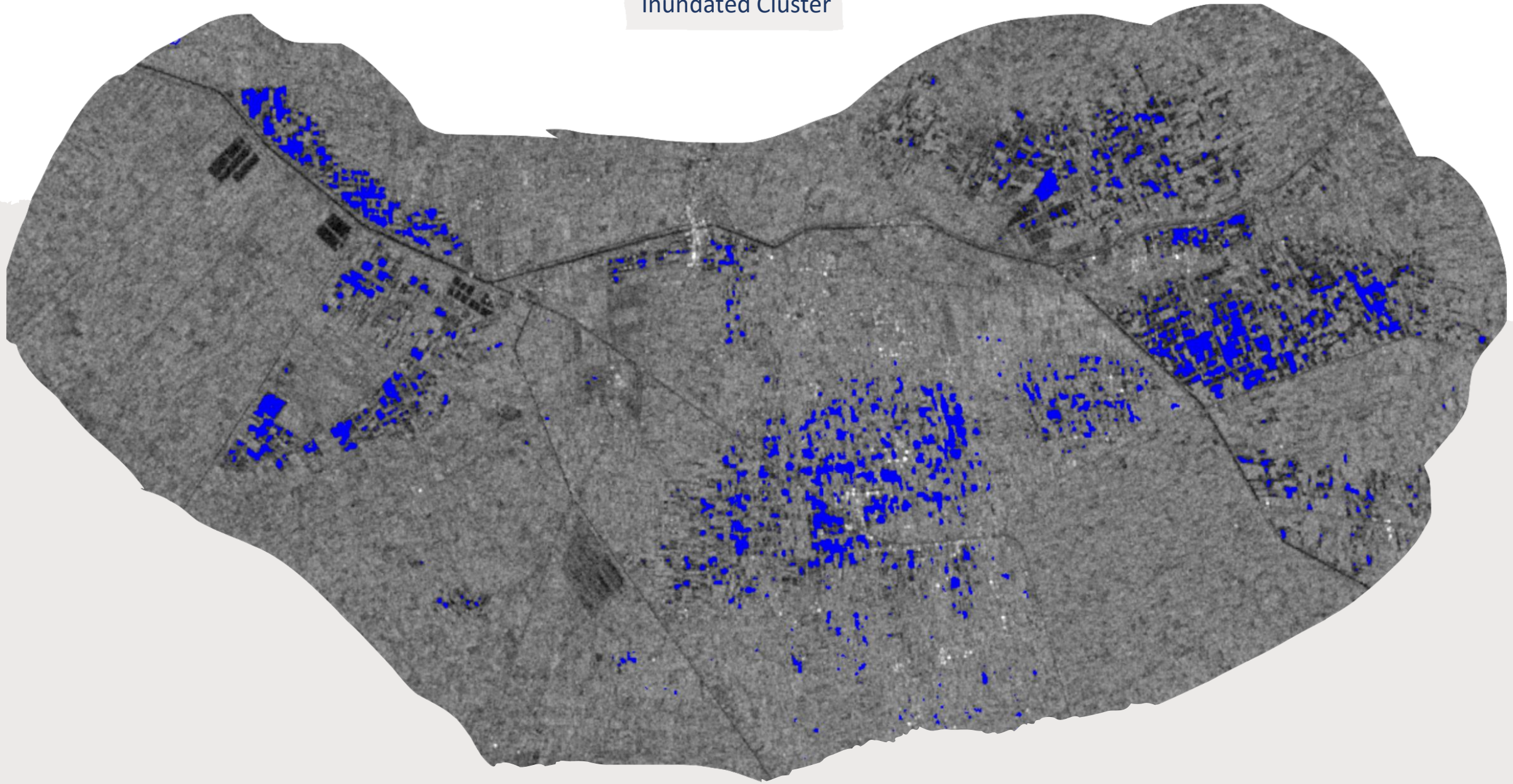
2015 Analysis Approach

- Al Kawm Al Asmar and Al Natron Valley assessment
- SAR Sentinel-1 satellite imagery
- 10-meter resolution
- Time series comparison between before and after images
- SAR image smoothing and speckle filtering (noise reduction)
- K-Means Clustering to cluster inundated hotspots on SAR image difference



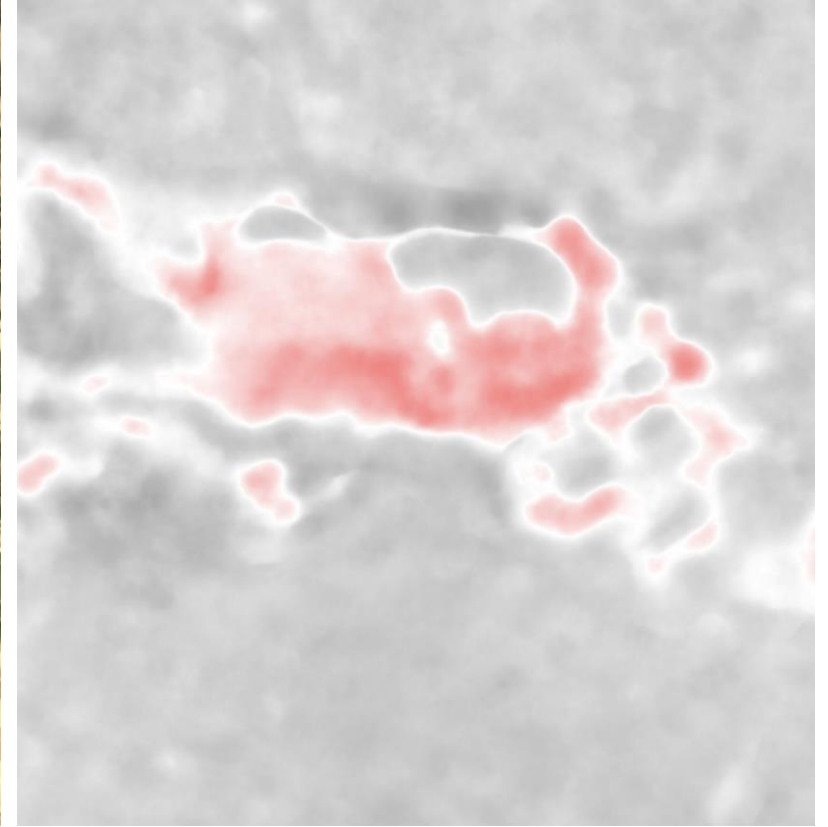
Al Kawm Al Asmar, Beheira Governorate

Inundated Cluster



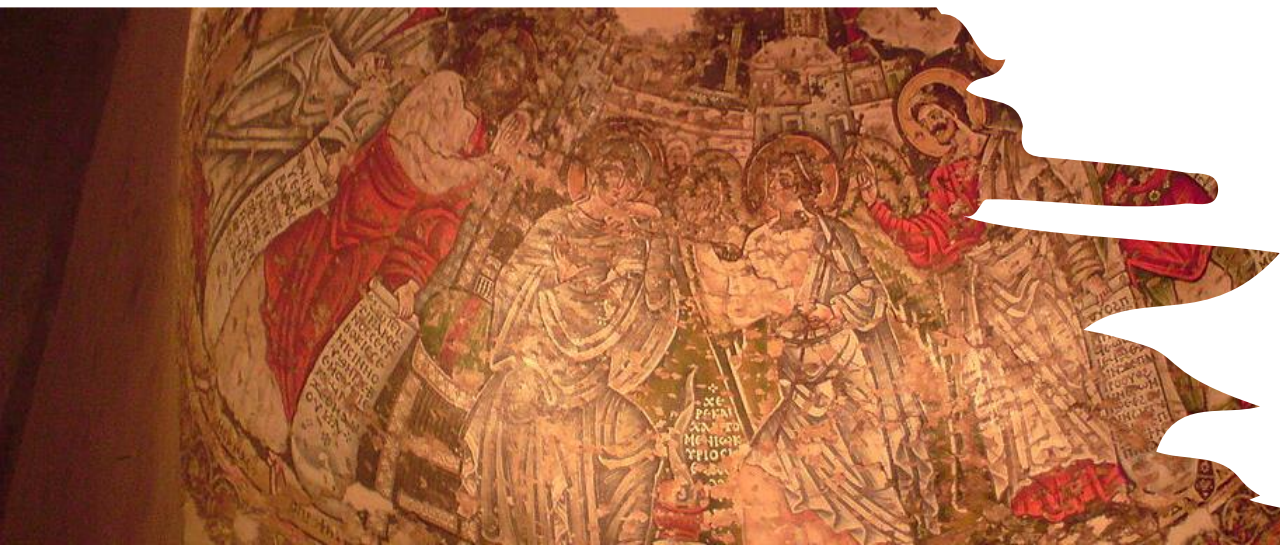
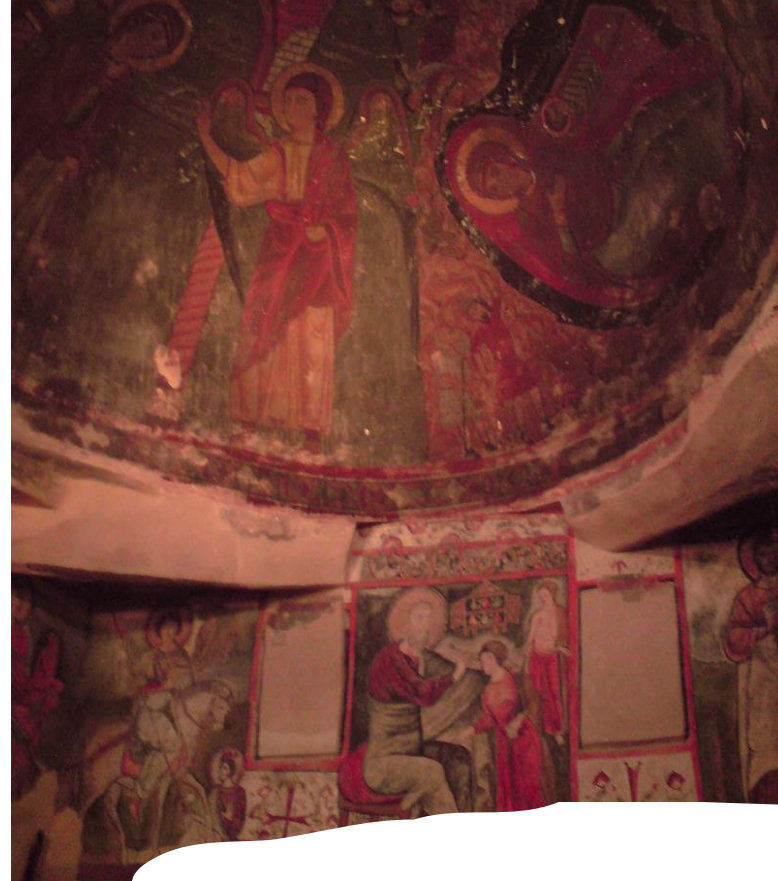
2015 Initial Damage Estimates – Al Kawm Al Asmar

Feature	Value
Location	Al Kawm Al Asmar
Governorate	Beheira and Alexandria
Disaster Year	2015
Urban Area Affected (500m buffer) in km2	57.31
Urban Area Affected (1000m buffer) in km2	153.96
Urban Area Affected (1500m buffer) in km2	249.66
Population Affected (500m buffer)	178162
Population Affected (1000m buffer)	463409
Population Affected (1500m buffer)	734275
Vegetation Area Affected in km2	29.35



Al Natron Valley - Beheira Governorate

Population - Economic damage (fishing farms) - Cultural areas damage (monastic centers)



Historically significant monastic centers
dating back to 2000BC

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Current Direction

Low-Income Settlements

Use of remote sensing imagery coupled with machine learning algorithms to classify low-income settlements

Goal is to determine which low-income settlements are in areas of flood risk



Automatic Identification System (AIS)



All ships have transponders that broadcast information regarding their route, type, location, and other details



This data will be explored for ships within the Suez canal



Objective is to determine if there is an impact from the extreme event on the movement of cargo and tanker ships within the canal



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Thank You