APPLICATION OF INTERNATIONAL EARTH OBSERVATION SUPPORT MECHANISMS FOR OPTIMUM FLOOD RESPONSE IN NIGERIA

by

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Session 5: Effective emergency response
United Nations Workshop on Space-based Technologies for Disaster Risk Reduction
9th December 2022

OUTLINE

- Nigerian Space Programme
- Flood Simulation Exercise Workshop
- International Mechanisms for Disaster Management
- UN-SPIDER Recommended Practices
  - Monitoring Lagdo Dam
- Charter Activation for Floods in Nigeria (2022)
  - Mapping Flood Extent
  - Flood Damage Assessment

THE NIGERIAN SPACE PROGRAMME

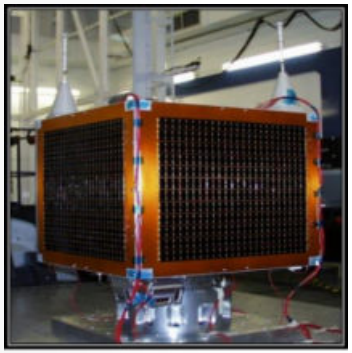
In 1999 the National Space Research and Development Agency (NASRDA) was established.

THE NIGERIAN SPACE PROGRAMME

The National Space Council is the Highest Decision-Making Body for NASRDA and is Chaired by Mr. President with the Vice President as Vice Chairman.

NIGERIA SPACE ASSETS

The National Space Research and Development Agency has launched a total of 6 satellites namely:



Nigeriasat-1 (2003)

NigComSat-1 (2007)

Nigeriasat-2 (2011)

NigeriaSAT-X (2011)

NIGCOMSAT -1R (2011)

Nigeria EduSat-1 (2017)

FLOOD SIMULATION EXERCISE

(Emergency Operation Centre)

NASRDA/UN-SPIDER/ZFL Interinstitutional Workshop on "The Use of Space-Based Information for Flood Response and Early Warning" 12th to 15th September 2022

Total Number Of Organizations: 30

Total Number Of Participants: 104

Simulation Of Transboundary River Flood

Group 1: Search, Rescue and Shelter Provision: FMHADMSD, NEMA, NASRDA etc

Group 2: Logistics: Armed Forces

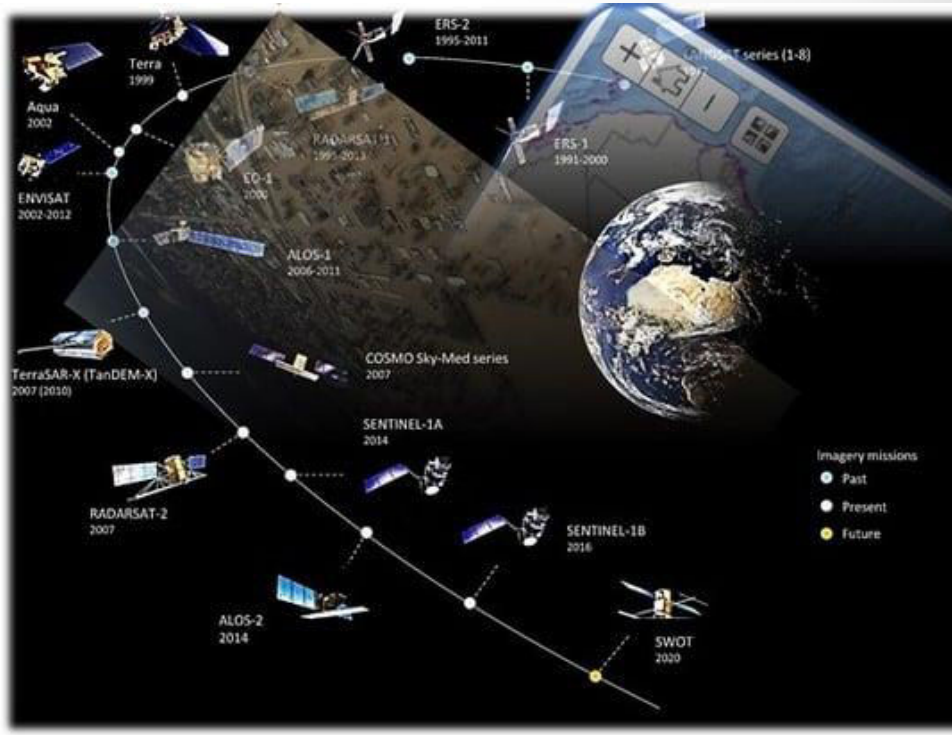
Group 3: Impacts: NOSDRA, Works, etc

Group 4: External Support: International Community, World Bank etc

International Mechanisms for Disaster Management

International Mechanisms for Disaster Management

- UN-SPIDER Recommended Practice : Global
- International Charter Space and Major Disasters : Global
- Copernicus Emergency Management Service (EMS): Global
- Emergency Telecommunications Cluster (ETC): Global
- Sentinel Asia: Asia –Pacific Region
- SERVIR: Africa, Mesoamerica, Himalaya
- UNITAR Operational Satellite Applications Programme (UNOSAT): Global



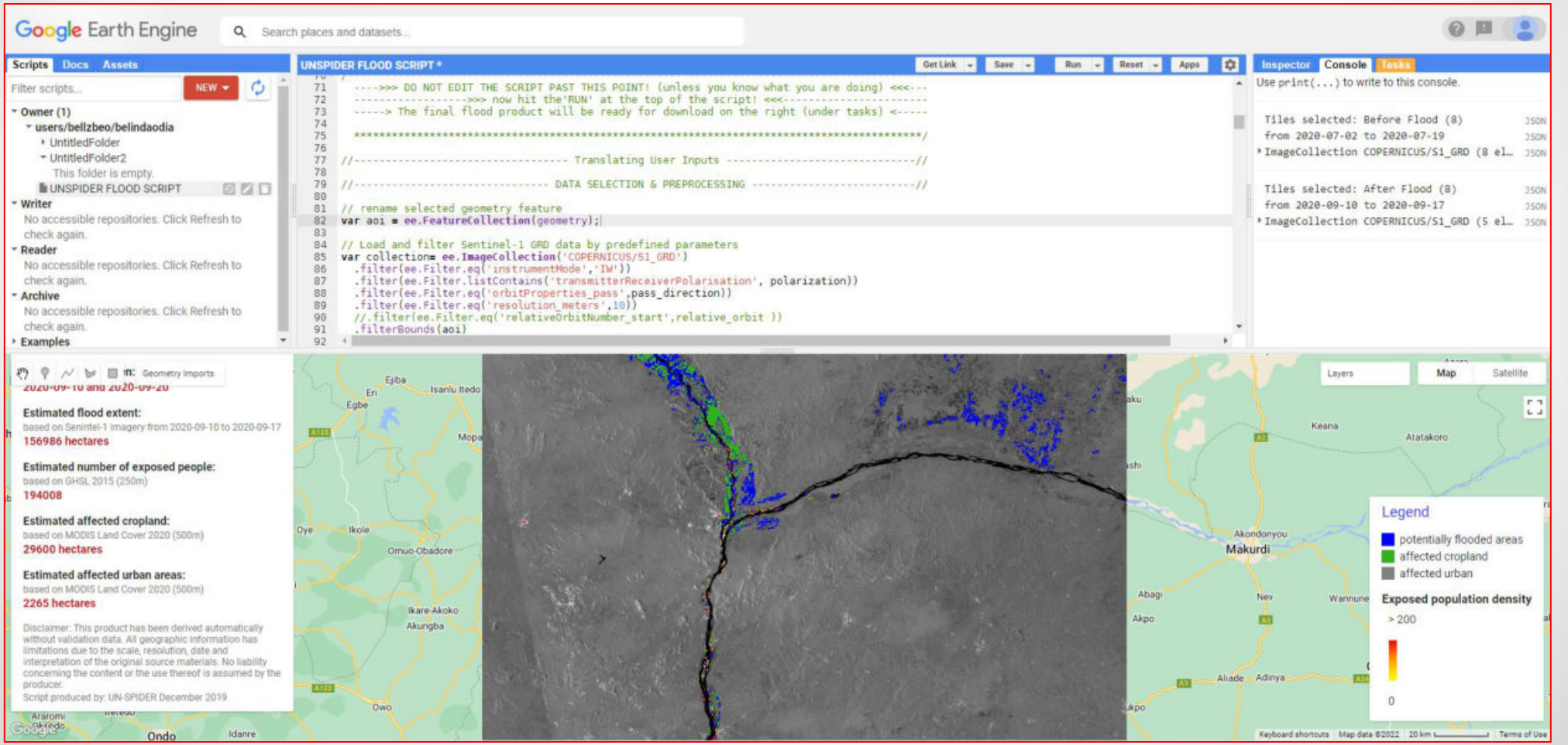
Source: remotesensing-10-01230-ag-550.jpg (550×413) (mdpi.com)

UN-SPIDER Recommended Practice: Flood Mapping and Damage Assessment Using Sentinel-1 SAR Data in Google Earth Engine

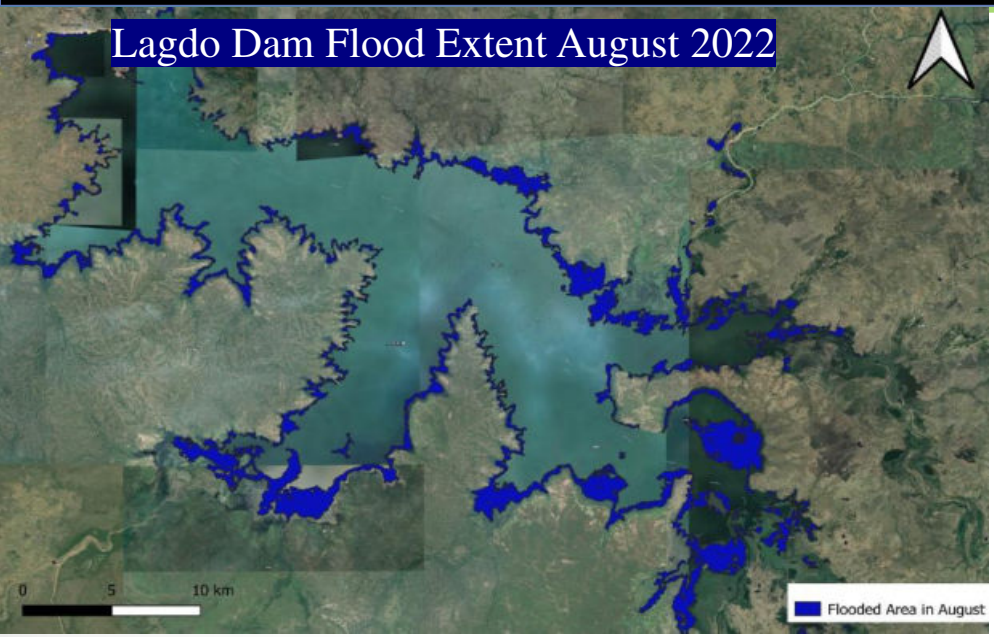
Early Warning

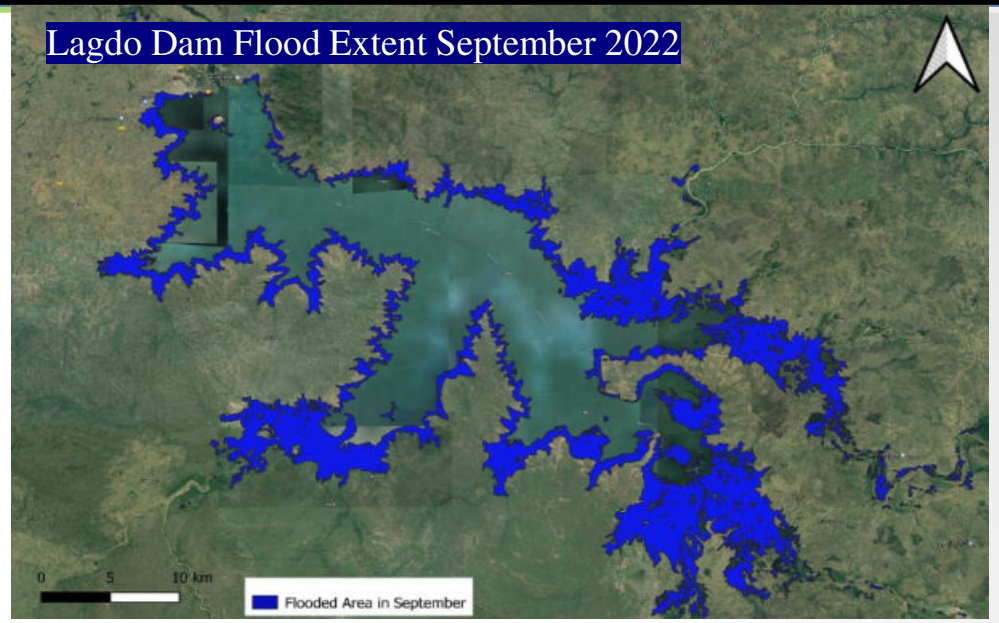
- SAR-based flood mapping is a standard and reliable method for determining the extent of major floods.
- This Recommended Practice aims to be a simple and quick tool for users of any experience level to create information about flooding.
- The code is to be input into Google Earth Engine and run according to the area and dates specified by the user.
- After the process has run, the code will create a delineation of flood extent using SAR data and change detection methodology.
- The code will also produce information about cropland, urban areas and population density exposed.

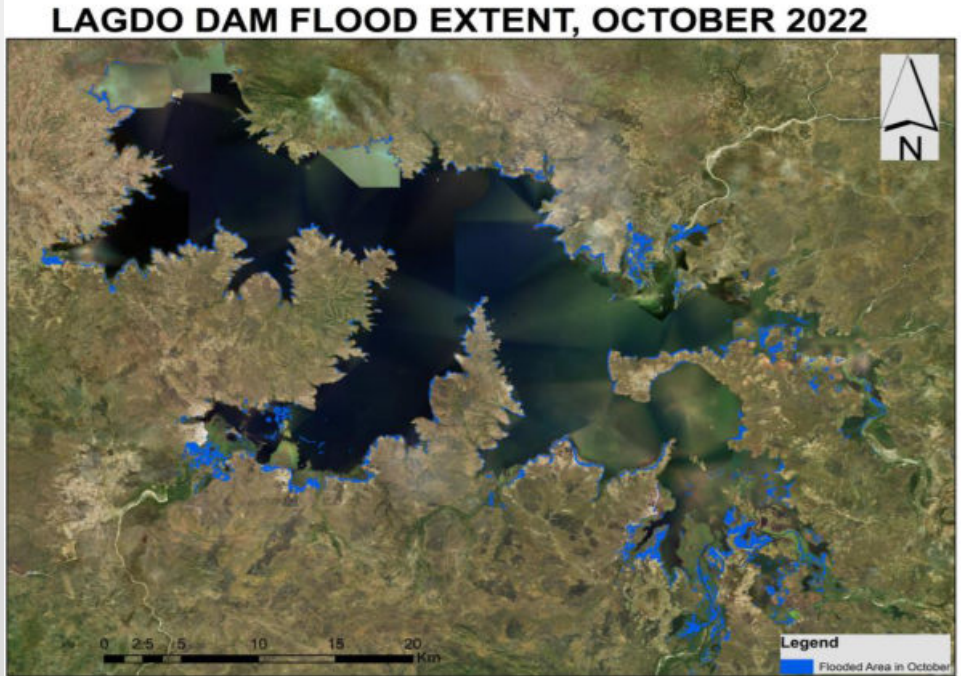
UN-SPIDER Recommended Practice: Flood Mapping and Damage Assessment Using Sentinel-1 SAR Data in Google Earth Engine

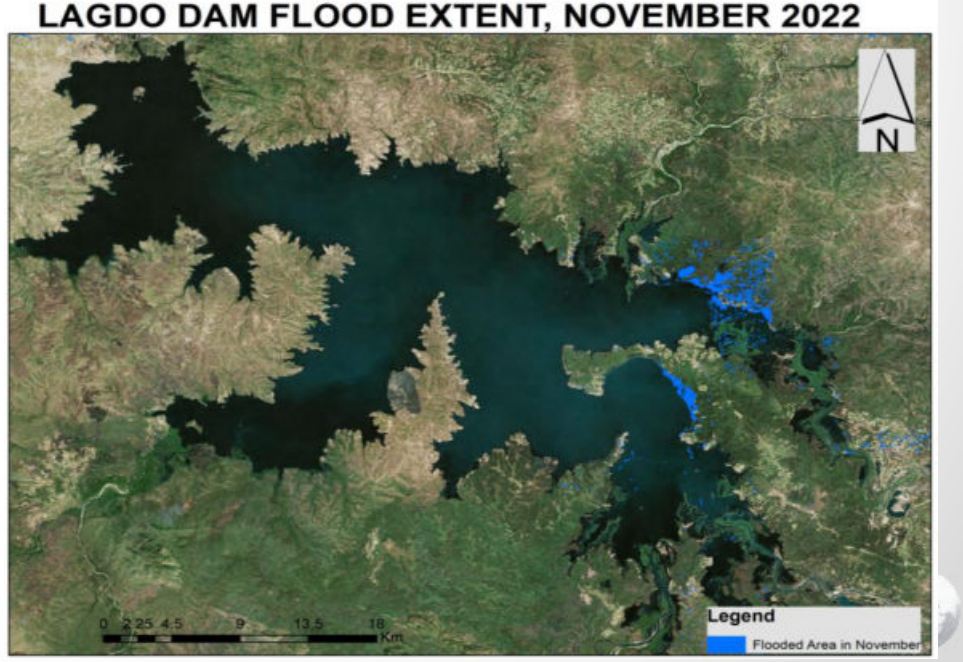


MONITORING LAGDO DAM

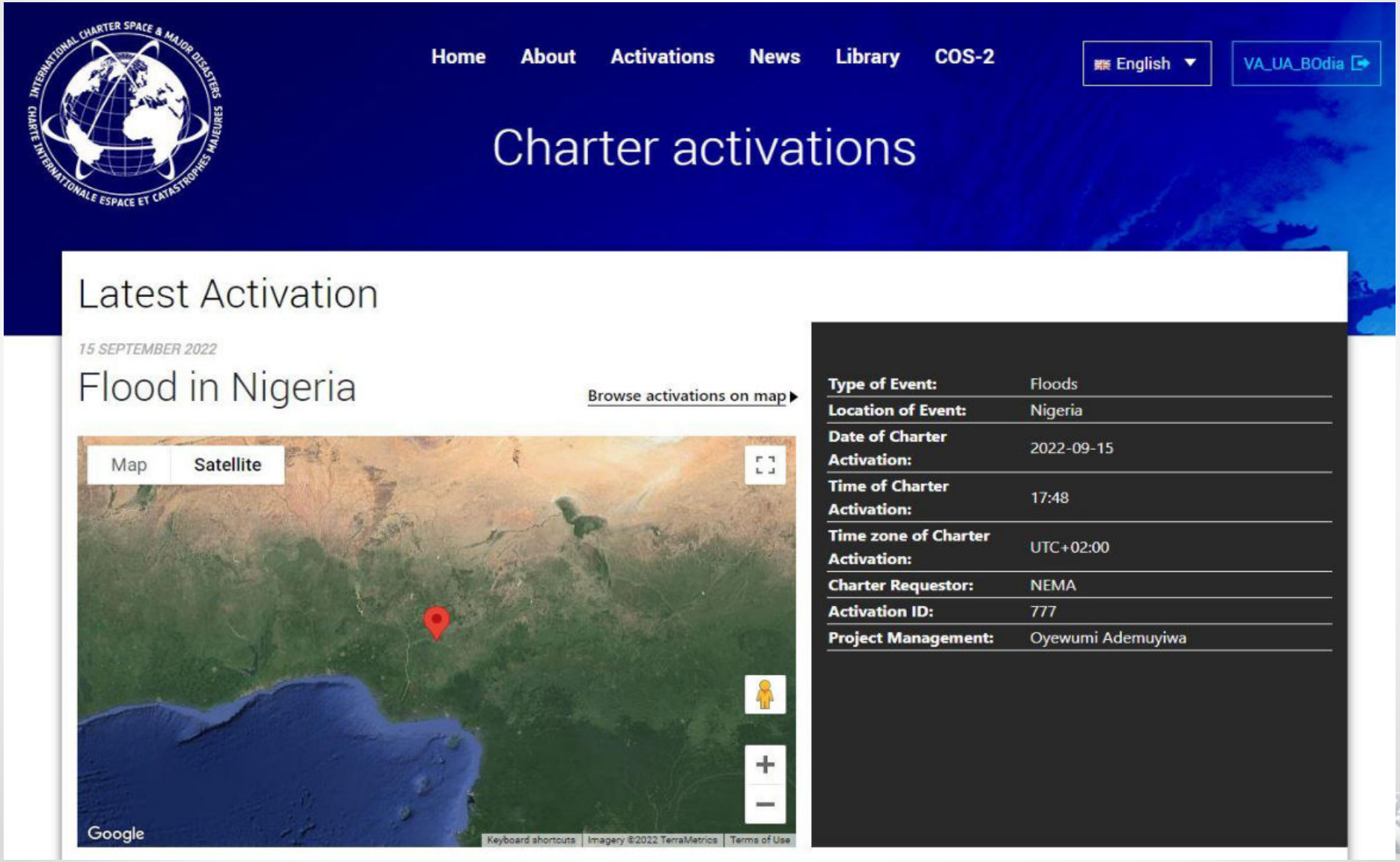




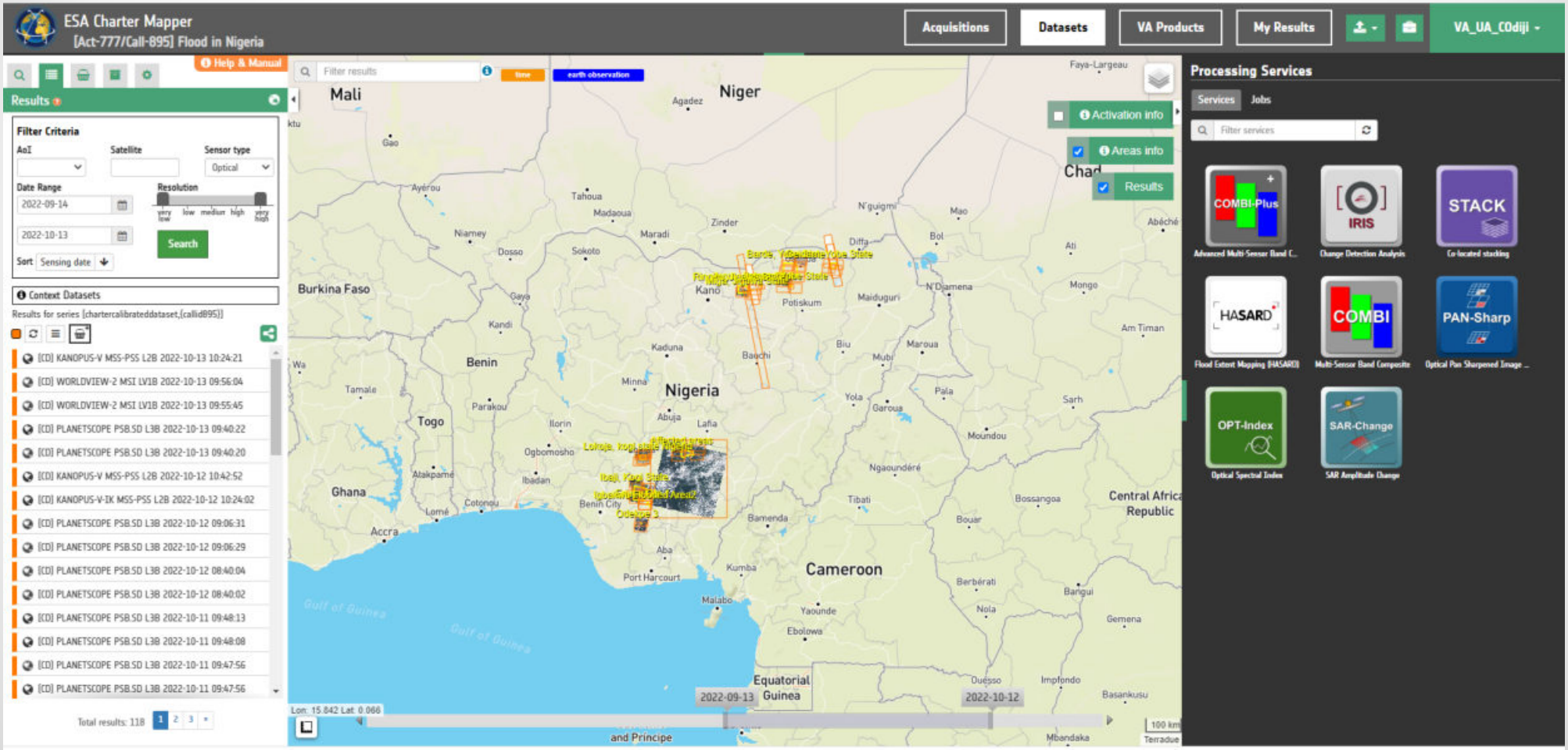




CHARTER ACTIVATION FOR FLOOD IN NIGERIA

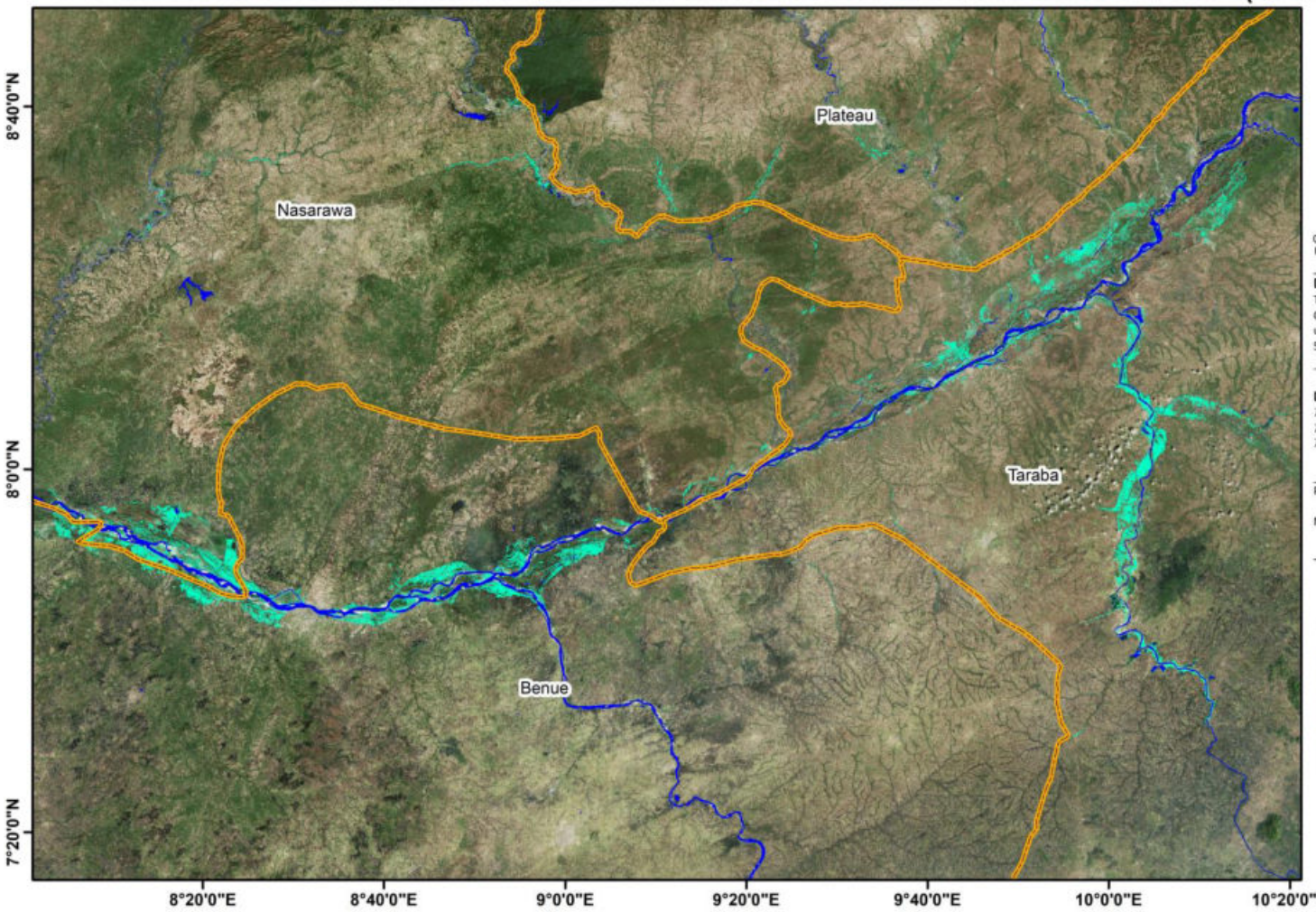


CHARTER ACTIVATION FOR FLOOD IN NIGERIA



MAPPING FLOOD EXTENT

FLOOD EXTENT ALONG THE RIVER BENUE CHANNEL IN BENUE AND TARABA STATE (UPSTREAM LOKO)



0 10 20 40 60 80 Km

Description

The map shows the flooded areas in Benue and Taraba State on the River Benue Channel upstream Loko. The HASARD algorithm was used to delineate flooded areas using a reference scene of 2022-09-14 and after event scene of 2022-09-26 of Sentinel-1 radar data.

Data sources

- Modified Copernicus Senintel-1 imagery (2022).
- Administrative boundary from OSGOF
- Background: Bing, Microsoft (2022)

Projection: UTM 31N, Datum: WGS 84

Map produced by National Space Research and Development Agency

Legend

- Built-up
- Waterbody
- Flooded Extent
- State Boundary

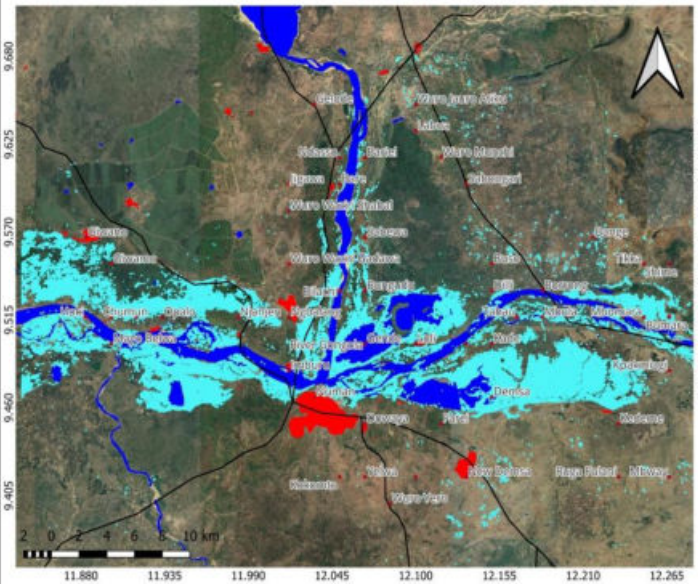
N

Microsoft Bing

esa

NEMA

FLOOD EXTENT BETWEEN IMBURU TO KABERE COMMUNITY



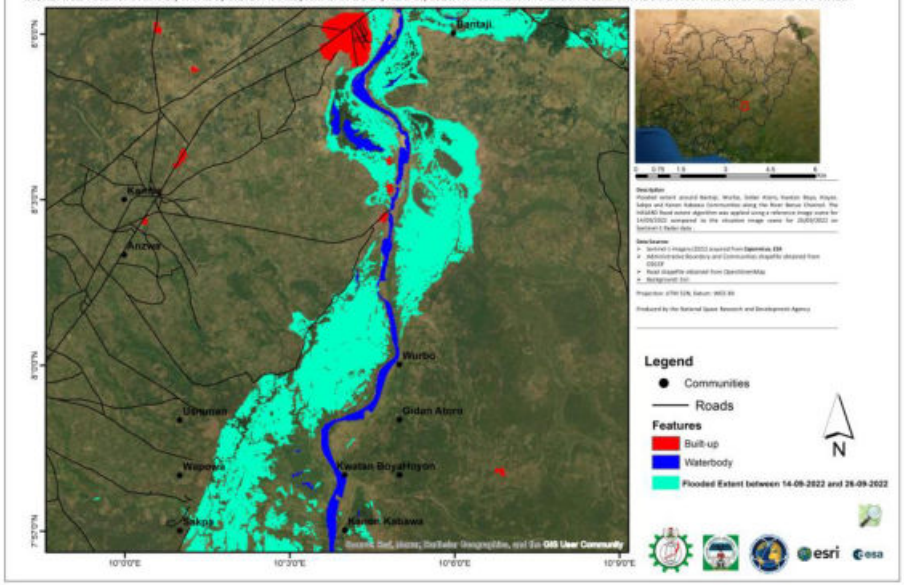
INTERPRETATION

Situation report of the flood extent from Imburu to Kabare community based on based on Senintel-1 imagery from 2022-09-04 to 2022-09-09 revealed that 15476 hectares of the channel was inundated, 6149 hectares of cropland, and 3798 people were exposed.

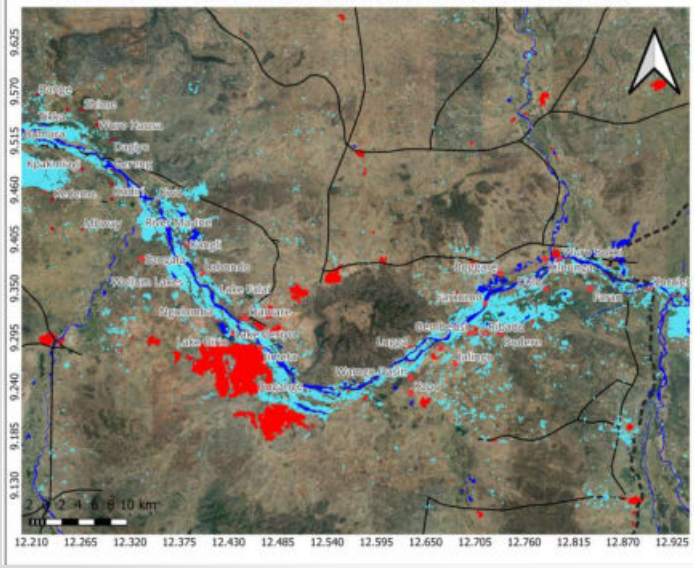
DATA SOURCES

- Senintel-1 imagery (2022). Acquired on September 10, 2022 provided by Europe Space Agency.
- Google Script Engine producedUNSPIDER, 2019.
-MODIS Land Cover 2020 (500m)
- Population data (GHSL) provided by European Commission, Joint Research Centre (JRC): Columbia University, Centre for International Earth Science Information Network (CIESIN)

INUNDATED AREAS: BANTAJI, WURBO, GIDAN ATORO, KWATAN BOYA, HOYAN, SAKPA AND KANON KABAWA COMMUNITIES ALONG THE RIVER BENUE CHANNEL



FLOOD EXTENT IN YOLA AND SURROUNDING COMMUNITIES



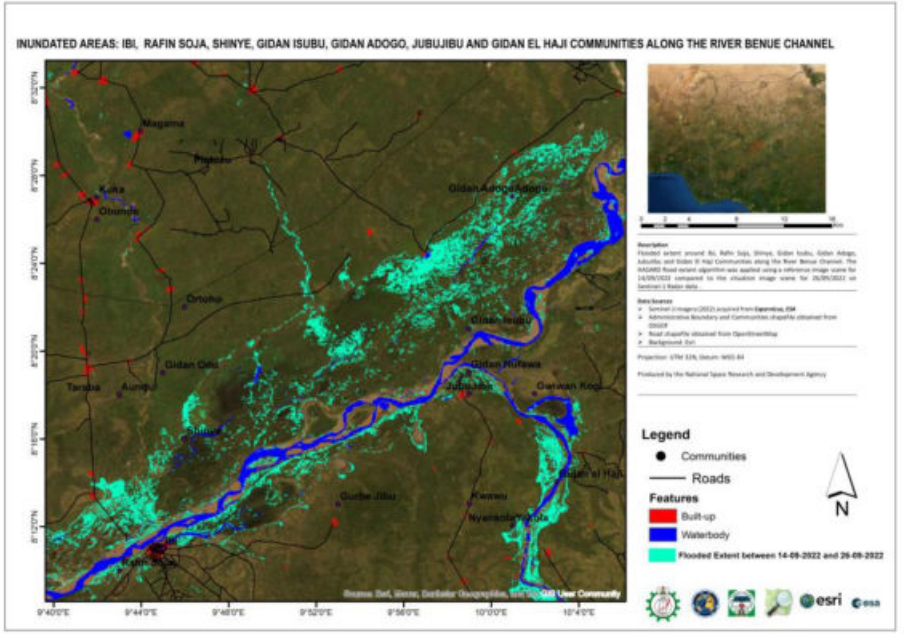
INTERPRETATION

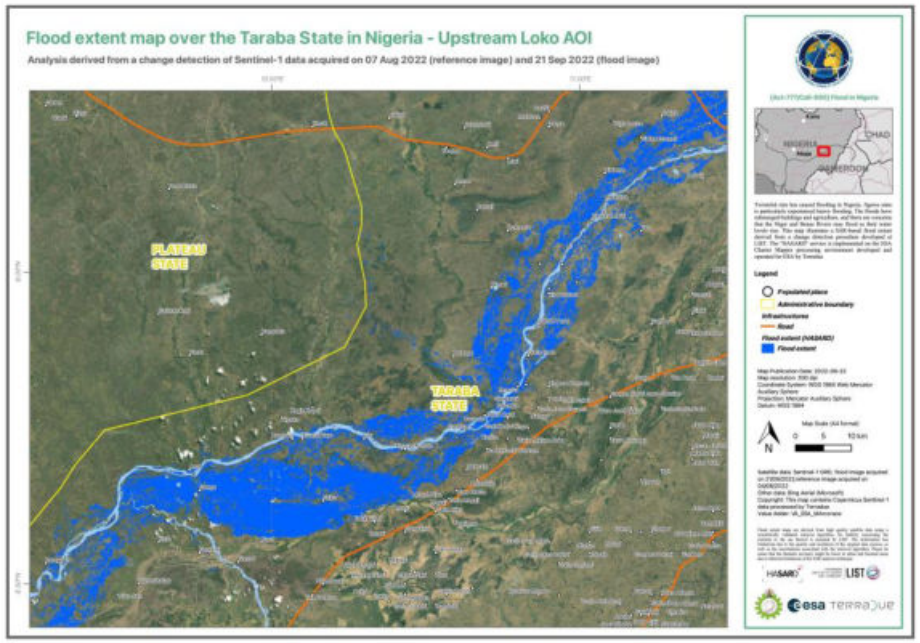
Situation report of the flood extent in Yola and surrounding communities based on based on Senintel-1 imagery from 2022-09-04 to 2022-09-09 revealed that 39667 hectares of the channel was inundated, 6878 hectares of cropland, and 43653 people were exposed.

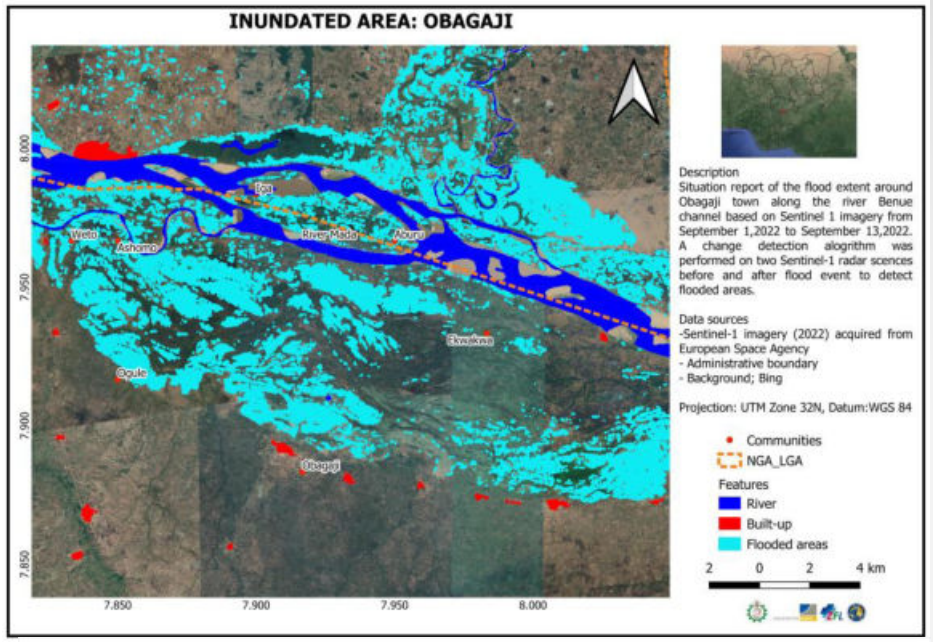
DATA SOURCES

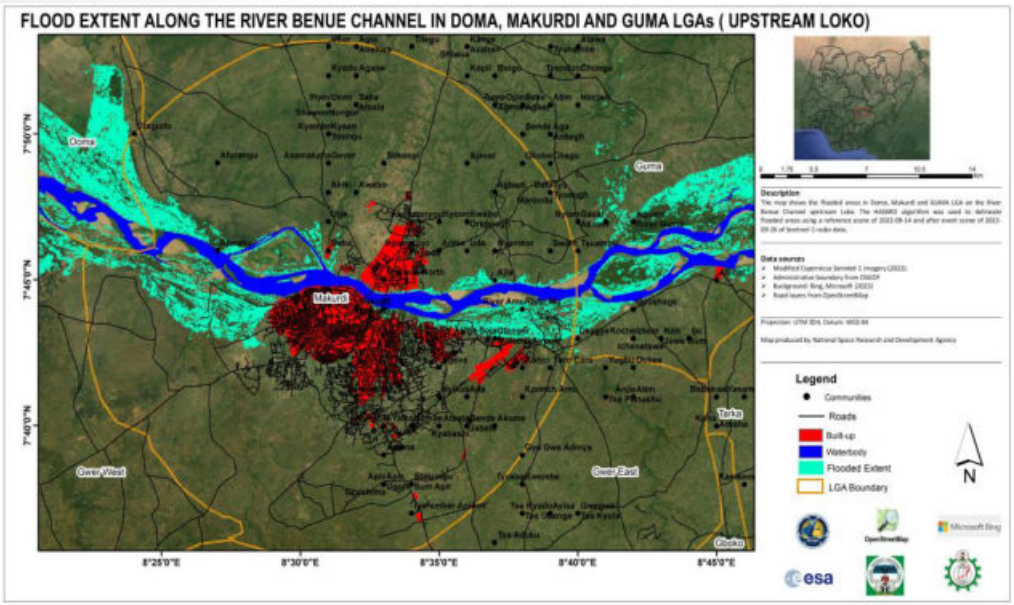
- Senintel-1 imagery (2022). Acquired on September 10, 2022 provided by Europe Space Agency.
- Google Script Engine producedUNSPIDER, 2019.
-MODIS Land Cover 2020 (500m)
- Population data (GHSL) provided by European Commission, Joint Research Centre (JRC): Columbia University, Centre for International Earth Science Information Network (CIESIN)

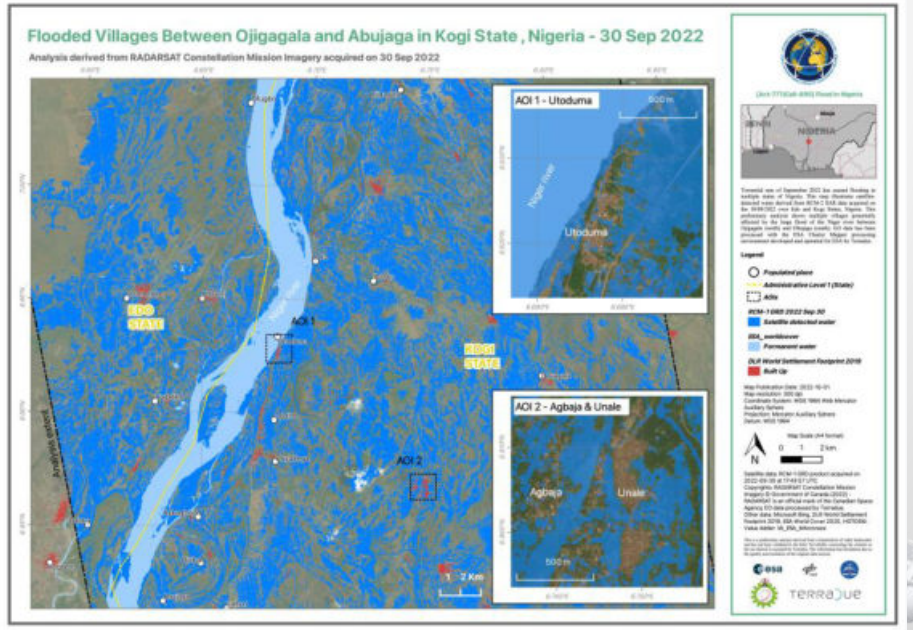
INUNDATED AREAS: IBI, RAFIN SOJA, SHINYE, GIDAN ISUBU, GIDAN ADOGO, JUBUJIBU AND GIDAN EL HAJI COMMUNITIES ALONG THE RIVER BENUE CHANNEL



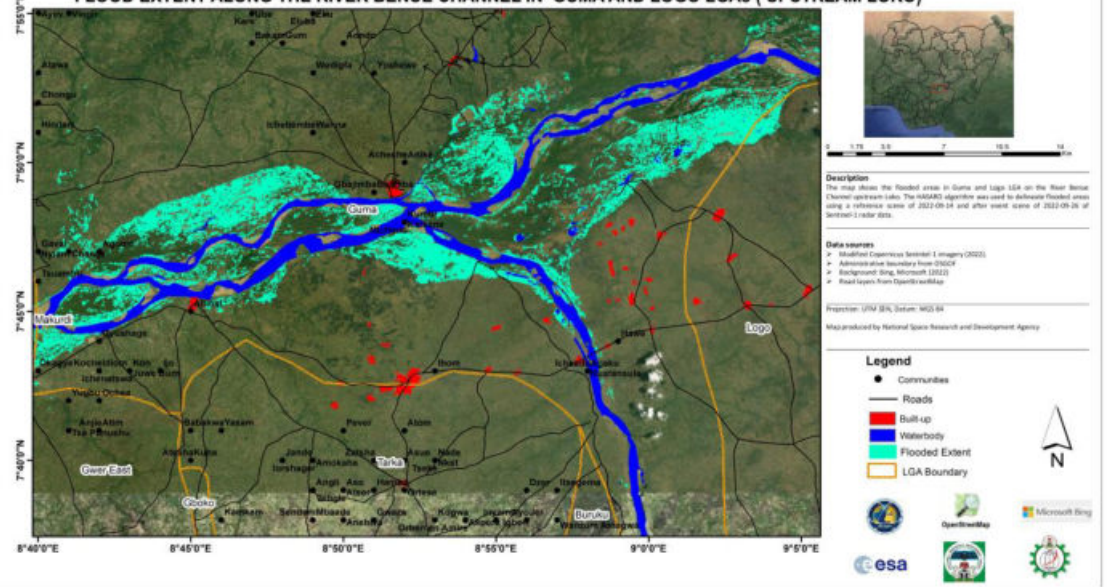

Flood extent map over the Taraba State in Nigeria - Upstream Loko AOI
Analysis derived from a change detection of Sentinel-1 data acquired on 07 Aug 2022 (reference image) and 21 Sep 2022 (flood image)
PLATEAU STATE
TARABA STATE
Legend
Flood extent
Flood extent (HASARD)
Road
Infrastructure
Administrative boundary
Populated place
Flood extent
HASARD
LIST
esa
terrajue


INUNDATED AREA: OBAGAJI
Ibai
Weto
Ashomo
River Mada
Aburu
Ekwukwu
Ogule
Obagaji
8.000
7.950
7.900
7.850
7.850
7.900
7.950
8.000
Description
Situation report of the flood extent around Obagaji town along the river Benue channel based on Sentinel 1 imagery from September 1,2022 to September 13,2022. A change detection alogrithm was performed on two Sentinel-1 radar scences before and after flood event to detect flooded areas.
Data sources
-Sentinel-1 imagery (2022) acquired from European Space Agency
- Administrative boundary
- Background; Bing
Projection: UTM Zone 32N, Datum:WGS 84
Communities
NGA_LGA
Features
River
Built-up
Flooded areas
2 0 2 4 km

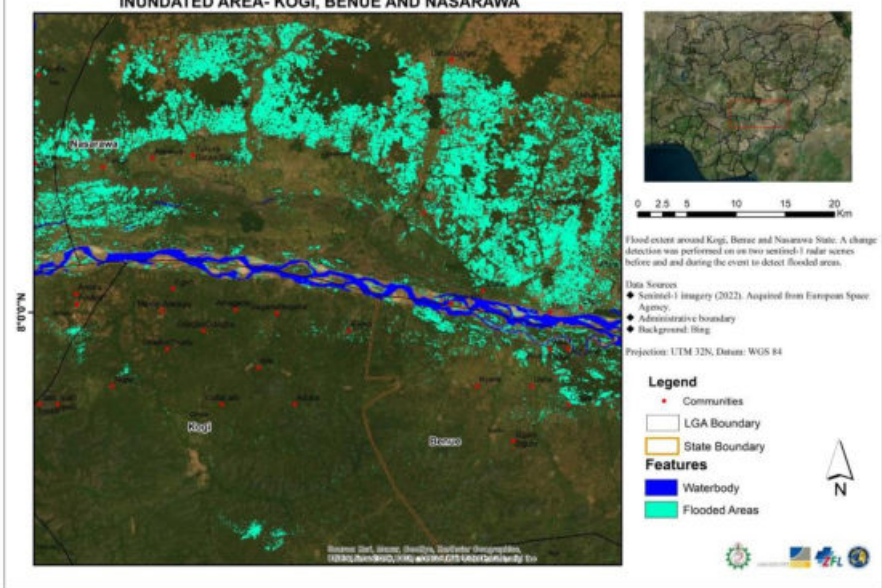

FLOOD EXTENT ALONG THE RIVER BENUE CHANNEL IN DOMA, MAKURDI AND GUMA LGAs (UPSTREAM LOKO)
Doma
Guma
Makurdi
Gboko
Tarka
Gwer West
Gwer East
8°25'0"E
8°30'0"E
8°35'0"E
8°40'0"E
8°45'0"E
Description
Data sources
Legend
Communities
Roads
Built-up
Waterbody
Flooded Extent
LGA Boundary
N
esa


Flooded Villages Between Ojigagala and Abujaga in Kogi State , Nigeria - 30 Sep 2022
Analysis derived from RADARSAT Constellation Mission Imagery acquired on 30 Sep 2022
AOI 1 - Utoduma
AOI 2 - Agbaja & Unale
AOI 1
AOI 2
Utoduma
Agbaja
Unale
Niger River
Analysis extent
EDO STATE
KOGI STATE
Legend
Populated place
Admin
Satellite detected water
Permanent water
Built-up
esa
terrajue

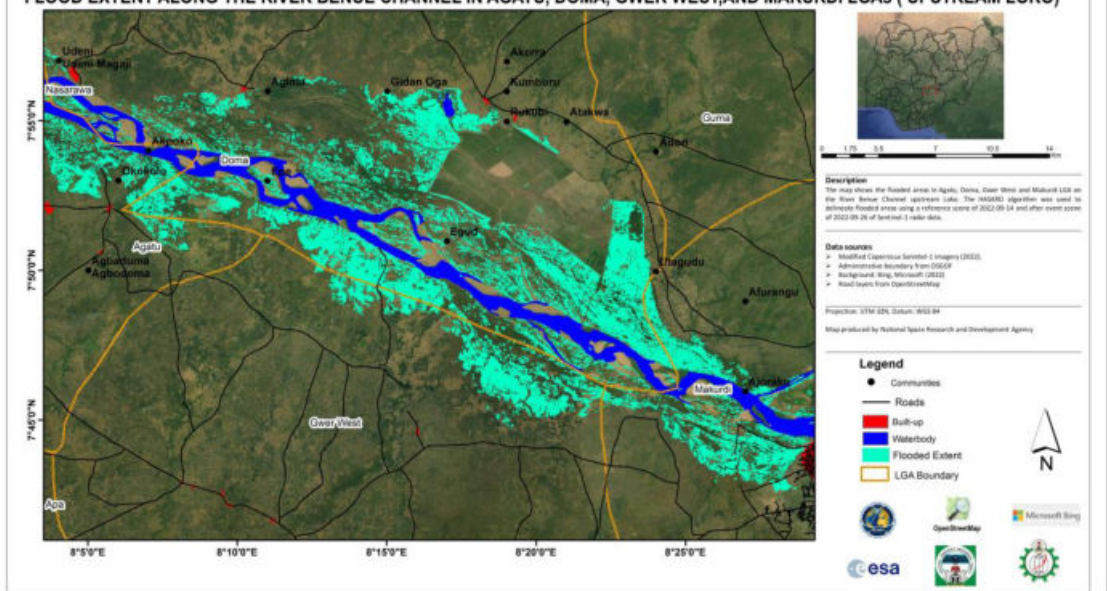
FLOOD EXTENT ALONG THE RIVER BENUE CHANNEL IN GUMA AND LOGO LGAs (UPSTREAM LOKO)



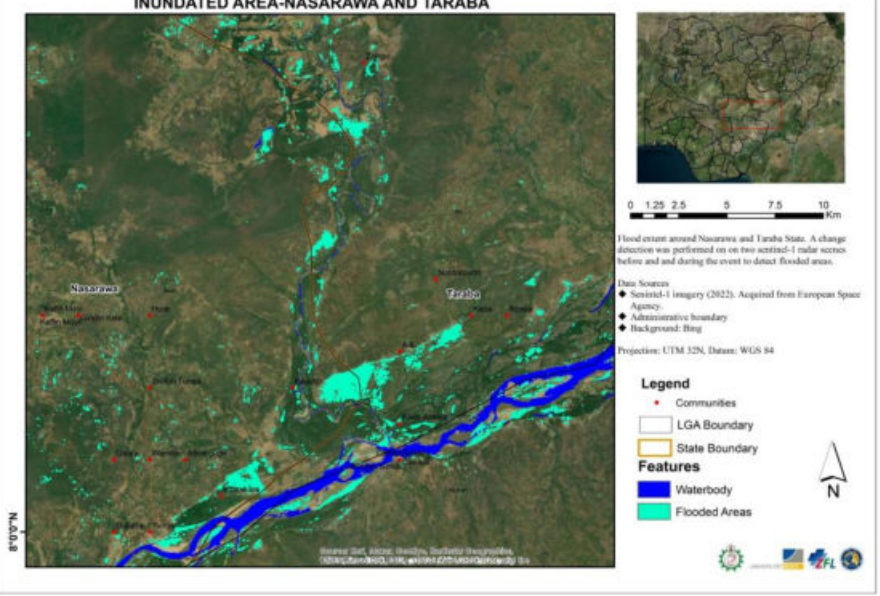
INUNDATED AREA- KOGI, BENUE AND NASARAWA



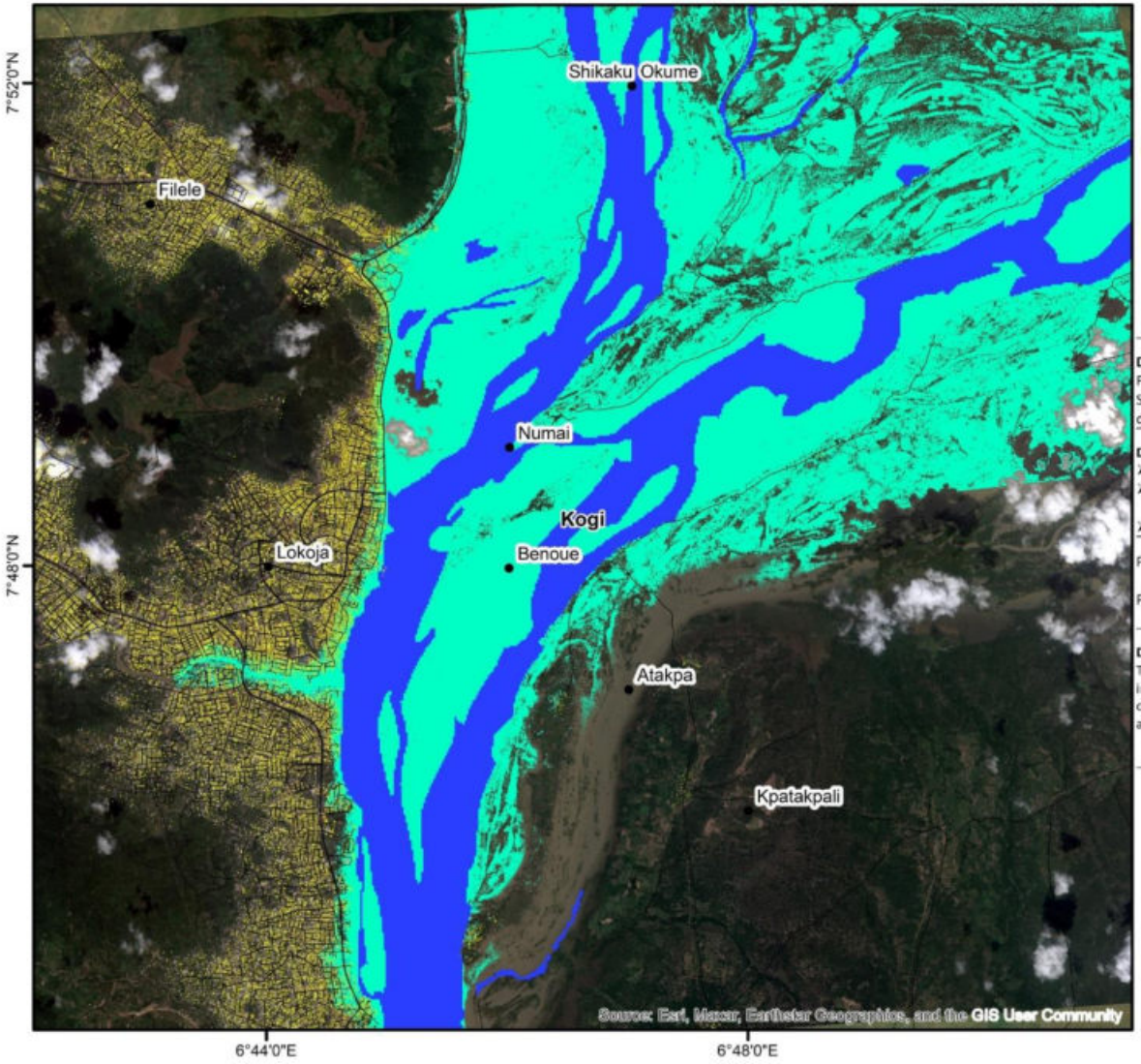
FLOOD EXTENT ALONG THE RIVER BENUE CHANNEL IN AGATU, DOMA, GWER WEST,AND MAKURDI LGAs (UPSTREAM LOKO)

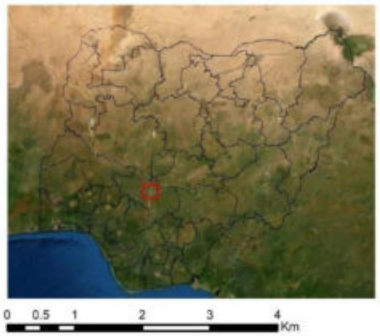


INUNDATED AREA-NASARAWA AND TARABA



SYNOPTIC VIEW OF THE FLOOD EXTENT IN LOKOJA AS OF 4-10-2022





Description

Flooded extent of Lokoja, Kogi state as of 4-10-2022. The Advanced Multi-Sensor Band Composite was applied on the Kompsat-3 satellite imagery to delineate the flood extent.

Data Sources

- Kompsat-3 imagery (4-10-2022)
- Administrative boundary, Communities and Roads shapefile obtained from OSGOF
- Background: Kompsat-3, ESRI

Projection: UTM 32N, Datum: WGS 84

Produced by the National Space Research and Development Agency

Disclaimer

This product has been derived automatically without validation data. All geographic information has limitation due to the scale, resolution, date and interpretation of the original source materials. No liability concerning the content or the use thereof is assumed by the producer.

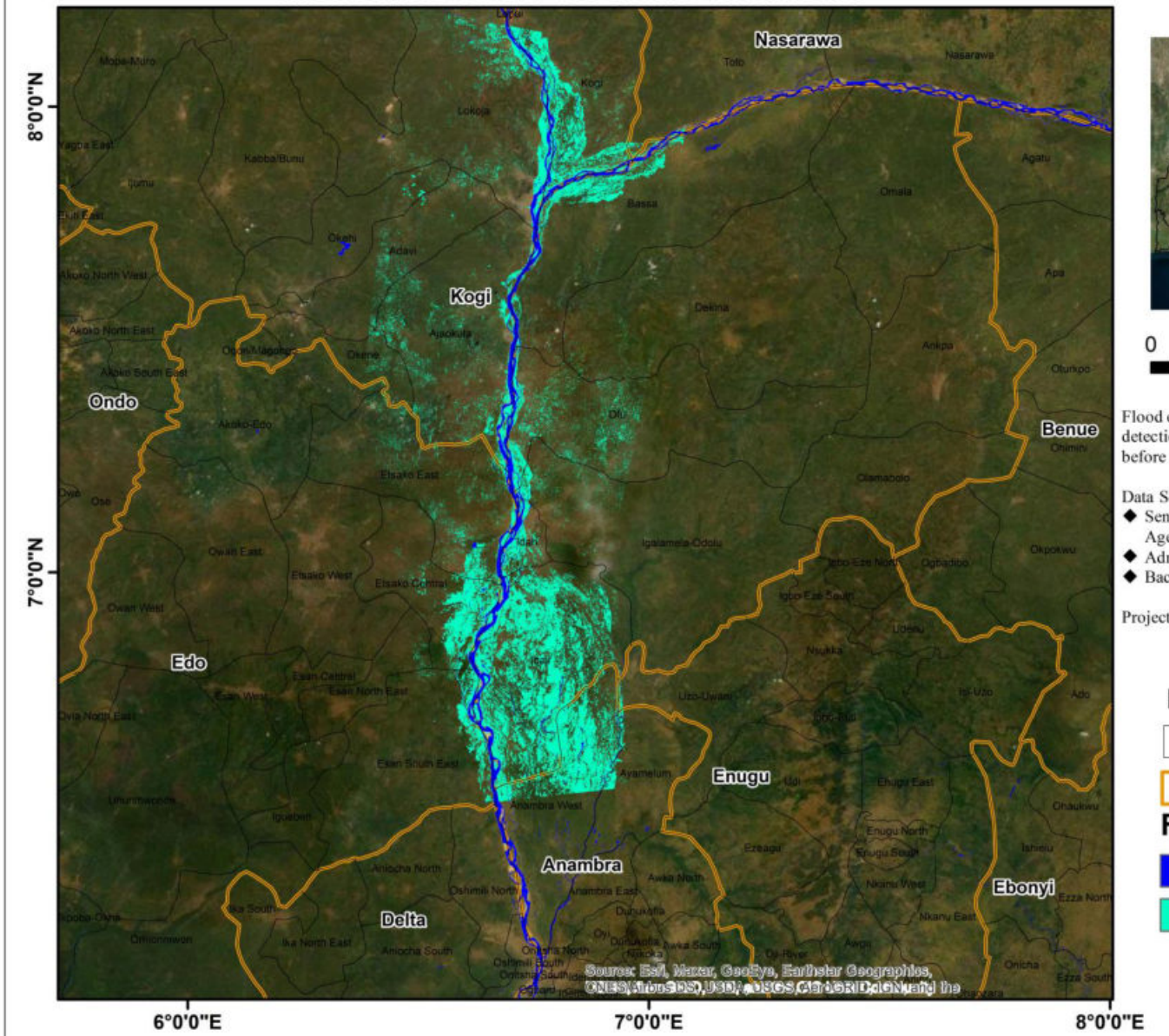
Legend

- Roads
- River
- Flooded Extent 04-10-2022

N

esri esa

INUNDATED AREA- KOGI AND ANAMBRA



0 10 20 40 60 80 Km

Flood extent around Kogi, and Anambra State. A change detection was performed on on two sentinel-1 radar scenes before and and during the event to detect flooded areas.

Data Sources
- Senintel-1 imagery (2022). Acquired from European Space Agency.
- Administrative boundary
- Background: Bing

Projection: UTM 31N, Datum: WGS 84

Legend

LGA Boundary

State Boundary

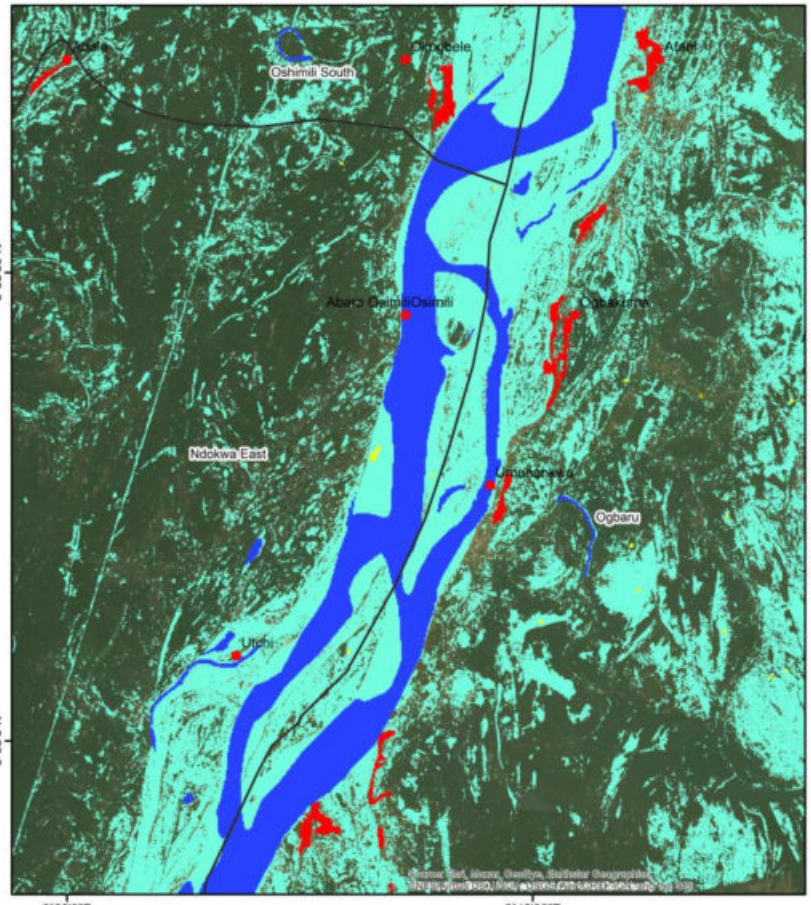
Features

Waterbody

Flooded Areas

N

FLOOD EXTENT IN NDOKWA EAST, OSHIMILI SOUTH AND OGBARU LGA AS OF 12 OCTOBER, 2022



0 0.75 1.5 3 4.5 6 Km

INTERPRETATION

Situation report of the flood extent in Ndokwa East, Oshimili South and Ogbaru LGA as of October 12, 2022

DATA SOURCES

- RCM-1 GRD imagery (2022). Acquired on October 12, 2022 provided by CSA.
- Administrative Boundary provided by OSGOF
- Background image: ESRI

Projection: UTM 32N, Datum: WGS 84

Map produced by National Space Research and Development Agency

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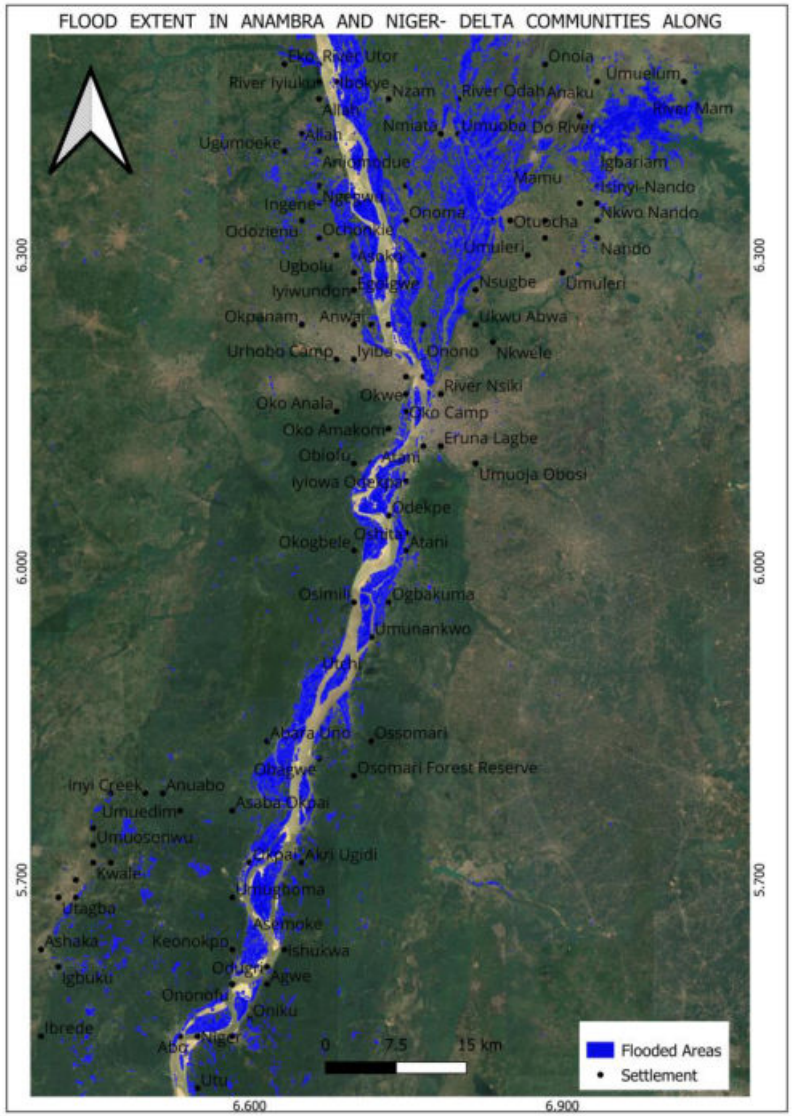
Legend

- Settlement
- LGA Boundary
- Flooded Extent
- Waterbody
- Built-up

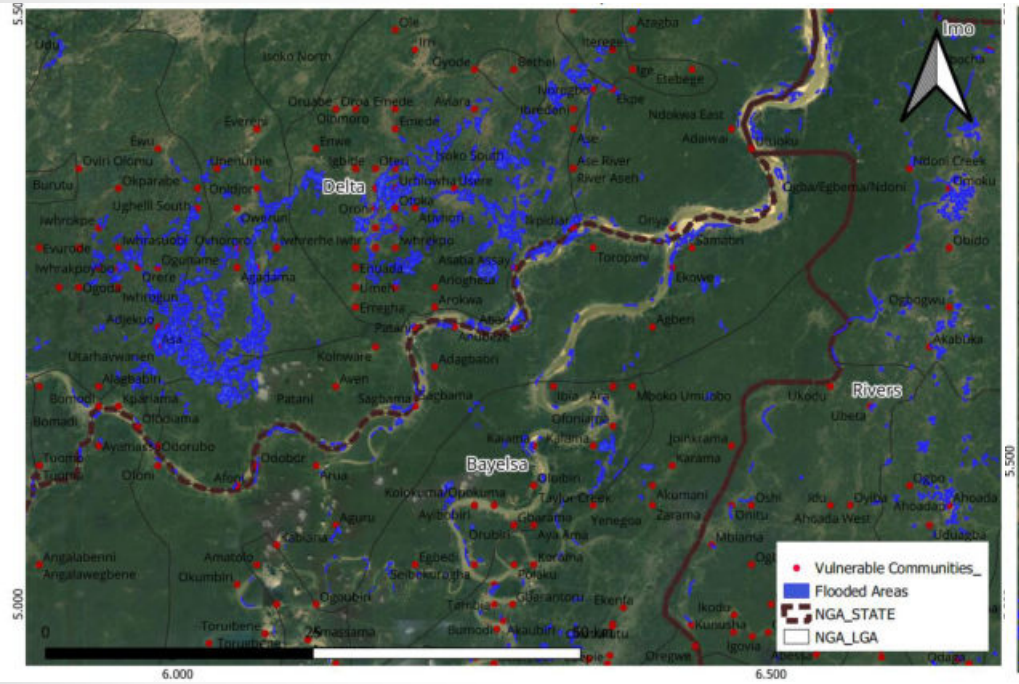
N

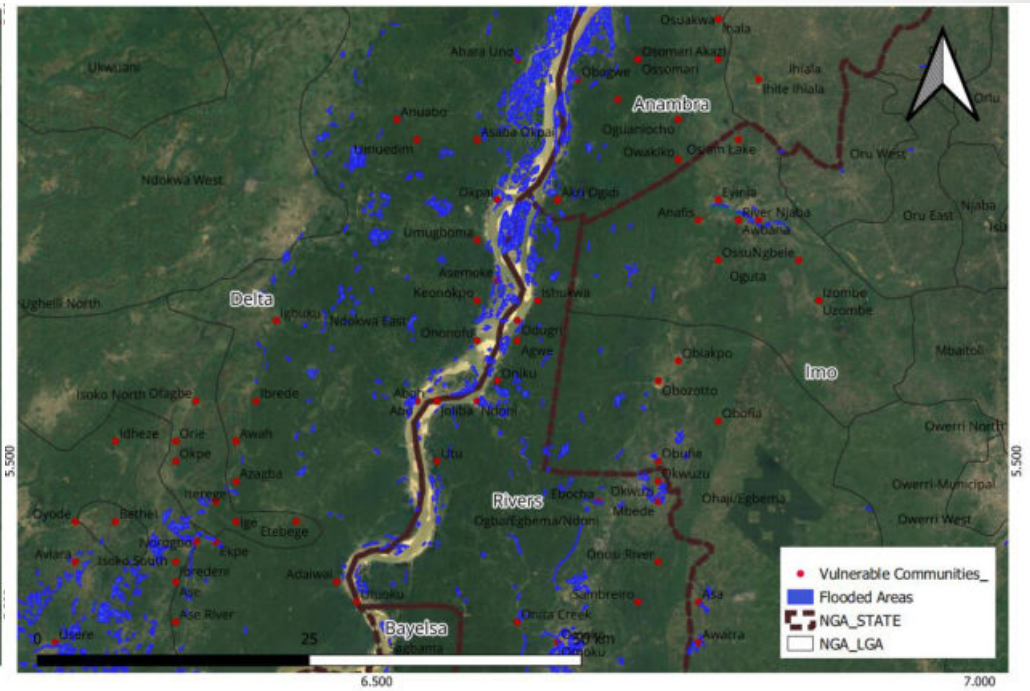
esri

FLOOD EXTENT IN ANAMBRA AND NIGER- DELTA COMMUNITIES ALONG

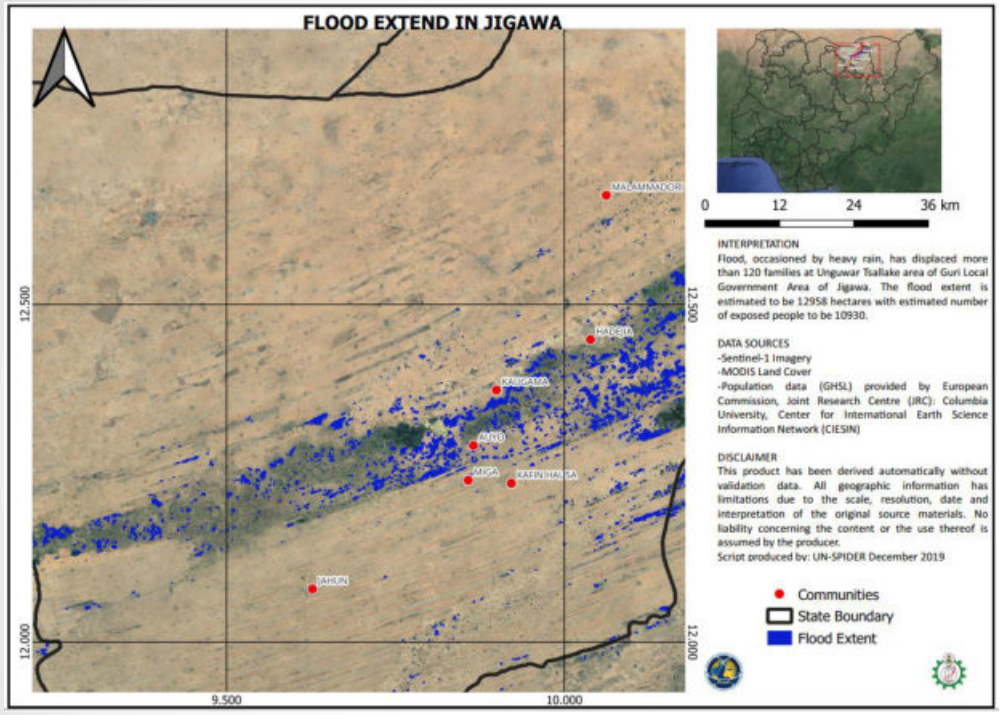


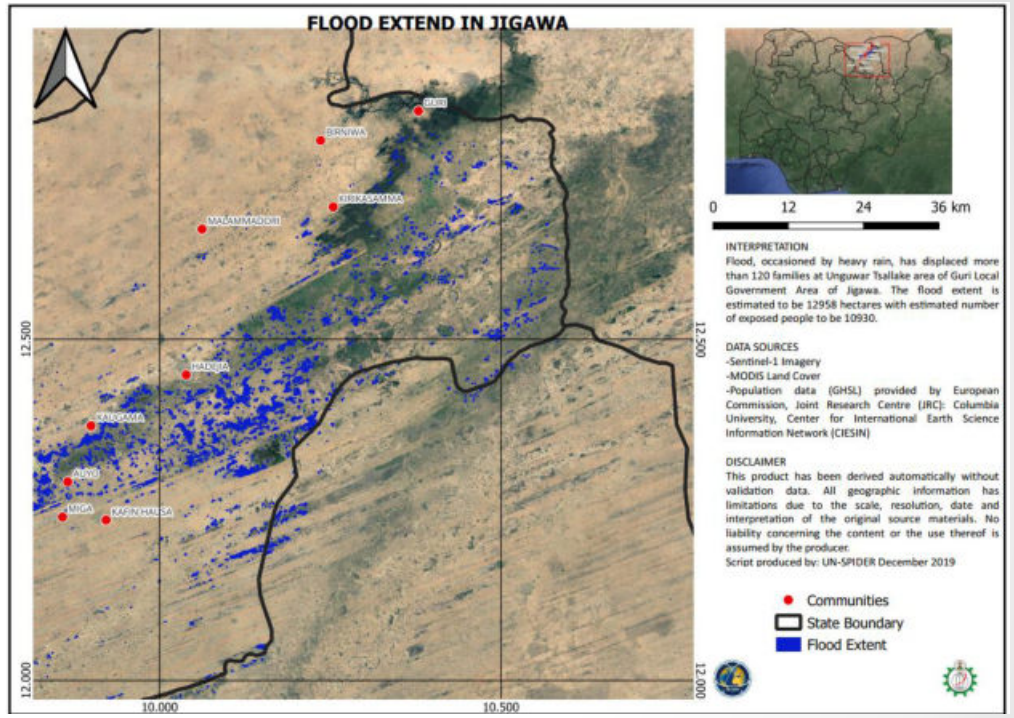
FLOODED AREAS IN NIGER-DELTA IN OCTOBER 2022

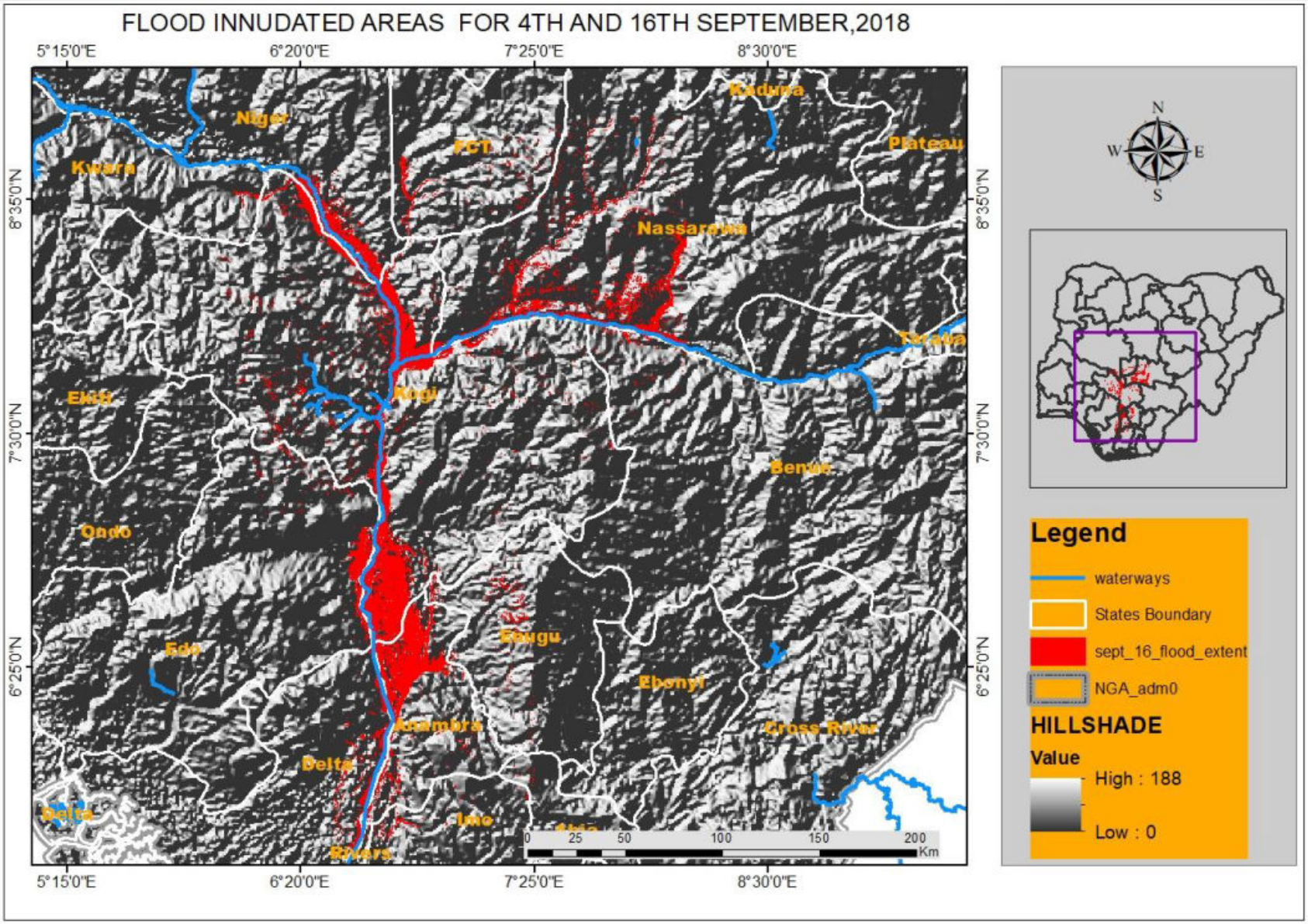




FLOODED AREAS IN JIGAWA STATE

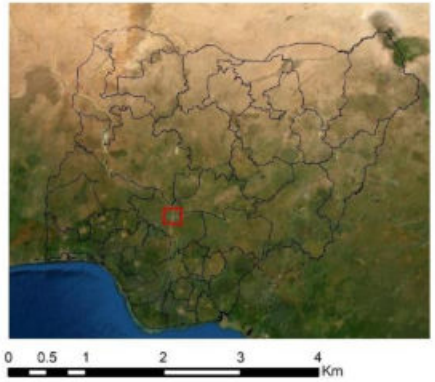





FLOOD INNUDATED AREAS FOR 4TH AND 16TH SEPTEMBER,2018
5°15'0"E
6°20'0"E
7°25'0"E
8°30'0"E
8°35'0"N
7°30'0"N
6°25'0"N
Niger
Kwara
FCT
Kaduna
Plateau
Nassarawa
Taraba
Ekiti
Kogi
Benue
Ondo
Edo
Enugu
Ebonyi
Anambra
Cross River
Delta
Imo
Rivers
0 25 50 100 150 200
Km
N
W
E
S
Legend
waterways
States Boundary
sept_16_flood_extent
NGA_adm0
HILLSHADE
Value
High : 188
Low : 0

FLOOD DAMAGE ASSESSMENT

SYNOPTIC VIEW OF THE FLOOD EXTENT IN LOKOJA AS OF 4-10-2022



Description

Flooded extent of Lokoja, Kogi state as of 4-10-2022. The Advanced Multi-Sensor Band Composite was applied on the Kompsat-3 satellite imagery to delineate the flood extent.

Data Sources

- Kompsat-3 imagery (4-10-2022)
- Administrative boundary, Communities and Roads shapefile obtained from OSGOF
- Background: Kompsat-3, ESRI

Projection: UTM 32N, Datum: WGS 84

Produced by the National Space Research and Development Agency

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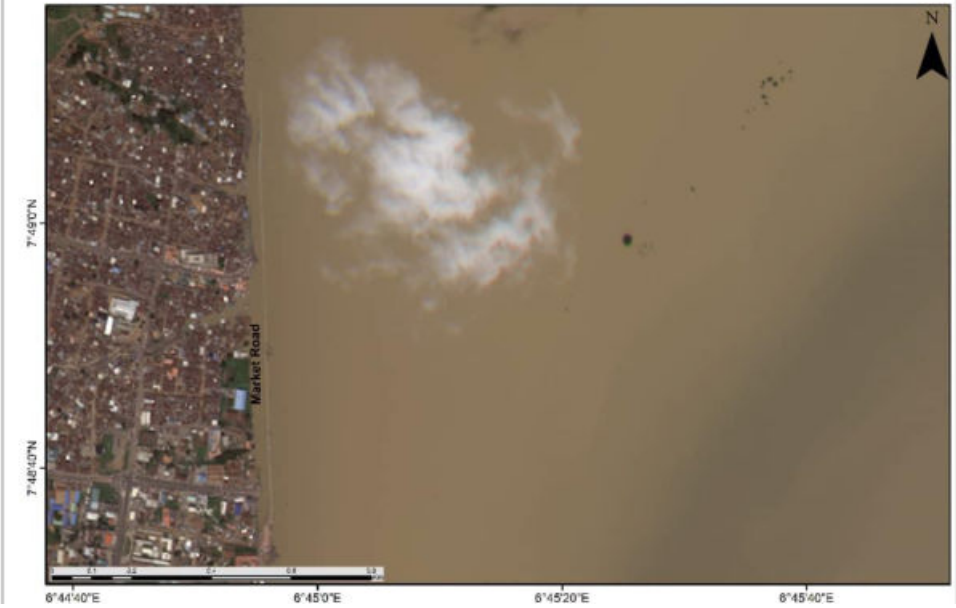
Legend

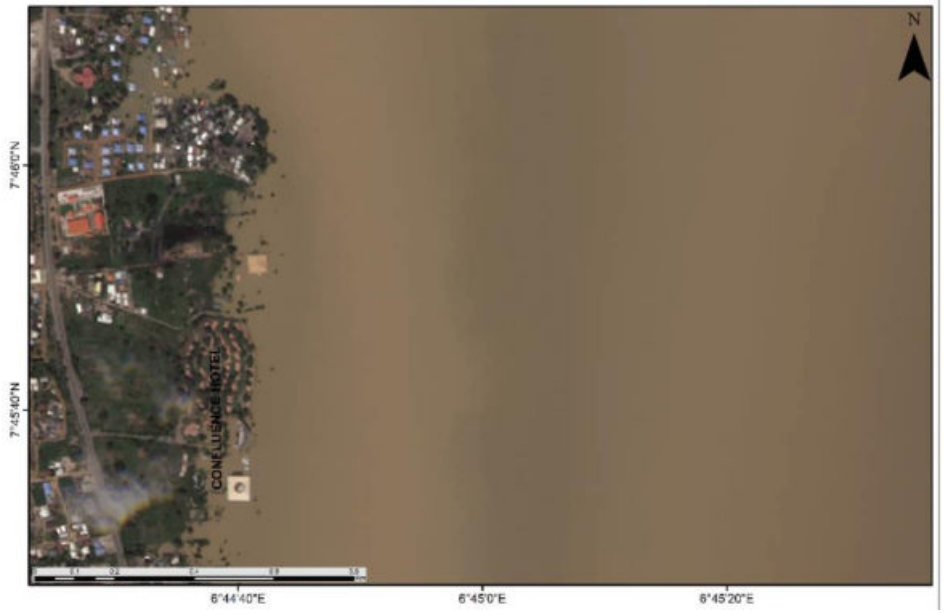
Roads

N

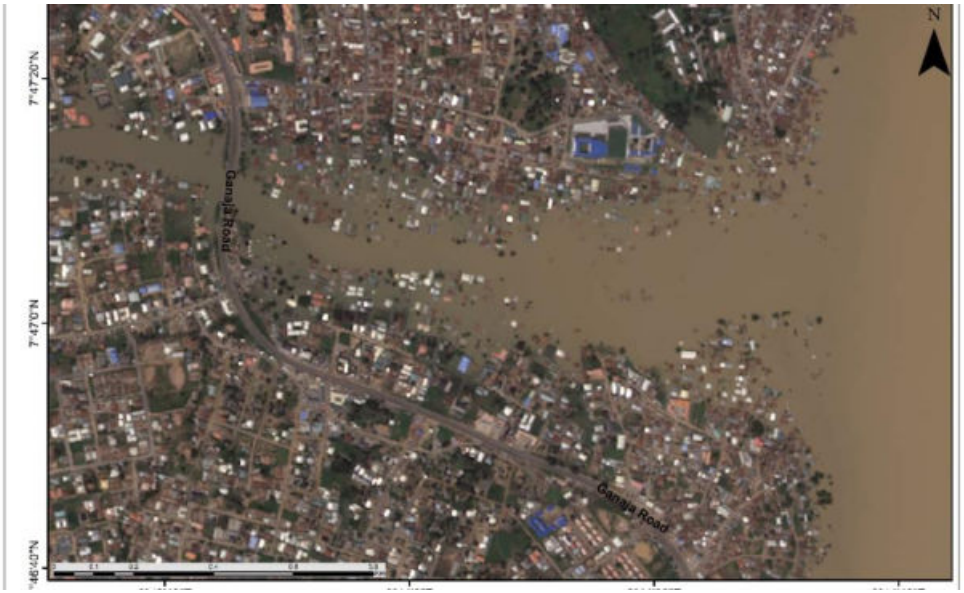
MARKET ROAD



CONFLUENCE HOTEL



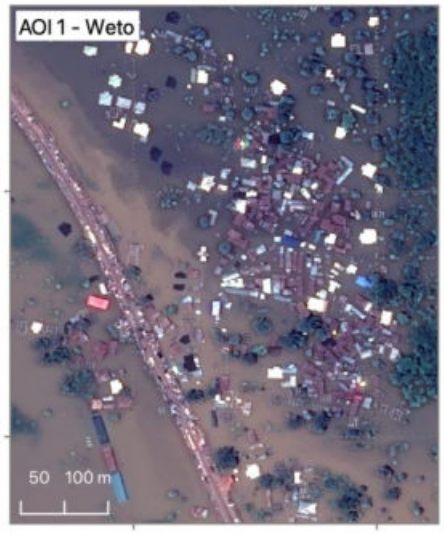
Ganaja Junction

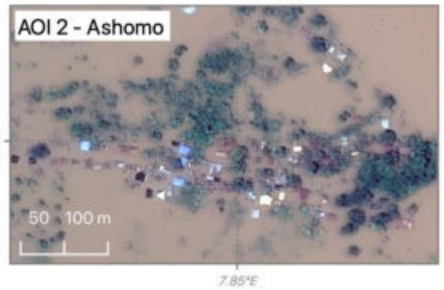


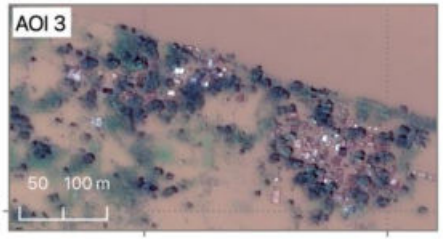
NATACO JUNCTION

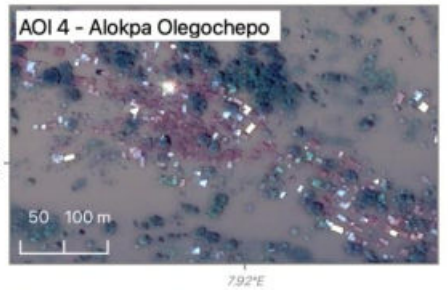
Flooded Villages Between Loko and Ekwakwa in Benue State , Nigeria - 24 Sep 2022

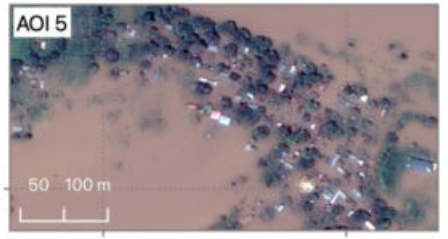
Analysis derived from Pleaiades-1A Multispectral EO data acquired on 24 Sep 2022











[Act-777/Call-895] Flood in Nigeria

Torrential rain has caused flooding in Nigeria. Jigawa state is particularly experienced heavy flooding. The floods have submerged buildings and agriculture, and there are concerns that the Niger and Benue Rivers may flood as their water levels rise. This map illustrates a True Color band composite from optical data acquired on the 24/09/2022 by the Pleiades-1A satellite over the Benue state, Nigeria. This preliminary analysis shows multiple villages between Loko and Ekwakwa in Benue State potentially affected by the large flood of the Benue river. EO data has been processed with the ESA Charter Mapper processing environment developed and operated for ESA by Terradue.

Legend

- Populated place
- AOI
- Road

ESA WorldCover 2020
- Permanent water

DLR World Settlement Footprint 2019
- Built Up

Map Publication Date: 2022-09-24
Map resolution: 300 dpi
Coordinate System: WGS 1984 Web Mercator Auxiliary Sphere
Projection: Mercator Auxiliary Sphere
Datum: WGS 1984

Map Scale (A4 format)

N

0 1 2 km

Satellite data: Pleiades-1A ORTHO product acquired on 24/09/2022 at 09:43:35 UTC.
Other data: World Settlement Footprint 2019, ESA World Cover 2020, HOTOSM.

Value Adder: VA_ESA_MArcorace

This is a preliminary analysis and has not been validated in the field. No liability concerning the contents or the use thereof is assumed by Terradue. The information has limitations due to the quality and resolution of the original data sources and cloud coverage.

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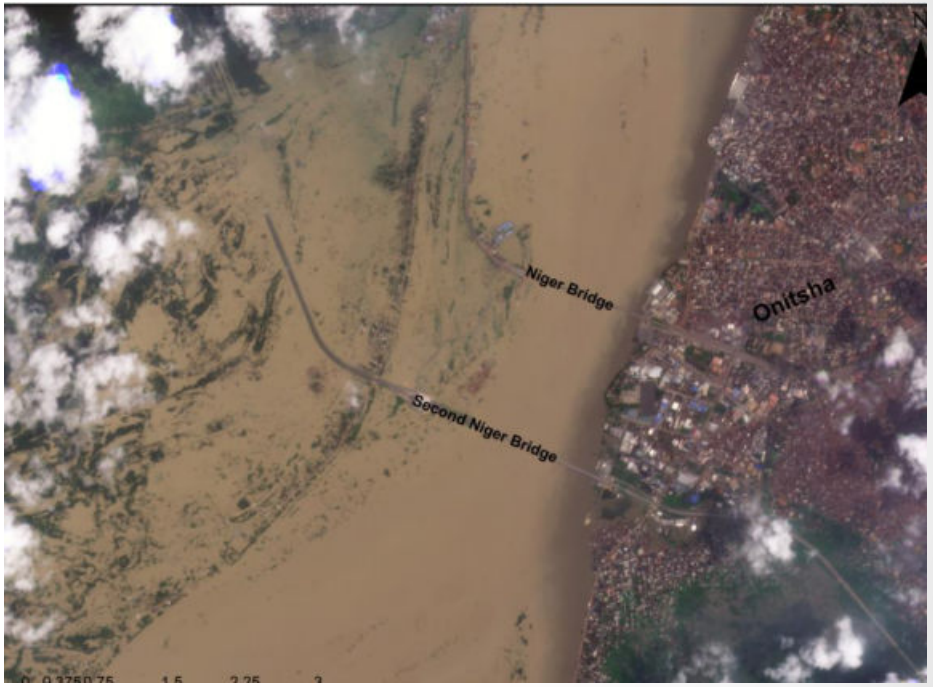
FLOOD DAMAGE EXTENT IN ONITSHA , OCTOBER 12, 2022

Before

After



FLOOD DAMAGE EXTENT IN ONITSHA , OCTOBER 12, 2022

Before

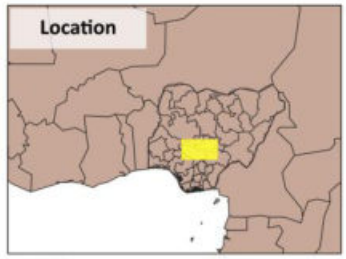
After

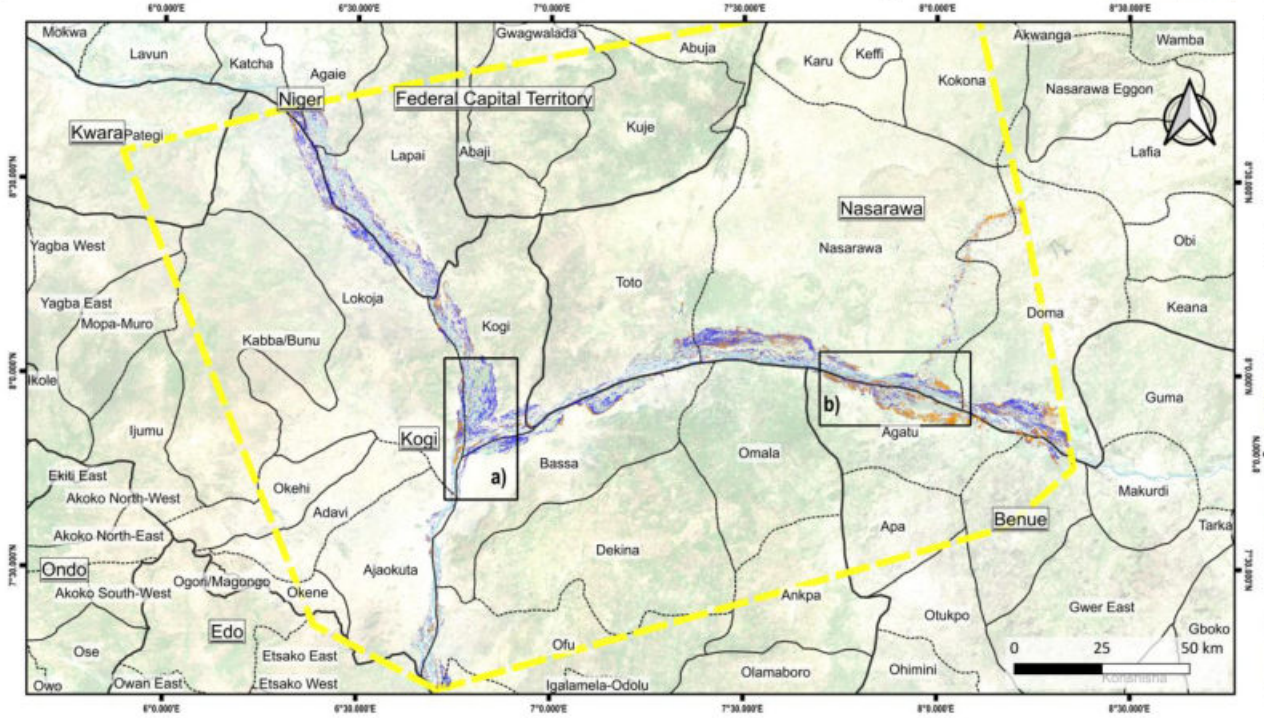
Flooded Cropland - Benue River; Benue-Niger confluence. Situation on 2022-09-19. Overview Map, Close-Up Maps and Table on Flooded Cropland Area per District.

Background
Torrential rainfall has caused severe riverine floods across the Niger and Benue rivers throughout Nigeria.

Description
This flood map shows areas flooded by water by the Benue and Niger rivers across multiple states in central Nigeria with a focus on flooded cropland (cropland as of 2020, as classified by the ESA WorldCover product). The HASARD Flood extent algorithm was applied, using a reference scene from 2022-08-02 compared to the situation on 2022-09-19 using Sentinel-1 radar data. The table on the right-hand side lists the districts within the processed region that contain affected cropland. **Within the processed region, a total area of over 272 km² of cropland were inundated as of 2022-09-19.** Note that within districts which are not fully covered by the processed area, further cropland might be flooded that is not shown on this map and not accounted for in the tabular data. This data is not verified.

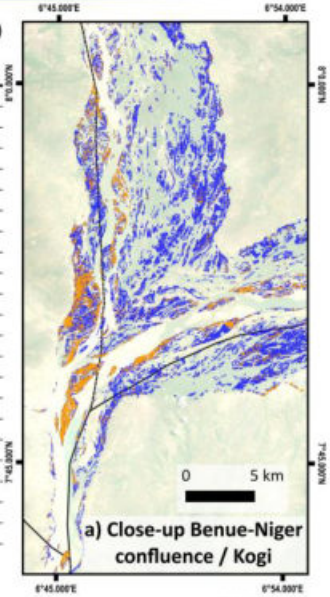
Legend
- Processed Area
- Flooded Cropland
- Flooded Area (in general)
- District Borders
- State Borders

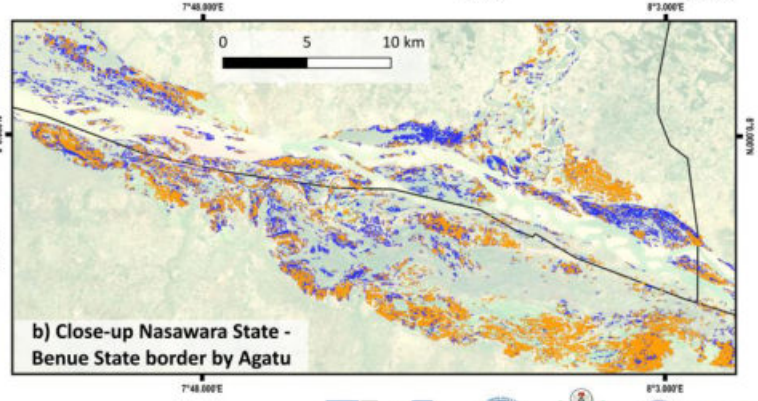




Flooded agricultural area by district (within processed area)
Sorted from high to low

State	Administrative District	Flooded Cropland [km²]
Nasarawa	Nasarawa	71,71
Benue	Agatu	50,56
Nasarawa	Doma	38,02
Kogi	Kogi	24,37
Kogi	Lokoja	24,25
Niger	Lapai	16,63
Kogi	Bassa	11,15
Nasarawa	Toto	10,47
Kogi	Ajaokuta	7,45
Benue	Gwer West	5,58
Kogi	Ofu	5,24
Niger	Agaie	3,32
Niger	Katcha	1,98
Federal Capital Territory	Kwali	0,48
Kogi	Igalamela-Odolu	0,39
Kogi	Omala	0,20
Federal Capital Territory	Abaji	0,07
Nasarawa	Kokona	0,07
Nasarawa	Karu	0,04
Benue	Apa	0,02
Kwara	Pategi	0,02
Federal Capital Territory	Abuja	0,01
Edo	Etsako East	< 0,01
Total in processed area		272,04





Data sources Contains modified Copernicus Sentinel data [2022] Administrative boundaries: GADM Background: © here, BING, Microsoft (2022)
Contains modified Copernicus Sentinel data (2020) processed by ESA WorldCover consortium
Local projection: UTM 32N, Datum: WGS 84

Conclusion

- One of the advantages of satellite remote sensing is access to information without being in physical contact with the source of the information.
- Moreover, the synoptic view of the area of interest is provided.
- These advantages will continue to support all phases of disaster management cycles.
- The Agency is planning a workshop with the disaster management agency in Nigeria to discuss feedbacks on the efficacy of the maps products.

Thank You