EO for Africa Symposium 2024

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ESA | ESRIN, Frascati (IT)

Enhancing Disaster Resilience in Greater Banjul area (The Gambia) through Earth Observation: Insights from the ESA EO4SD Disaster Risk Reduction Project

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26/09/2024

ESA EO4SD – DRR project

- The **ESA EO4SD Disaster Risk Reduction project (June 2018 – March 2022)** aims to promote the adoption of **Earth Observation-based products and services mainstreamed into the working processes of IFIs** (e.g. World Bank, Asian Development Bank) funded projects that seek to prevent or mitigate the adverse impacts of natural disasters in developing countries.
- The project pursues the following objectives:
  - **Carrying out demonstrations of the benefit and utility of Earth Observation (EO)-based information** in support of international development projects and activities in the thematic domain of Disaster Risk Reduction
  - **Supporting directly programs / projects**, monitoring & evaluation methodologies and policy & planning **of the IFIs** and their respective Client States not only in the sector of disaster management but also in transportation, habitat, energy, water and sanitation;
  - **Mainstreaming and transferring EO-based information into operational working processes** of the individual countries and development organizations.

Partners of the EO4SD DRR consortium

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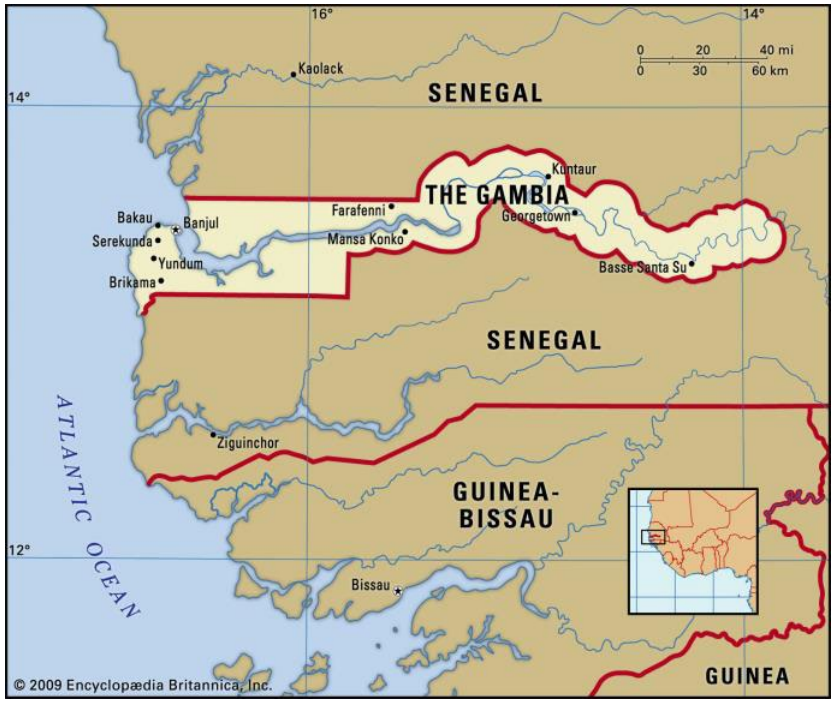
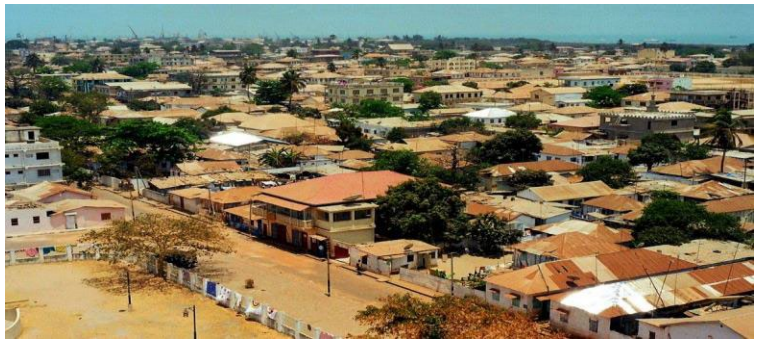
Géosciences pour une Terre durable brgm

nazka

THE GREATER BANJUL USE - CASE OBJECTIVES

- To demonstrate the benefit and utility of Earth Observation EO-based information to reduce disaster risks related to Natural hazards (subsidence, storm surge, flooding) and Climate change impacts (e.g. sea-level rise)
- Capacity Building activities performed in 2020 (remotely due to the COVID-19 pandemic) to foster awareness, acceptance and adoption of EO techniques





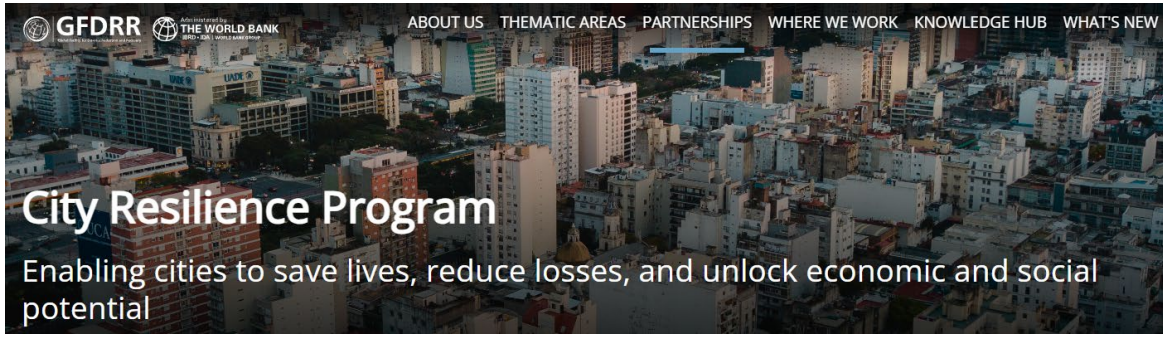
Banjul, the Capital of The Gambia

THE GREATER BANJUL USE - CASE END-USERS

- IFI: World Bank

THE WORLD BANK

- End-Users involved through dedicated Capacity Building activities (remotely due to COVID-19):
  - Gambia National Users (e.g. National Disaster Management Agency, National Environmental Agency, Land Survey and Planning Ministry)
  - Collaboration and synergies with the **WACA** (West Africa Coastal Areas) management program and **CRP** (City Resilience Program) were established during the project.



THE GREATER BANJUL USE - CASE SERVICE COMPONENTS

- Ground motion analysis

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- Storm surge/Coastal flood analysis

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- Bathymetry mapping, as well as monitoring of bathymetric changes

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- Exposure mapping

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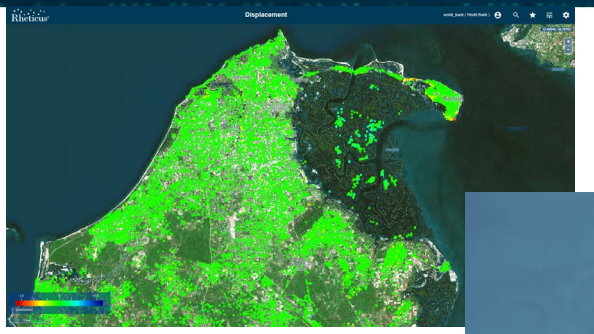
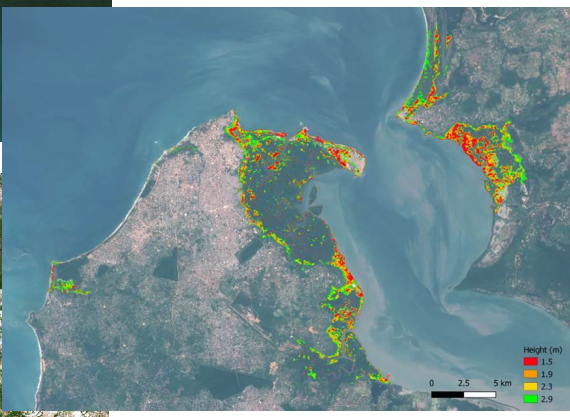
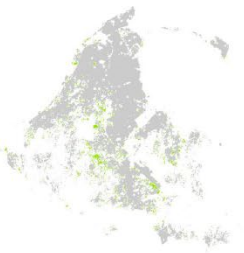
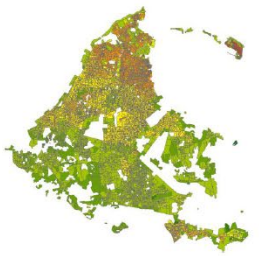


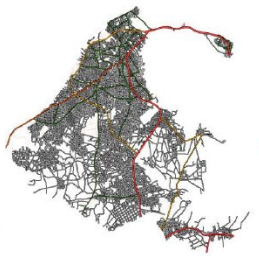




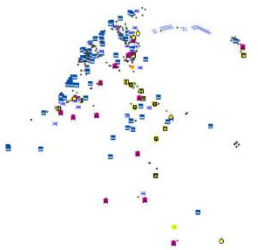
Built-up area and evolution



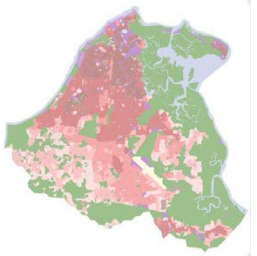
Populaton



Transportation network



Point of Interest



Land Use Land Cover

THE GREATER BANJUL USE - CASE SERVICE COMPONENTS

- Ground motion analysis

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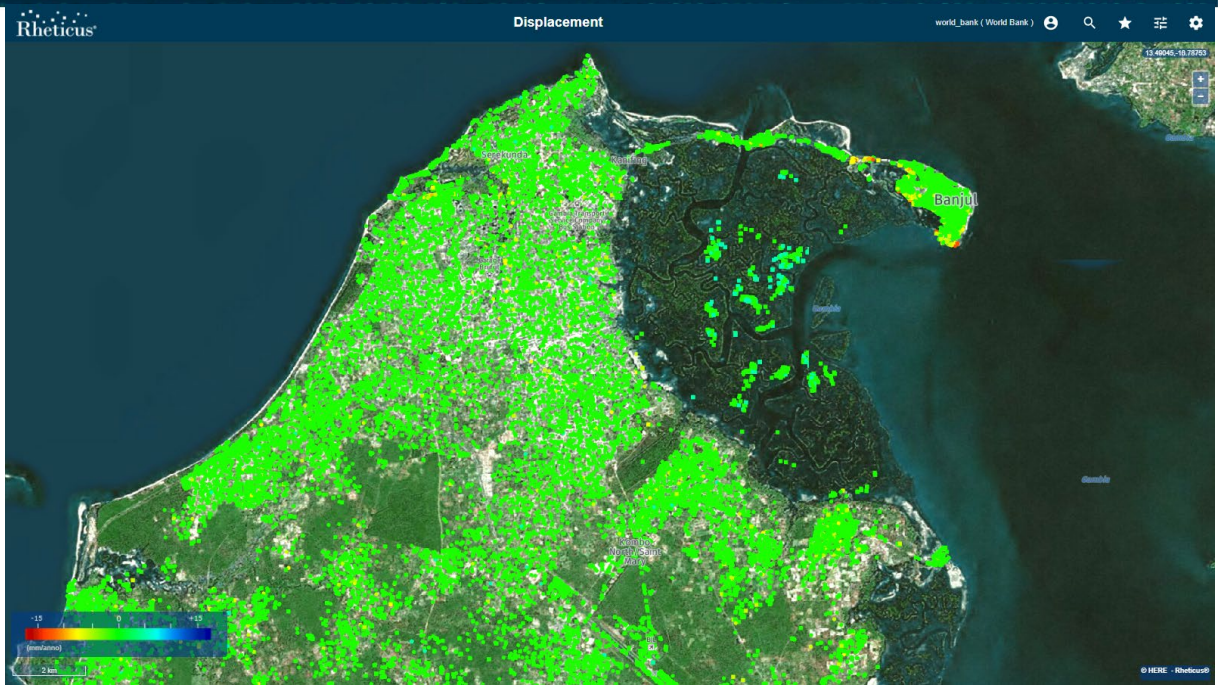
Assess the ground motion is important for Greater Banjul because the altitude of the eastern side of the coastal area is about 80 cm and considering the sea water level rise scenarios (IPCC), the World Bank needs the subsidence assessment to support the government in the management of the hydro-meteorological risks connected to these phenomena.



The scope of the terrain deformation analysis is to assess the historical ground motion of the Greater Banjul AREA, through the **Rheticus® Displacement service** that implement the Persistent Scatterers Interferometry (PSI) technique.

Sensor: Cosmo-SkyMed (3 m res.)
N. of images: 65
Temporal Resolution: 2011-05-31 / 2018-09-07

- Ground motion analysis

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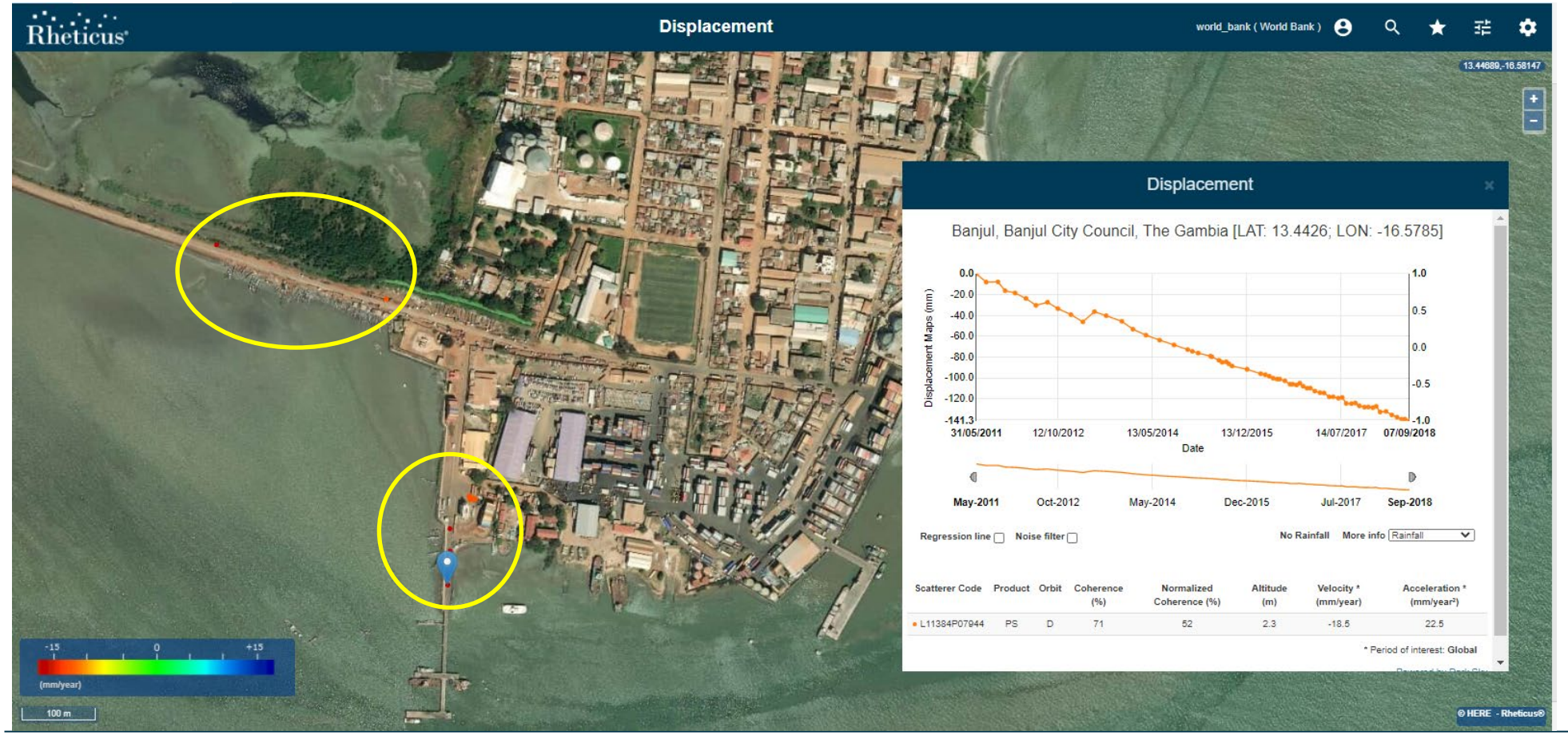


Example of localized ground motion phenomena close to Banjul harbor, with detailed time series graph of the displacement visualized in Rheticus® Displacement Web-platform that shows a total movement of about **14 cm from May '11 to September '18.**

THE GREATER BANJUL USE - CASE SERVICE COMPONENTS

- Ground motion analysis

- Storm surge/Coastal flood analysis

Potential elevation of sea level in IPCC scenarios
(Referenced to land Vertical Datum)

Epoch	Hypothesis	Elevation/VD
2000	High storm surge on top of Spring tide	1.6 m
IPCC 2100 Hypothesis A	High storm surge on top of Spring tide plus IPCC 0.3 m lowest rise projection (RCP 2.6 MSL)	1.9 m
IPCC 2100 Hypothesis B	High storm surge on top of Spring tide plus IPCC 0.7 m middle rise projection (1/2 [RCP 2.6 + RCP 8.5])	2.3 m
IPCC 2100 Hypothesis C	High storm surge on top of Spring tide plus IPCC 1.1 m highest rise projection (RCP 8.5 MSL)	2.7 m

Flood hazard map distribution in the area of interest, with information of water height (m) and estimated flood areas extent, from projected sea water levels onto land topography.

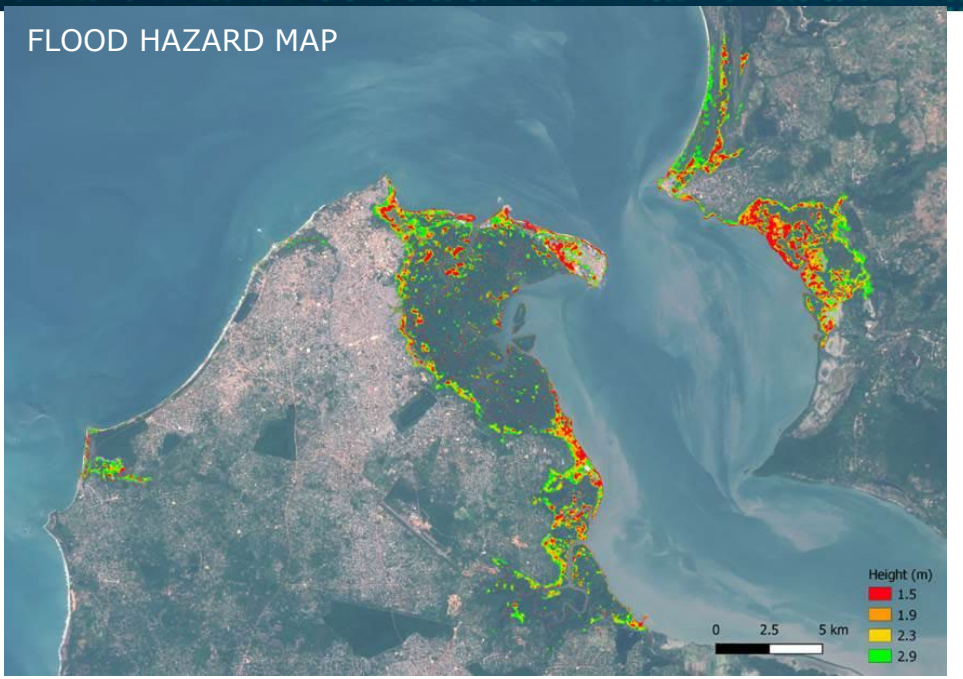
THE GREATER BANJUL USE - CASE SERVICE COMPONENTS

- Ground motion analysis

- Storm surge/Coastal flood analysis

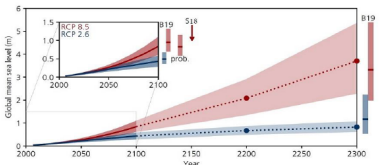
The final product provides the user with a **qualitative assessment** under different scenarios of probability of occurrence (negligible, acceptable, undesirable or unacceptable) of the flooding susceptibility along the coastline to **identify potential hot-spot areas** that need to be further investigated at very detailed scale and to be reflected in mitigation plans, including climate change scenarios.

The accuracy of the analysis depends on available data sources. For topography, DEMs such as SRTM and ASTER GDEM at 30m spatial resolution and bathymetry with a <10m accuracy, the expected final accuracy is <30m.



INPUT

- DEM delivered by the WB - Vertical reference : land Vertical Datum
- Water levels:
  - max spring tide: 1.1 m - Vertical reference : Chart Datum
  - storm surge/historical record: 0.5 m
  - IPCC sea-level rise (3 scenarios: from 0.3 to 1.1 m)



THE GREATER BANJUL USE - CASE SERVICE COMPONENTS

- Ground motion analysis
- Storm surge/Coastal flood analysis
- Bathymetry mapping, as well as monitoring of bathymetric changes
- Exposure mapping

SDB (Satellite Derived Bathymetry) is a physics-based model in estuaries where the seabed can only be seen intermittently and describes the most sediments-laden water column at different seasons and tides. The satellite multispectral images can see layers of ± fluid mud (lutocline) that can be interpreted and classified.

INPUT: 46 Sentinel-2 images, Global Bathymetry data (GEBCO, S5), DEM (open source)

THE GREATER BANJUL USE - CASE SERVICE COMPONENTS

- Ground motion analysis
- Storm surge/Coastal flood analysis
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The deep channel can be seen occasionally within the collection of 46 Sentinel-2 images, and it was confirmed by the AIS traffic plot of ships sailing across the fluid mud (lutocline).

THE GREATER BANJUL USE - CASE SERVICE COMPONENTS

- Ground motion analysis
- Storm surge/Coastal flood analysis
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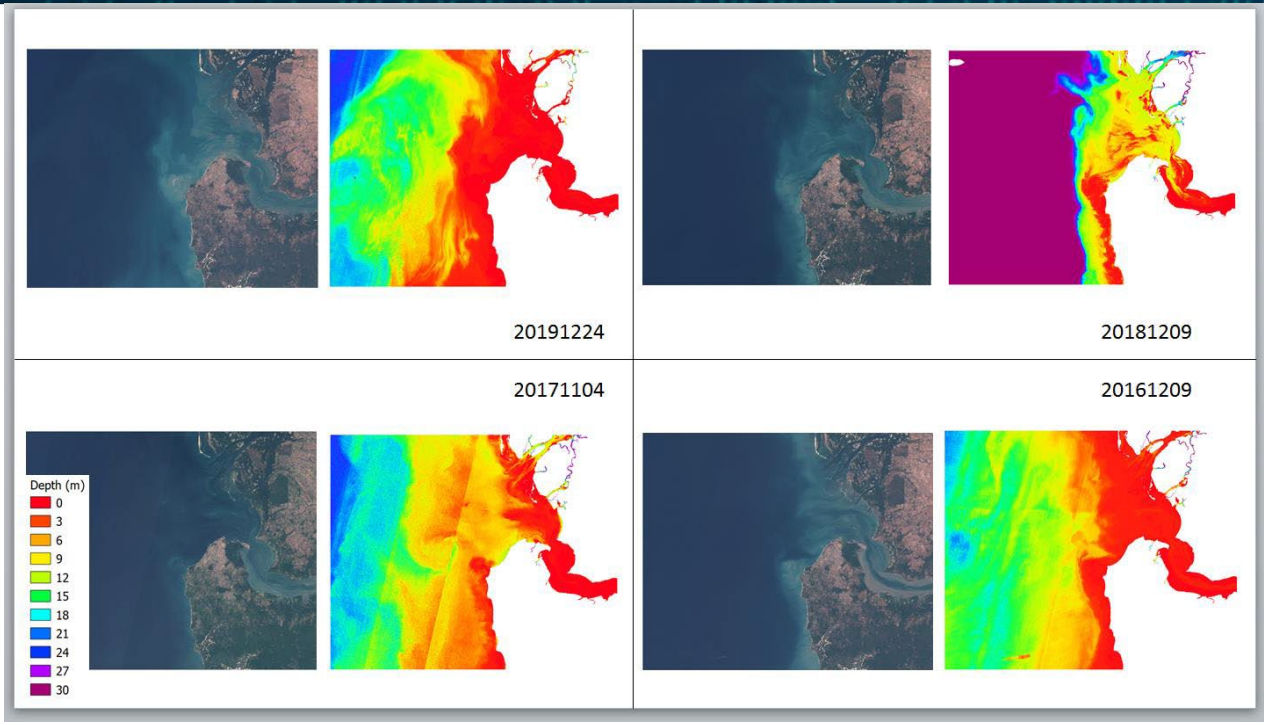


One Bathymetry map for each year (2016-2019) with information of depth (m) per pixel were generated. The 4 maps show the bathymetric changes provided as a result of the multi-temporal analysis.

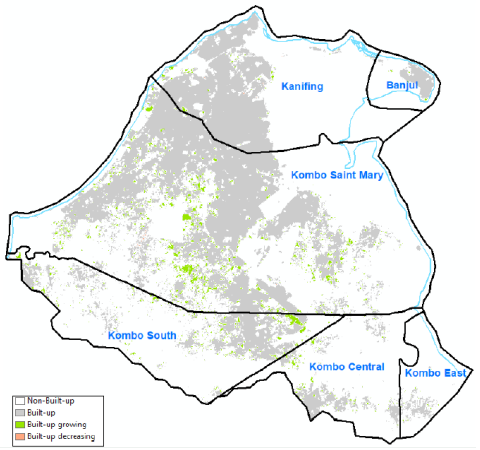
The expected vertical accuracy is of ± 0.5m for depths 0 to 7 m and ±1 m for up to 15-20 m depths.

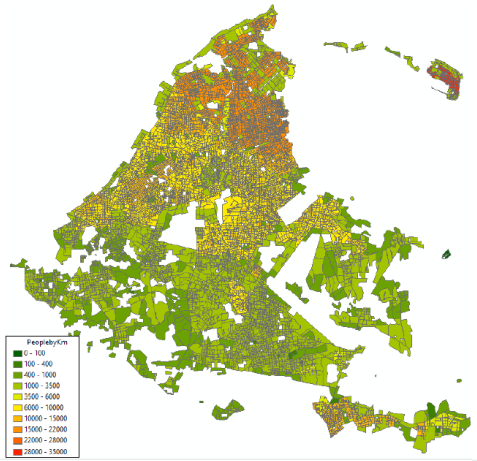
THE GREATER BANJUL USE - CASE SERVICE COMPONENTS

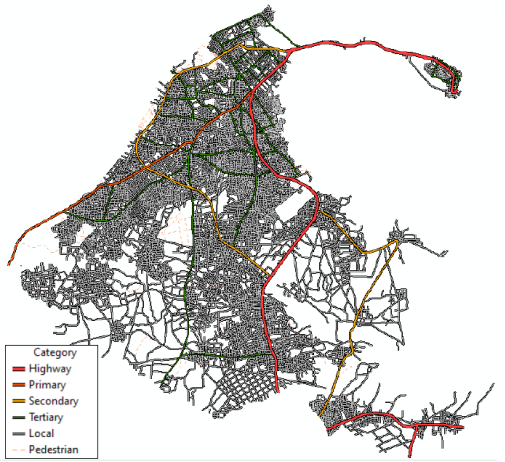
The exposure mapping products contributed to:

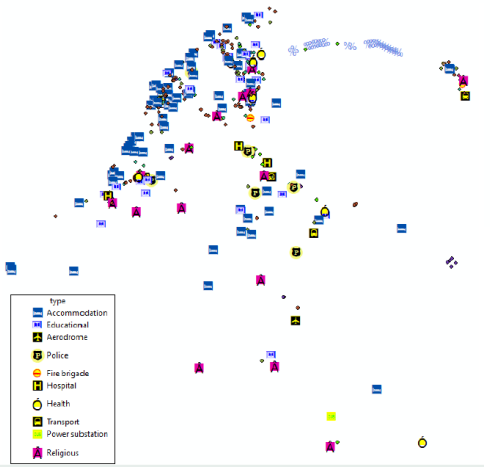
- Identifies vulnerable assets and infrastructure
- Map areas and the related population exposed to hazards

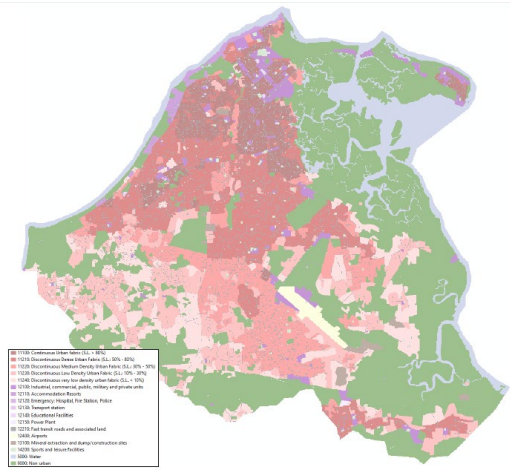
INPUT: **Sentinel-2 images and OSM as main sources. WorlpPop 2020, LULC (free data, open source, open access)**











Built-up area and evolution

Spatial delineation of human settlements (city, town, village or any agglomeration of buildings).
Technical Approach: Deep Learning on Sentinel-2 images.

Population exposed & population density

Total number or people & Density of people computed for each urban patch area.
Technical Approach: Dasymetric and areal interpolation.

Transportation network

Geographical representation in vector format (lines) of the central axis of roads, streets, and other communication routes classified by their order..
Technical Approach: OSM integrated with the Sentinel-2 2020 interpretation.

Point of Interest

Layer representing the center point of relevant asset for risk assessment including infrastructures of transport, energy, education, health, religion, culture, and public services..
Technical Approach: OSM integrated with the Sentinel-2 2020 interpretation.

Land Use Land Cover

Map that delimits and classifies the territory according to the physical coverage of the land or human use.
Technical Approach: Visual interpretation of Sentinel-1 and adaptation of LULC generic schema for The Gambia.

- Exposure mapping

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CONCLUSIONS

- Satellite EO-based geological and hydrometeorological hazard maps and models developed during the EO4SD project represent an innovative solution that provides new ways for the IFI like the World Bank to address the challenges in developing countries.

- The satellite EO-derived products provided with the Greater Banjul use-case, represent an important source of information for the national users of The Gambia, supporting their understanding of environmental dynamics and associated hazards.

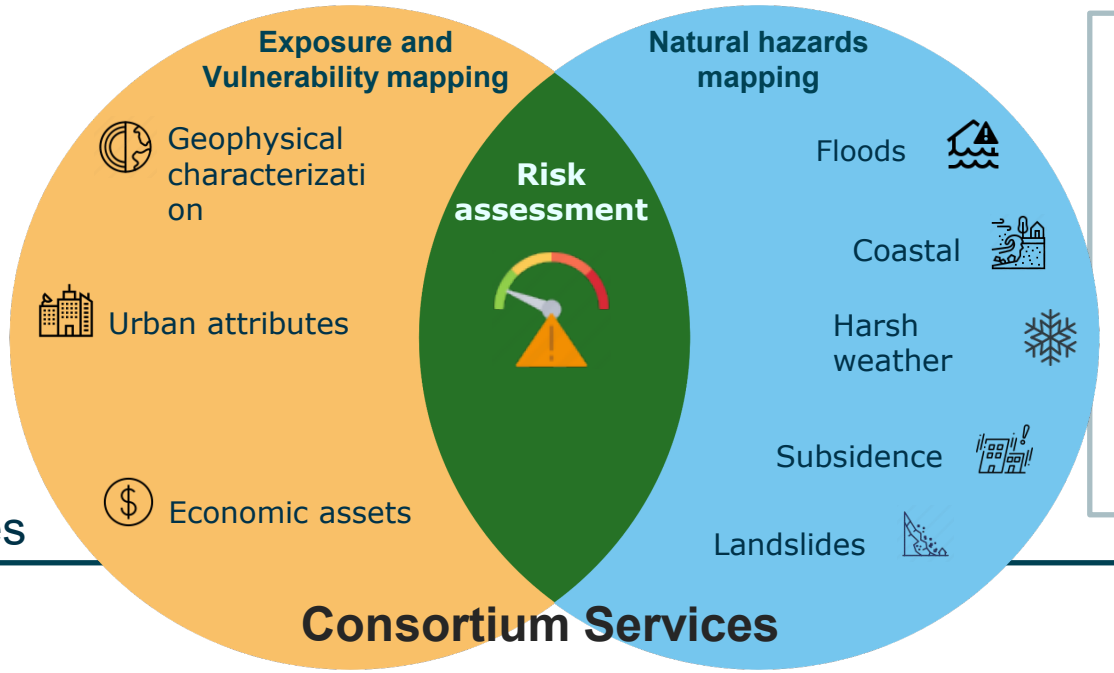
- The capacity-building activities performed in cooperation with the World Bank increased the awareness and demonstrated the usefulness of the EO-based services to support the national users' development core practices and decision-making processes.

- The availability of Copernicus data (SAR and Optical) and cloud platforms for their processing and exploitation, avoids large initial investments, making the EO techniques extremely useful to be used for damage and risk assessment of the built environment over wide areas and developing countries.

EO4SD-DRR Follow-up

esa → **Global Development Assistance** → GDA

EO developments funded by ESA and provided as 'in-kind service' to the IFIs



Consortium Services

indra, cima, gisat, ARGANS, planetek italia, LIST, DLR, TERRAQUE, ZAMG

Supported IFI initiatives

THE WORLD BANK

ADB ASIAN DEVELOPMENT BANK

Thanks for your attention
Questions?

Contact: massimi@planetek.it

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