Global Development Assistance

Climate Resilience

July 2023

powered by esa in partnership with ADB

Contents

Use Cases

List of abbreviations

ADB- Asian Development Bank

AGB - Above-ground Biomass

AID - Agile EO Information Development

CMCC - Euro-Mediterranean Center on Climate Change

CMEMS - Copernicus Marine Environment Monitoring Service

CO2 - Carbon Dioxide

ECMWF - European Centre for Medium-Range Weather Forecasts

EO - Earth Observation

ESA - European Space Agency

FHI - Flood Hazard Index

GDA - Global Development Assistance

GEDI - Global Ecosystem Dynamics Investigation

GHG - Greenhouse Gas

GPBP - Geospatial Planning and Budgeting Platform

IFI - International Financial Institution

IMERG - Integrated Multi-satellitE Retrievals for GPM

JBA - Jeremy Benn Associates Limited

KPI - Key Performance Indicator

LC - Land Cover

MRV - Measurement, Reporting and Verification

NDCs- Nationally Determined Contributions

SAR - Synthetic Aperture Radar

SLB - Sustainability-Linked Bonds

SMOS - Soil Moisture and Ocean Salinity

SOC - Soil Organic Carbon

TAMSAT - Tropical Application of Meteorology Using Satellite Data and Ground-Based Observations

TIR- Thermal InfraRed

UAV - Unmanned Aerial Vehicle

VCI - Vegetation Condition Index

WB - World Bank

WTW - Willis Towers Watson

What does ESA's Global Development Assistance (GDA) Activity on Climate Resilience do?

ESA's GDA Programme is a global partnership implemented with key International Financial Institutions (IFIs) to mainstream the use of EO into development operations. To achieve this mission, the GDA programme focuses on targeted Agile EO Information Development (GDA AID) applied to thematic priority sectors. The thematic consortium of Climate Resilience focuses on activities to enhance the ability to anticipate, absorb, accommodate, or recover from climate change in a timely and efficient manner.

Resilience has emerged as an important framework for policy and programme development. To achieve climate resilience, an access to high quality information on environmental risks is needed and EO has a considerable potential to inform and facilitate climate resilient development around the globe. EO enables global climate research by providing timely and accurate information in large quantities about the Earth's atmosphere, landmasses, and oceans. When combined with societal information, they can provide vital knowledge about climate risks and resilience building opportunities.

For further context please see: https://gda.esa.int/thematic-areas/

What topics of Climate Resilience are included?

Enhancing Resilience of Climate-Vulnerable Communities

The most severe climate change impacts are faced by poor and vulnerable communities in low-income countries. Thus, many national and international initiatives are taking steps to improve the resilience of livelihoods and production systems to climate change. Environmental management is crucial for improving resilience, and EO plays a vital role in identifying the health condition of ecosystems and providing information on prioritized sites for restoration opportunities.

Climate Financing

Incorporating geospatial data, including that derived from space-based platforms, into financial decisions and products is a crucial requirement for transitioning and stewarding the real economy towards achieving net-zero emissions by 2050. To accomplish this, innovative public-private financing solutions are necessary to address the anticipated changes in tail risk, which may render traditional insurance or financing uneconomical.

Emission Reductions

The transition toward global climate neutrality is an ambitious goal that requires more precise and reliable information on GHG emission and sequestration to monitor progress and steer NDC activities. Functioning forests play a critical role in this transition and require close monitoring. Their carbon cycles are complex and difficult to measure directly. Monitoring of the dynamics of biomass, soil carbon contents and changes in land uses help estimate CO_2 fluxes from forest resources.

Who runs GDA Climate Resilience?

The GDA Climate Resilience project is implemented by a consortium of seven European companies and institutions leading in the fields of EO, remote sensing, risk assessments, climate services and the integration of technology into international development contexts. The consortium is led by GMV.

The members are GMV, Telespazio UK, SISTEMA, JBA Consulting, Willis Towers Watson (WTW), the Euro-Mediterranean Center on Climate Change (CMCC), and GeoVille.

Priorities for GDA Climate Resilience

In close collaboration with WB and ADB, the consortium works to understand the operational needs of climate-related projects to identify opportunities to support activities using innovative EO-based applications. Through this process, EO products and services were developed for 9 IFI projects.

The EO services provided are:

1. **Demand-driven**: The IFI has expressed a need for a particular product or service to overcome a challenge that they face in a climate-related project.

2. **Innovative**: The request requires novel, innovative products or services that require customisation and therefore are not available through existing commercial entities.

3. **Scalable**: The requested product or service or product has significant potential for operational uptake and adoption in client countries or may support other climate-related project activities.

Use case examples

Soil carbon monitoring
EO-based soil organic carbon map

Description: SOC map from satellite imagery for agricultural lands

Use: Determination of the topsoil organic carbon in croplands and grazing areas to establish an accurate baseline of the SOC that facilitates the estimation of soil carbon changes resulting from land management

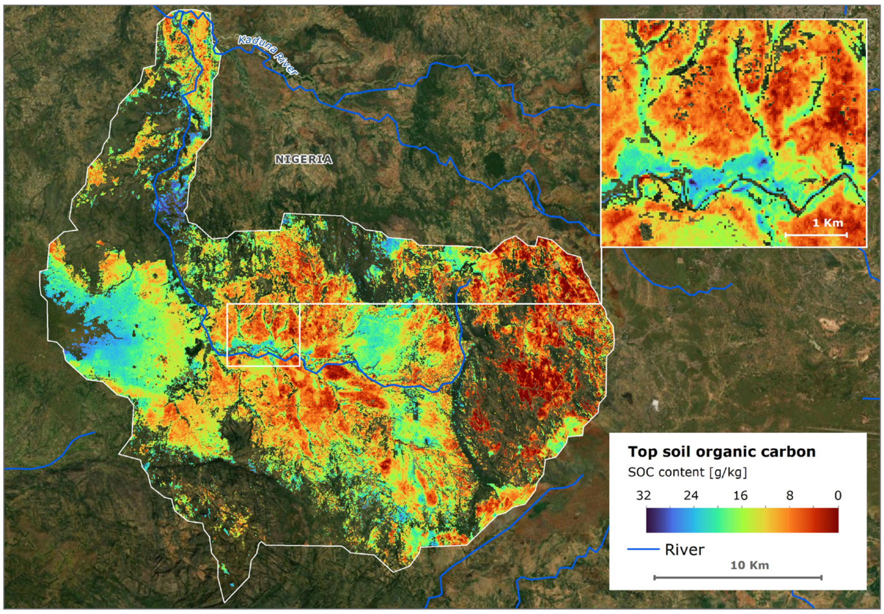
Input: Sentinel-2 and Landsat

Spatial resolution and coverage: 10-30 m, global

Frequency: Under request

Benefits:

- The EO-based SOC baseline can feed farm/watershed management models to calculate the carbon stock and simulate farming and climate scenarios
- Detailed information on soil carbon stock and loss, supporting MRV efforts
- Improving sustainable landscape management practices and prevent soil degradation through integrated watershed management plans



Map of topsoil SOC retrieval on cropland soils in a catchment in the region Kaduna, Nigeria

Use case examples

GHG emissions from forests

Forest above-ground biomass monitoring

Description: Large scale and cost-efficient EO-based biomass assessments, based on dense EO-based time series and using modern image interpretation technology

Use: Biomass assessments inform carbon stocktaking and change assessments in forests and aid in the leveraging of climate funds and facilitation in the carbon market

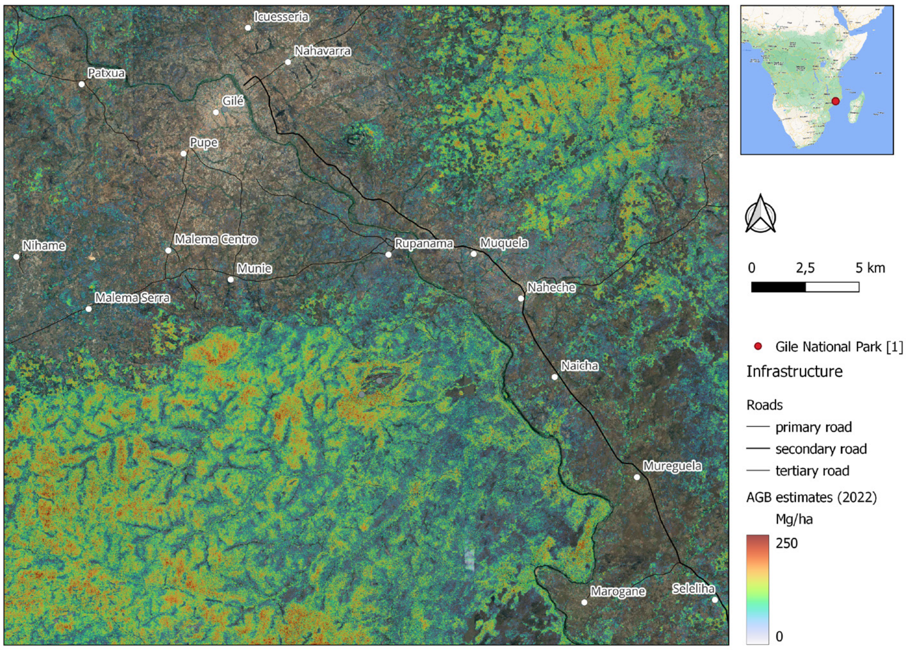
Input: Sentinel-2, GEDI, in-situ biomass measurements estimates

Spatial resolution and coverage: 10 m, global

Frequency: Annually to bi-annually

Benefits:

- Large scale assessments over remote or inaccessible terrain
- Cost-efficient assessments as an alternative to costly local field campaigns or small scale UAV based assessments
- High revisit times enable stakeholders to conduct frequent assessments



Map showing AGB estimates in Mozambique (2021)

GeoVille

Use case examples

Geospatial Planning & Budgeting Platform

Climate change risk assessment tool for public investment projects

Description: A user-friendly web-interface platform through which Ministries of Finance, Economy, Planning and sector agencies at national and local levels can review public infrastructure investments and assets footprints against geospatial climate exposure layers

Use: GPBP allows users to upload project-related information such as asset type, geographic footprint, expected lifetime, run climate risk assessment tools and obtain risk scores for different climate variables and different disruption levels

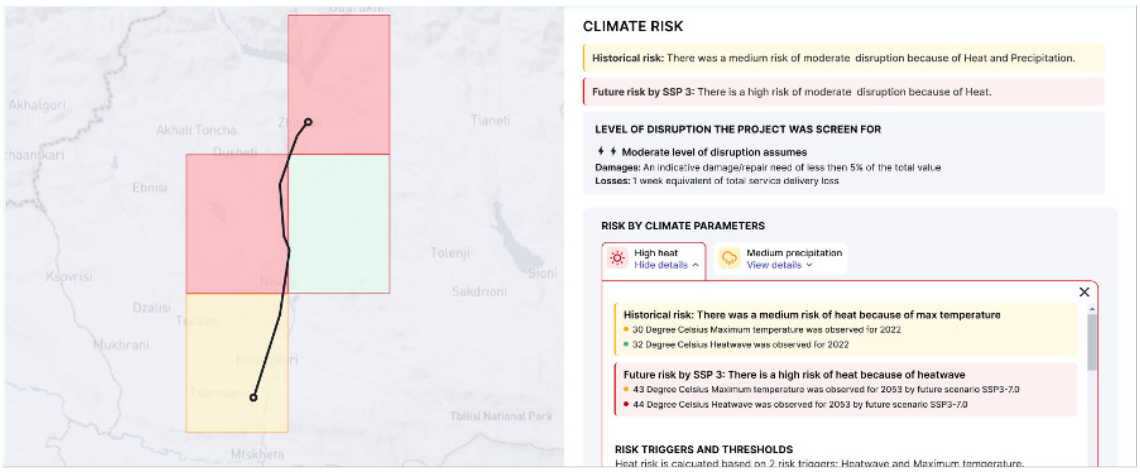
Input: Climate re-analysis, climate projections, other geospatial layers

Spatial resolution and coverage: 9 Km (historical data), 50 Km (climate projections), global with country-aggregated data

Frequency: Daily data are used to assess climate risks

Benefits:

- It is a simple tool that can be used by non-expert users
- It provides an objective tool to assess climate risk for different asset types
- It can be scaled to each country in the world
- Its modularity allows easy integration of new geospatial layers and new analytical tools



Snapshot of the geospatial portal in use in Georgia

SISTEMA
Environmental Information Mining

Use case examples

Hydrological extremes assessment in Afghanistan

Flood risk and impact maps, meteorological and agricultural drought risk maps

Description: Satellite-based flood risk maps and impact maps, meteorological and agricultural drought risk maps

Use: Monitoring of critical infrastructure through high resolution near real time satellite images, identification of infrastructures potentially-impacted by floods and identification of provinces with higher drought risk

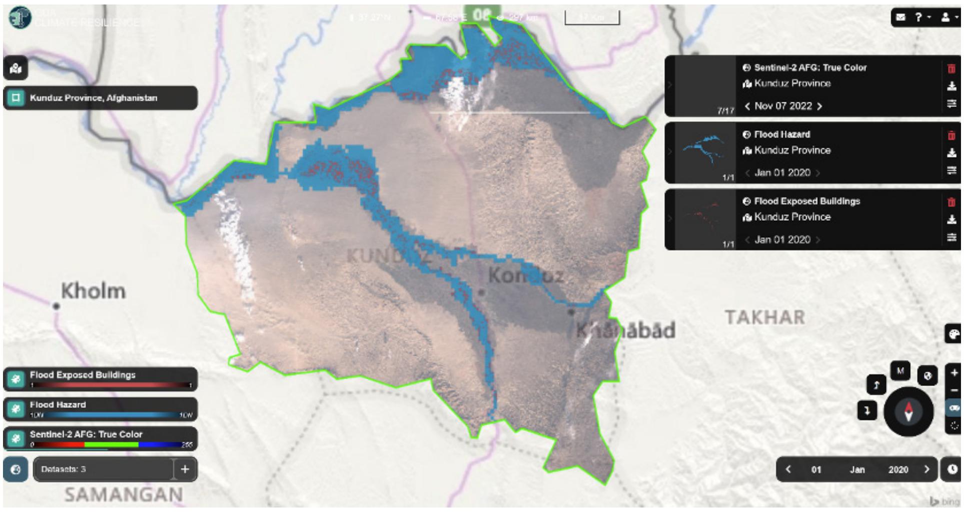
Input: Sentinel-2, SMOS, IMERG, Copernicus Land VCI, Global Human Settlement Layers

Spatial resolution and coverage: 10 m, 10 Km, Afghanistan

Frequency: Daily (precipitation, soil moisture), every 5 days (high resolution satellite data), upon request (drought maps)

Benefits:

- Remote monitoring of critical infrastructures being developed and operated in Afghanistan
- Assessment of flood risk over the whole country in combination with near real time satellite data, precipitation and soli moisture data
- Possibility to identify in advance provinces that will suffer of food shortage and arrange support actions



A snapshot of the platform providing data for the Kunduz area

Use case examples

KPIs for sustainability financing instruments

Quarterly monitoring of historical and recent Land Use and Land Cover (LULC) transitions

Description: Highly accurate determination of LULC long-lasting changes over time by applying change detection and classification techniques based on satellite imagery, and artificial intelligence

Use: Understanding the drivers behind LULUCF to support construction of KPIs for sustainability financing instruments (e.g., SLBs) and forecasting likely spatiotemporal trajectories for LULUCF developments

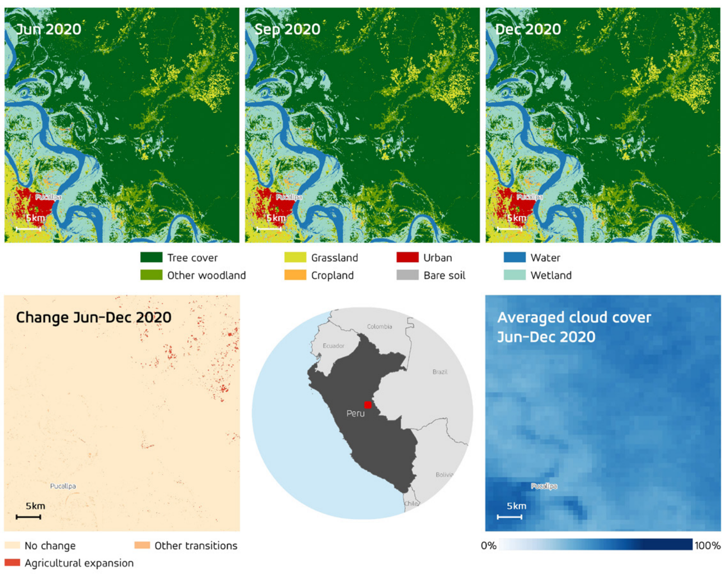
Input: Landsat and Sentinel-1

Spatial resolution and coverage: 30 m, global (including tropical regions)

Frequency: Quarterly, large-scale time series

Benefits:

- Resilience to spurious changes caused by image contamination, or short-lived events, such as floods or wildfires
- 40 years of regional to national LULC changes at high resolution
- LC classification based on optical and radar satellites makes use of the unique information provided by both sensors: spectral information from optical imagery and structural information from SAR imagery



This map shows Land Cover changes in Perú derived from Landsat and Sentinel-1 satellite imagery

Use case examples

Large-scale flood hazard assessment
EO-based flood hazard map

Description: Regional and national flood hazard frequency map from EO imagery

Use: Identification of floodable areas and temporal analysis of flood events, including the estimation of the frequency of inundation

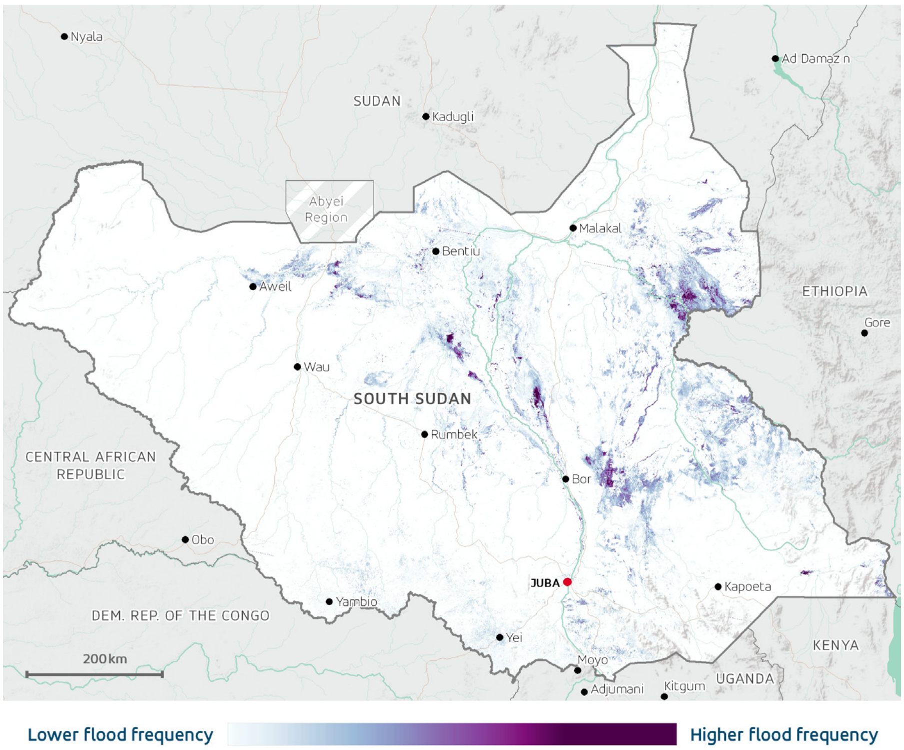
Input: Sentinel-1

Spatial resolution and coverage: 30 m, global (2015-present time)

Frequency: From 7 to 14 days

Benefits:

- Multi-annual regional to national EO-based flood hazard assessment products
- Enhanced knowledge on flood hazard and flooding hotspots



Recurrent flooding in South Sudan.

Use case examples

EO-based flood hazard index

Description: Categorization of target areas based on a combined FHI, accounting for flood frequency and percentage of flooded area over a specific time-period (seasonal, annual, multi-annual) based on EO imagery

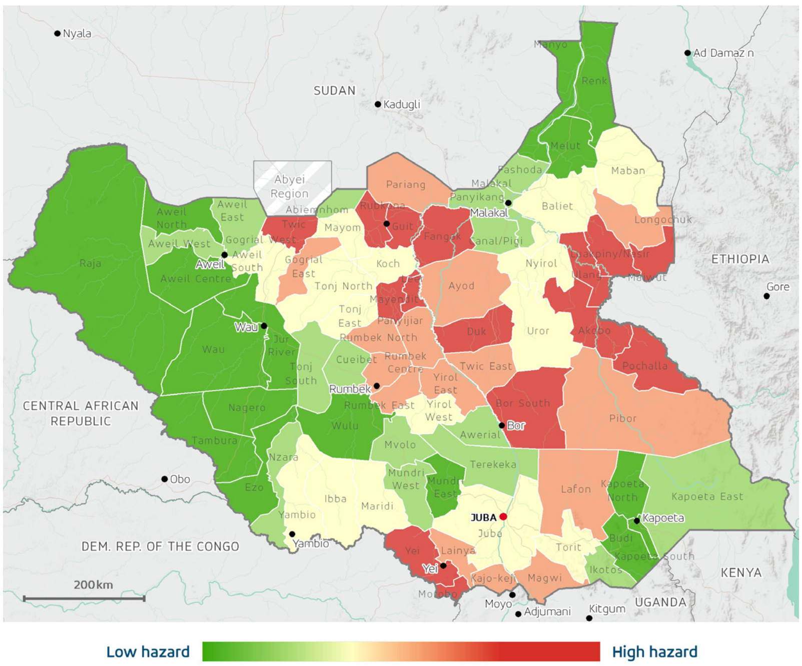
Use: Classification of administrative or hydrological units based on their flood hazard

Input: EO-derived mean flood frequency and flooded extension (%) over each target unit based on flood identification map (Sentinel-1)

Spatial resolution and coverage: Selected target boundaries, global (2015-present time)

Benefits:

- Improved understanding on flood hazard at large-scale level
- Identification of flood-prone regions
- Facilitate targeted mitigation efforts and informed decision-making



County flood hazard classification based on the FHI for South Sudan

Use case examples

EO-based flood persistence assessment

Description: Estimation of flood persistence over targeted areas

Use: Characterization of flooding dynamics over target areas for the identification of those that experience prolonged inundations versus those that rarely flood, enabling effective flood hazard management

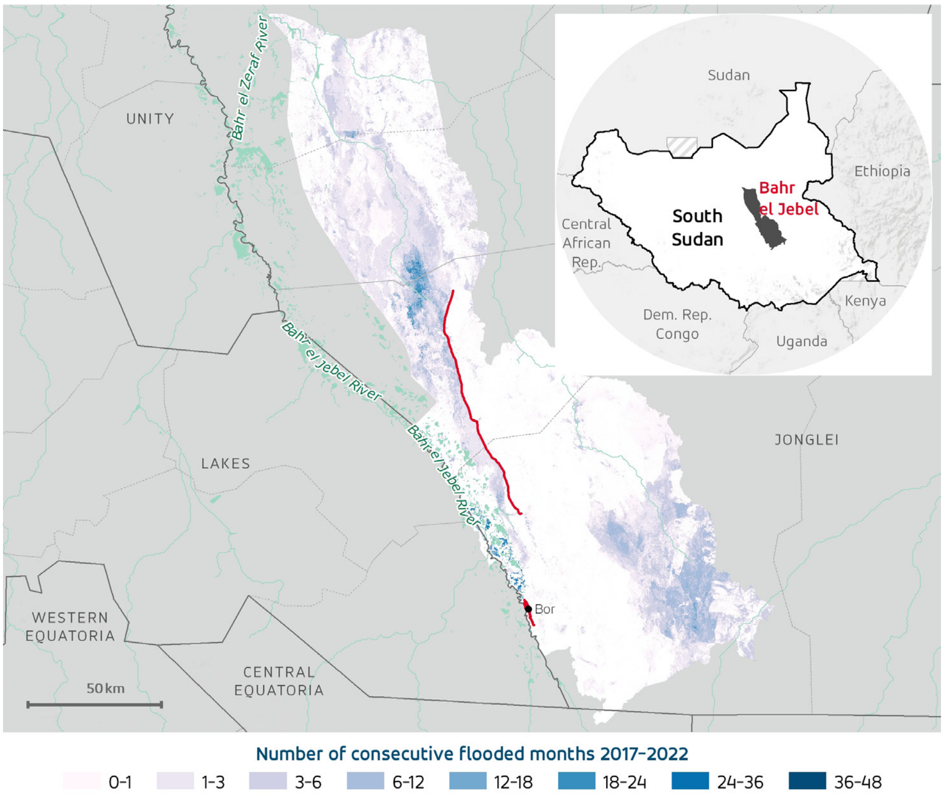
Input: Flood mask time series derived from Sentinel-1

Spatial resolution and coverage: 30 m for specific target areas, global (2015-present time)

Frequency: TAMSAT precipitation estimates are available at daily, pentadal, dekadal, monthly and seasonal frequencies

Benefits:

- Multi-annual regional EO-based products on flooding persistence



EO-detected flooded areas in South Sudan

Use case examples

Extreme weather events

Precipitation analysis

Description: Analysis of the EO-based precipitation data to develop extreme precipitation indices and trend maps

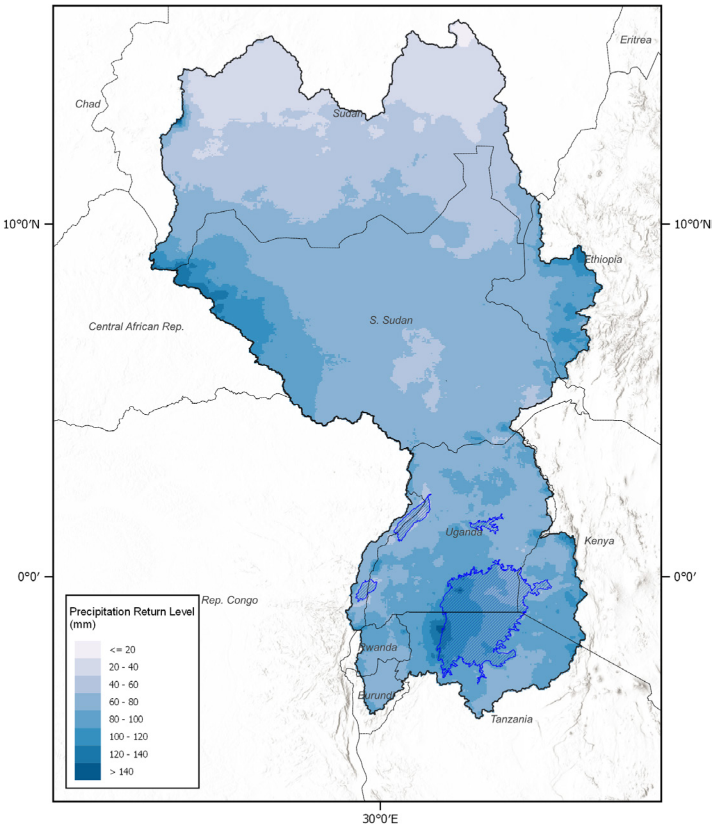
Use: The precipitation analysis products provides users with an up to date overview of long-term precipitation regime, anomalies and extreme precipitation hotspots. This includes detailed information on their spatial and temporal variations, as well as statistical metrics such as return levels and return periods

Input: Meteosat TIR observation calibrated using ground-based observations (available via TAMSAT)

Spatial resolution and coverage: 4 km, Africa

Benefits:

- Long-term precipitation data (1983 to 2 days behind real-time)



20-year return levels of maximum 5-day cumulative precipitation

TELESPAZIO
a LEONARDO and THALES company

Use case examples

Coastal risk assessments in Georgia

EO-based shoreline monitoring

Description: Monitoring of the position of sandy shorelines over time

Use: Historic and continuous monitoring and tracking of the position changes in sandy shorelines over time using Earth Observation satellite imagery

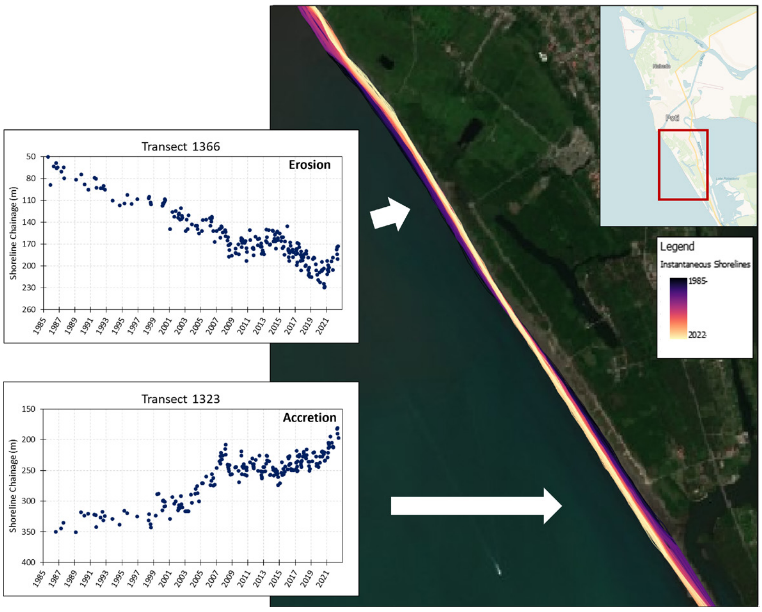
Input: Landsat and Sentinel-2

Spatial resolution and coverage: 10 m, global

Frequency: 6-day repeat cycle for the Georgia Black Sea coast. Frequency varies depending on global location

Benefits:

- 30+ years (and growing) of publicly available satellite imagery
- Open-source toolbox
- Nominal subscription fee through SentinelHub to access images



A map showing extracted shorelines from Landsat imagery between 1985 and July 2022 for region of Poti, Georgia

Use case examples

Coastal vulnerability index

Description: Development of coastal vulnerability index for Georgia's Black Sea coast

Use: Using metocean and shoreline mapping data to develop a spatial vulnerability profile for the study area. The vulnerability for a number of coastal sections is devised by ranking metocean and erosion dynamics to develop a ranking of vulnerable areas. Locations quantified as vulnerable can be further studied for coastal zone management interventions

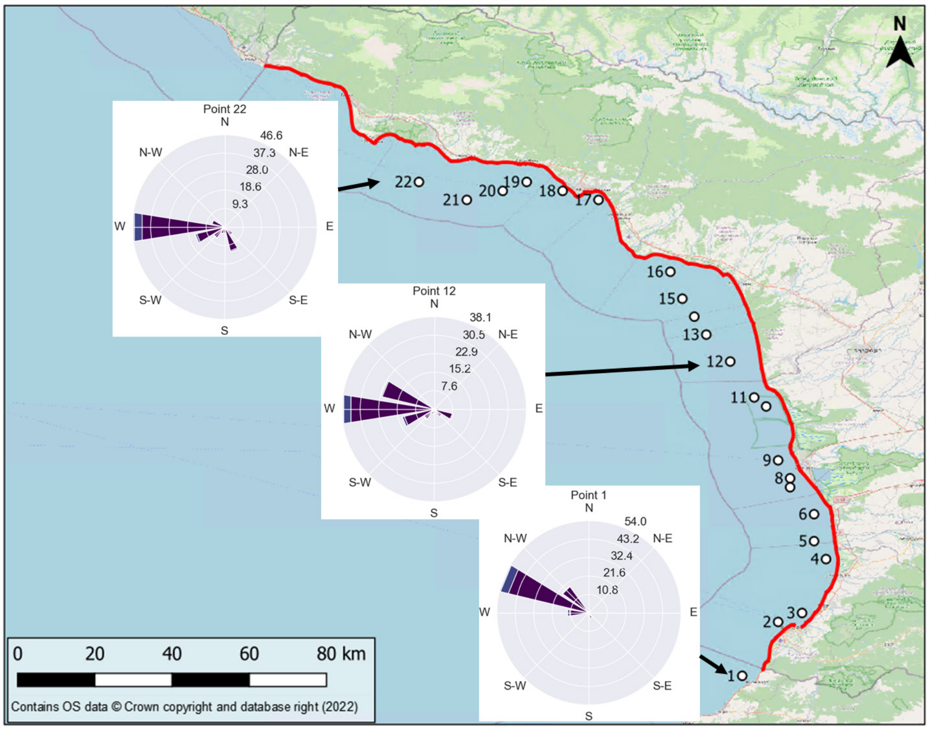
Input: Landsat, Sentinel-2, bathymetry and wave hindcast from CMEMS, sea level and storm surge reanalysis from ECMWF, roading infrastructure from OpenStreetMap

Spatial resolution and coverage: 1/27 to 0.25 degrees, Georgia

Frequency: Under request

Benefits:

- Quantification of vulnerability
- Insights into the specific physical drivers of those vulnerabilities



A map showing the spatial resolution of wave directions

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