esa

Global Development Assistance

Disaster Resilience

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

The European Space Agency's Global Development Assistance (GDA) programme emphasises Agile EO Information Development (AID) across critical sectors. Led by Indra, the Disaster Resilience theme stands as a pressing development concern, with developing countries accounting for 82% of climate and weather-related fatalities from 1970 to 2019. Contemporary disaster resilience is being influenced by climate change, societal inequality, and governance concerns. GDA AID's objective is to collaborate with International Financial Institutions (IFIs), developing EO-based solutions that provide essential data for every phase of Disaster Management. These resources fortify initiatives striving to enhance resilience, reduce vulnerability, and accelerate recovery. In the GDA AID initiative, a comprehensive multidisciplinary approach to develop cutting-edge products and services is carried out. The strategy involves seamlessly integrating geospatial data with a wide range of information sources to facilitate customised analysis, ultimately enhancing decision-making processes.

This booklet provides a summary of GDA Disaster Resilience activities. It also presents examples of combining different EO Information to visualise Disaster Resilience phenomena.

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

What topics of Disaster Resilience are included?

Exposure and Vulnerability Mapping

Exposure and Vulnerability Mapping identifies hazard-prone assets and describes how they will react to a hazardous event. This mapping service is essential to produce a quantitative estimation of risk. This process considers physical, social, and economic influences, providing a holistic risk view that is necessary for developing effective disaster management strategies.

Natural Hazards Mapping

Natural Hazard Mapping is the process of identifying and quantifying areas susceptible to natural hazards. This component, together with exposure and vulnerability mapping, is essential to understand the potential impacts and geographical distribution of risk. The insights derived from this mapping process are essential for the strategic planning of disaster prevention measures and the development of efficient response plans to minimise damage.

Risk Assessment

Risk Assessment measures the likelihood and impact of hazards, encompassing exposure and vulnerability to facilitate risk estimation. This analysis guides the development of targeted mitigation and preparedness strategies, serving as a cornerstone of disaster risk management.

For further context please see: https://gda.esa.int/thematic-area/disaster-resilience/

Who runs GDA Disaster Resilience?

A consortium of nine European industry leaders in Earth Observation, Remote Sensing, and Disaster Management spearheads this initiative. They excel in seamlessly integrating technology within international development contexts, with a determined commitment to driving impactful and efficient transformations.

The consortium is led by **Indra**.

The members are:

Indra	(ES)
CIMA	(IT)
Gisat	(CZ)
Argans	(UK)
Planetek	(IT)
LIST	(LU)
DLR	(DE)
GeoSphere	(AUT)
Terradue	(IT)

Understanding of the project objective and overall workflow

Priorities

1. Using Earth Observation to deliver precise, helpful, and cost-effective information, enabling improved decision-making in disaster risk management.
2. Supporting International Financial Institutions' initiatives, augmenting global development efforts.
3. Providing adaptive and flexible Earth Observation initiatives, leveraging agile methodologies to effectively address emerging needs and situational shifts.

Supported IFI Initiatives

Eight distinct IFI initiatives have been supported by targeted EO-based products and developments. Please see below for further details on the individual use cases. These projects were financially backed by major institutions such as the World Bank and the Asian Development Bank.

EO developments

EO advancements have paved the way for the generation of exposure maps, comprehensive flood mapping services, and thorough risk assessments. Notably, mature EO services were also successfully delivered to end users.

Case Examples

Use Case: EO-based analytics to provide disaster risk metrics in support to Country Climate Development Reports (CCDR)

Users: The Global Program for Disaster Risk Analytics (GPDRA) of the World Bank
Location: Azerbaijan

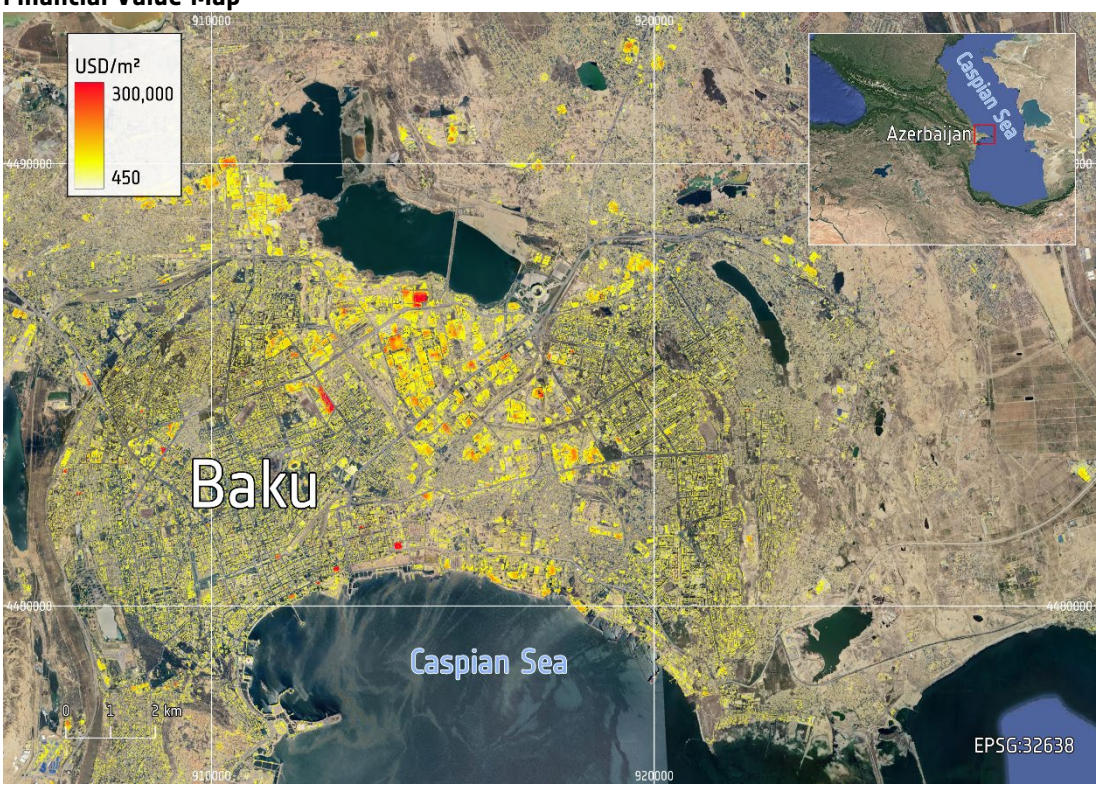
Description

The World Bank's Global Program of Disaster Risk Analytics aims to utilise advanced data analytics to enhance disaster risk understanding and guide risk management decisions. It examines data related to hazards, exposure, and vulnerability. This includes elements such as climate patterns and population density. Its goal is to provide decision-makers with precise, timely information for mitigating and managing disaster impact. The programme prioritises the creation of advanced disaster risk models and tools, enhances data collection and analysis through technologies such as remote sensing, and builds the capacity of nations to harness these data for enriching their disaster response strategies. It also encourages collaboration and information exchange among various stakeholders in disaster risk management.

Product sample

Financial Value Map

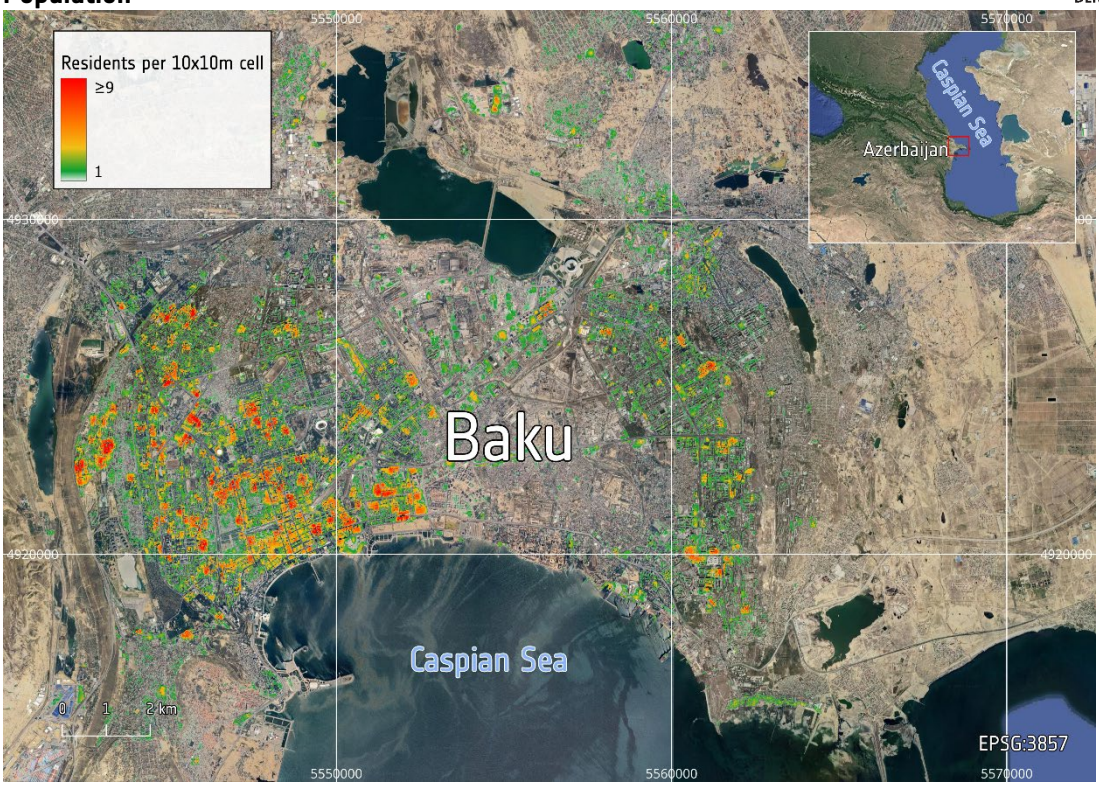
indra



The financial value map presents assets' value in Baku, Azerbaijan, as USD/m², helping stakeholders in evaluating potential economic risks during downturns or disasters and in devising effective risk management strategies and resource allocation.

Population

DLR



The estimated number of residents per 10x10m cell is derived from redistributing total population per administrative unit, considering building density, use, and height. This sophisticated approach enhances our understanding of population density for strategic planning.

Use Case: Support to Natural Based Solutions using flood hazard and green infrastructure mapping

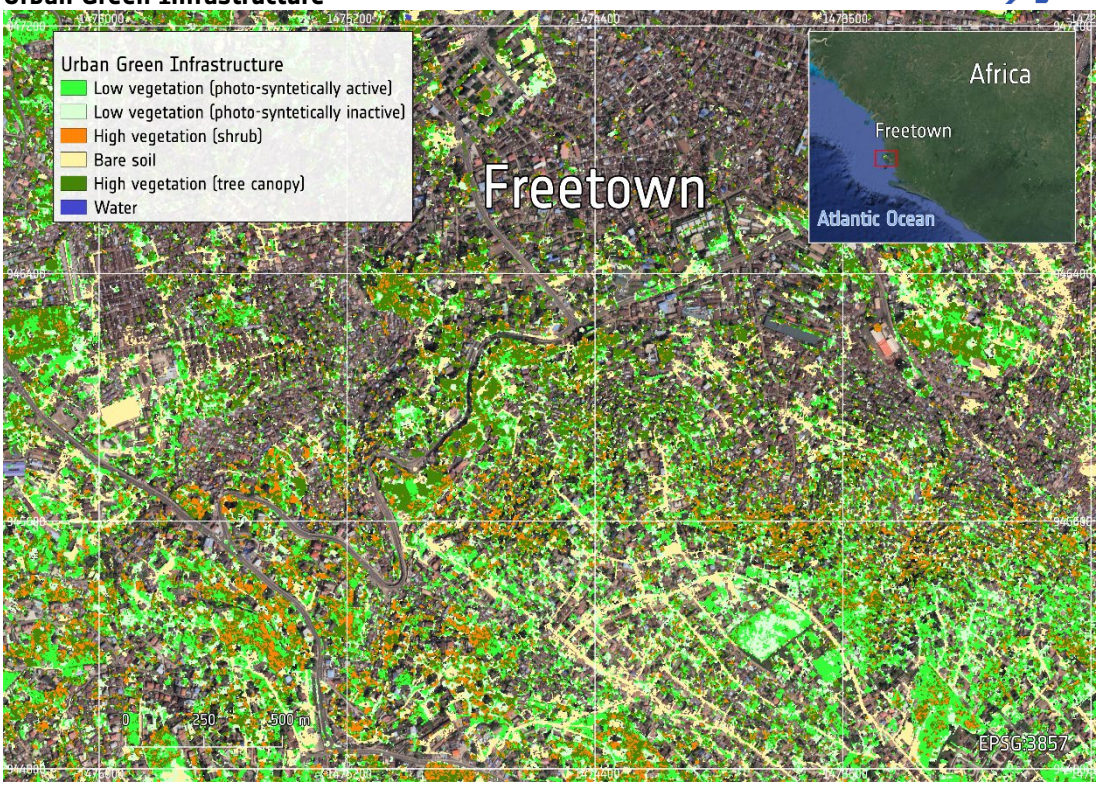
Users: Global Program on Nature-Based Solutions (NBS) for Climate Resilience of the World Bank
Location: Thailand, Argentina, Democratic Republic of Congo, and Sierra Leone

Description

EO-based flood products were utilised to discern areas where specific Nature-Based Solutions, including green corridors and urban parks, could potentially support in flood risk reduction. Techniques involving spatial overlay and rudimentary runoff reduction models were deployed to gauge the effectiveness of diverse solutions at neighbourhood level. In addition, deep learning classification techniques of EO imagery were used to inventory current vegetation and potentially suitable areas for NBS actions. These products served as crucial inputs for a cost-benefit analysis of various solutions, considering significant benefits such as recreation, air quality, and the potential costs saved from refraining from urban development. This well-structured approach highlights the pivotal role that advanced analytics and EO play in improving our comprehension and management of disaster risks.

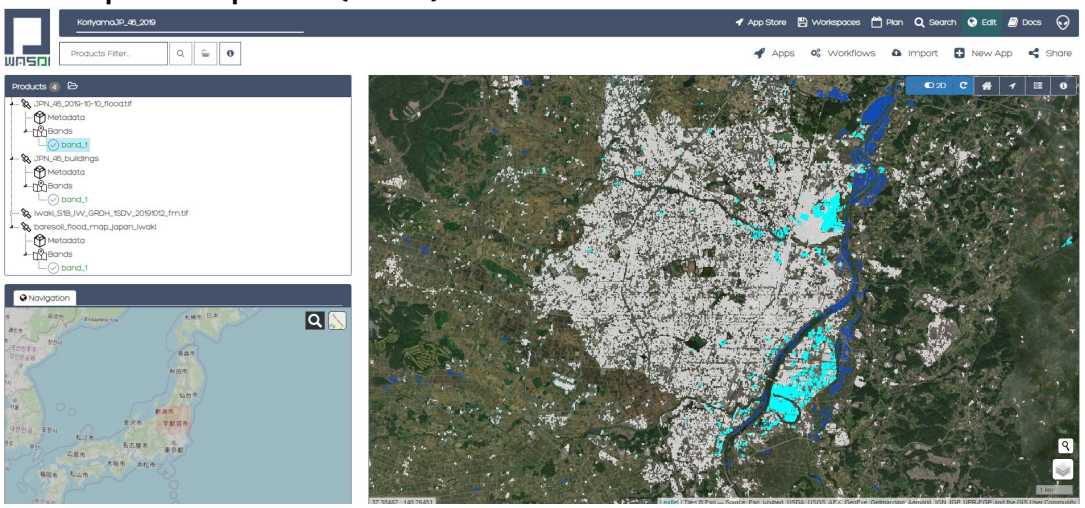
Product sample

Urban Green Infrastructure



The Urban Green Infrastructure map of Freetown, Sierra Leone, offers a citywide understanding of specific urban greenery classes crucial for the World Bank's NBS team regarding the vegetation present in the city, especially with regard to its potential to prevent the expansion of floods.

Flood Maps: Online platform (WASDI)



Leveraging Sentinel-1 and -2 data, the online platform WASDI facilitates the identification of flood-prone areas, including urban landscapes. This is a valuable data source for users who aim to improve disaster resilience by understanding zones flooded in the past.

Use Case: Monitoring coastal trends from space to characterize coastal risk

User: West Africa Coastal Areas (WACA) Management Program of the World Bank
Location: Ghana

Description

The WACA-programme has supported Ghanaian institutions by exploiting EO to assess coastal dynamics affected by natural and human factors. A demonstration of a potential data service has utilised a historical set of geospatial products from Sentinel-2, Landsat 5 and 8, including waterlines, shorelines, and Land Use/Land Cover (LULC) maps. To offer further substantiation regarding the underlying processes influencing the observed coastal changes, a series of innovative new products has been developed. These products include a series of maps showing shoreline evolution, wave properties, sediment source, and sediment flow. In collaboration with local Ghanaian expertise and engagement with the WACA World Bank representative, a test site around the Keta region was selected to bring these tools together. A time series approach has been adopted to assess shoreline changes over time, identifying potential intervention points and risk locations. Although not predictive, this comprehensive historical evaluation supports evidence-based coastal management.

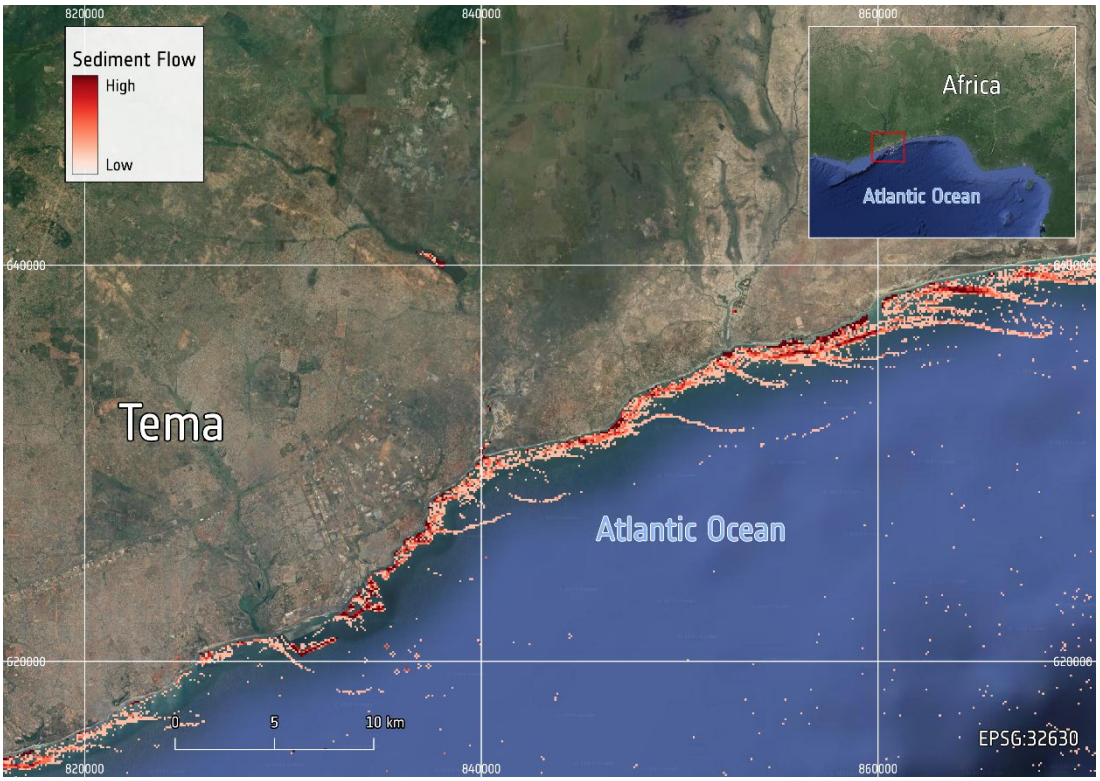
Product sample

Shorelines Evolution

The shoreline evolution map (2013-2022) of Old Ningo, Ghana, illustrates coastline changes, highlighting areas of accretion and erosion. This vital data aids in identifying vulnerable zones,

planning land-use, assessing infrastructure risk, evaluating long-term coastal changes, and conserving and restoring coastal ecosystems.

Sediment Flow



The sediment flow map of Tema, Ghana, displays varied location-specific sediment flow values. It facilitates the pinpointing of risk zones to promote conservation and restoration efforts and climate change adaptation measures.

Use Case: Enhanced flood and exposure mapping to enable better financial risk management

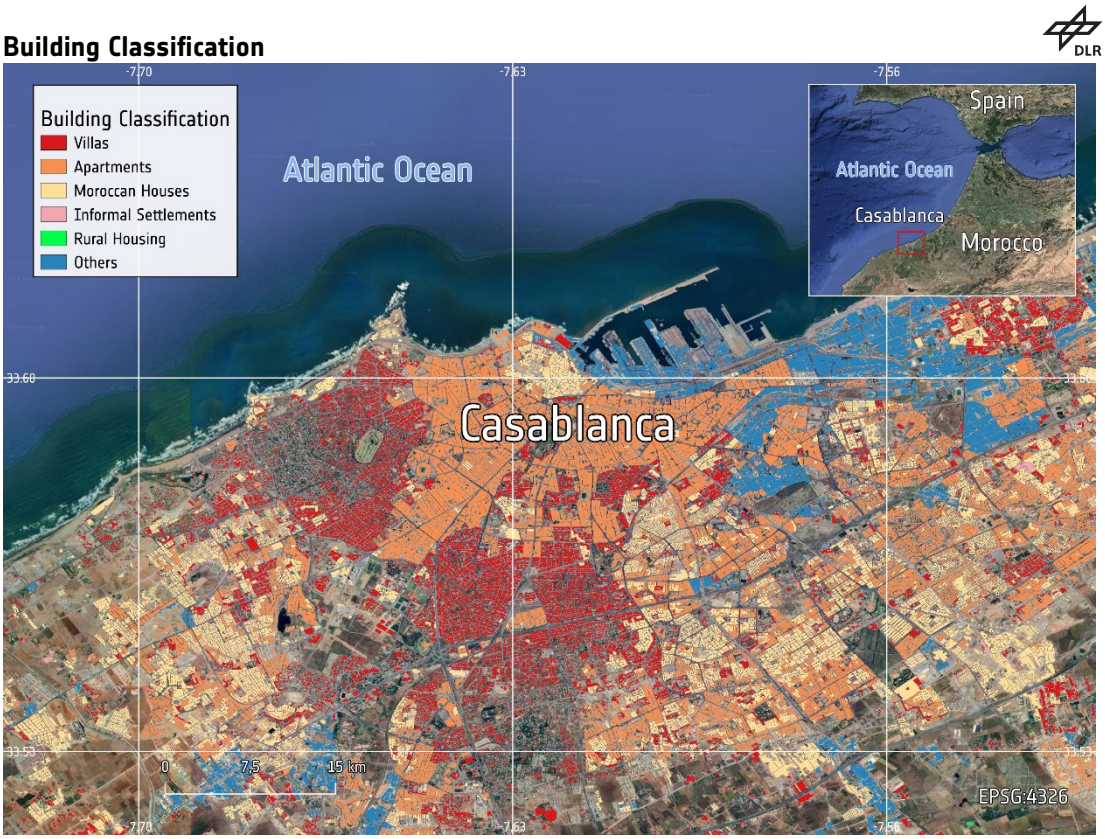
Users: Risk Financing and Insurance (DRFI) Program of the World Bank
Location: Morocco

Description

The Disaster Risk Financing team at the World Bank supported the Fonds de Solidarité Contre les Événements Catastrophiques (FSEC) team at Morocco's Ministry of Finance to enhance their capacity to construct a comprehensive flood risk profile. In the context of data scarcity, the demand for improved flood and exposure mapping emerged as a critical aspect to upgrade the current flood risk model. This use case aligns with the World Bank's DRFI Programme, which is dedicated to bolstering countries' financial resilience against disasters. The DRFI Programme combines technical assistance, analytical support, financial instruments, and disaster risk reduction measures to offer a multi-faceted approach to disaster risk management.

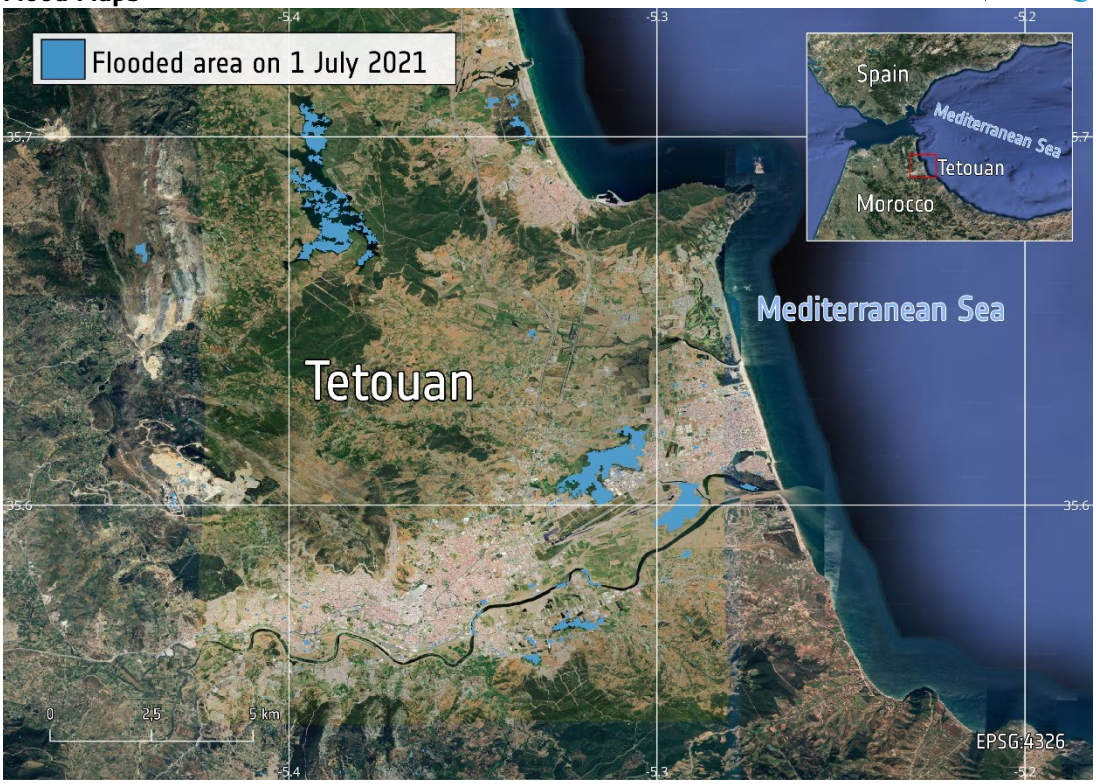
Product sample

Building Classification



The building classification map of Casablanca, Morocco, estimates the types of buildings within the identified settlement pixels based on the World Settlement Footprint (WSF) 2019 product. This classification is crucial for enhancing financial resilience to natural disasters because the type of building is not only linked to its economic value but also to its vulnerability.

Flood Maps



Leveraging Sentinel-1 and -2 data, the Tetouan, Morocco, flood map innovatively identifies both rural and urban flooded areas. This contributes to improve resilience to disaster risk with better emergency preparedness and climate change adaptation strategies through knowledge of flood prone areas.

Use Case: Urban subsidence and flood diagnosis

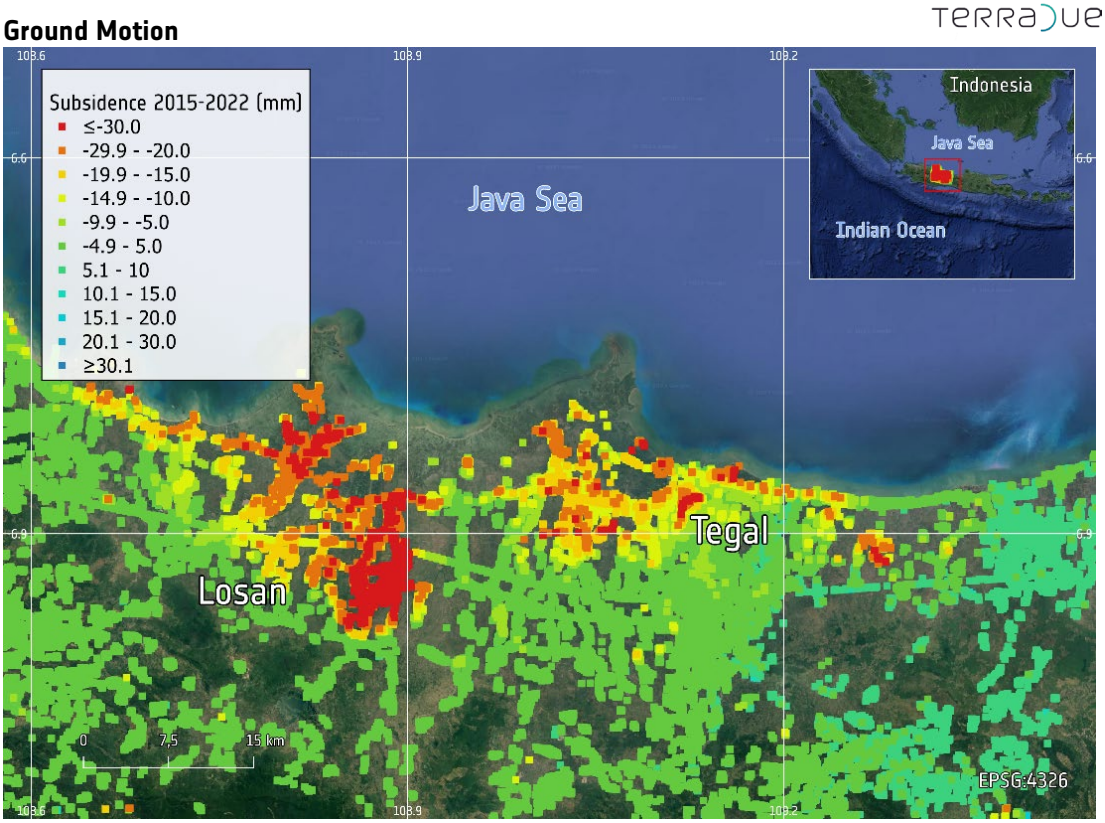
User: Flood Management and coastal Protection in North Java project of the Asian Development Bank
Location: Indonesia

Description

The Asian Development Bank-funded project addressed subsidence risks in five Indonesian cities, including Jakarta, Cirebon, Pekalongan, Semarang, and post-earthquake Palu. The project employed EO advancements to improve building stability risk analytics. Key measures encompassed the integration of 3D city data, the updating of subsidence and flood studies using current imagery, the development of an advanced exposure database, and the formulation of a comprehensive impact index to assess combined flood and subsidence risks. These measures have empowered the Indonesian Government to enhance its capacity for more effectively mitigating flood and subsidence risks in the impacted urban centres.

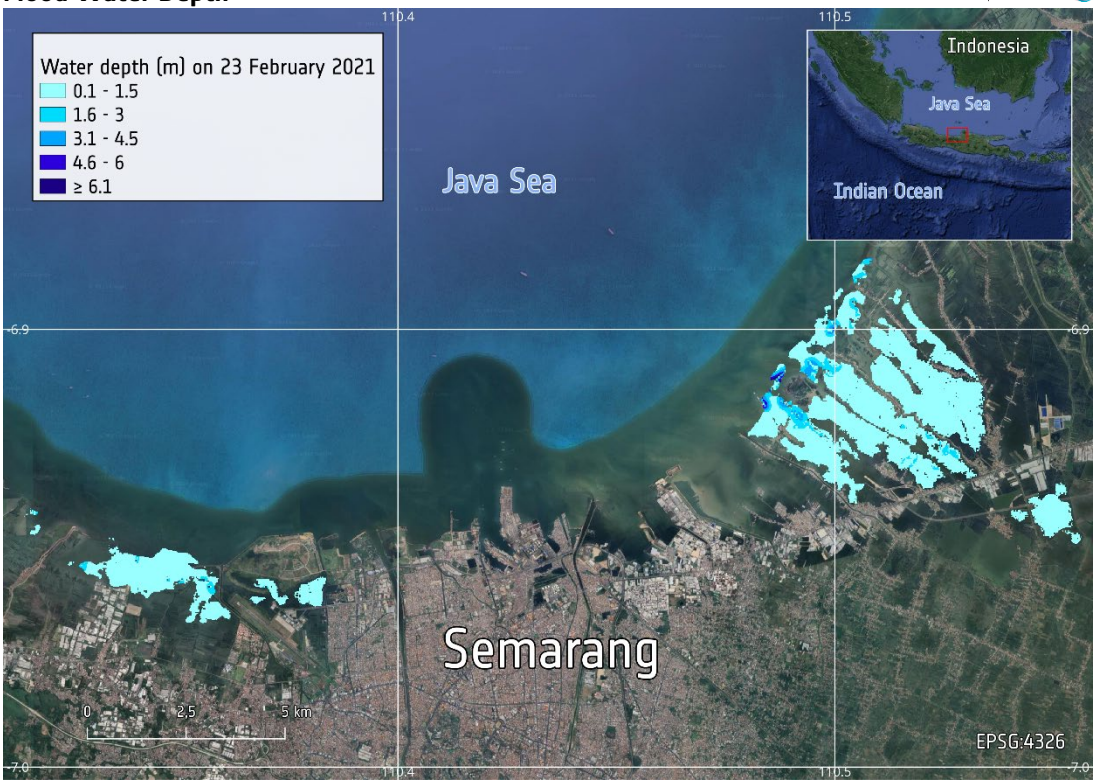
Product sample

Ground Motion



The subsidence map of Losan, Indonesia, offers crucial geo-analytical insights derived from detailed evaluations of building movement trends within predefined zones of surveillance. It effectively monitors any deviations, capturing their evolution and advancement over time.

Flood Water Depth



The flood water depth map of Semarang, Indonesia, serves as an invaluable tool for identifying flood-affected areas and determining the depth of flooding. This information informs strategies aimed at improving resilience against future flood events.

Use Case: Spatio-temporal analysis of dzud hazard

User: Mongolia Sustainable Fodder Management Project of the Asian Development Bank
Location: Mongolia

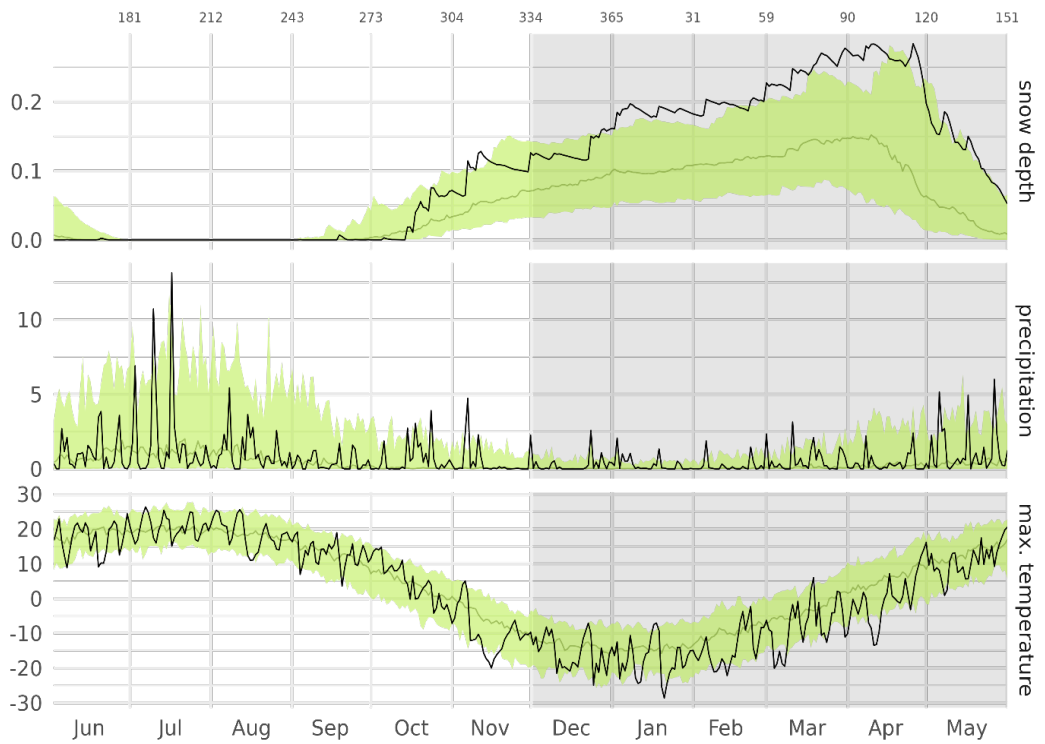
Description

The aim of the use case was to enhance understanding of dzud events. A "dzud" is a disastrous extreme weather event in which a significant proportion of livestock dies, primarily due to starvation. Reasons for livestock loss are manifold and include climate drivers such as snow and ice hindering grazing, low temperatures, and drought. To support the understanding of dzud genesis, the project intended to collect extensive data on dzud precursor conditions. The benefits of this work included the identification of areas prone to dzuds from a climate hazard perspective, the delineation of thresholds for important climate drivers, and the provision of harmonised data for future risk assessment studies. Moreover, it facilitated a comprehensive assessment of climate drivers for dzuds within a multi- hazard framework, factoring in severe cold, snow depth, and available fodder sources.

Product sample

Multi-hazard Event (winter 2009-2010)

GeoSphere Austria



The 2009-2010 multi-hazard event chart displays annual patterns of snow depth, precipitation, and peak temperature. This comprehensive data visualisation tool proves invaluable for detecting climatic hazards, such as dzud events, helping to facilitate emergency preparedness and climate adaptation strategies.

Use Case: Geospatial indicators of land stability, and flood susceptibility to improve water management

Users: Department of public health engineering, National Agency (Central Government), Department of water Resources Engineering, and Dept. of University of Engineering and Technology (BUET)
Location: Bangladesh

Description

This use case supports the resident mission of the Asian Development Bank in Bangladesh by delivering EO-derived geospatial maps and indicators in the Cox's Bazar district. The service's primary goal is to improve water management and assess natural hazards such as flooding, subsidence, and landslides. In the Cox's Bazar district, users rely on these services to identify flooded areas, evaluate flood risk, track seasonal trends in surface water bodies, and assess ground motion hazards in populated areas. Three platforms were utilised to provide these services: the GEP platform for medium-resolution ground motion monitoring, the WASDI platform for mapping flooding frequency and analysing seasonal trends in surface water bodies, and the Rheticus® platform for geospatial analytics related to subsidence and landslide hazard assessments in major built-up areas, identified through dedicated land cover classification.

Product sample

Ground Motion Hazard Assessment

The Rheticus® Platform's ground motion hazard assessment for Cox's Bazar assigns concern levels to hexagonal cells representing territory sections. Factors such as surface displacement trends, morphological features, land cover types, and infrastructure presence determine these ratings. Rheticus®, a web application, presents this map among its EO-based products for Cox's Bazar district, Bangladesh.

Use Case: Coastal flood hazard mapping

User: City Resilience Program (CRP) of the World Bank
Location: Timor-Leste

Description

This use case focuses on developing a coastal flood hazard mapping service designed to help coastal cities understand and mitigate risks related to sea-induced flooding. This innovative service leverages cutting-edge land classification maps joined with space-based Lidar data to generate a digital terrain model that reflects the true ground shape. Lidar, an acronym of "light detection and ranging" measures distances or elevations by using a laser and measuring the time for the reflected light to return to the receiver. This service represents a significant advancement over global canopy models, which are prone to producing inaccurate and unrealistic flood predictions. The resultant models excel at pinpointing areas susceptible to water flow or channelling, substantially enhancing our understanding of how coastal floods (such as storm surges or tsunamis) behave in real-world scenarios. This is especially crucial in regions at risk of sea-level rise, land subsidence, and severe storms. By furnishing detailed geospatial parameters, the service empowers city authorities, engineering firms, and financial institutions to develop dynamic flood models for improved decision-making and preparedness.

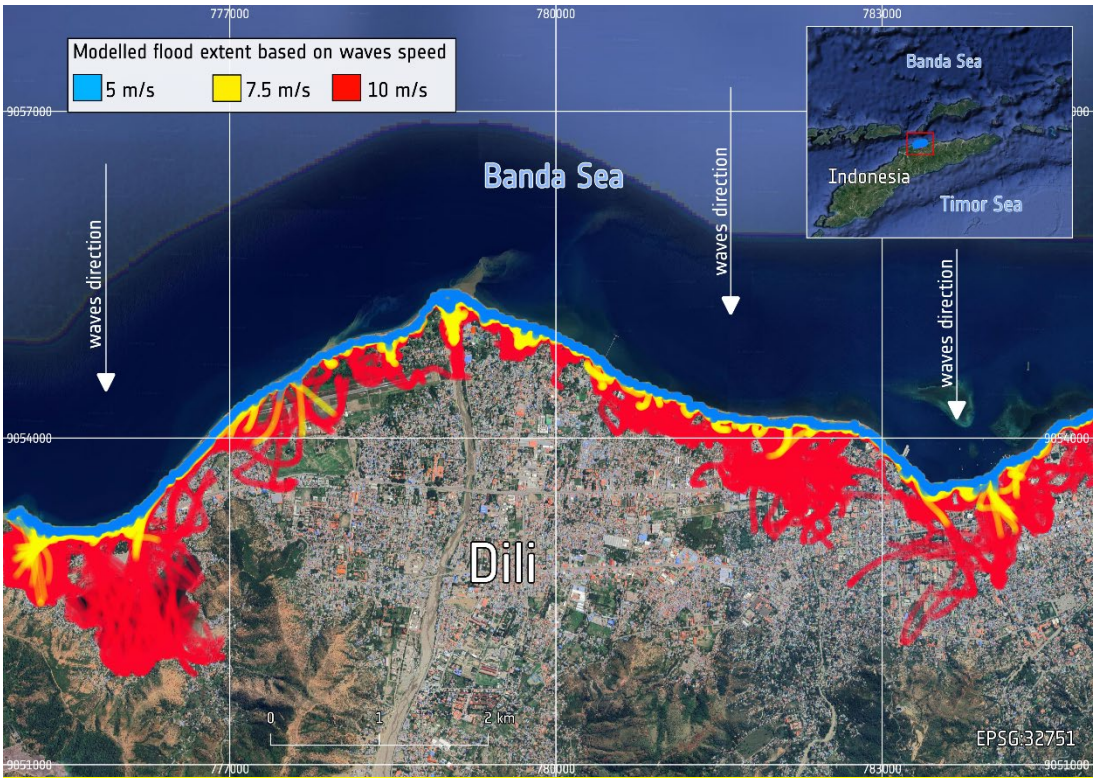
Product sample

Bathtub Coastal Flooded Area

Identifying coastal regions susceptible to the bathtub phenomenon - a simplistic approach to flood modelling where the land is filled with water like a bathtub - refines flood risk management. It

optimises preparedness, resource allocation, warning systems, supports resilient urban planning, protects infrastructure, and mitigates economic losses from coastal floods.

Inverse Watershed Coastal Flooded Area



Understanding the trajectories of waves at different speeds along the coast increases the interpretation of a prospective map of the extent of flooding, generated through modelling. This information amplifies efficient coastal management, promotes tailored disaster preparedness, and sharpens hazard mapping. Additionally, it informs the creation of robust infrastructure, helps the preservation of coastal ecosystems, and reduces the potential damage during severe weather events.

Explore GDA #AcceleratingImpact at gda.esa.int
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