Global Development Assistance

Fragility, Conflict and Security

April 2023

GDA powered by esa in partnership with ADB

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Glossary

What does ESA's Global Development Assistance (GDA) Activity on Fragility, Conflict, Security do?

ESA-Global Development Assistance (ESA-GDA) programme focuses on the targeted Agile EO Information Development (GDA-AID) applied to 10 thematic priority sectors. The Fragility, conflict and Security (FCS) thematic area, led by e-GEOS, is a critical development challenge: violent conflict has spiked dramatically since 2010 and the fragility landscape is becoming more complex with the effects of global climate change, rising inequality, demographic change, poor governance and illicit financial flows. The world is facing the largest forced displacement crisis ever recorded, and the COVID-19 pandemic adds greater stress. ESA-GDA-AID-FCS programme engages with IFI partners to co-design tools providing timely and precise information in support of ongoing initiatives aiming at reducing poverty, helping economic development and promoting environmental safety in states affected by FCS. As part of this GDA AID activity, products and services are developed following a multidisciplinary approach, combining geospatial data and data from heterogeneous sources, to feed customised analyses and reports that improve decision making processes.

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

What topics of Fragility, Conflict, Security are included?

Food Security

Food Security has several aspects or dimensions. Basically it means that all people, at all times, have physical and economical access to sufficient quantities of foods that are sufficiently nutritive, safe in the manner it has been produced and according to the cultural reality of the society. This information must be transparent and available so the members of the society are able to make informed decisions about their choices.

Agriculture applications as Smart farming (yield mapping, input management and farm management recording), Field scale and crop dynamics mapping and monitoring, Irrigation management and drought monitoring, Crop production and food security monitoring, can be supported by EO products

Situational Awareness

Situational awareness refers to the process of aggregating spatio-temporal variables and measurements from different sources, aiming to improve the semantic outcome. Remote Sensing satellites for Earth Observation acquire key variables that, when properly aggregated, can provide precious insights about the observed area in the thematic sector of FCV and to reduce the uncertainties associated with standard geospatial intelligence.

Impact assessment and exposure

Novel EO data and analytics methods allow to map components of critical relevance to FCV settings at unprecedented levels of spatial detail. Important aspects are descriptive variables capturing urban growth dynamics and state. This comprises not only actual settlement extents, building arrangements and city layouts, but also the inhabiting population, through statistics on population distribution and density. Knowing spatial details on population distribution can subsequently enable the definition and derivation of population-linked socio-economic indicators.

For further context please see: https://gda.esa.int/thematic-area/fragility-conflict-security/

Who runs GDA Fragility, Conflict, Security?

The activity is implemented by a consortium of six European companies leading in the fields of Earth Observation, Remote Sensing, Navigation and Communication, Open Source Intelligence (OSINT) and Socio-Spatial Intelligence (SOSINT), and the integration of technology into international development contexts.

The consortium is led by e-GEOS

The members are:

e-GEOS	(IT)
Janes	(UK)
Hensoldt Analytics	(AT)
VITO	(BE)
DLR	(DE)
CGI	(IT)

Priorities for GDA Fragility, Conflict, Security

Understanding of the project objective and overall workflow

4 PRIORITIES

1. Improved assessment of exposure to fragility risks and analysis of coping capacity
2. Effective characterization of dynamics and needs in FCS contexts
3. Enhanced generation of information services for planning, monitoring and management of post-conflict reconstruction activities
4. Better assessment of assets and natural resources

10 USE CASES

Categories of activities in which specific EO product/information technical developments shall be used and assessed for impact

11 EO products/information

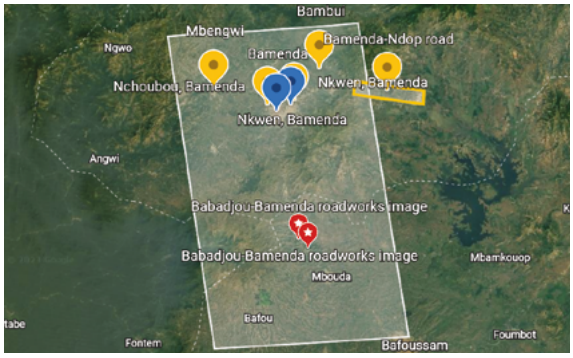
EO-based information developments identified as possible candidate to be prototyped, used and assessed within the broader use-cases described in the next pages

UC1 – Security/assessment briefings

WB project: P150999 - Cameroon Transport Sector Development Project

Final product description: operational reporting to track security events occurred along Bamenda road (Cameroon), that can affect civilians in the neihborhood areas. Events as military attacks, militants clash, kidnappings are detected on the basis of intelligence and socia-media mining systems (OSINT/SOSINT), from September 2022 up today, monthly basis. Focused damage assessment analysis are performed on the basis of optical VHR EO data, in buffer zones from the centre of the event. A comprehensive actual and retrospective overview of security threats are performed and provided in a security report for operational usage.

OSINT/SOSINT events detected



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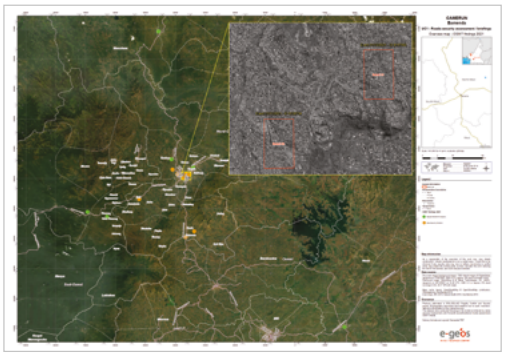
EO/OSINT data integration

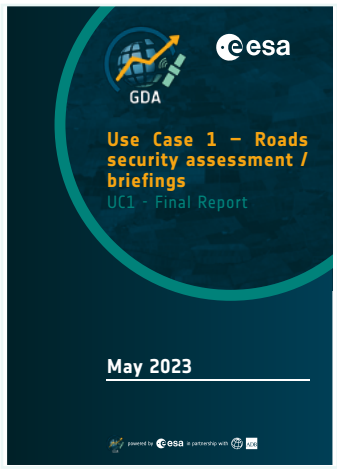


e-geos

EO-based damage assessment

e-geos

FINAL PRODUCT: Security Report



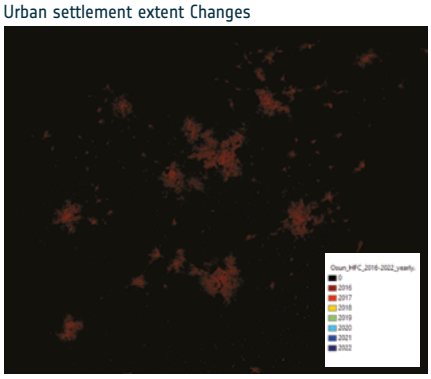
Use case examples

UC2 – EO to support impact evaluation

WB project: P144852 - Impact Evaluation – Rural Access and Mobility; P095003 - Nigeria - Rural Access & Mobility Project-Phase 2

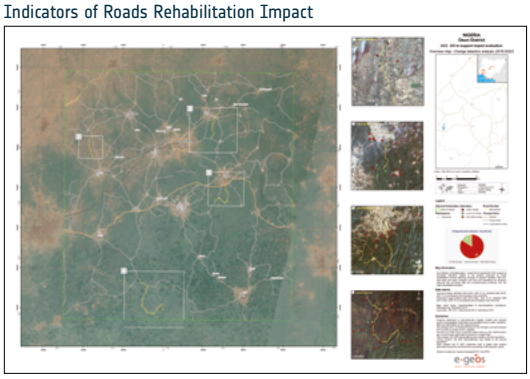
Final product description: impacts produced by activities of roads' rehabilitation (Nigeria) are evaluated in the perspective of urban settlement extent changes derived from Sentinel-1and Sentinel-2 data, as well as optical Multi-temporal cherence Sentinel-1 based indicators, identifying changes related to man-made, urban changes and land use over the time period 2016-2022, at district/country level, yearly basis. Products above were integrated into a final one, to focus on major changes occurred, within buffer areas of 5Km from the roads' section.

Urban settlement extent Changes



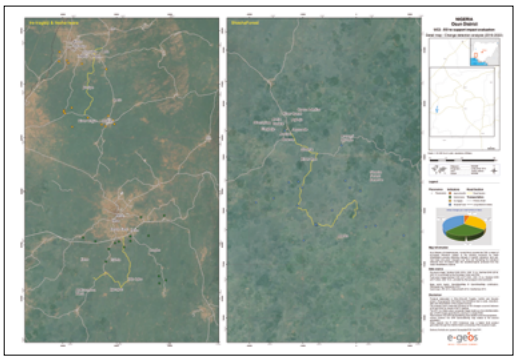
DLR

Indicators of Roads Rehabilitation Impact



e-geos

Indicators of Roads Rehabilitation Impact



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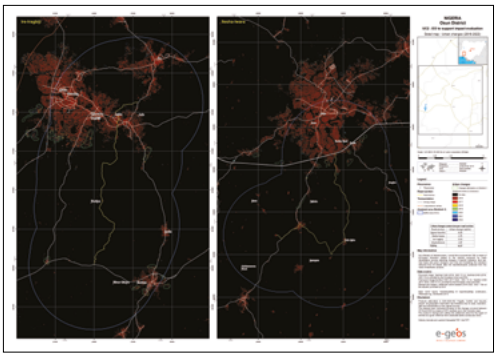
FINAL PRODUCT:
Integrated Results Urban Changes



e-geos

UC3 – Smallscale infrastructures monitoring

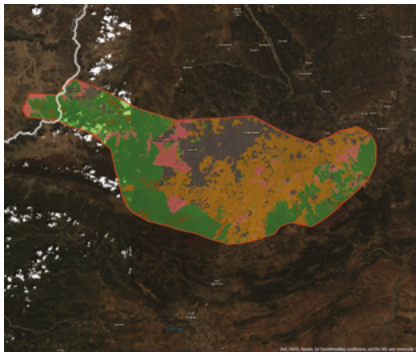
WB Project: P151075 - Pakistan Community Support Project - PCSP

Final product description: (re)construction status of small-scale infrastructures in Northern Pakistan is monitored through a change detection analysis based on optical VHR EO data, from 2020 up today, at infrastructures level. Five classes are identified comparing the pre-event and the post-event EO data on means of visual photo-interpretation: completed, reconstruction ongoing, changed, unchanged, not analyzed. A dedicated Artificial Intelligence (AI) model was developed for an automatic extraction of LandUse/LandCover (LULC) classification, Sentinel-2 based. A baseline was produced for December 2022. EO-based results, environmental and socio-economic data gathered in the field from the end-user are ingested in an unique dashboard to aggregation, analytics, monitoring and comprehensive visualization.

EO - Based Change Detection Analysis

e-geos

Automatic LandUse/Land Cover



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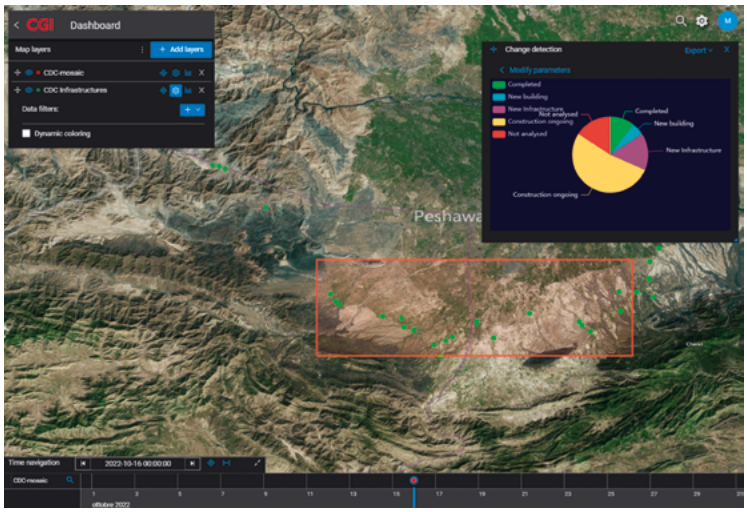
FINAL PRODUCT: Interated Dashboard Analytics



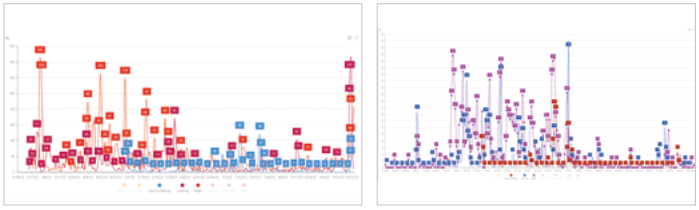
CGI

UC4 - Land grabbing assessment

WB project: P128950 - Assessing the Nexus of Land Administration and Resilience to Disaster and Climate Risk - Ukraine

Final product description: systematic and opportunistic land grabbing events are detected in a dedicated assessment report, on the basis of combined open-source information (from social/traditional media), intelligence analysis and indicators retrieved from earth observation damage proxy maps (Sentinel-1 data), wildfires monitoring (Sentinel-2 data), nightlights monitoring (SUOMI/VIIRS data), high frequency urban settlement extent changes (Sentinel-1, Sentinel-2 data) and seasonal crops monitoring (Sentinel-2 data).

Traditional/Social Media and intelligence analysis



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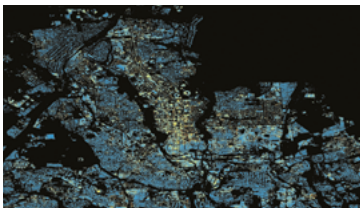
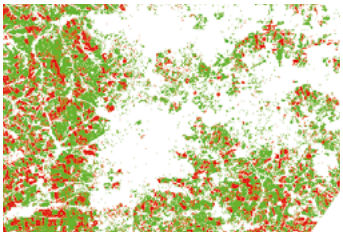
Urban settlement extent



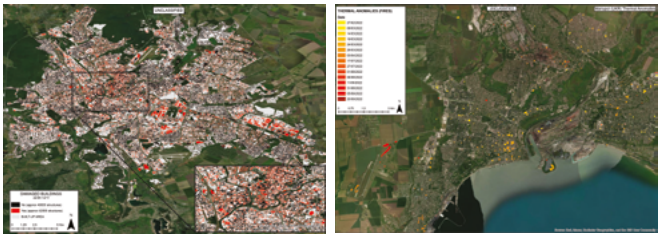
DLR

Crops monitoring



vito

Damage assessment and Wildfires monitoring



e-geos

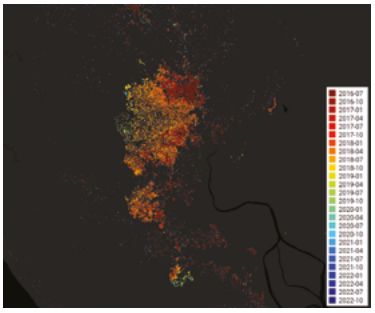
FINAL PRODUCT: Land grabbing assessment report

UC5 - Effects of displaced population on local economy

WB Project: P172830 - The Cox's Bazar Analytical Program - Bangladesh

Final product description: AI model development to monitor the welfare growth at district level (Cox's Bazar, Bangladesh), produced by the refugees' arrival. Indicators of the local economic growth are retrieved from the automatic extraction of buildings footprint (excluding refugee camps or similar), for urban level assessment, as well as the automatic detection of asphalted roads. Changes in urban areas are correlated with the nearest refugees' camp area to assess the impact of the camps produced since their arrival. The AI model is implemented on the basis of results obtained from High Frequency Urban Settlement Extent Changes (Sentinel-1, Sentinel-2 data), as well as the automatic extraction of Land Use/Land Cover (Sentinel-2 data) and focusing with optical VHR EO data acquired over the districts in scope of the analysis.

Urban settlement extent Changes



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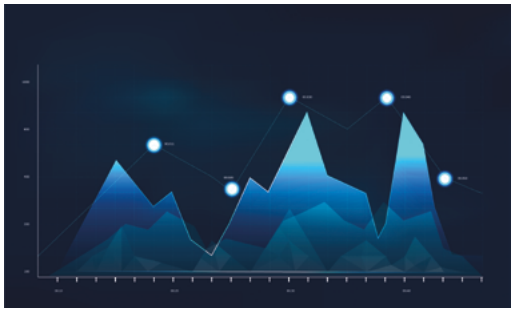
OSINT Socio-economic assessment



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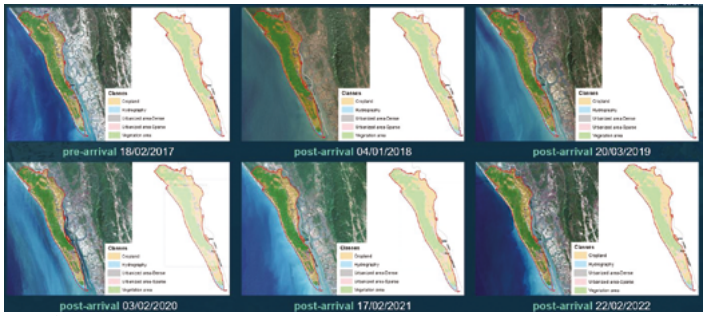
Land Use/Land cover classification



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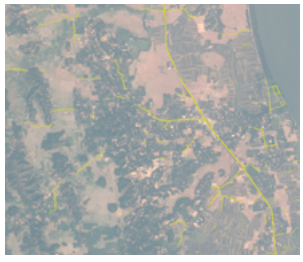
FINAL PRODUCT: Automatic buildings/roads extraction for welfare growth indicators monitoring

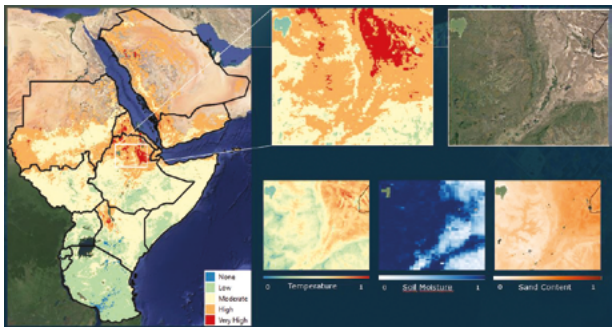


UC6 - IGAD through emergency locust response program

WB program: P174546 - Emergency Locust Response Project - East Africa

Final product description: Sentinel-2 images combined with the FAO Locust Hub https://locust-hub-hq-fao.hub.arcgis.com/ to assess the extent of cropland damage by desert locusts in East Africa. While the Locust Hub contains data on different types of locusts (adult, bands, hopper, and swarm), this experimental analysis is based on the swarm data. The experimental analysis is done on three tiles of sentinel 2 located in north Ethiopia. By combining these two data sources, change detection was made by comparing images of pre- and post-swarm damage dates. The estimated damage dates were inferred from the FAO locust hub information backed by NDVI time series decomposition.

Risks zones identification



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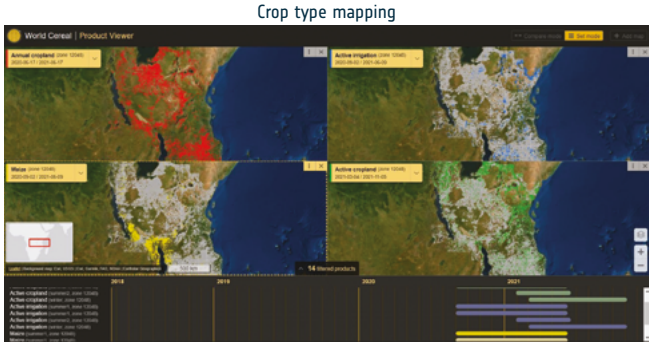
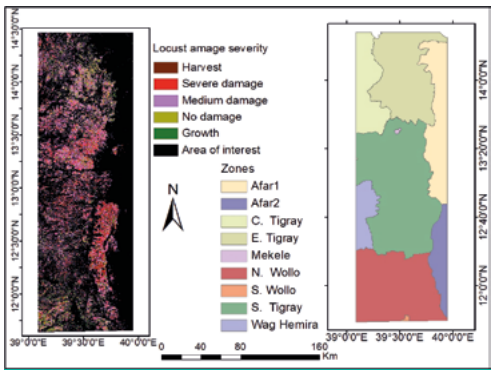
Crop type mapping



vito

FINAL PRODUCT: Locusts damage assessment

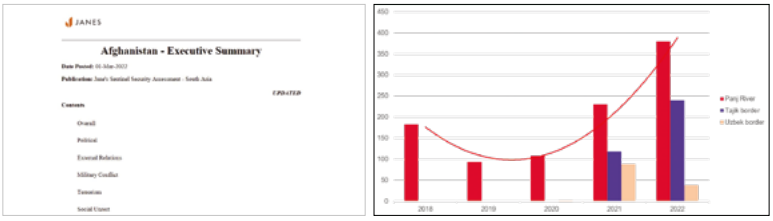


UC7 – Population movement

ADB program: TA 9986 Regional: Enhancing Differentiated Approaches in Context-Sensitive Situations - Afghanistan, Tajikistan, Uzbekistan

Final product description: dashboard implementation for results visualization and analytics of cross-borders migration flow drivers/indicators assessed through evidence from SOSINT/OSINT analysis integrated within EO-based products (Afghanistan, Tajikistan, Uzbekistan). Keywords population movement related are retrieved from OSINT reporting at country level, then tailoring the social-media mining system to provide drivers for EO-based analysis, as monitoring urban settlement extent changes at country level (Sentinel-1, Sentinel-2 data) as an indicator of population growth, monitoring cross-borders changes through heatmaps seasonally development (Sentinel-1 data) and focusing with optical VHR EO data for detailed analysis over refugee camps araes identified.

OSINT/SOSINT findings



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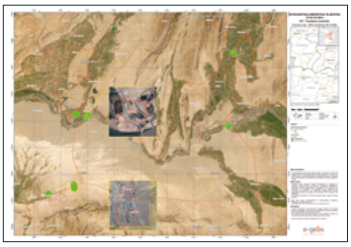
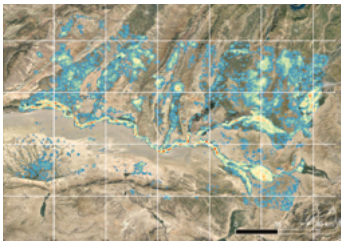
EO-data integration



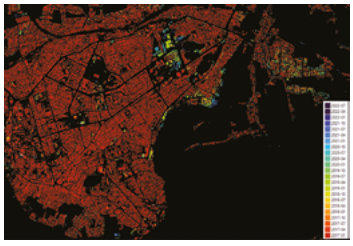
e-geos

Heatmaps



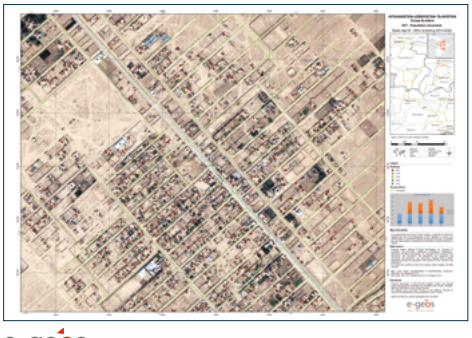
e-geos

Urban settlement extent changes



DLR

FINAL PRODUCT: VHR EO-based population movement monitoring for dashboard analytics integrations



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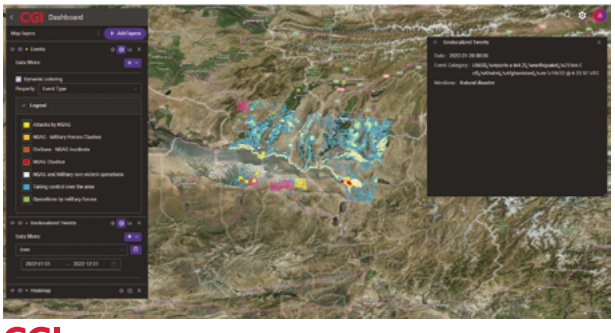
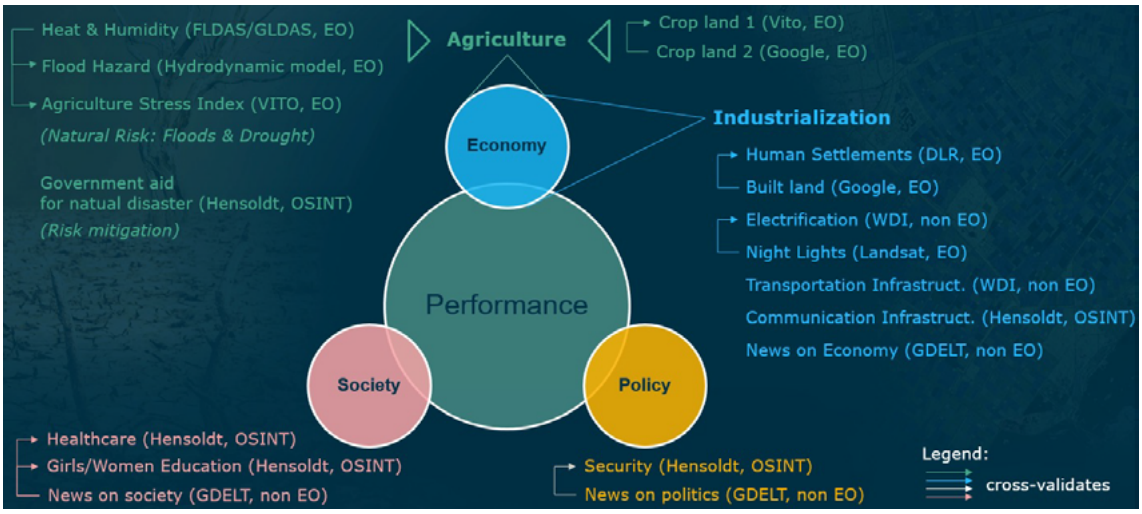


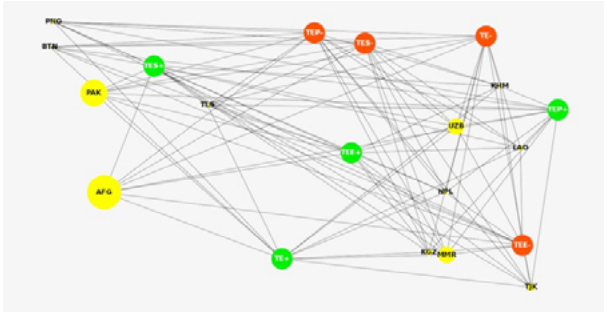
CGI

UC8 - Enhanced Country Performance Assessment

ADB program: TA 9986 Regional: Enhancing Differentiated Approaches in Context-Sensitive Situations - FCAS Countries

Final product description: AI model development with statistics and trends from the EO-based and OSINT/SOSINT-based indicators used as input to a machine learning model along with the CPA already drafted for the countries under consideration, in order to compute a new index that corrects the current CPA estimated from ADB. The design of a validation methodology for the AI model with the aim of studying how the information extracted from EO data is able to give indications at the CPA level. This activity will design a sensitivity analysis to critical design choices to assess the robustness of model results. Infographic at country level is the final product, showing correlation among countries in terms of sentiment analysis conducted from various perspectives (i.e. economic, political, social, climatic, agricultural, security, etc), as well as cluster representation.



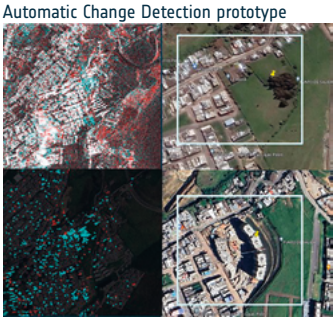


UC9 – Post-conflict Impact Assessment

IFAD program: 1100001491: Building Rural Entrepreneurial Capacities Programme: Trust and Opportunity - Colombia

Final product description: Automatic change detection tool applied on change detection product obtained from SAR images which allowed to highlight some hotspots within the urban area where new features have been built up between the first acquisition (2017) and the second (2023). Map of settlement extent changes, specifying point previously present, and according to the colour code, characterizing the temporal development of built-up structures. In addition, was present also a task of identifying coca plantation extent changes through an AI classification methodA complementary methodology has been performed to provide a security analysis about violent events and drug-trafficking events, in order to highlight evolution over time and related trends in violence and narcotics related activities, as shown in the graph below. A comprehensive analysis of the region was performed and maps of coca plantations within the area of interest throughout the years of study, maps of change in landcover obtained from Artificial Intelligence algorithms applied on optical data, and comprehensive analysis of the scenario, that considered several aspects due to the high level of criminal events related in the zone.

Automatic Change Detection prototype



e-geos

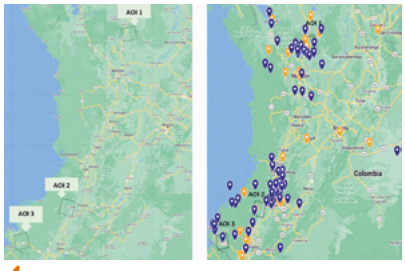
LandUse/LnadCover automatic extraction

e-geos

Settlment extent changes

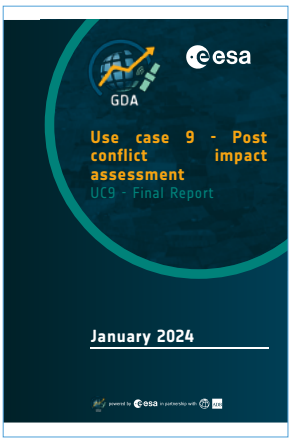
DLR

Security events extraction through OSINT



JANES

FINAL PRODUCT:

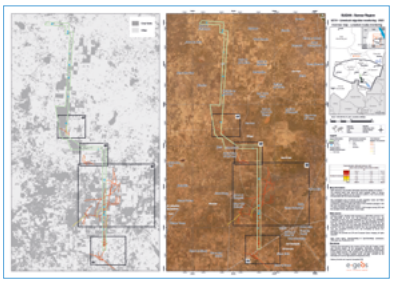


UC10 – Livestock Migration Monitoring

IFAD program: P2000002105: Sustainable Natural Resources and Livelihoods Programme (SNRLP) - Sudan

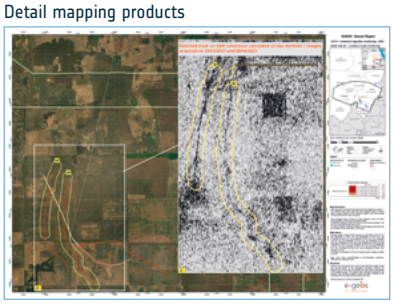
Final product description: Tracks detection based on a Multi Temporal Coherence obtained from Sentinel-1 data: the coherence is a unique higher information content product from which interesting features can be extracted, such as disturbed terrain that could be related to the passage of livestock. Analysis from 2023 and data from the field allowed to extend the analysis over previous years and compare tracks over time. Cropland mapping intersected with EO-based indicators were produced, to detect the tracks of the livestock passage along the IFAD routes, comparing the development of these two indicators along the period of interest. Key findings of EO based analysis outlined that the usage of the corridor increased in 2023 with respect to previous years. OSINT-based context and security events analysis produced integrated information to better assess experienced political turbulence, ongoing water and fuel shortage, increased resource competition amongst farmers, pastoralists, and residents contributing to instability, violence, and deaths in Sennar state.

Livestock routes extraction



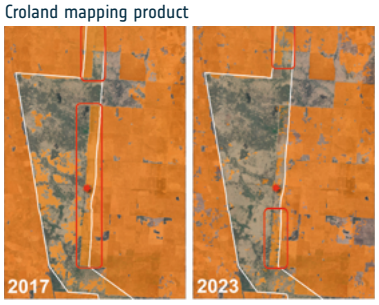
e-geos

Detail mapping products



e-geos

Croland mapping product

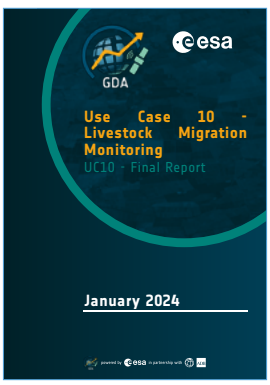


vito

Security events extraction through OSINT

JANES

FINAL PRODUCT



Glossary

MTC - Multi-Temporal Coherence (MTC): The MTC is a false-colour composite image made up of an interferometric pair of SAR images generated by placing in a single RGB: i) Red channel: the SAR backscattering map related to the first acquisition; ii) Green channel: the SAR backscattering map related to the second acquisition; iii) Blue channel: the IF SAR Coherence map, a higher level product generated through the interferometric processing of the acquired couple.

OSINT - Open Source Intelligence: is the practice of collecting and analysing information gathered from open sources to produce actionable intelligence. This technique provides support to national security, law enforcement and business intelligence. Before the digital revolution and recent developments in terms of social media, high-speed computing, machine learning, natural language interpretation and Artificial Intelligence, scenario analysis (of any nature) was the exclusive prerogative of intelligence agencies.

SOSINT - Socio-Spatial Intelligence: Adoption of social-media to gather open information.

NDVI - Normalized Difference Vegetation Index: is a simple graphical indicator that can be used to analyze remote sensing measurements, often from a space platform, assessing whether or not the target being observed contains live green vegetation.

VHR EO – Very High Resolution Earth-Observation: this refers to the spatial resolution of the satellite imagery (<= 0.50m).

Credit images

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