# CAMEO

## CORRIDOR AND ASSET MONITORING USING EARTH OBSERVATION

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CAMEO aims to boost the understanding and integration of satellite Earth Observation (EO) services by companies and agencies managing pipeline and energy transmission corridors, including underground electricity cables. This will be achieved by demonstrating the benefits of the EO based services in collaboration with asset managers and in-sector providers that do not traditionally use EO services. CAMEO will complete demonstrations where EO data is combined with traditional on-ground data and cutting-edge data processing and analytics techniques enabling improved monitoring insights.

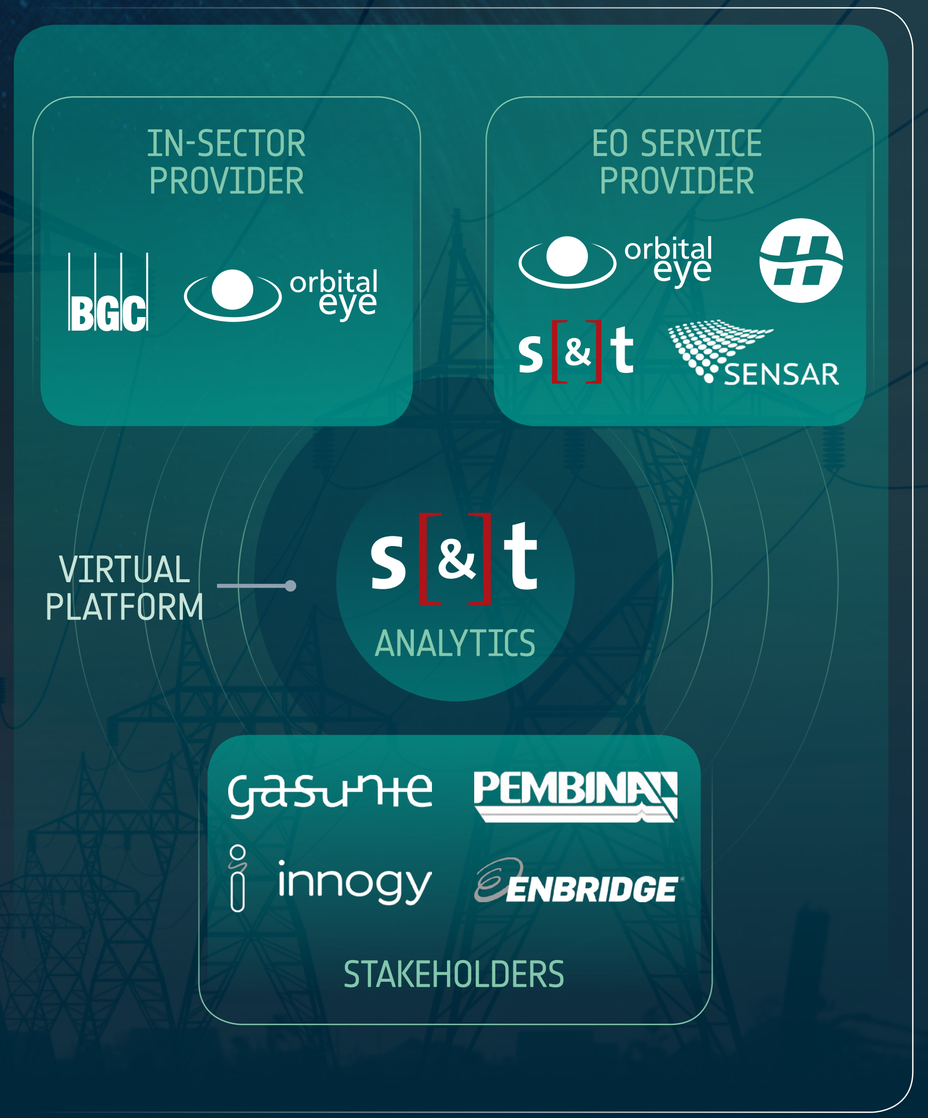
The CAMEO project is led by Science & Technology Corporation *(The Netherlands (NL) and Norway)* with partners Hatfield *(Canada)*, BGC Engineering *(Canada)*, Orbital Eye *(NL)* and Sensar *(NL)*. The two-year project is part of ESA's "Expand Demand" initiatives with a focus on the Security sector.

*Natural gas pipeline network in Europe (Source: European Parliament)*

## CAMEO OBJECTIVES

1. Show the added value of EO data to stakeholders in the corridor & asset monitoring domain. This will be addressed by gaining a deep understanding of the information needed by the end users and their working processes, and subsequently showcasing information services to them. The demonstration services will cover a diversity of environments in which the stakeholders operate, with three broad categories of services:
   - Structural integrity
     *e.g. surface deformation, leak occurrence*
   - Environmental and geo-hazards
     *e.g. flooding, wildfire, landslides, vegetation change*
   - Threat assessment
     *e.g. third-party interference, encroachment*

2. Implement the services using a "virtual platform" concept, where distributed sources of EO and non-EO data are integrated regardless of where geospatial data is hosted.
   EO service providers implement services in scalable cloud computing environments with information products combined with other data sources to deliver information to users. In-sector providers or end-users may process the information provided using their own algorithms thus turning the data into information with operational value. The In-sector providers play a crucial role in the solution as they can translate the end-user priorities and requirements and utilize the EO-based services.



## CO-DESIGN APPROACH WITH STAKEHOLDERS

Successful implementation of CAMEO requires participation of stakeholders and end users in the corridor & asset monitoring domain in all stages of the project.


### Scoping

A series of online interviews and group meetings will be held with stakeholders and users in June 2020 to:

- Provide inputs on information requirements
- Describe existing practices and challenges and gaps that may be addressed
- Describe how EO information may be delivered or integrated into monitoring

### Operations

- Support the design of demonstrations of services
- Specify Performance levels, such as reliability, availability, detection probability, false alarm rates, minimum mapping unit, coverage per monitoring/analysis activity, processing and delivery time constraints

### Prototyping and Testing

- Apply a co-design approach, provide regular inputs as services are prototyped
- Help to guide the adjustment of early prototypes before demonstration trials

### Demonstration Trials

- Receive and/or observe demonstration services along specific corridors
- Support the validation of services with independent datasets

### Operational Roadmap

- Assess how far the developed services fulfil the requirements
- Take part in interviews and group meetings
- Contribute to a roadmap for the further development of corridor and asset monitoring services

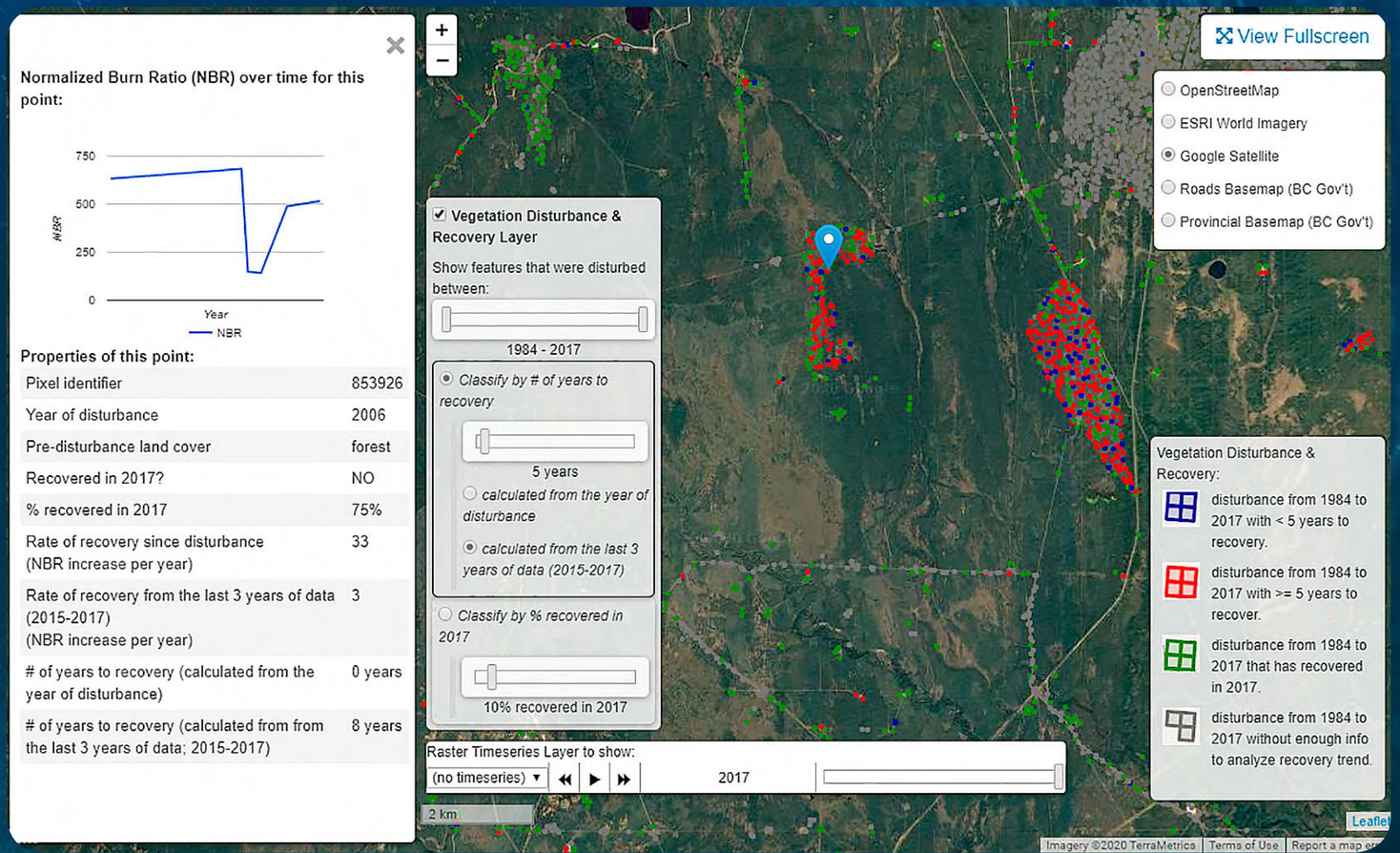
## EXAMPLE SERVICES - ENVIRONMENTAL AND GEO-HAZARDS

### VEGETATION CONDITION MONITORING
**Provider: Hatfield**

This vegetation monitoring service aims to complement conventional ground and aerial survey approaches to monitor linear infrastructure or area disturbances. Availability of current, freely available high-resolution satellite imagery and commercial very high-resolution satellite imagery allows for detection, delineation and monitoring of vegetation types and condition.

Dense time series from Landsat and Sentinel-2 optical EO data allows for characterization of vegetation change, including the rate of recovery following clearance or a disturbance event.

Hatfield's EO-Recover algorithm detects disturbance events across the landscape and monitors the vegetation characteristics over time.




*Vegetation monitoring along linear corridors*

## EXAMPLE SERVICES - ENVIRONMENTAL AND GEO-HAZARDS

### FLOOD HAZARD MONITORING

**Provider: Hatfield**

Pipelines and energy corridors cross varied landscapes including floodplains and watercourse crossings. Information on flood conditions and flood extent supports the protection of assets and management of risks.

During flood events, radar EO data such as Sentinel-1 provides observations regardless of cloud cover and radar data are sensitive to surface water conditions. Optical satellite EO data, including high resolution data, supports automated flood extent mapping. Hatfield provides flood mapping services based on optical and EO data and can highlight changes post-flood along rights of way and at watercourse crossings.


*Pipeline right of way pre- and post-flood conditions*

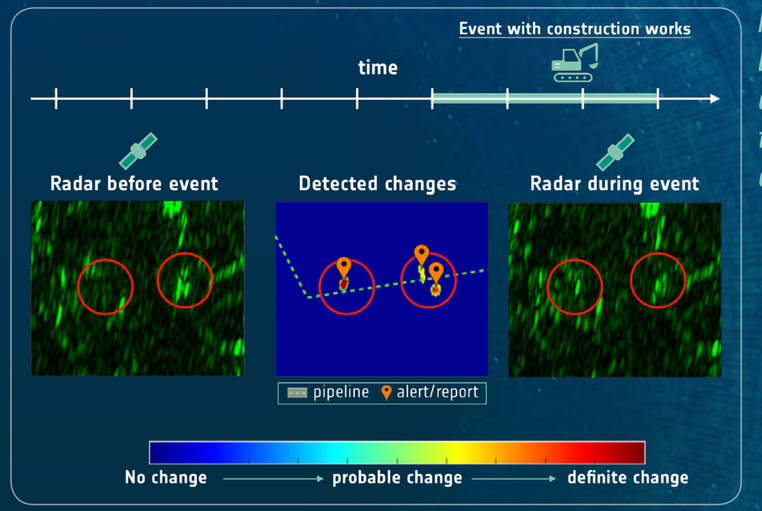
## EXAMPLE SERVICES - THREAT ASSESSMENT

### THIRD PARTY INTERFERENCE
**Provider: Orbital Eye**

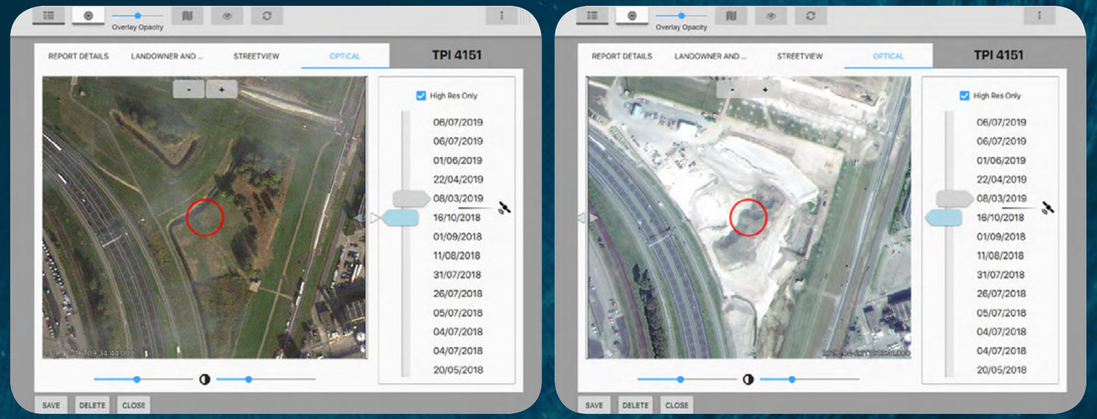
Pipeline and energy corridors may be affected by deliberate or accidental interference from third parties, such as excavation, construction, and agricultural activities. To mitigate potential impacts on corridor assets, surveillance is conducted using a variety of methods such as human observations via ground and aerial surveys.

New satellite EO services can complement, enhance, and ultimately replace existing third-party interference monitoring methods and can utilize free and open EO data together with commercial EO images. Orbital Eye's PIMSyS uses Sentinel-1 radar data to monitor corridors for human activities close to the infrastructure on a regular, almost daily basis, which greatly improves the detection probability.

Once change events are detected using the radar data, the service also supplies high resolution optical EO images before and after the event of only the small areas where a change event has been flagged. The service fully integrates with optical imagery data providers.




*High resolution EO images before and after event detected by the PIMSyS radar change detection*




*PIMSyS radar change detection for third party interference*

# CONTACTS

**European Space Agency**
**www.esa.int**

**Project Consortium**

- Science [&] Technology Corporation (The Netherlands): www.stcorp.nl
- Science [&] Technology AS (Norway): www.stcorp.no
- Hatfield (Canada): www.hatfieldgroup.com
- BCG Engineering (Canada): www.bgcengineering.ca
- Sensar (The Netherlands): www.sensar.nl
- Orbital Eye (The Netherlands): www.orbitaleye.nl

**Stakeholders**

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