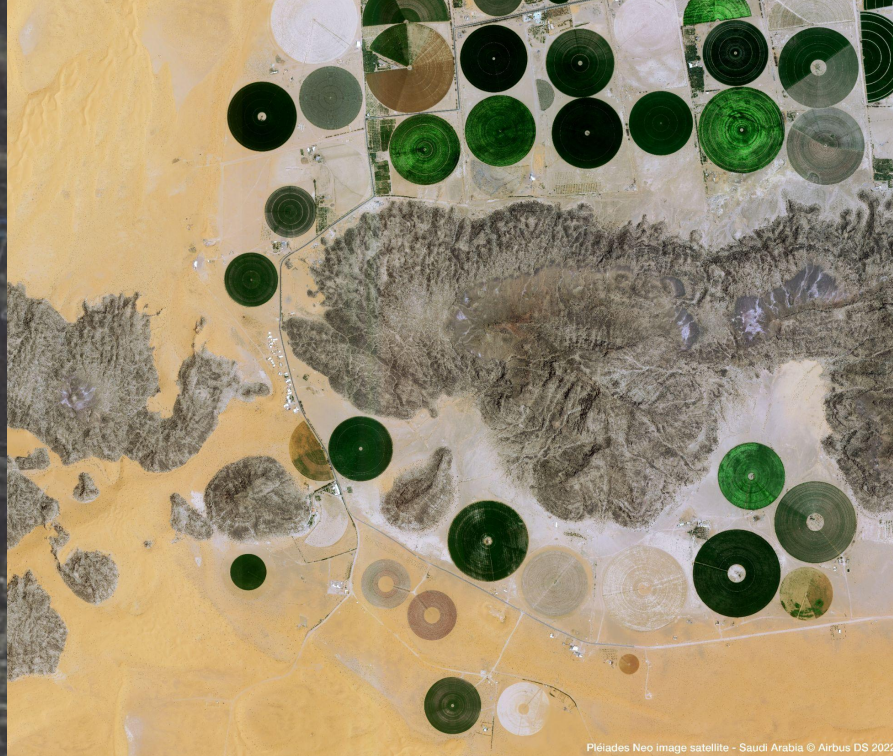




DEFENCE AND SPACE

Earth Observation and X-Band: Enabled Applications and Impact

Matteo Emanuelli, Program Manager, Airbus Defence and Space



WORLD
METEOROLOGICAL
ORGANIZATION

Global ITU/WMO Seminar on Spectrum use for meteorology: challenges, opportunities and evolving requirements
Genève, 30.09.2026

AIRBUS



UMBRA		Location
Tarbela Dam, Pakistan		Lat, Long
34.00°, 72.70°		Res
500m		Mode
Bistatic Spotlight		

SOIL WATER CONTENT - Oklahoma & Kansas, USA

For Public Use



WILDFIRE - Valparaiso, Chile

Spectrum availability directly impacts what we can accomplish through space.

What we can accomplish through space directly impacts what our lives look like on Earth.

EARTHQUAKE IN TURKEY & SYRIA - Hisdesat Servicios Estratégicos S.A

© Airbus DS 2024

Francis Scott Key Bridge, Baltimore, USA

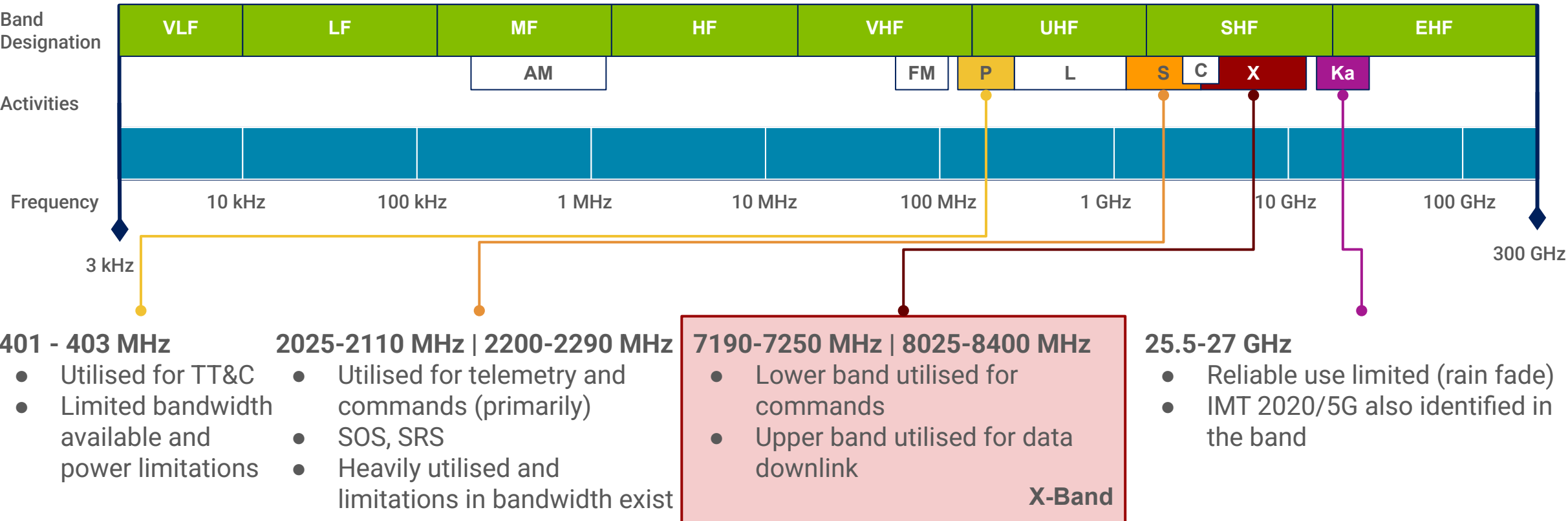




Spectrum is fundamental for carrying out Earth Observation as Radio Frequencies (RF) are used for downlink data, uplink commands and as well for various imaging and scientific payloads.

Available Spectrum for Earth Observation Up/Downlink

Allocations to remote sensing satellites, are divided across various frequency bands to optimize and enable specific functions of satellite systems.



WRC-27: The Earth Observation Challenge

In 2023, WRC adopted a new agenda looking into the introduction of new mobile phone networks (i.e. 6G) in the frequency band 7 125-8 400 MHz (or parts thereof). *Europe & Africa* *Americas* *Asia-Pacific*

Region 1	Region 2	Region 3
4 400-4 800 MHz		4 400-4 800 MHz
7 125-7 250 MHz 7 750-8 400 MHz	7 125-8 400 MHz	7 125-8 400 MHz
14.8-15.35 GHz	14.8-15.35 GHz	14.8-15.35 GHz



Earth observation satellites could become severely constrained, impacting the collective ability to timely react to natural disasters, security threats, monitor weather and climate variables and support economy and developments

The Vital Role of X-Band for Earth Observation

X-band is the single most significant spectrum portion for downlinking Earth observation data acquired by satellites, due to:

- **Physics:** the 8025-8400 MHz waves allows cloud- and weather-independent links,
- **Coexistence** with current coprimary services, including FS and FSS.
- **Global harmonization** for remote sensing satellite applications; and

No current alternative to X-band downlink exists at scale, due to:

- Lack of available protected, large enough bandwidth in other frequency ranges;
- Lack of standardization and/or technological maturity; and
- Physics: other bands are subjected to weather fade

The Vital Role of X-Band for Earth Observation

X-Band remains the most important downlink band because

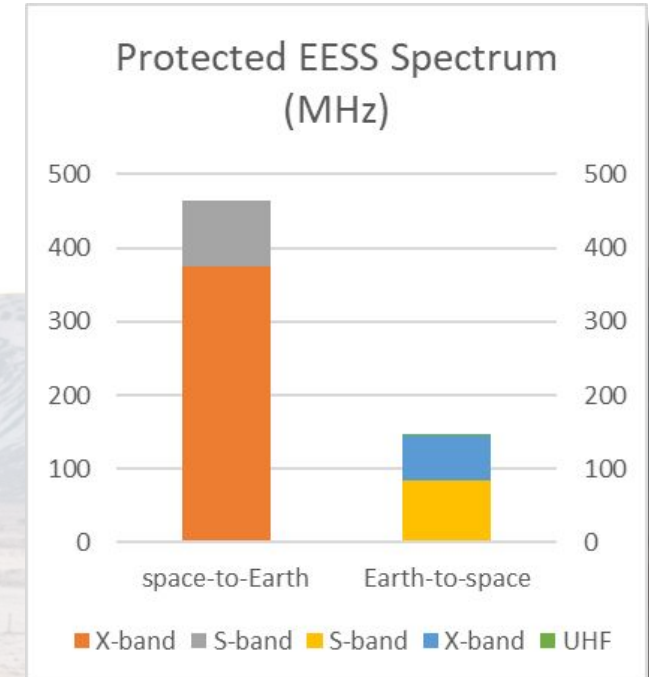
- **Capacity**

Higher data rate if compared to S-Band (2 GHz)

- **Transmission condition**

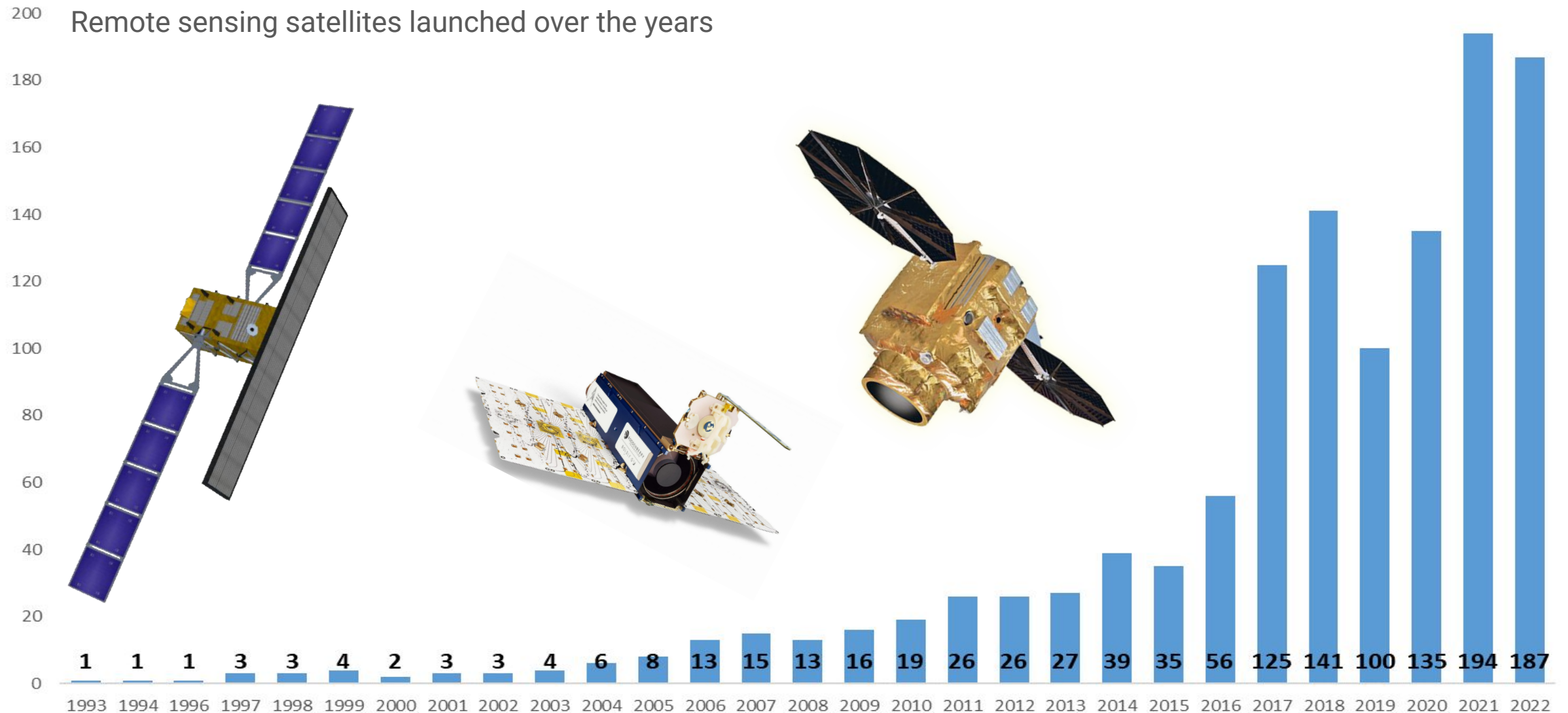
Weather-independent link better than Ka-Band (26 GHz)

- **Existing worldwide ground network**

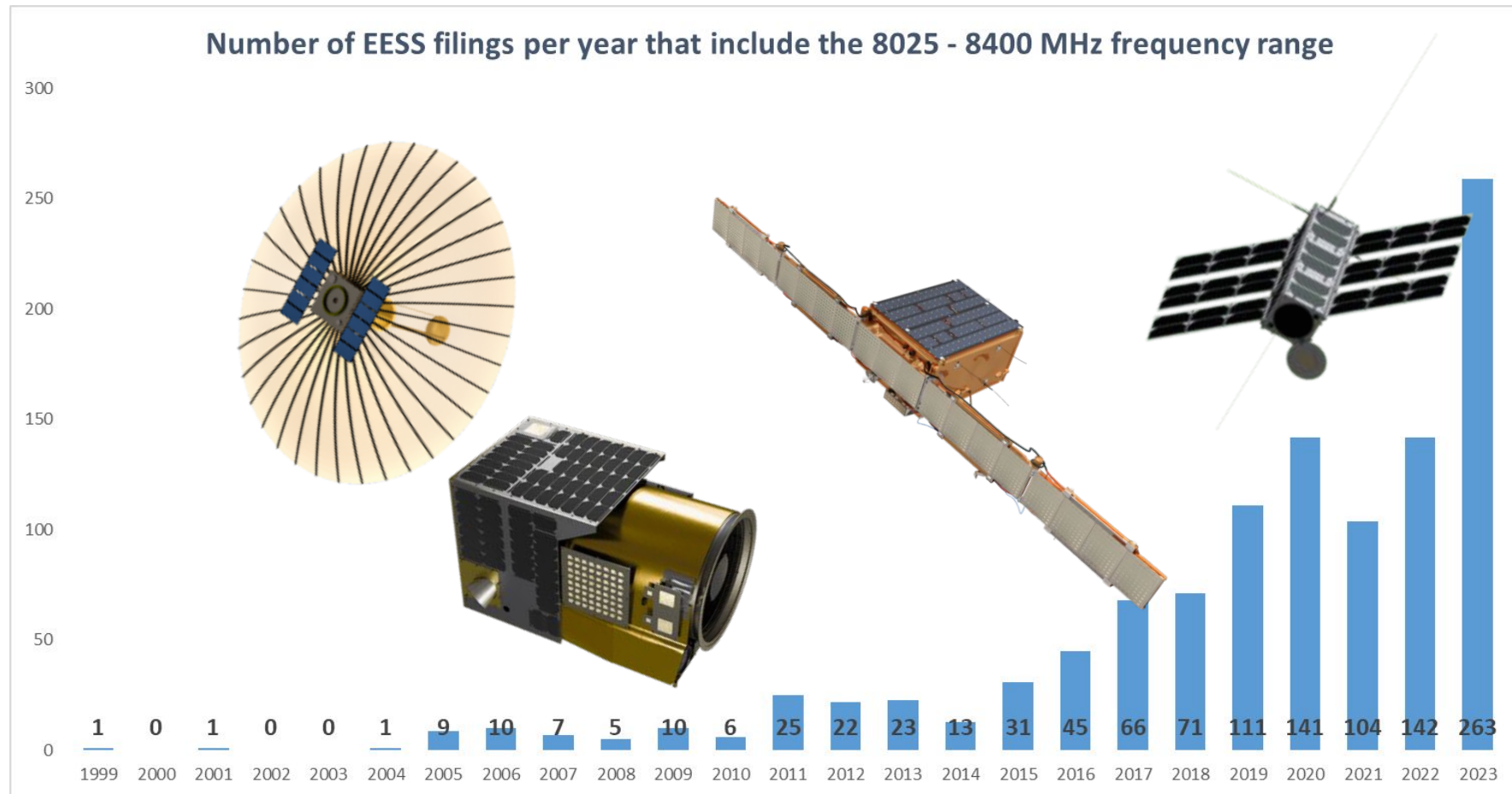


The contiguous 375 MHz of protected bandwidth is the backbone to the remote sensing sector with no current viable alternative.

The Surge of Earth Observation Satellites

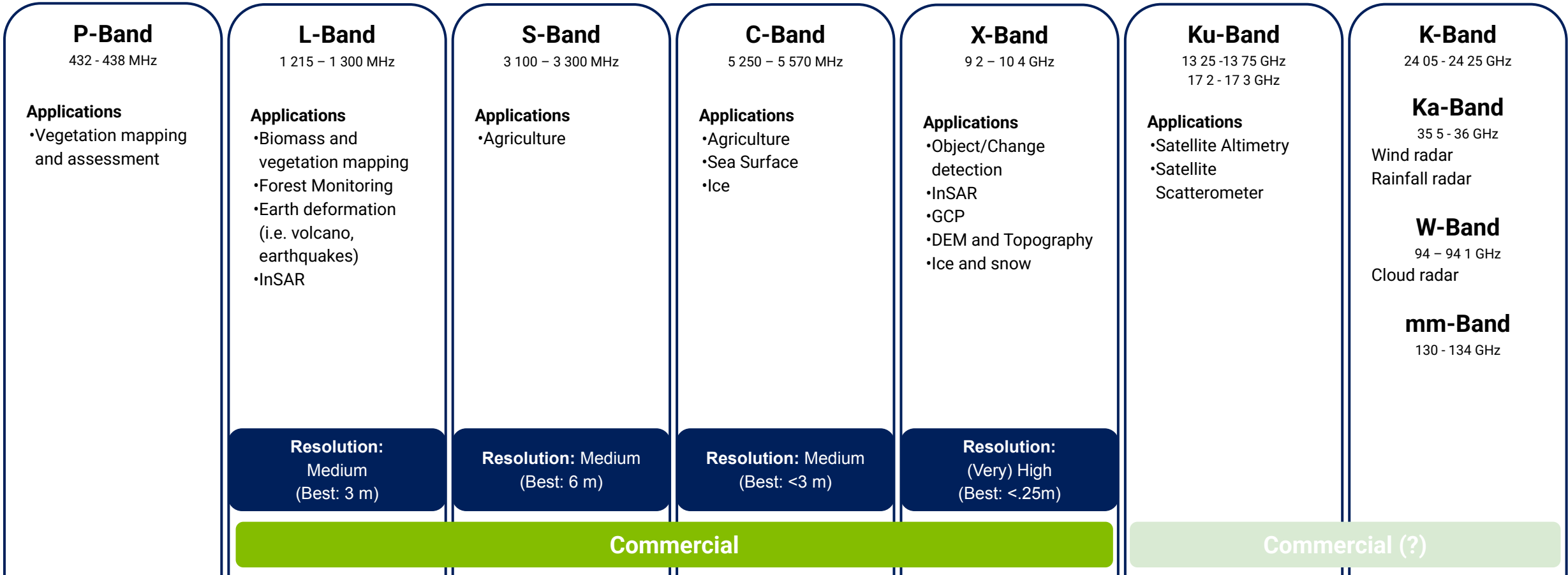


Adoption Rate of X-Band for Downlinking EO data



X-Band is the present and future standard for Earth observation missions and needs reliable ground infrastructure.

Available Spectrum for Earth Observation Sensors (EESS Active)



Because of the difference in wavelength and thus penetration of the electromagnetic waves, frequency bands and applications are closed connected and although some level of overlapping is possible, physical limitations apply.

Available Spectrum for Earth Observation Sensors (EESS Active)

P-Band 432 - 438 MHz Missions BIOMASS	L-Band 1 215 – 1 300 MHz Missions SAOCOM-1 SAOCOM-2 ALOS-2 ALOS-4 NISAR-L ROSE-L TanDEM-L SAR XL	S-Band 3 100 – 3 300 MHz Missions NovaSAR-S NISAR-S	C-Band 5 250 – 5 570 MHz Missions Sentinel-1 Radarsat-2 RCM EOCS Chorus-C CHEOS Hisea MicroSAR	X-Band 9 2 – 10 4 GHz Missions TerraSAR / TanDEM PAZ PAZ-2 Kompsat-6 CSK / CSG / CTG ICEYE Chorus-X Capella Space Synspective iQPS UMBRA NOX NimBUS SAR [...]	Ku-Band 13 25 -13 75 GHz 17 2 - 17 3 GHz Missions Sentinel-3 Sentinel-6	K-Band 24 05 - 24 25 GHz Ka-Band 35 5 - 36 GHz W-Band 94 – 94 1 GHz mm-Band 130 - 134 GHz
	Commercial				Commercial (?)	

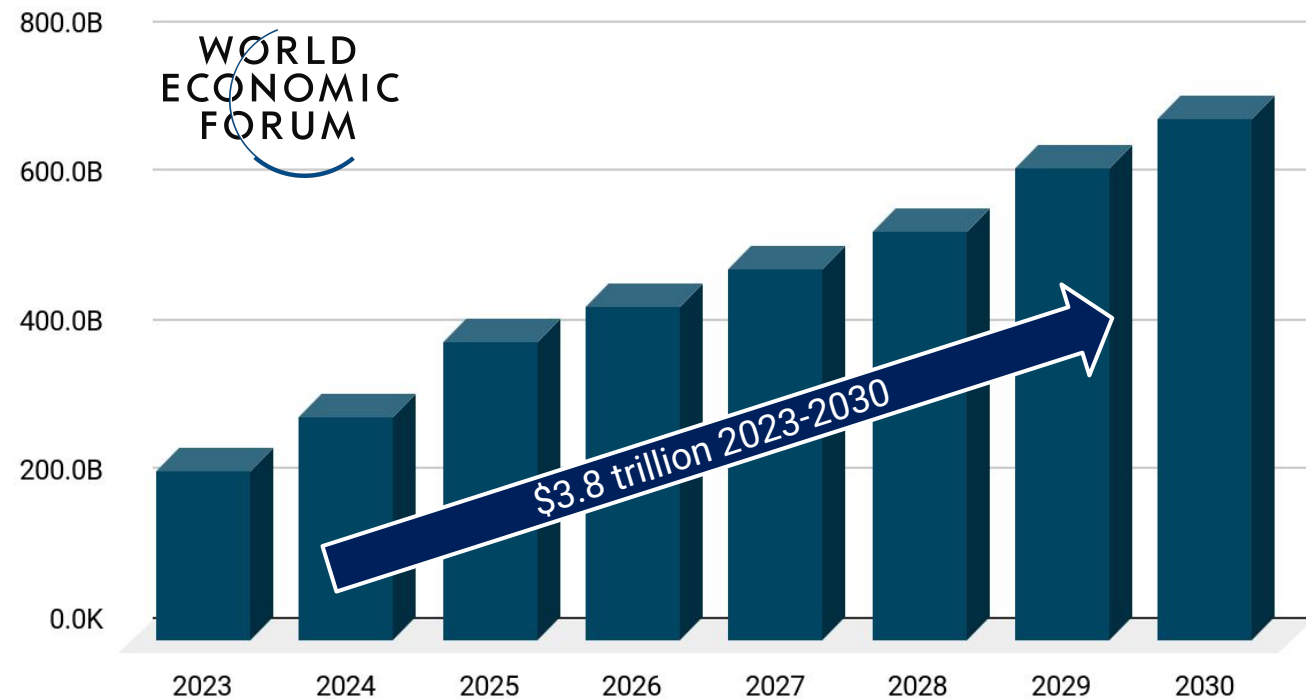
Due to the large bandwidth available, the consequent application potential (coupling good swath and high-res) and leveraging opportunities offered by tech miniaturisation, X-Band has imposed as the dominant band for commercial space-based radar systems

The Value of Earth Observation

Earth observation satellites are established as essential tools for various applications and domains, including agriculture, risk and disaster management, critical mineral exploration and subsurface mapping, climate change and environmental monitoring and adaptation, urban planning, defence and security, scientific research, etc.



Potential value-added to GDP from Earth observation data

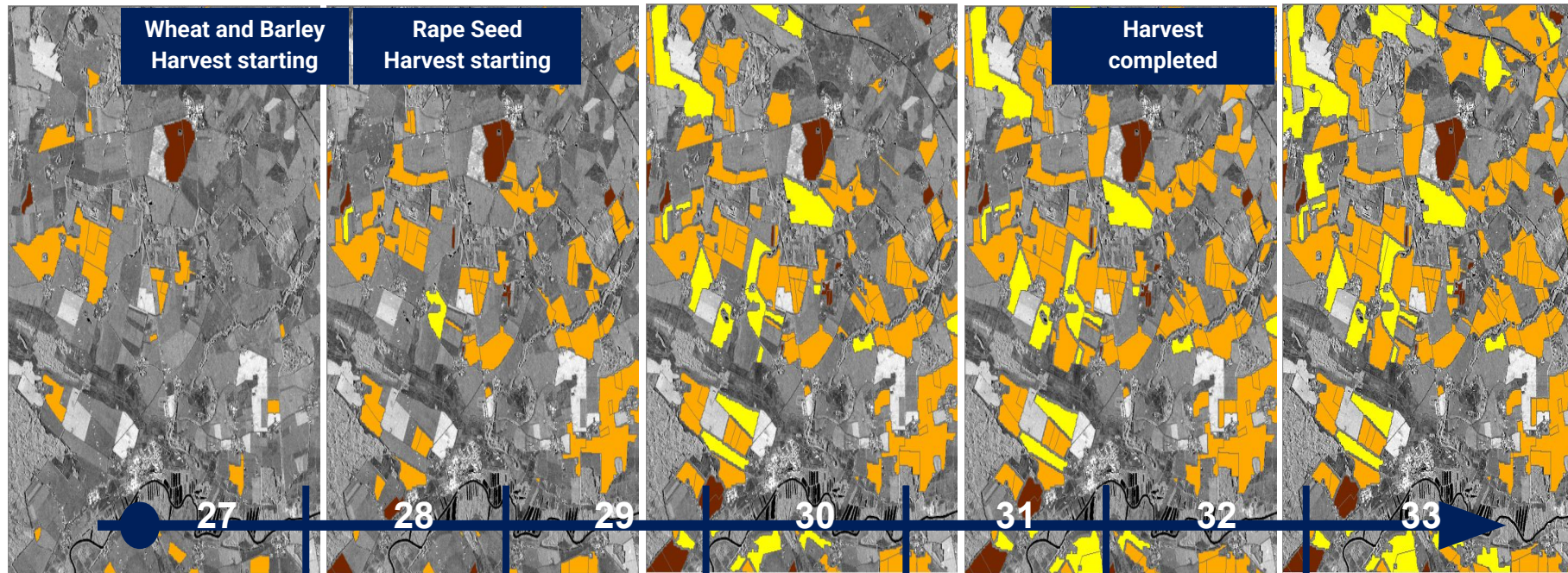


SUSTAINABLE DEVELOPMENT GOALS



APPLICATIONS

SELECTION OF COMMERCIAL EARTH OBSERVATION APPLICATIONS

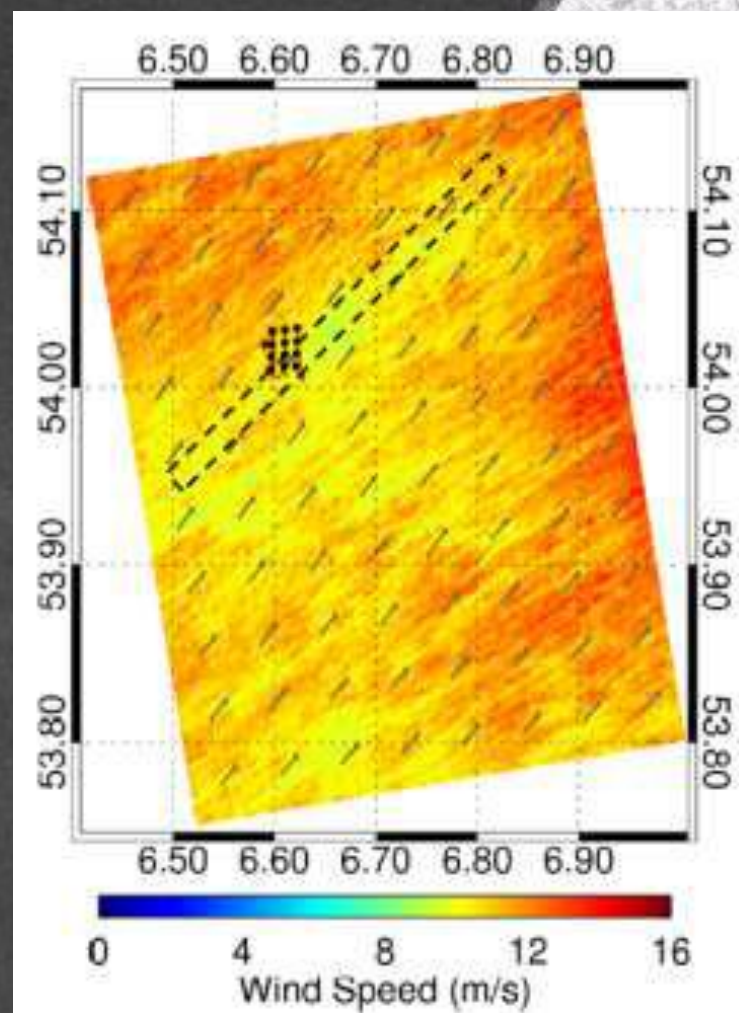


Sustainable Agriculture

Earth observation is able to assess the growth status, yield estimate, damage mapping and classification of the crops



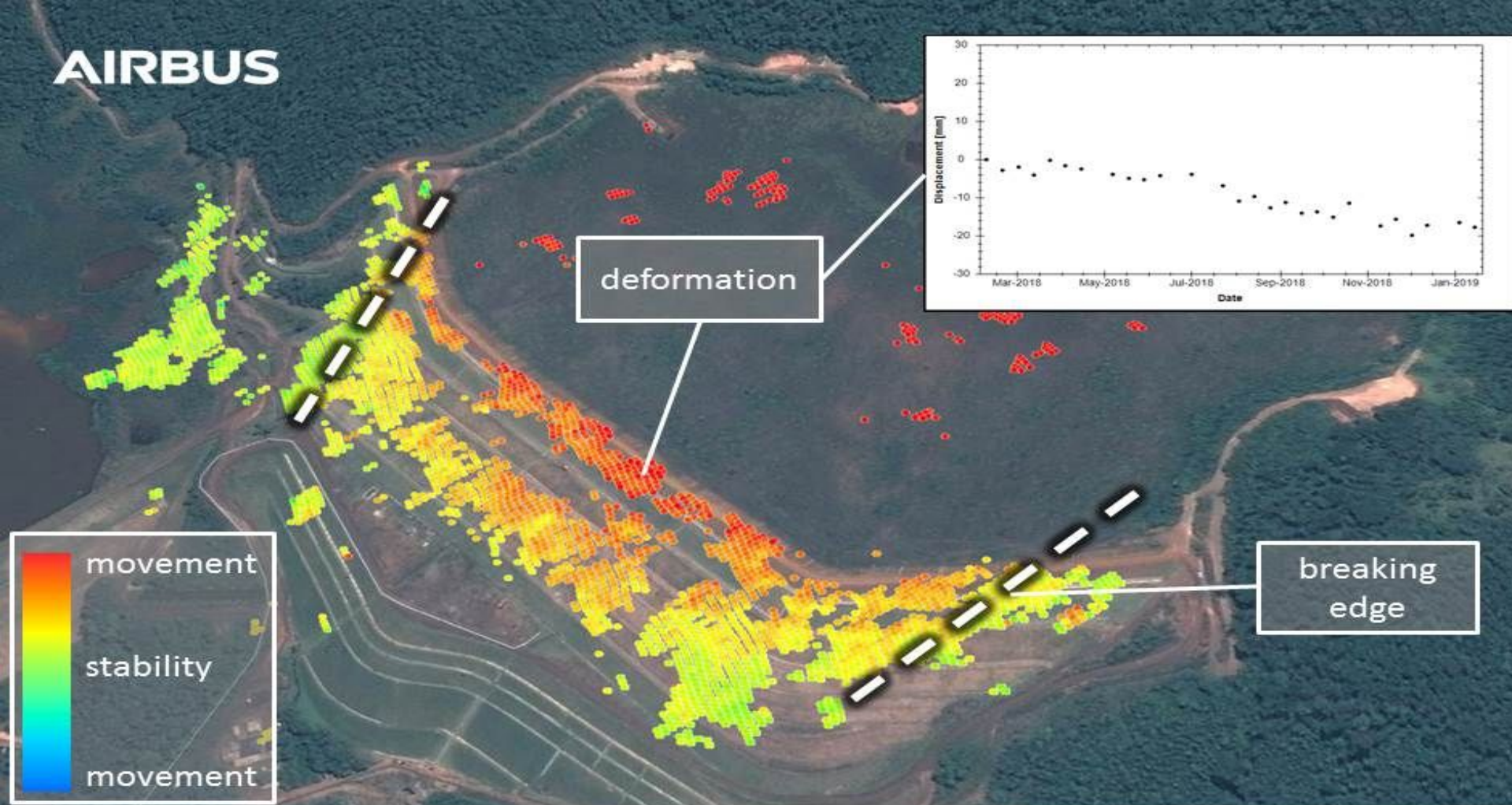
Determination of the wind direction



Optimal placement of wind farms

Space-based EO measurements and derived products support the renewable energy industry





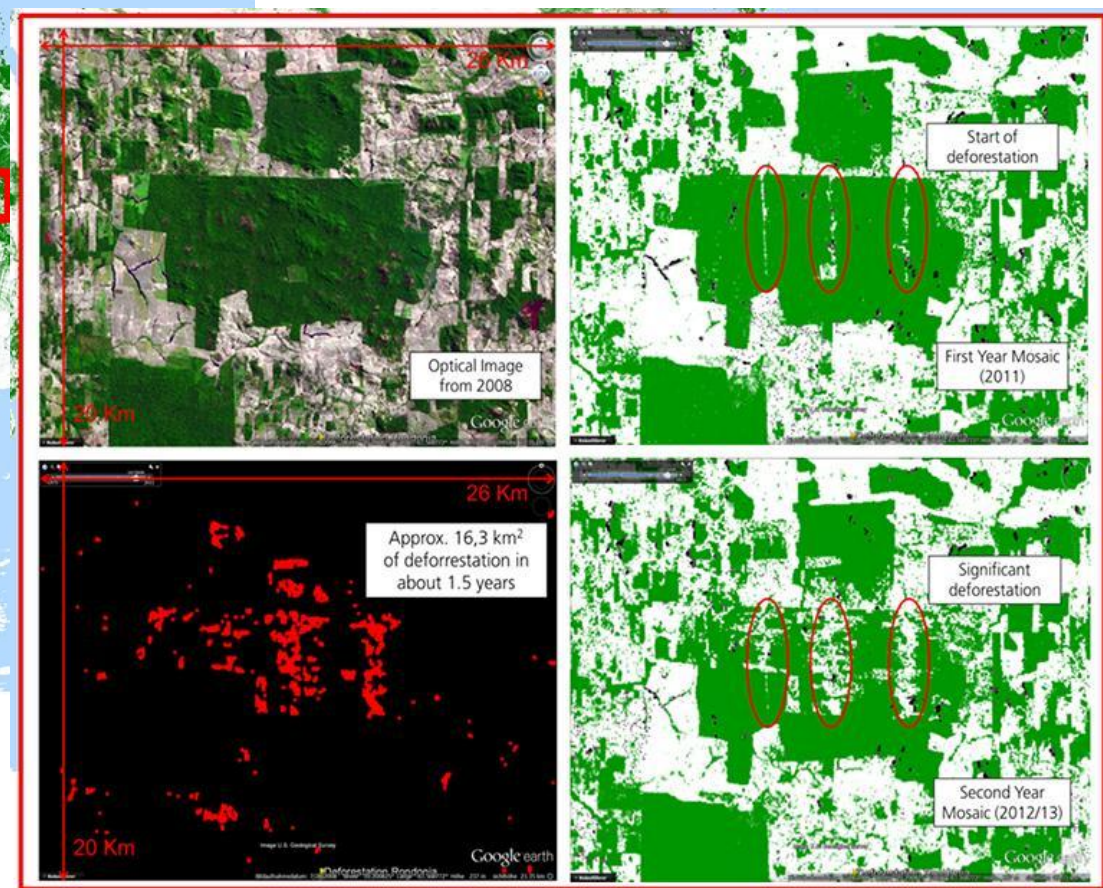
Landslide Monitoring

Radar sensors allow frequent and extremely precise assessments of the buildings and infrastructure integrity supporting monitoring and preventive actions.





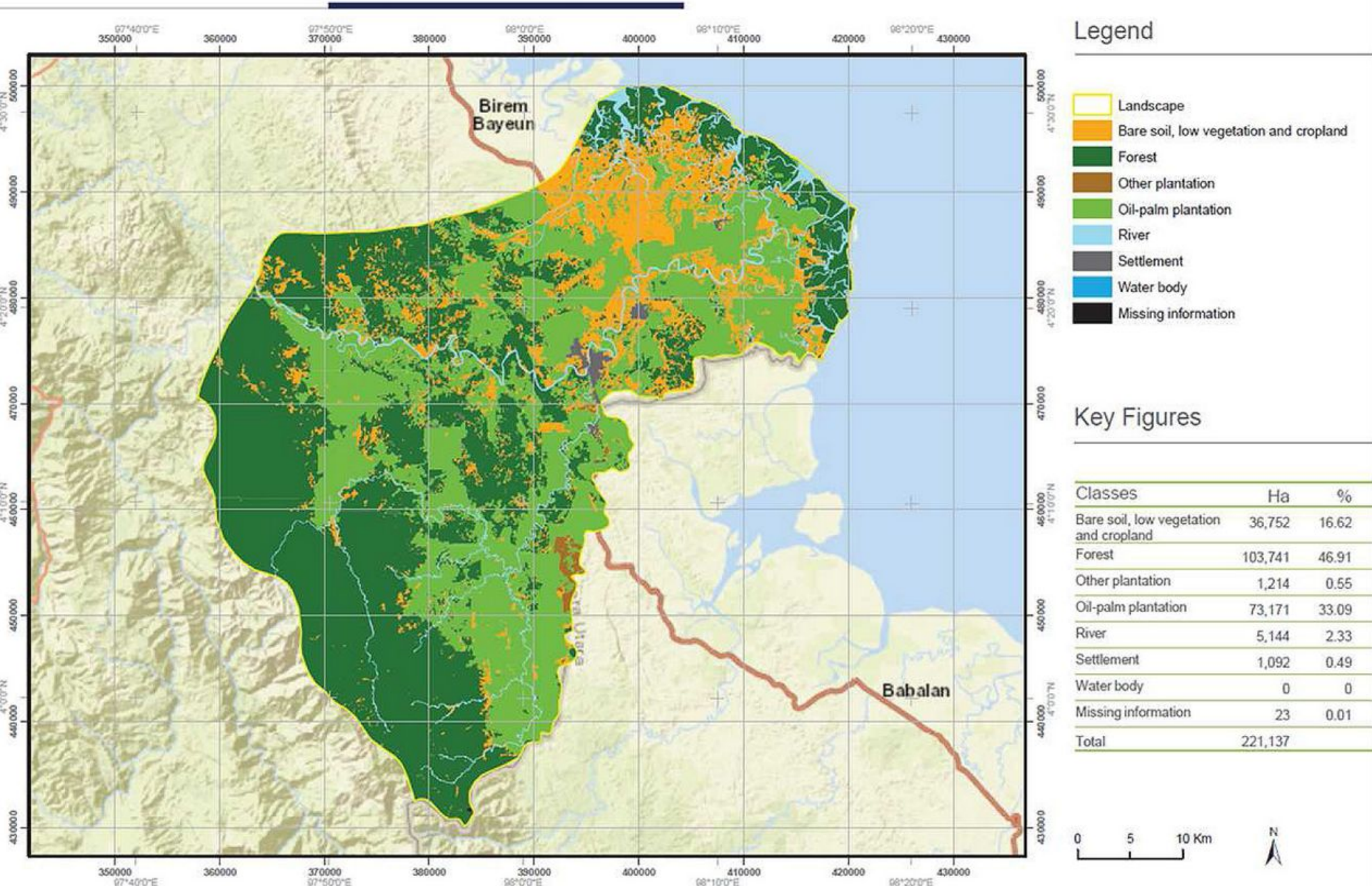
Rondonia State - Brazil



Deforestation monitoring down to single-log precision

EO is watchful eye enabling precise, actionable and near real-time information to protect biodiversity on land.





Key Figures

Classes	Ha	%
Bare soil, low vegetation and cropland	36,752	16.62
Forest	103,741	46.91
Other plantation	1,214	0.55
Oil-palm plantation	73,171	33.09
River	5,144	2.33
Settlement	1,092	0.49
Water body	0	0
Missing information	23	0.01
Total	221,137	

Sustainable Palm Oil Production

EO offers tools to monitor global supply chains from extractions to shipment and delivery monitoring both sustainable exploitation of resources and respect of human rights.

11 SUSTAINABLE CITIES AND COMMUNITIES

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

15 LIFE ON LAND

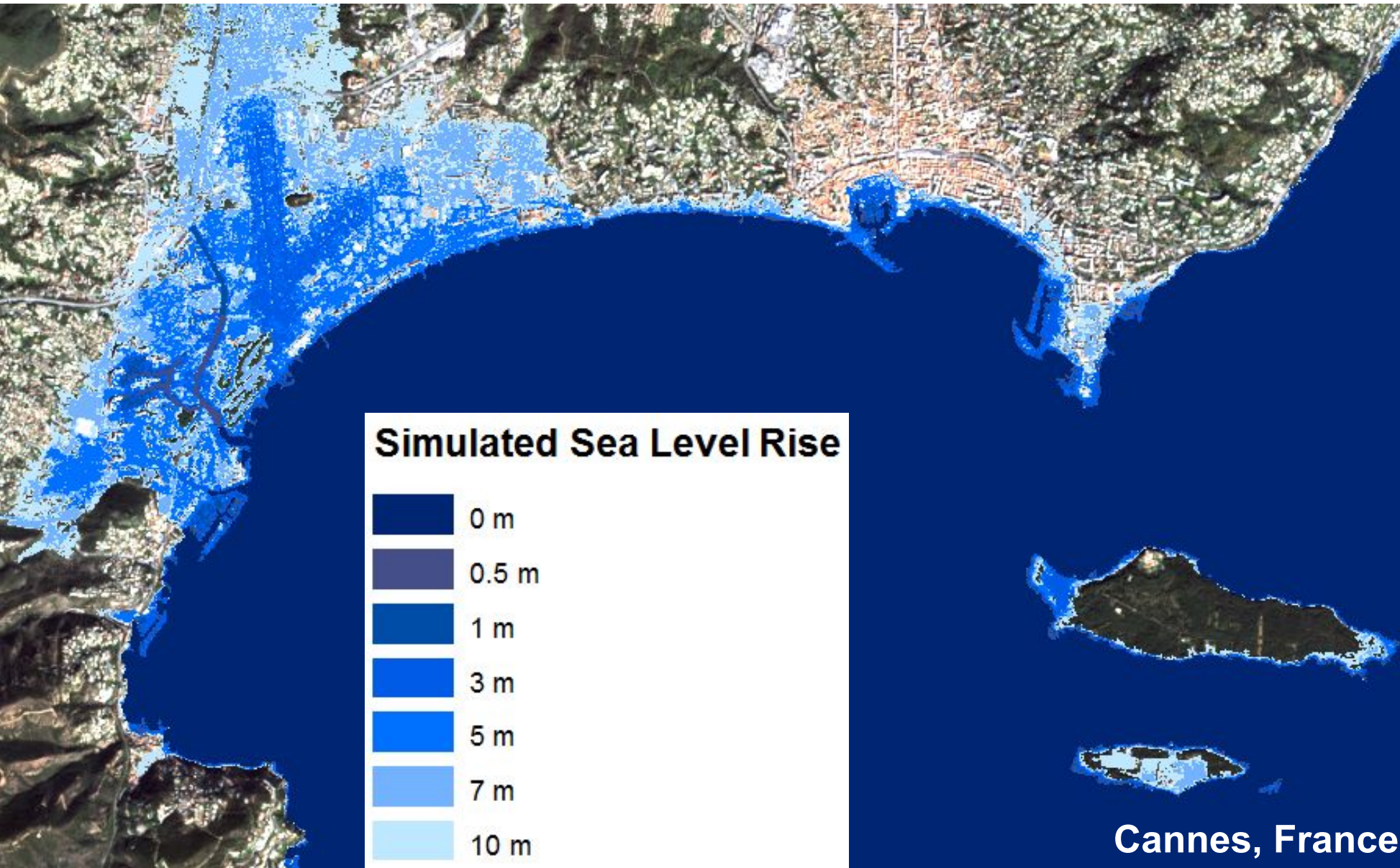
Deep Water Horizon



Oil Spilling

EO enables easier
identification of sea
polluters via
frequent data
acquisitions
utilising diverse
sensors





Flooding Scenarios

Digital terrain and 3D models derived, by leveraging high resolution data and thus the enhanced level of details, allows for an excellent delineation of the water distribution and potential passes between structures and buildings.





Center for Satellite-Based Crisis Information
Emergency Mapping & Disaster Monitoring
a service of DLR

German Remote Sensing Data Center
German Aerospace Center

USA
Mexico
Gulf of Mexico
Pacific Ocean
Venezuela
Colombia
Gulf of Mexico
Mexico
Villahermosa
Tuxtla Gutierrez
Guatemala

Legend

Settlement Vegetation Swamp Agriculture

Flood Situation (Nov 10, 2007) Infrastructure

Water canals Major roads

Normal water level

Interpretation

A week of heavy rains caused rivers to overflow, surpassing meter posts of the state of Tabasco and the neighbouring state of Chiapas. The city of Villahermosa, with a population of more than half a million people, has been most severely hit by the flood event.

This map shows the extent of the flood situation in the region of Villahermosa, Tabasco, Mexico as mapped by the German TerraSAR-X radar satellite on November 10, 2007. TerraSAR-X is jointly operated by the German Aerospace Center (DLR) and Infoterra GmbH, Germany. Please note that the flood areas in urban areas may in some cases not be detected properly due to radar geometry.

For visualising reasons an archived SPOT image (ground resolution of 10 m) was combined with the TerraSAR-X image and used as background.

The map was produced in order to support the Mexican civil protection agency (CENAPRED).

Scale

0 250 500 750 1 000 m

Scale: 1:15.000 for DLR's printing

Reference coordinate system: Geographic coord. info

Projection: UTM Zone 16 N Geographic (DMS)

Spheroid: WGS 84 WGS 84

Datum: WGS 84 WGS 84

Data Sources

SPOT5 © ERMES/SPOTNADIO 2007

TerraSAR-X © German Aerospace Center (DLR) 2007

Commercial exploitation rights: infoterra

Processing/Analysis

Image processing and map creation by DLR

- Derivation of normal water areas from SPOT

- Derivation of flooded water areas from TerraSAR-X

Map created November 13, 2007 by zkgjdr.36

For more information visit: <http://www.zli.dlr.de>

TERRA-SAR X

For Public Use

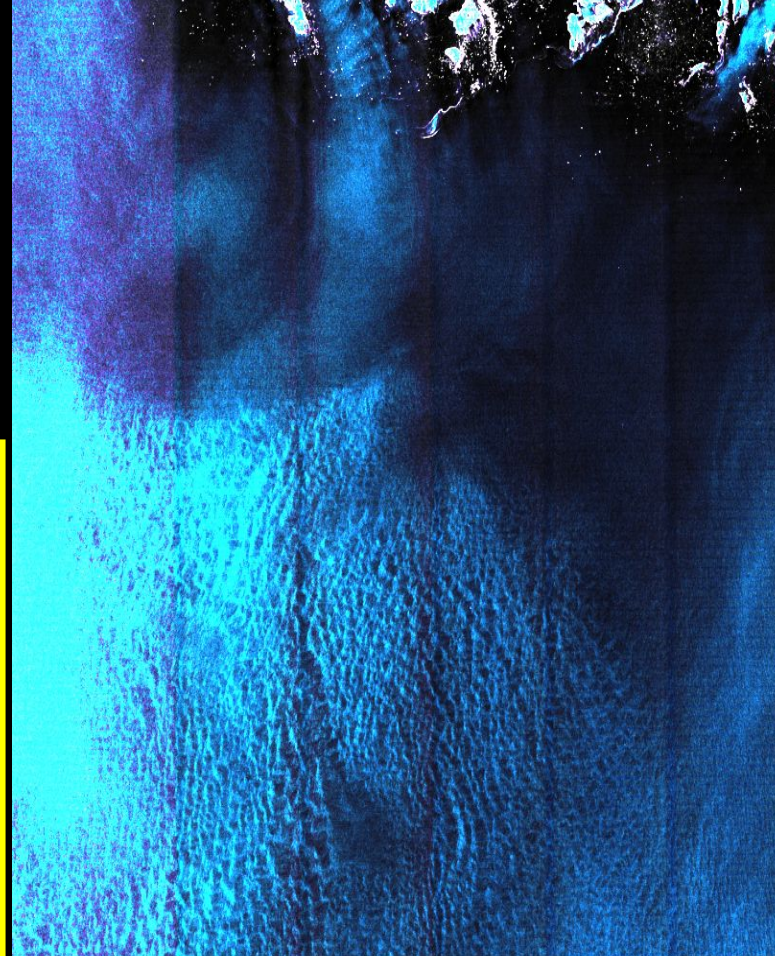
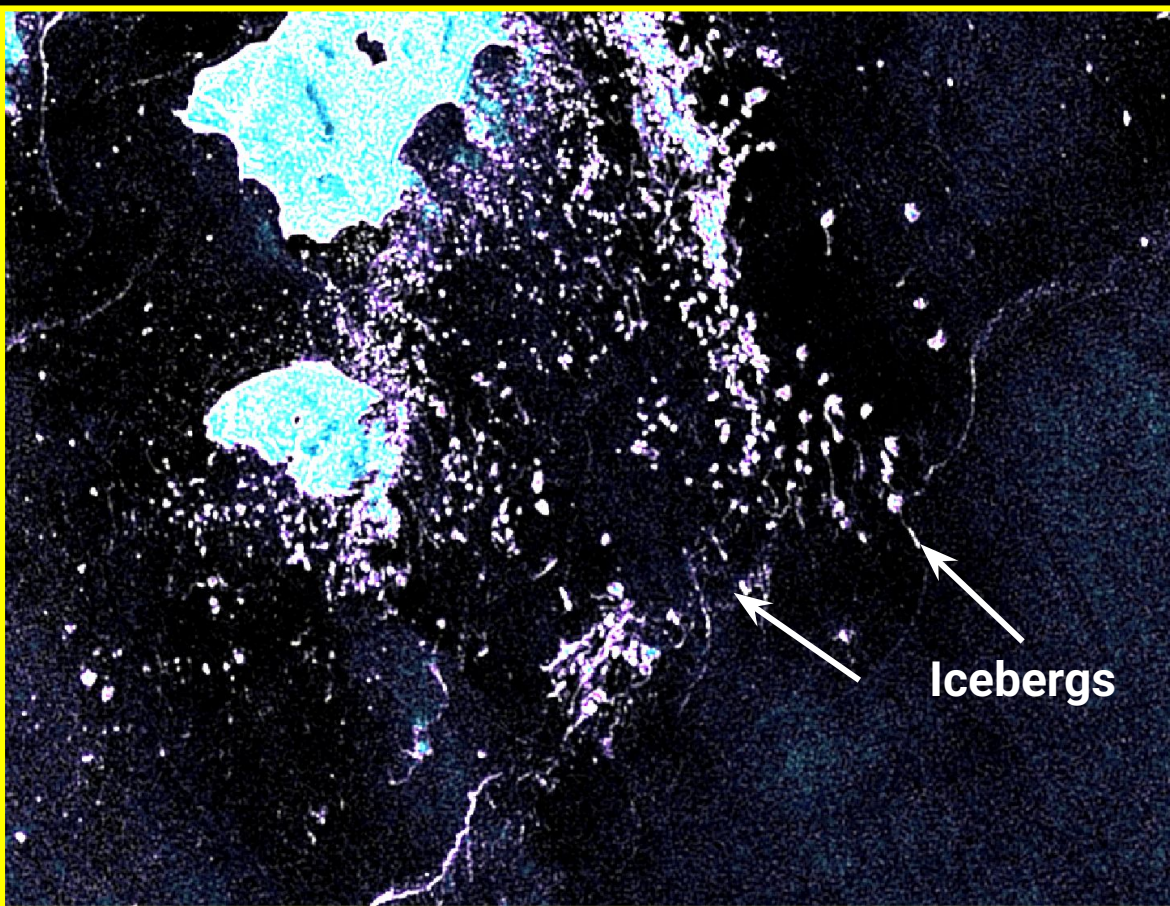
Flood Mapping

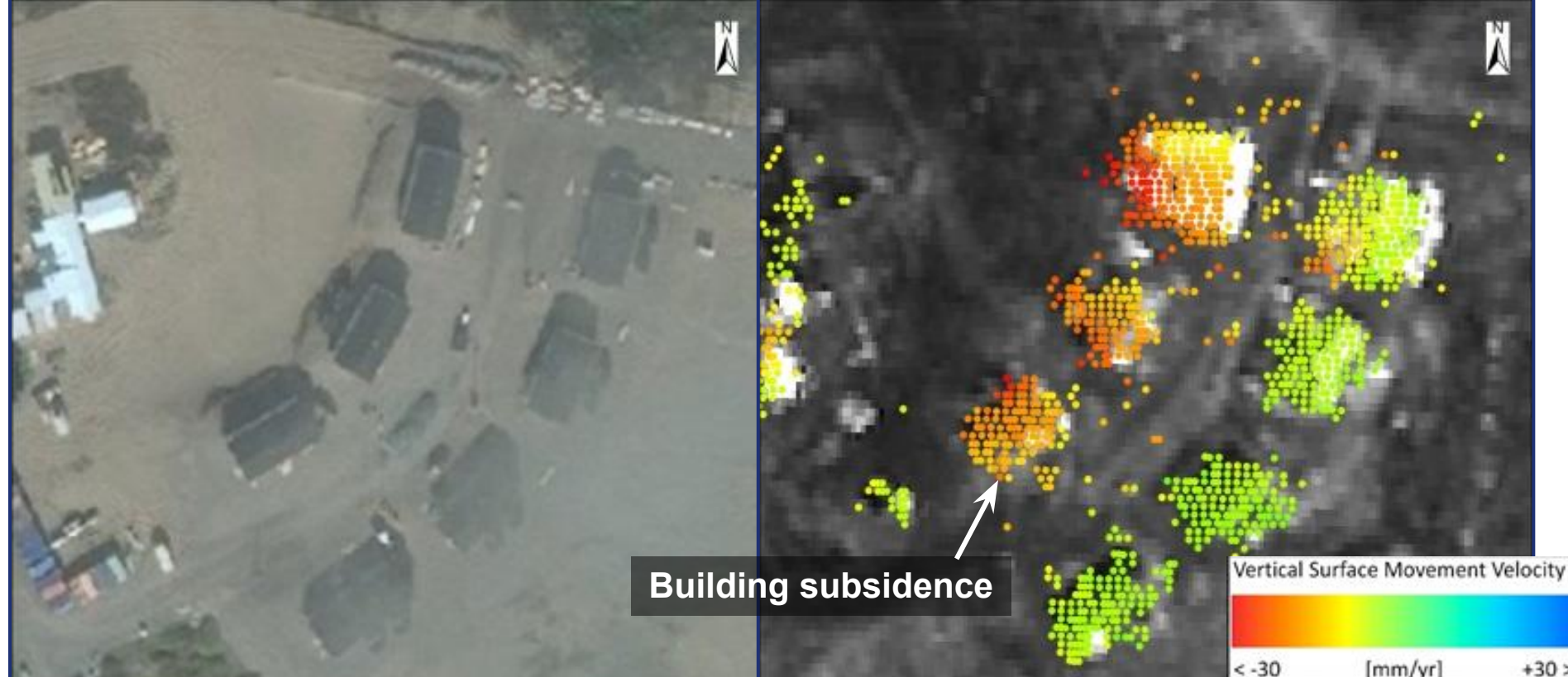
Earth observation satellites are now able to provide high-resolutions and shorter revisit time, which can facilitate effective resource allocation during emergency response



Iceberg Monitoring

Iceberg Monitoring and sea ice mapping at every latitude is not only a useful method to monitor climate change but also to avoid disasters at sea which could pollute newly opened water transportation ways

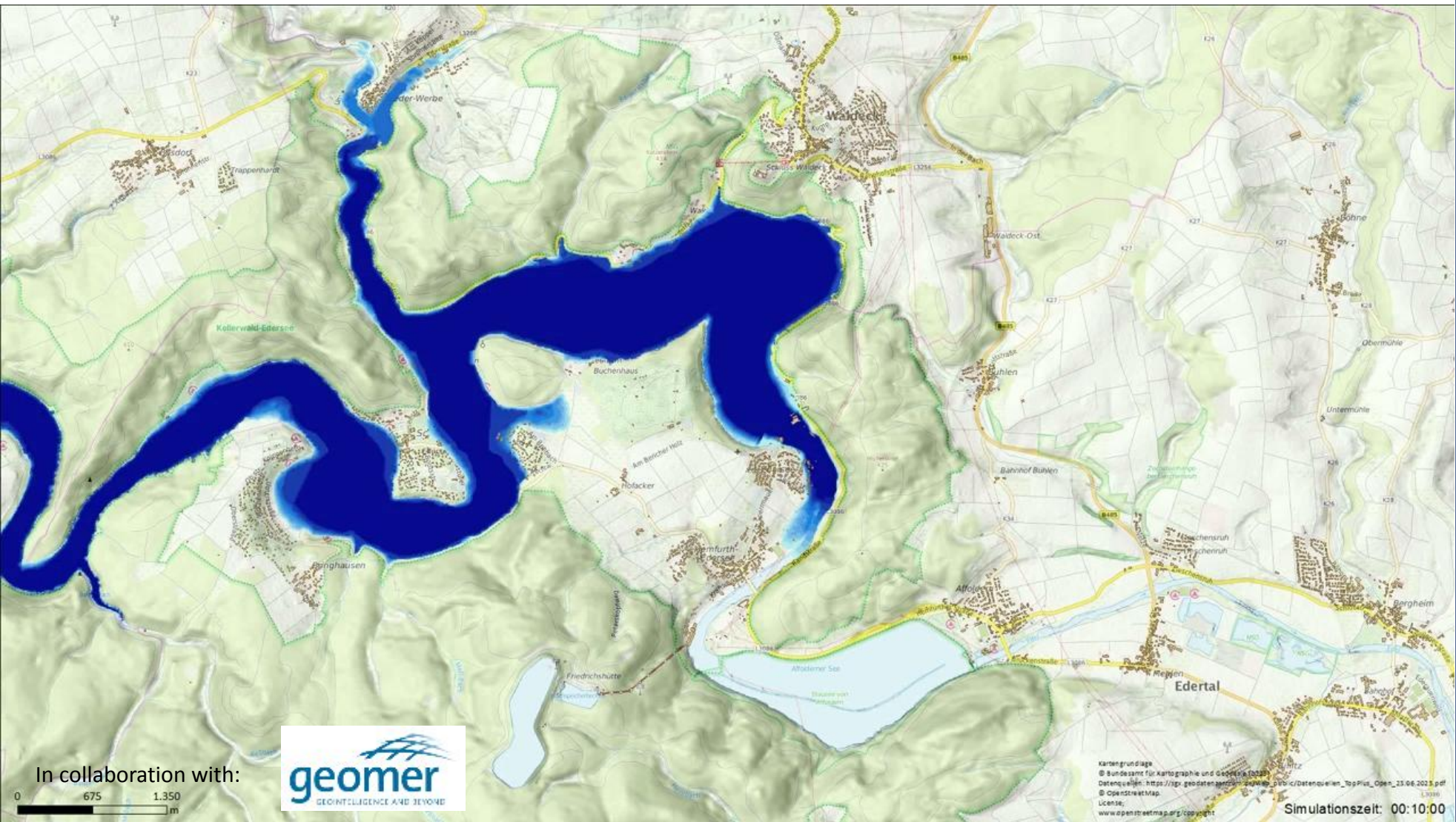




Permafrost Thaw

EO allows for more efficient quantitative measures of the stability of infrastructure that is affected by the thawing permafrost soils.





Hydrodynamic Modelling

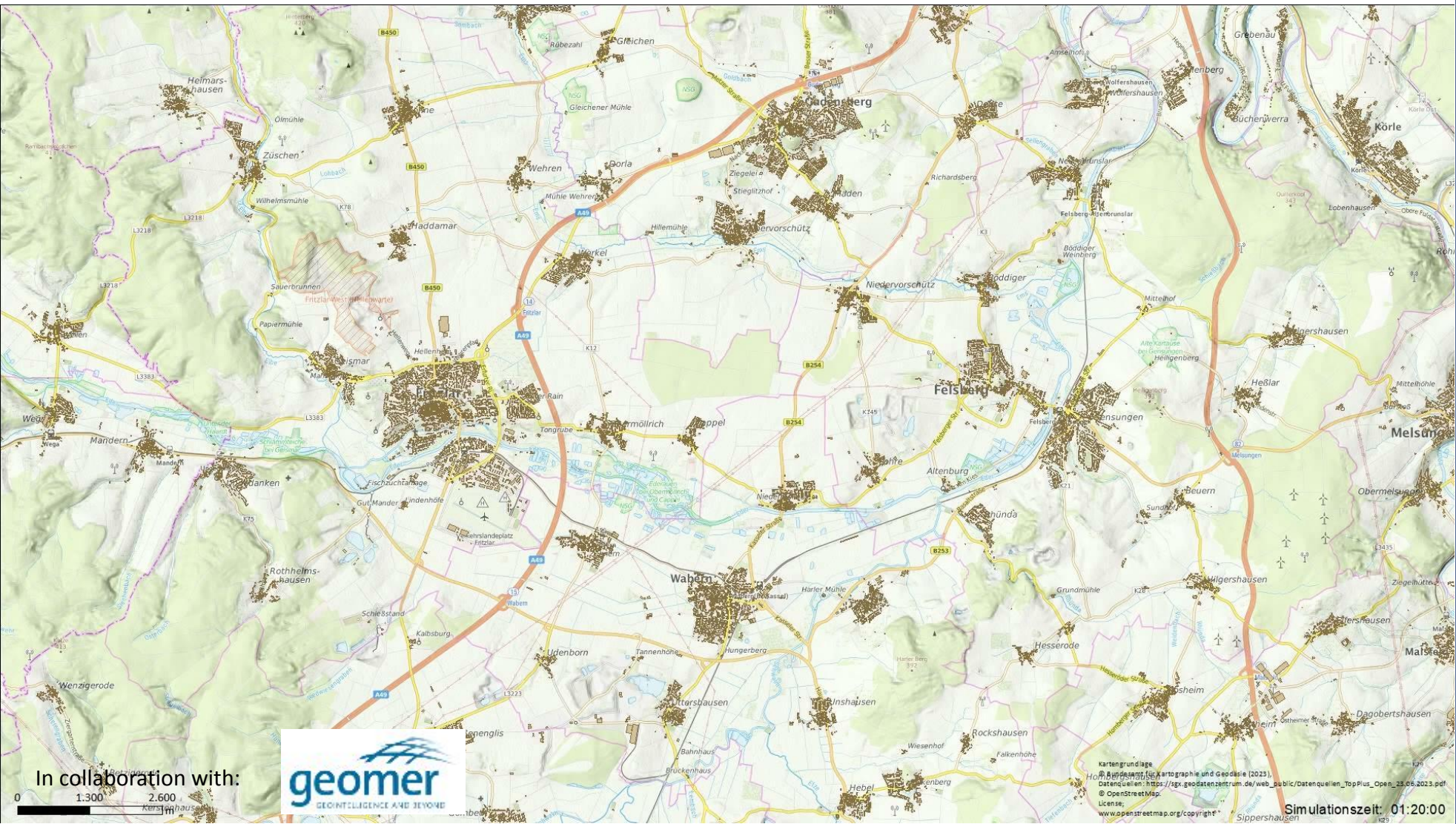
Dam Failure Simulation

Edertalsperre, North Hesse, Germany

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

11 SUSTAINABLE CITIES AND COMMUNITIES

13 CLIMATE ACTION



Hydrodynamic Modelling

Dam Failure Simulation

Edertalsperre, North Hesse Germany

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE



11 SUSTAINABLE CITIES AND COMMUNITIES

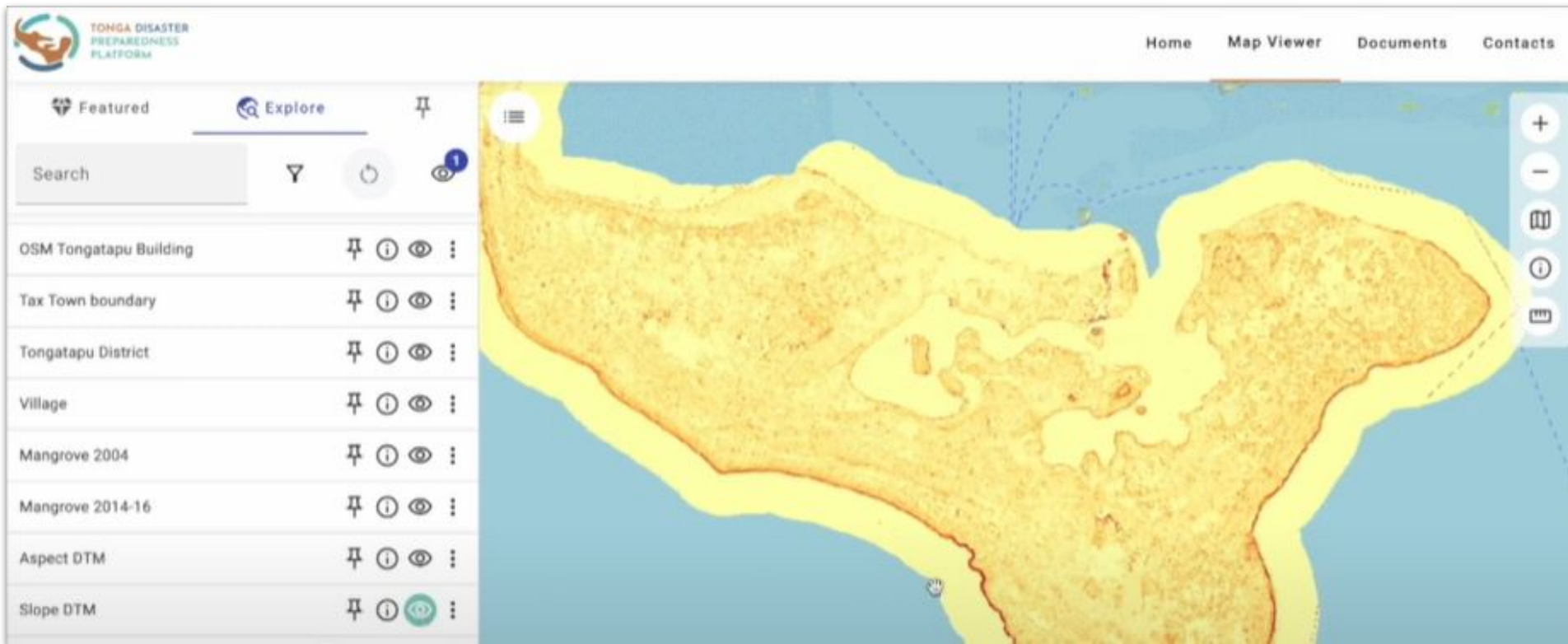


13 CLIMATE ACTION



Integrated Risk Management

Simulate impact of Sea Level Rise, Tsunamis, Storm Surges, and other flood events.



Derived products as aspect and slope are further used in the identification of other hazards as e.g. landslides.

NDRMO/UNOOSA/CEOS initiative

https://www.youtube.com/watch?v=-RAIo50fBIM&ab_channel=UN-SPIDER



Why Should You Care?

- The **radio frequencies are a finite resource**
- **Earth Observation satellites provide timely and reliable data for critical applications** such as disaster management, weather predictions, natural resource monitoring and security.
- **X-band is essential** to downlink and disseminate data under any weather **and has no viable alternative**
- The **X-band has been adopted at scale by satellites and ground stations**, making it ever more affordable and widespread
- The **X-band is an enabler for equitable access to space** fostering remote sensing programs for emerging commercial endeavours.
- **The X-band for Earth Observation data downlink enables several critical applications globally and across sectors.**



Imagery courtesy of:
Airbus Defence and Space GmbH
Airbus DS
EU Copernicus Programme
DLR e.V
Hisdesat Servicios Estratégicos S.A.
Leaf Space
Planet Labs PBC
Umbra Lab Inc.

Matteo EMANUELLI
matteo.emanuelli@airbus.com