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PONTOS VIRTUAL TRAINING MODULES

December 2022

PONTOS-EU.AUA.AM

AUA ACOPIAN CENTER for the ENVIRONMENT

CERTH CENTRE FOR RESEARCH & TECHNOLOGY HELLAS

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Module 1

INTRODUCTION TO EARTH OBSERVATION AND ITS APPLICATIONS

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Responsible Partner – AUA Acopian Center for the Environment
Supporting Partner – Environmental Protection and Monitoring Inspection Body of RA
Slides and scripts prepared by – Name of the researchers
Contact Information – pontos@aua.am

This module is developed in the frames of the BSB 889 PONTOS Project

LEARNING OBJECTIVES OF MODULE 1

Familiarize with Earth observation (EO) and applications

Brief to EO data and its use, the value of EO data

Advantages, benefits and limitations

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MODULE STRUCTURE

Part 1: What is Earth observation (EO)?

Part 2: The technology-platforms and sensors

Part 3: The value of EO data

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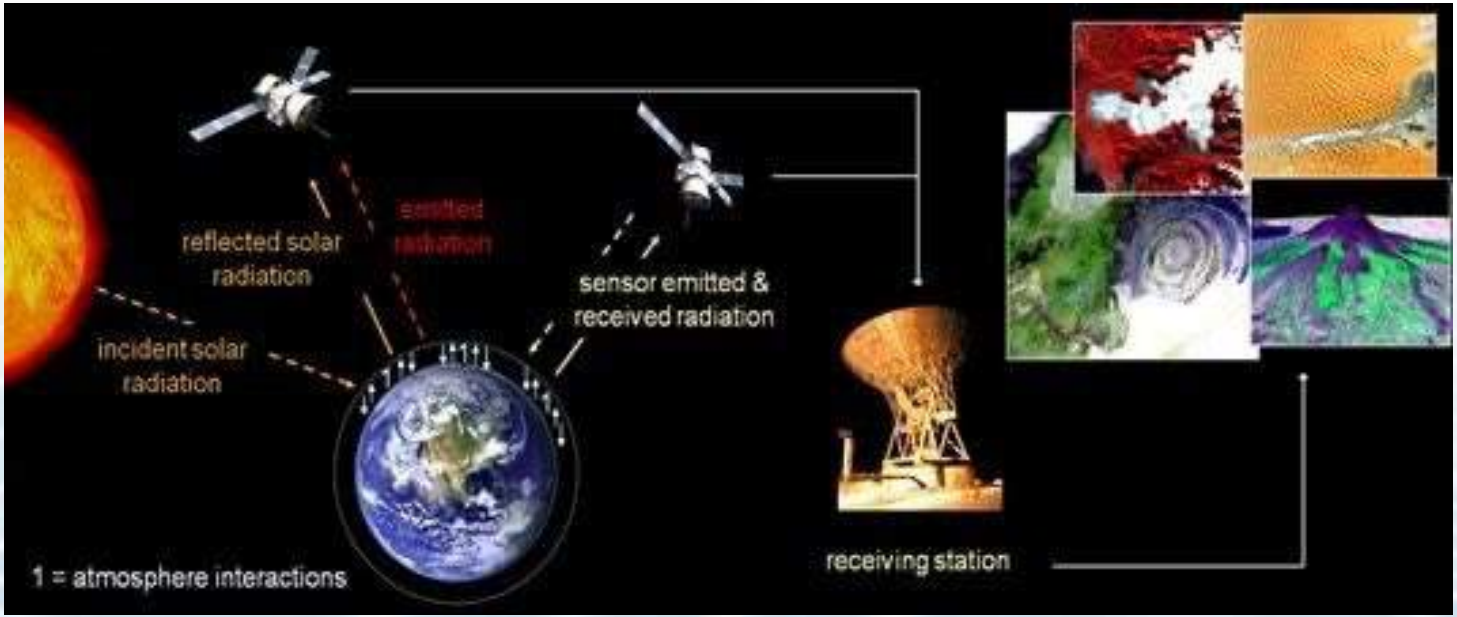
Part 1: What is Earth observation (EO)?



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Understanding the terms

Remote sensing

Gathering information about an **object or phenomenon** without making physical contact

Earth observation

Gathering information about **Earth's** physical, chemical and biological systems via **remote sensing** technologies

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Introduction to Earth Observation

Earth observation is the gathering of information about planet Earth's physical, chemical and biological systems via remote sensing technologies, usually involving satellites carrying imaging devices.

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Introduction to Earth Observation

Earth observation is used to monitor and assess the status of, and changes in, the natural and manmade environment.

Space-based technologies deliver reliable and repeat-coverage datasets, which combined with research and development of appropriate methods, provide a unique means for gathering information concerning the planet.

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Introduction to Earth Observation

Examples include the monitoring of the state and evolution of our environment, be it land, sea or air, and the ability to rapidly assess situations during crises such as extreme weather events or during times of human conflict.

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Types

Earth observations may include:

- Numerical measurements taken by a thermometer, wind gauge, ocean buoy, altimeter or seismometer
- Photos and radar or sonar images taken from ground or ocean-based instruments
- Photos and radar images taken from remote-sensing satellites
- Decision-support tools based on processed information, such as maps and models

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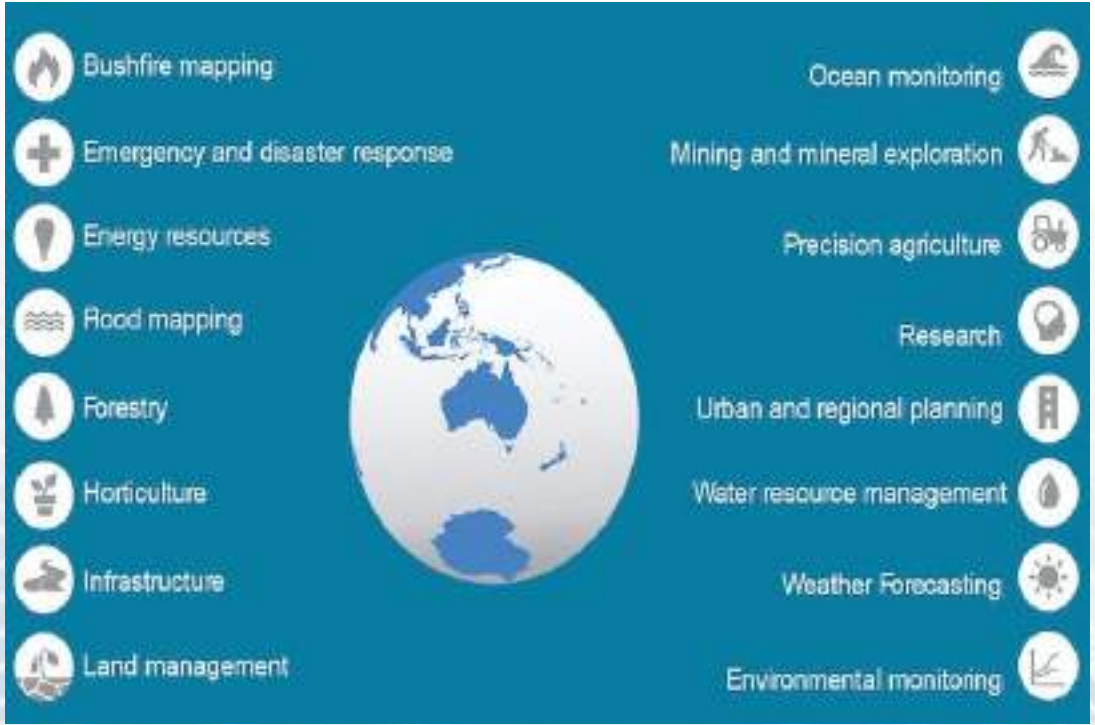
Earth Observation Applications: Implementation Challenges

Just as Earth observations consist of a wide variety of possible elements, they can be applied to a wide variety of uses.



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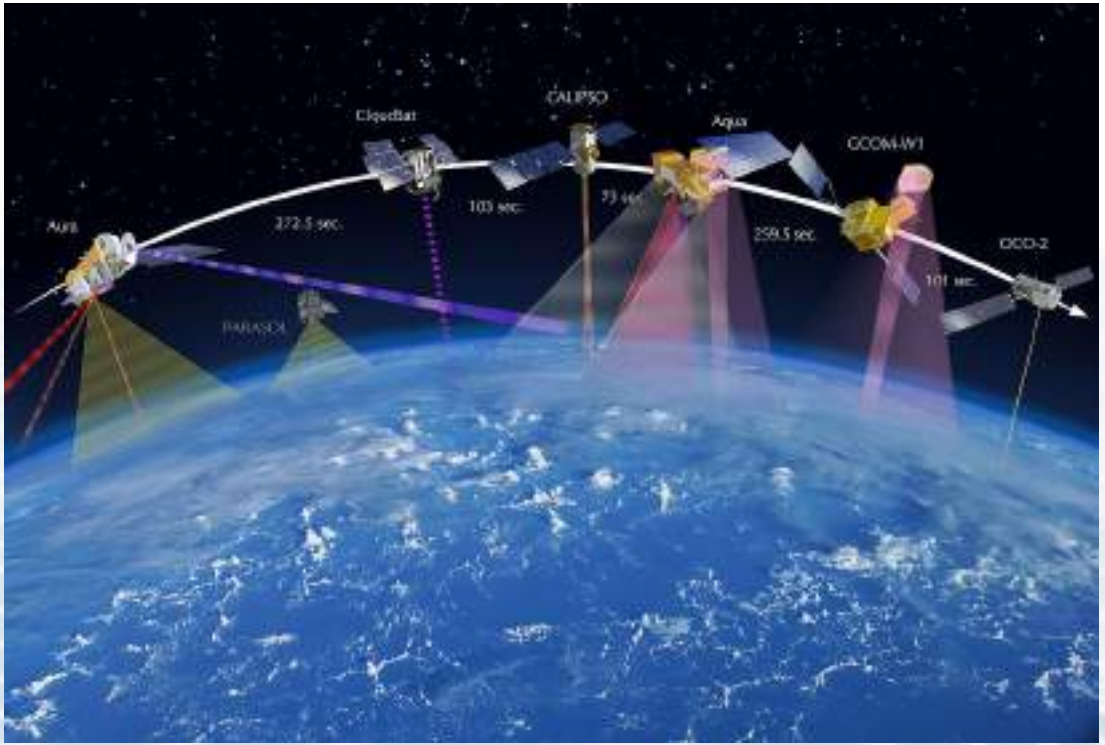
How many satellites?

- Thera are thousands of satellites currently in orbit

- Around ~ 950 satellites are EO missions

✓ Meteorology
✓ Land
✓ Marine
✓ Cryosphere



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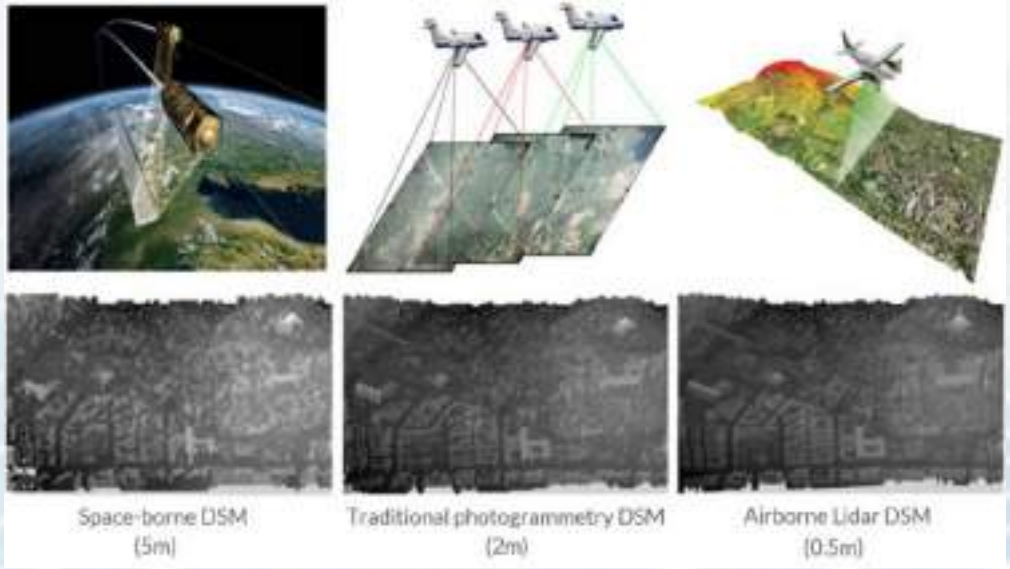
Land management



Flood mapping

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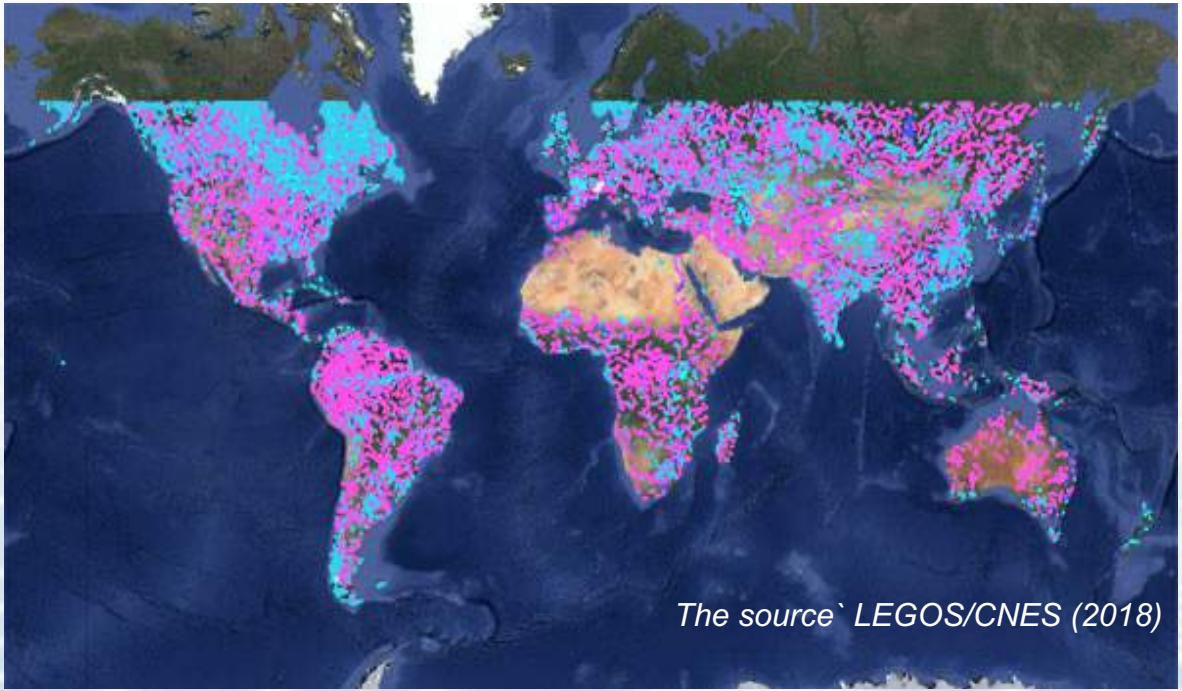
Water recourses management

Illustration of 32,500 virtual stations (lakes and reservoirs in blue, rivers in pink, glaciers in white)



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Forest mapping

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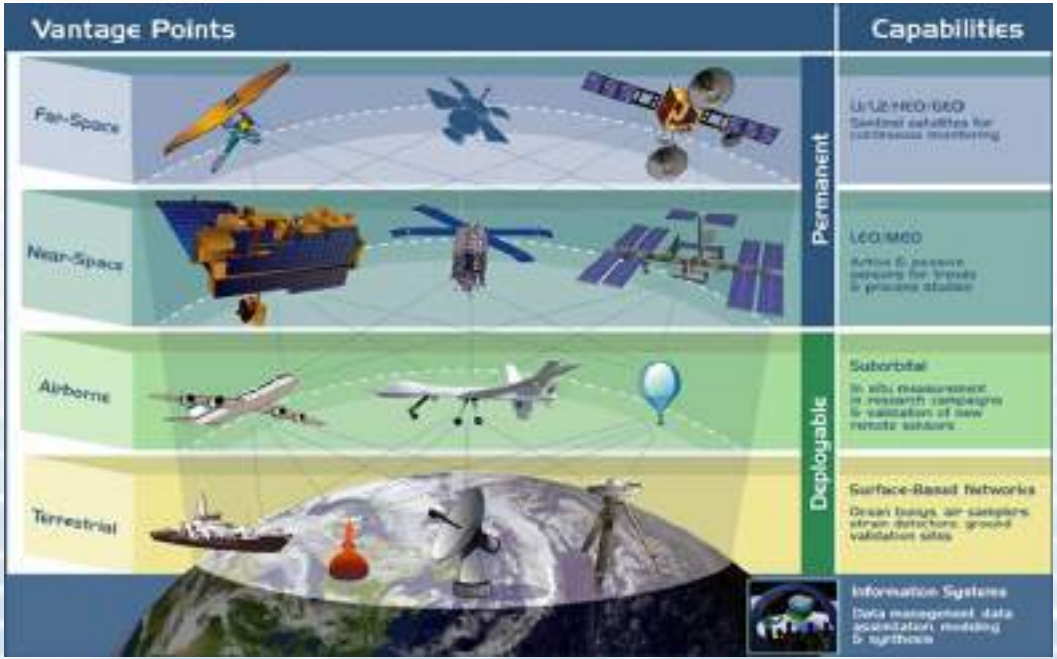
Part 2: The technology-platforms and sensors



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Types of sensing

Measures radiation reflected from the Earth's surface such as visible light and infra-red; cannot 'see' through clouds.

Optical

- Like taking a picture from space
- Affected by clouds
- Imaging through the atmosphere

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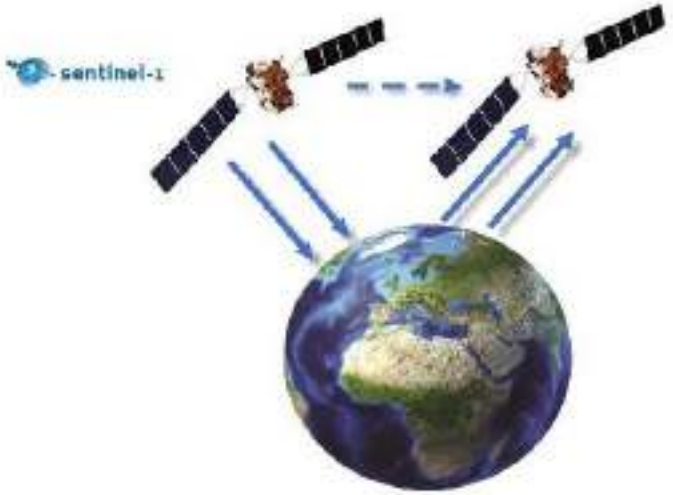
Types of sensing

Radar

- Very different to optical
- Unaffected by clouds
- Higher learning curve



Transmit their own energy towards Earth and measures the returned signal; can 'see' through clouds.

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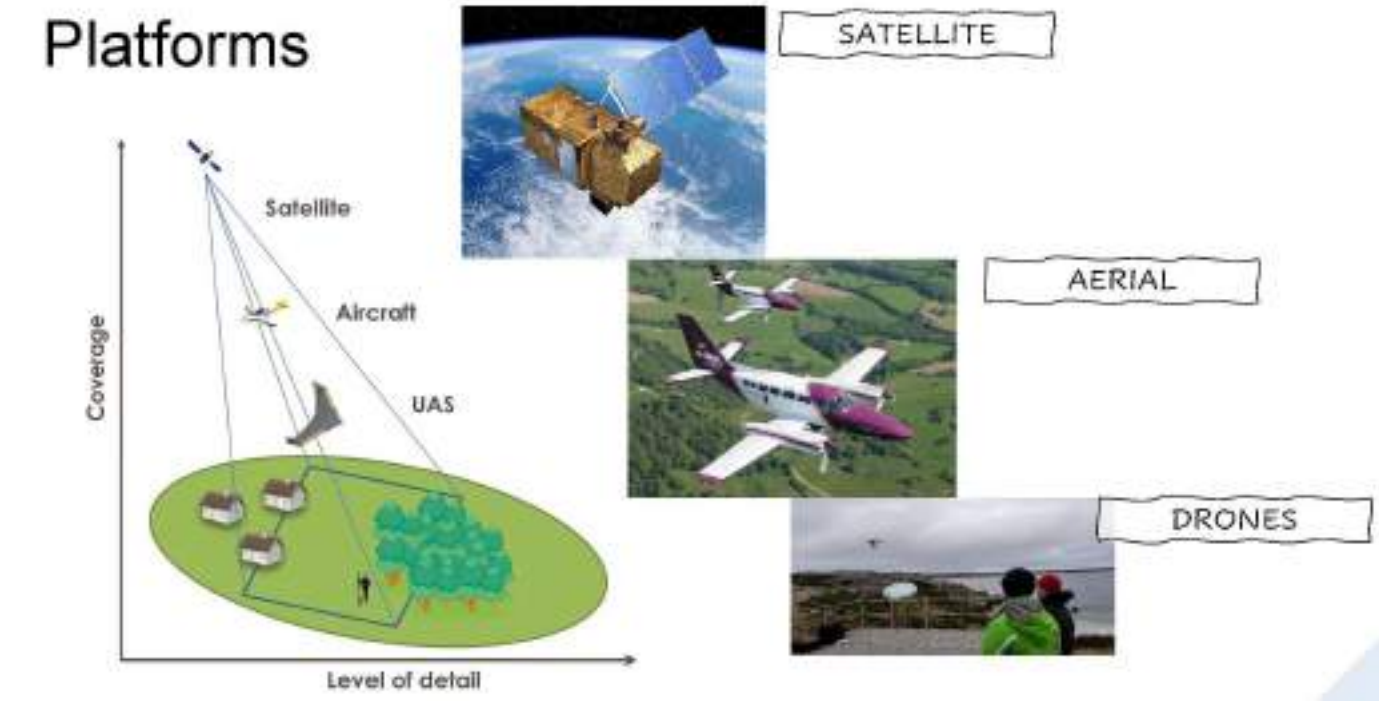
Remote sensing



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Remote Sensing Platforms

Space borne platforms:

- Sensors are mounted on-board a spacecraft
- Rockets , satellites and space shuttles

Advantages :

- Cover large area
- Repetitive coverage of an area of interest

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Remote Sensing Platforms

Aircraft:

Advantages:

- High spatial resolution (20 cm or less)
- Analog photography is possible (analog photo gives high resolution)
- Easily change schedule to their avoid weather problems
- Sensor maintenance and repair is easy

Dis Advantages:

- Permission to intrude into foreign airspace is required
- Many passes to cover larger area
- Swath is much less compare to satellite
- High cost per unit area

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Remote Sensing Platforms

Drones - UAS

- Height: 1 m - 1000 m
- Consumer drones are relatively inexpensive and easy to operate.
- They have a short flight time (20-30 minutes).

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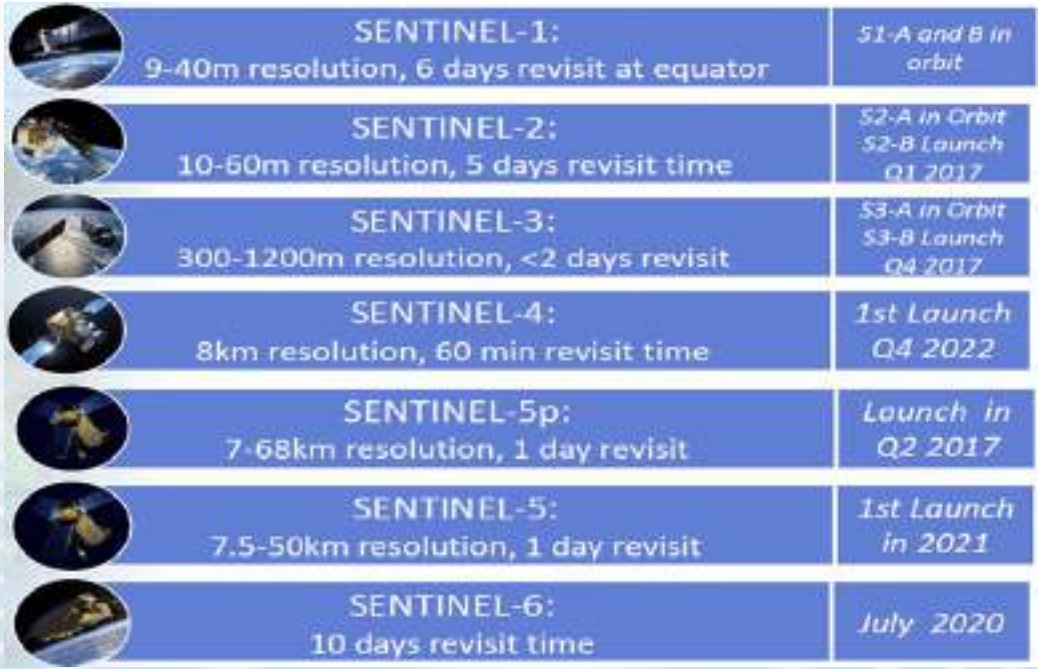
Sentinel Mission and Status

- The European Space Agency ESA is developing a new family of missions called Sentinels specifically for the operational needs of the Copernicus programme.
- Each Sentinel mission is based on a constellation of satellites to fulfil revisit and coverage requirements, providing robust datasets for Copernicus services.
- These missions carry a range of technologies, such as radar and multi-spectral imaging instruments for land, ocean and atmospheric monitoring:



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Sentinel-1

- **Sentinel-1** is a polar-orbiting, all-weather, day-and-night radar imaging mission for land and ocean services. Sentinel-1A was launched on 3 April 2014 and Sentinel-1B on 25 April 2016. Both were taken into orbit on a Soyuz rocket from Europe's Spaceport in French Guiana. The mission ended for Sentinel-1B in 2022 and plans are in force to launch Sentinel-1C as soon as possible.

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Sentinel-2

- Sentinel-2 is a polar-orbiting, multispectral high-resolution imaging mission for land monitoring to provide, for example, imagery of vegetation, soil and water cover, inland waterways and coastal areas.
- Sentinel-2 can also deliver information for emergency services. Sentinel-2A was launched on 23 June 2015 and Sentinel-2B followed on 7 March 2017.

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Sentinel-3

- Sentinel-3 is a multi-instrument mission to measure sea-surface topography, sea- and land-surface temperature, ocean colour and land colour with high-end accuracy and reliability.
- The mission supports ocean forecasting systems, as well as environmental and climate monitoring. Sentinel-3A was launched on 16 February 2016 and Sentinel-3B joined its twin in orbit on 25 April 2018. .

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Sentinel-4

- Sentinel-4 is a payload devoted to atmospheric monitoring that will be embarked upon a Meteosat Third Generation-Sounder (MTG-S) satellite in geostationary orbit.
  - It will be launched in 2023

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Sentinel-5

- Sentinel-5 is a payload that will monitor the atmosphere from polar orbit aboard a MetOp Second Generation satellite.

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Sentinel-5P

- Sentinel-5 Precursor – also known as Sentinel-5P – is the forerunner of Sentinel-5 to provide timely data on a multitude of trace gases and aerosols affecting air quality and climate.
- It has been developed to reduce data gaps between the Envisat satellite – in particular the Sciamachy instrument – and the launch of Sentinel-5. Sentinel-5P was taken into orbit on 13 October 2017 on a Rockot launcher from the Plesetsk Cosmodrome in northern Russia.

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Sentinel-6

- Sentinel-6 carries a radar altimeter to measure global sea-surface height, primarily for operational oceanography and for climate studies. The first satellite was launched into orbit on 21 November 2020 on a SpaceX Falcon 9 rocket from the Vandenberg Air Force Base in California, US.

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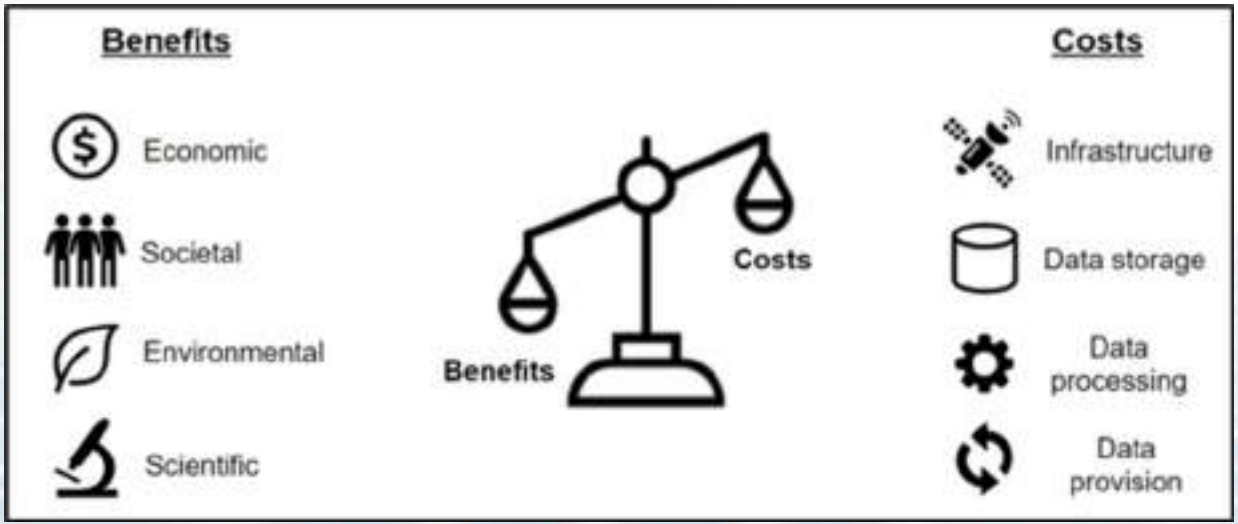
Part 3: The value of Earth Observation data



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- Earth observation data brings immense benefits to society, as they enable countless innovative solutions for monitoring, understanding and predicting changes in our environment.
- The usage of this spatial data for better decision making brings significant societal, economic, environmental and scientific benefits.

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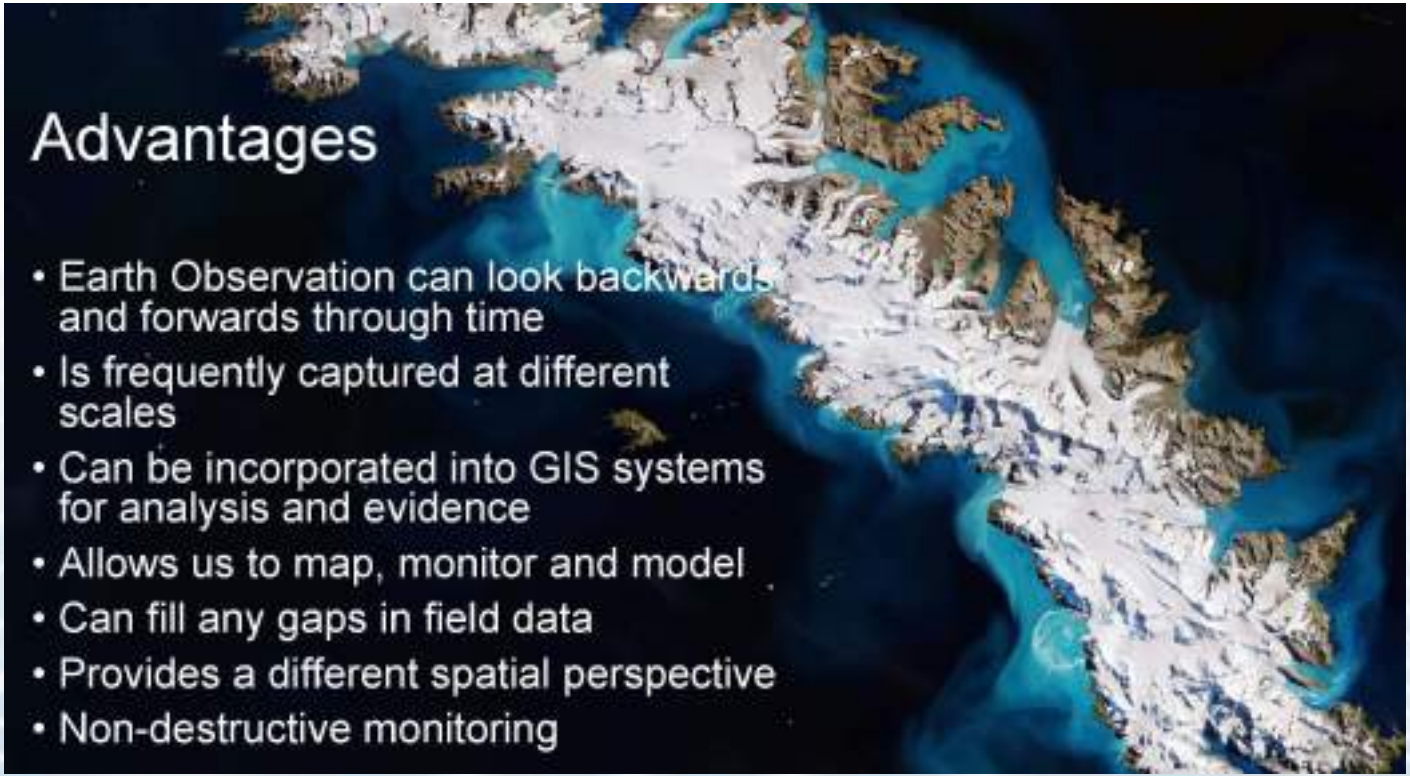

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Benefits of Earth Observation

Pipeline Infrastructure Monitoring in the Netherlands

Benefits for the Netherlands: €15 to €18 M/year

Forest Management in Sweden

Benefits for Sweden: €16 to €22 M/year

Winter Navigation in the Baltic

Benefits for Sweden and Finland: €24 to €116 M/year

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The Union Earth Observation and monitoring programme


Protect people and assets


Increase general knowledge on the state of the Planet


Improve environmental policy effectiveness


Facilitate adaptation to climate change


Monitor the environment


Foster downstream applications in a number of fields


Help managing emergency and security related situations

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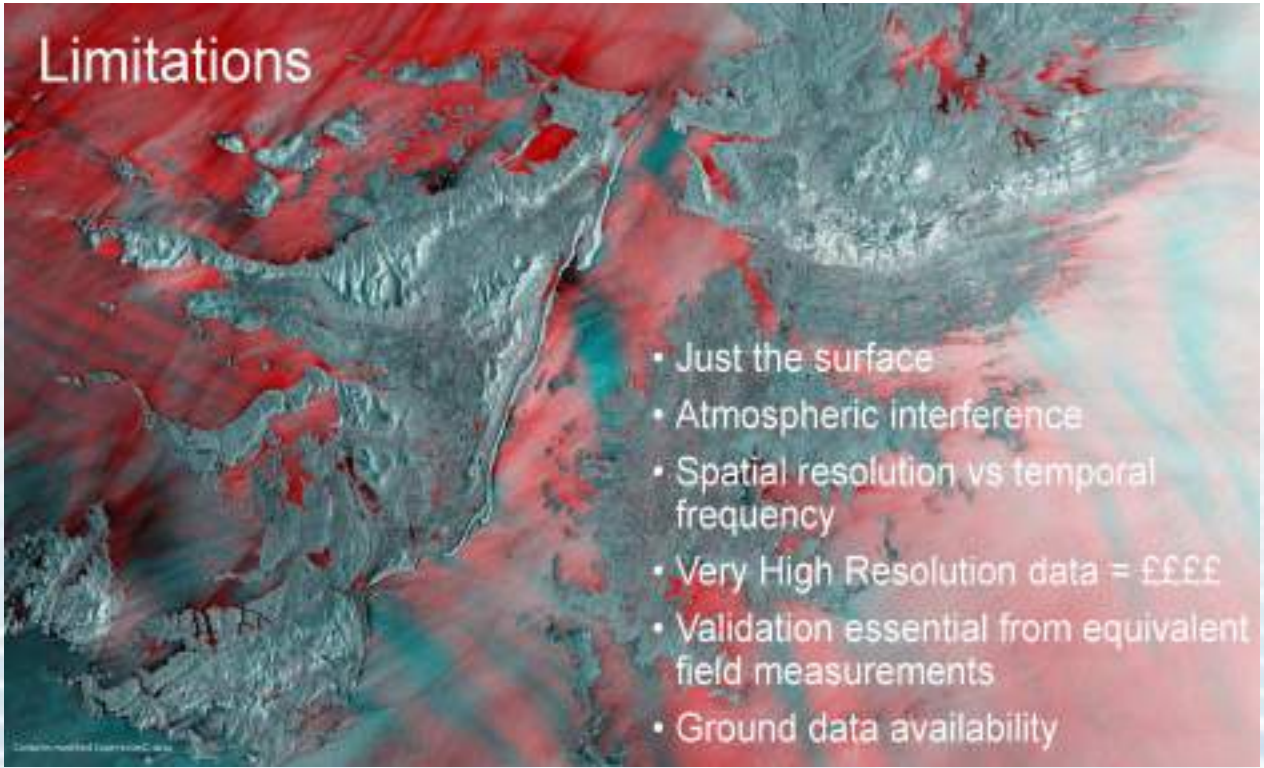

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Earth observation (EO) tools, applications and free open source platforms

Sentinel Hub - https://www.sentinel-hub.com/

Earth Track - https://www.earthtrack.net/

SNAP - https://step.esa.int/main/download/snap-download/

Copernicus Open Access Hub - https://scihub.copernicus.eu/

Earth Observation Data for Ecosystem Monitoring (EODESM) system - https://ieeexplore.ieee.org/

PONTOS platform - https://pontos-eu.aua.am/pontos-platform/

Earth System Lab - https://www.earthsystemdatalab.net/

Open Data Cube - https://www.opendatacube.org/

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Copernicus Assisted Environmental Monitoring across the Black Sea Basin – PONTOS
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