



AIR CENTRE  
ATLANTIC INTERNATIONAL RESEARCH CENTRE

# Use of Space Assets for Coastal Protection

**Eurisy- ESA**

Webinar Series

February 2021





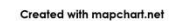
- **AIR Centre Introduction**
- **Earth Observation Laboratory and ESA\_Lab**
- **AIR Centre missions related to Coastal Protection**
- **Atlantic Pole to Pole Observation System of Systems**
- **Constellation of Small Satellites**
- **Selected Coastal Protection Use Cases:**
  - **Coast Pollution Control**
  - **Coast Water and Air Quality**
  - **Coastal Natural Disaster Monitoring**
  - **Coast Safety: Fight against Piracy**
  - **Coast Safety: Control of Illegal Vessel Traffic**
- **Conclusions**



# AIR CENTRE: MISSION AND VISION

- International non-profit organization with a distributed and collaborative network
- To foster **job creation** and **knowledge driven economic development** in Atlantic regions
- Based in **scientific excellence** and providing services to the scientific community
- To monitor and decisively contribute to reach the UN sustainable development goals
- It integrates space, climate, earth, ocean, energy and data sciences
- To promote South-North/North-South cooperation
- With main actions oriented towards selected **main thematic missions**







# EARTH OBSERVATION LABORATORY & ESA LAB



The graphic features a large lightbulb on the left. To its right is a circular diagram with concentric rings. The outermost ring contains the word 'innovate' at the top and 'inspire' at the bottom. The next ring inward contains the word 'inform' at the top and 'interact' at the bottom. The center of the diagram shows a globe of the Earth with the text 'space 4.0' overlaid. The ESA logo is in the top right corner. At the bottom, there is a row of flags from various European countries and the text 'European Space Agency'.

**ESA\_Lab@**

**space 4.0**

esa

European Space Agency



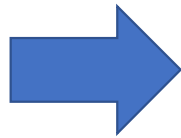
# MISSION: CLEAN AND PRODUCTIVE BAYS AND ESTUARIES

- Bays and estuaries are among the most productive areas on Earth, providing a wide range of valuable ecosystem services to coastal populations and wildlife.
- These areas are being severely threatened by both anthropogenic impacts (e.g. pollution, physical changes, loss of habitats, urban sprawl) and environmental changes (e.g. sea level rise, water temperature increase, coastal erosion, ocean acidification).
- The AIR Centre will promote ecosystem-based approaches for the integrated management of bays and estuarine areas and foster comparative assessment and action research for the preservation, restoration, and sustainable development of several key locations around the Atlantic Ocean.





## **CLEAN AND PRODUCTIVE BAYS AND STUARIES**



- Coastal erosion monitoring
- Coast pollution (oil spill, plastics, contamination)
- Water temperature increase
- Sea level rise monitoring
- Marine spatial planning
- Monitoring and surveillance of maritime activities
- Coastal bathymetry
- Ecosystems monitoring
- Port activity monitoring
- Mangroves monitoring



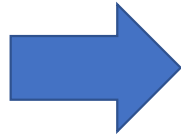
# MISSION: RESILIENCE TO COASTAL NATURAL HAZARDS

- The frequency and severity of coastal hazards are expected to increase as a result of the combined effects of climate change and human activities.
- Preventing and reducing risks as well as increasing preparedness for response against coastal hazard exposure and vulnerability to natural or man-made disasters are critical aspects for the well-being and security of coastal populations and wildlife preservation.
- The AIR Centre will stimulate collaborative research on coastal resilience (with emphasis on floods, sea level rise, extreme weather, and coastal erosion) and promote the development of multi-hazard early warning systems to prevent loss of life and reduce the economic and material impacts of hazardous events..





## RESILIENCE TO COASTAL NATURAL HAZARDS



- Climate change monitoring
- Mitigation of natural disasters:
  - Tsunami
  - Flooding
  - Earthquake
  - Volcanoes
  - Fires
- Sea level rise monitoring
- Coastal erosion monitoring
- Extreme weather events
- Marine weather forecast
- Atmospheric and Air quality monitoring
- Marine operations safety (AIS + IoT communications)



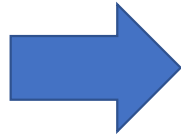
# MISSION: IMPROVED MANAGEMENT OF MARINE AND COASTAL RESOURCES

- Economic growth in recent decades has been accomplished mainly through unsustainable exploitation of many natural resources.
- This paradigm must be changed in order to maintain the integrity of oceans and coastal areas for future generations. It is vital to secure the integrity of marine habitats and the biodiversity they support so that key ecosystem services promoting human well-being continue to be delivered.
- The AIR Centre will build capacity for evidence-based governance of marine and coastal resources and raise awareness of local communities and decision makers on the economic value of marine spatial planning for sustainable development and preservation of marine and coastal ecosystems and biodiversity.





## IMPROVED MANAGEMENT OF MARINE AND COASTAL RESOURCES



- Biodiversity preservation monitoring
- Communication system for ocean animal tag tracking (IoT transponder)
- Seagrass monitoring
- Corals monitoring
- Sargassum monitoring
- See surface temperature, ocean color, salinity, chlorophyll maps for biodiversity applications
- Marine and coastal resources monitoring
- Marine ecosystems monitoring
- Chryosphere: See ice monitoring
- Coastal spatial planning

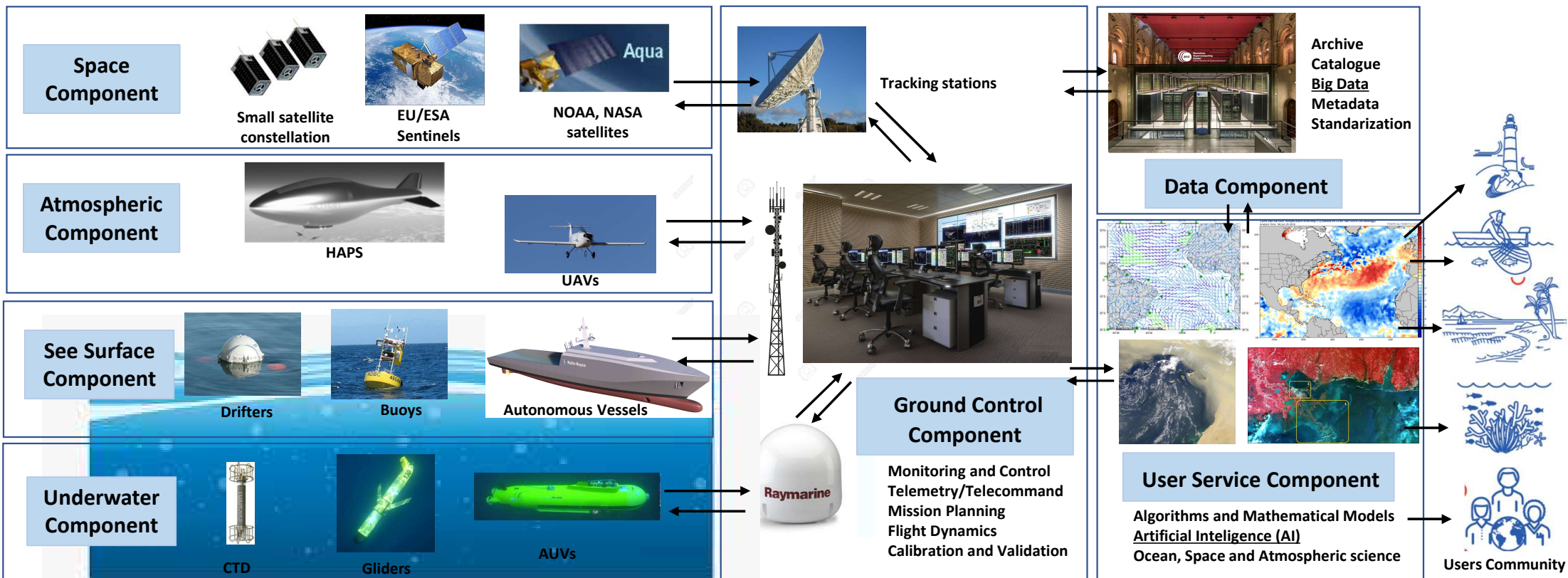
# ATLANTIC COASTAL PROTECTION USER NEEDS

- Coastal erosion, bay and stuarine area protection
- Sea level rise monitoring and adaptation
- Detection of oil spills, plastics and coastal contamination
- Climate change monitoring and marine weather forecast
- Sea ice monitoring and marine operations safety
- Ocean ship monitoring and traffic service (AIS)
- Coast disaster monitoring:
  - Floods risk and evolution
  - Tsunami alert
  - Fire risk and recovery
  - Earthquakes and volcanoes
- Biodiversity assessment in coastal ecosystems
- Coast water and air quality, resources and management
- Coast Safety

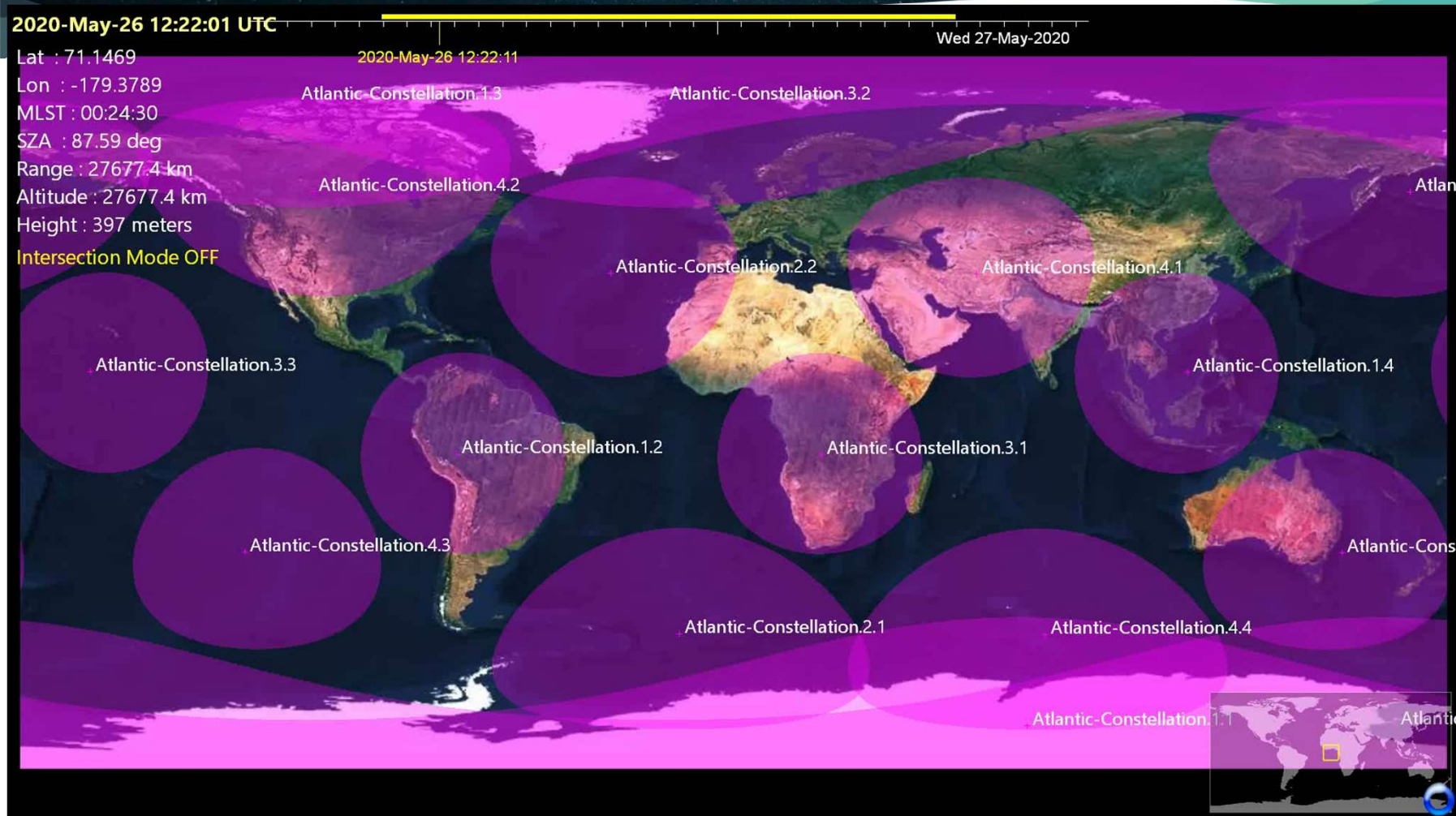




# APPOSS ARCHITECTURE



# CONSTELLATION DESIGN: 2D VIDEO



- 2D graphical animation of the Atlantic Constellation with visibility of the cone of coverage of each satellite
- The image on the poles are distorted due to the projection used in this video



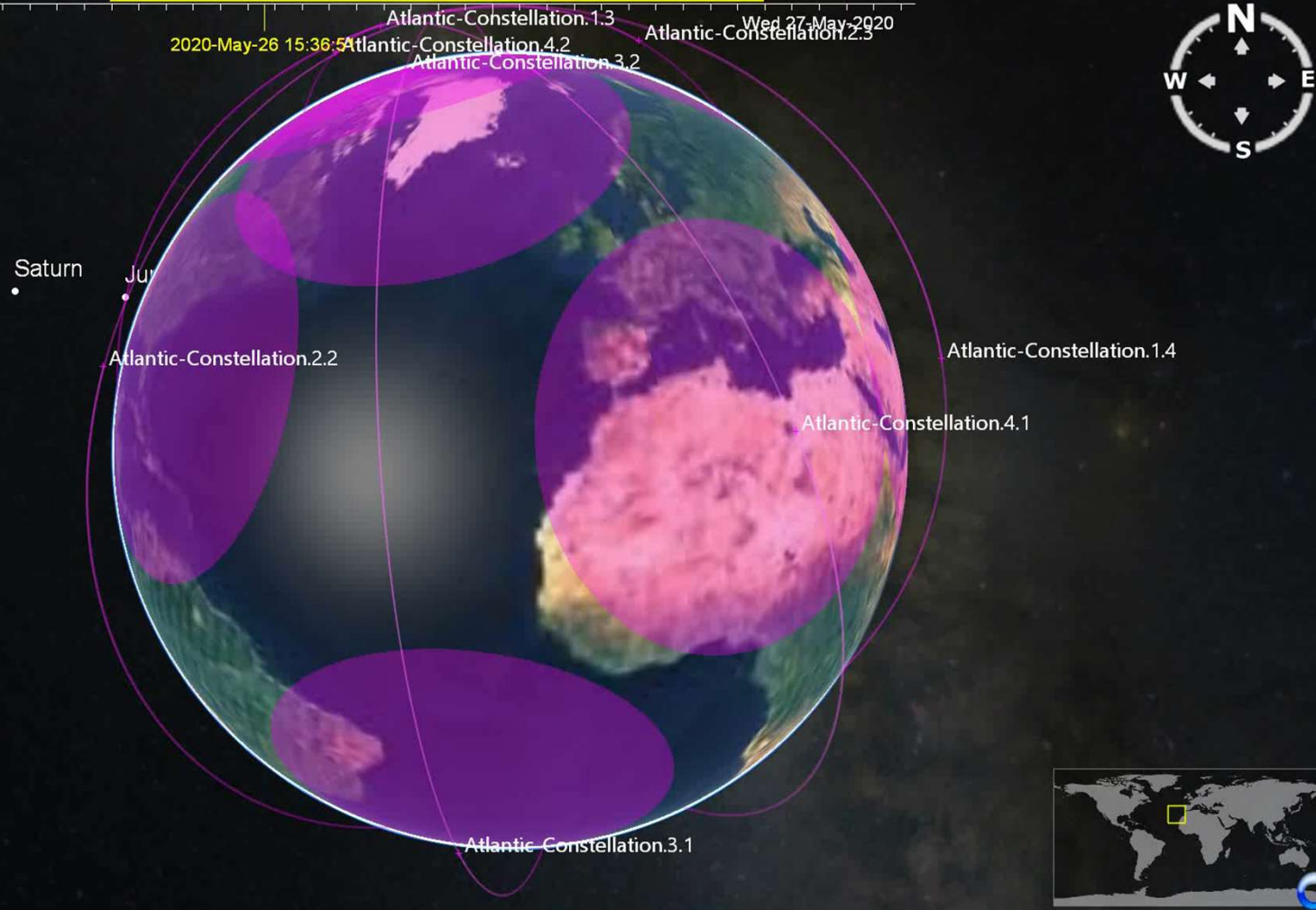


AIRCENTRE

# CONSTELLATION DESIGN: 3D VIDEO

2020-May-26 15:36:39 UTC

Lat :  
Lon :  
MLST :  
SZA :  
Range : 12756.3 km  
Altitude : 12756.3 km  
Height : 0 meters  
Intersection Mode OFF



- 3D graphical animation of the Atlantic Constellation with visibility of the cone of coverage of each satellite
- Some gaps of coverage appears on the video, but they are closed always in a few minutes

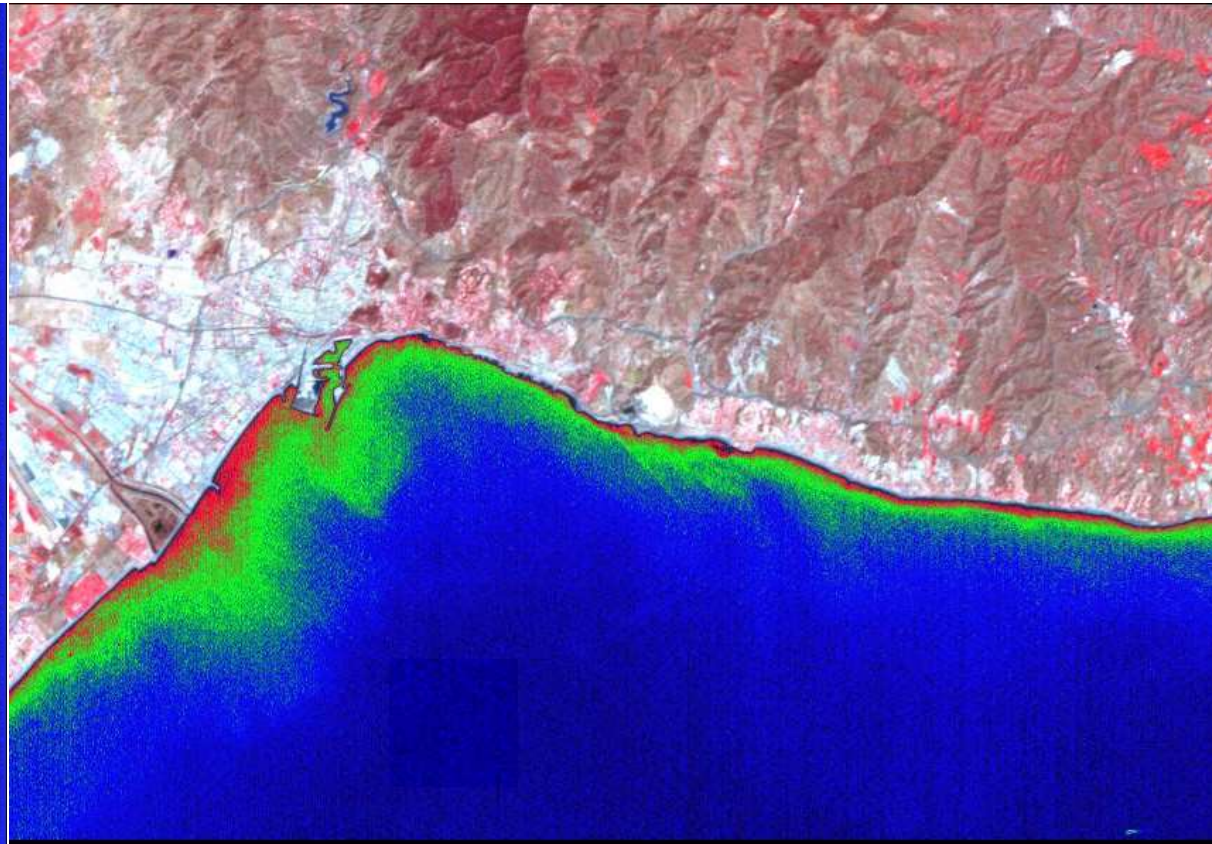
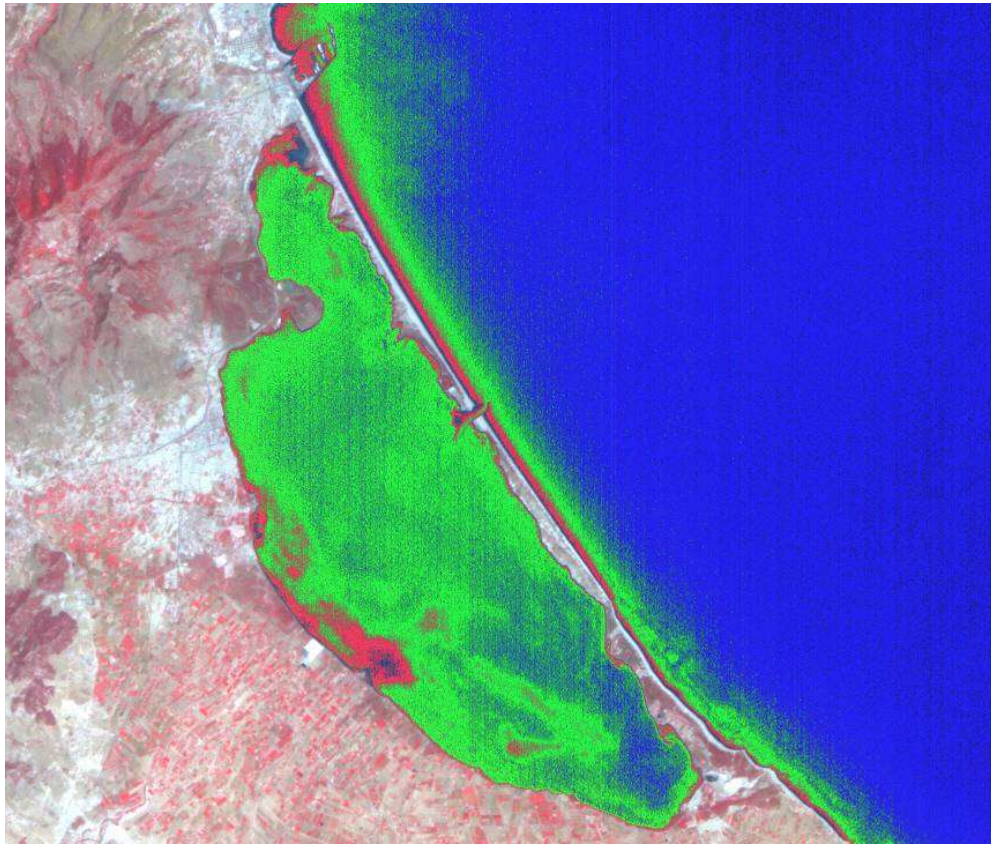
# COASTAL POLLUTION CONTROL

- AI tools in combination of satellite radar and optical imagery can predict and mitigate the effect of coastal pollution disasters like oil spills or underwater volcanic eruption
- This image shows the Island of El Hierro in Spain with an underwater volcanic eruption
- AI techniques were used to predict the evolution of the volcanic ashes to protect coast and fishing areas



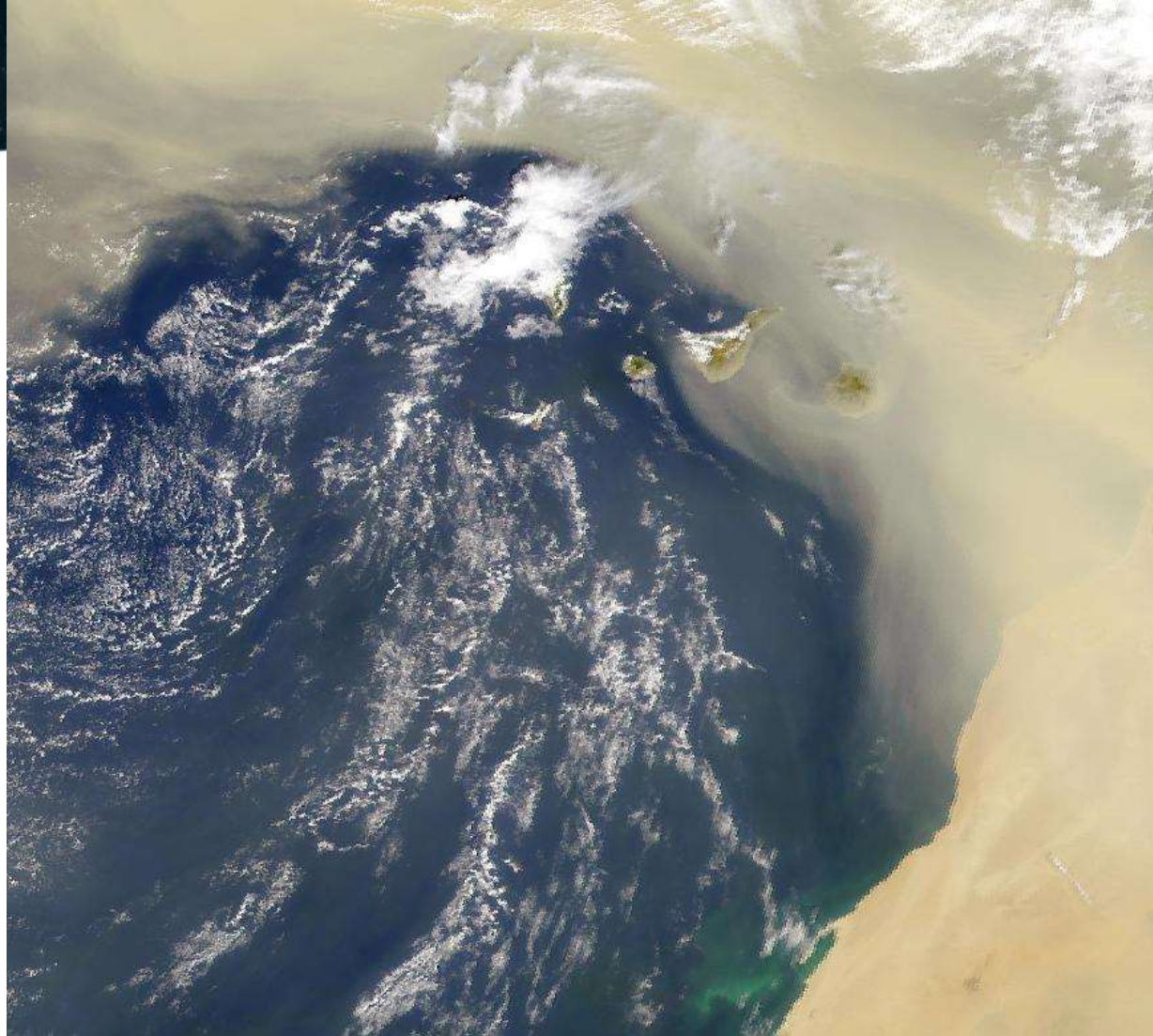


# COASTAL POLLUTION: WATER QUALITY, DETECTION OF ORGANIC DISCHARGES TO THE SEE





# COASTAL POLLUTION: AIR QUALITY CONTROL





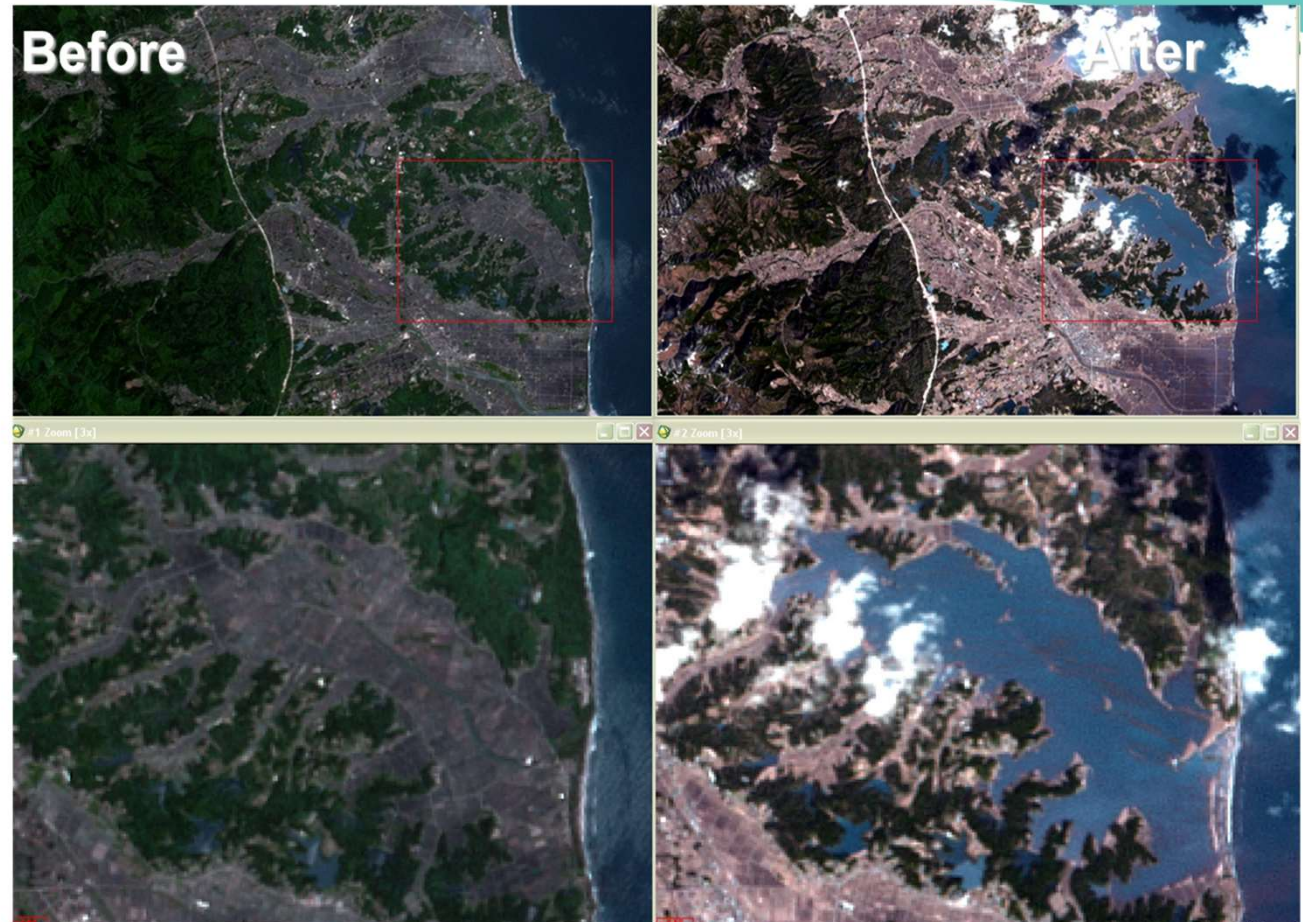
# COAST NATURAL DISASTER MONITORING: TSUNAMI IN JAPAN





# COAST NATURAL DISASTER MONITORING: TSUNAMI IN JAPAN

- Satellite radar and optical imagery are also a valuable tool for mitigation of coast natural disasters
- Change detection algorithms provide a first alarm in case of large affected areas
- This image presents áreas of Japan before and after the tsunami, a quick analysis of infrastructures was done with above techniques





# DISASTER MONITORING: TSUNAMI IN JAPAN (FUKUSIMA)





# COAST NATURAL DISASTERS: FLOODING (Katrina)



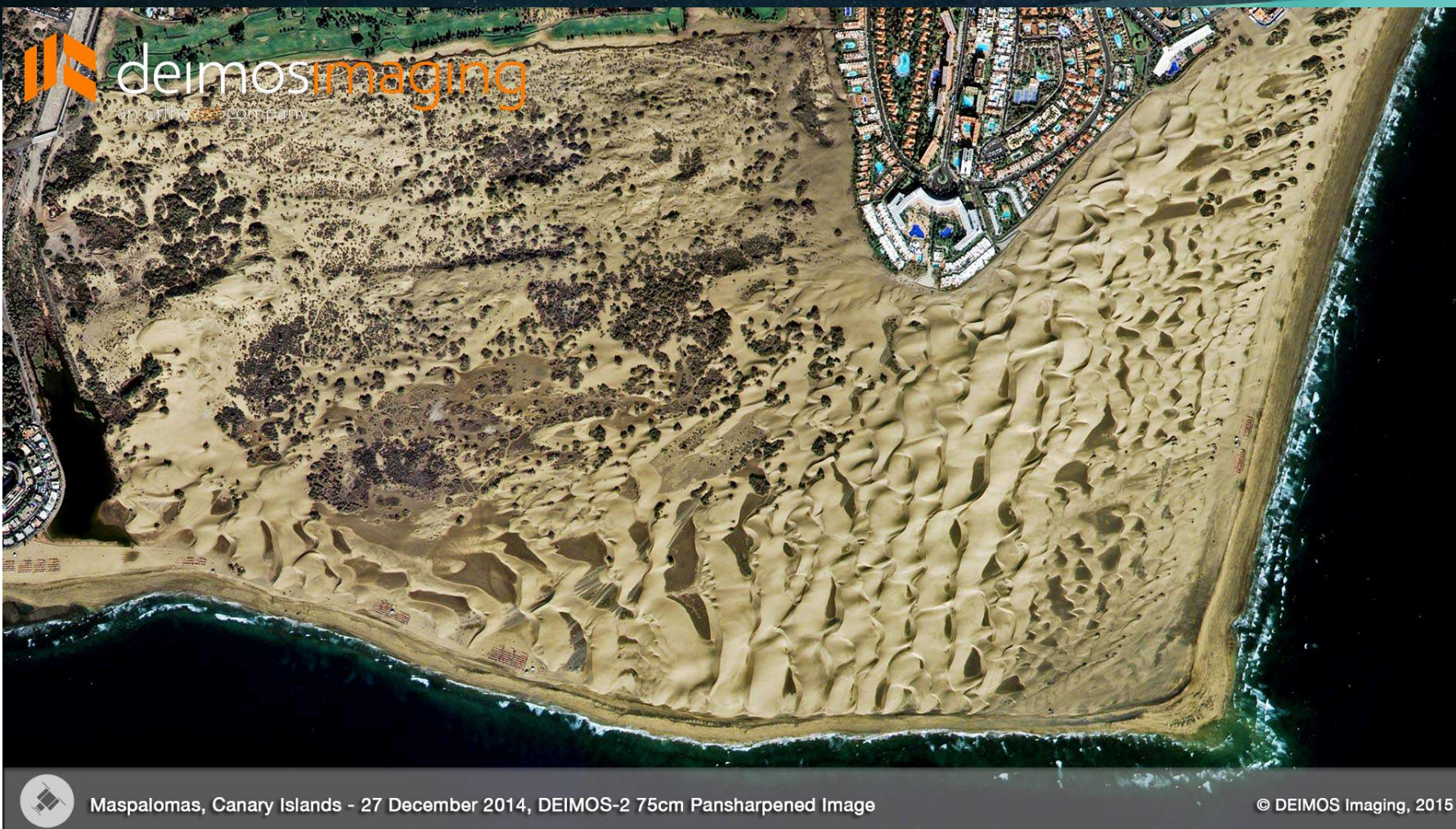


# COAST NATURAL DISASTERS: FLOODING (Katrina)



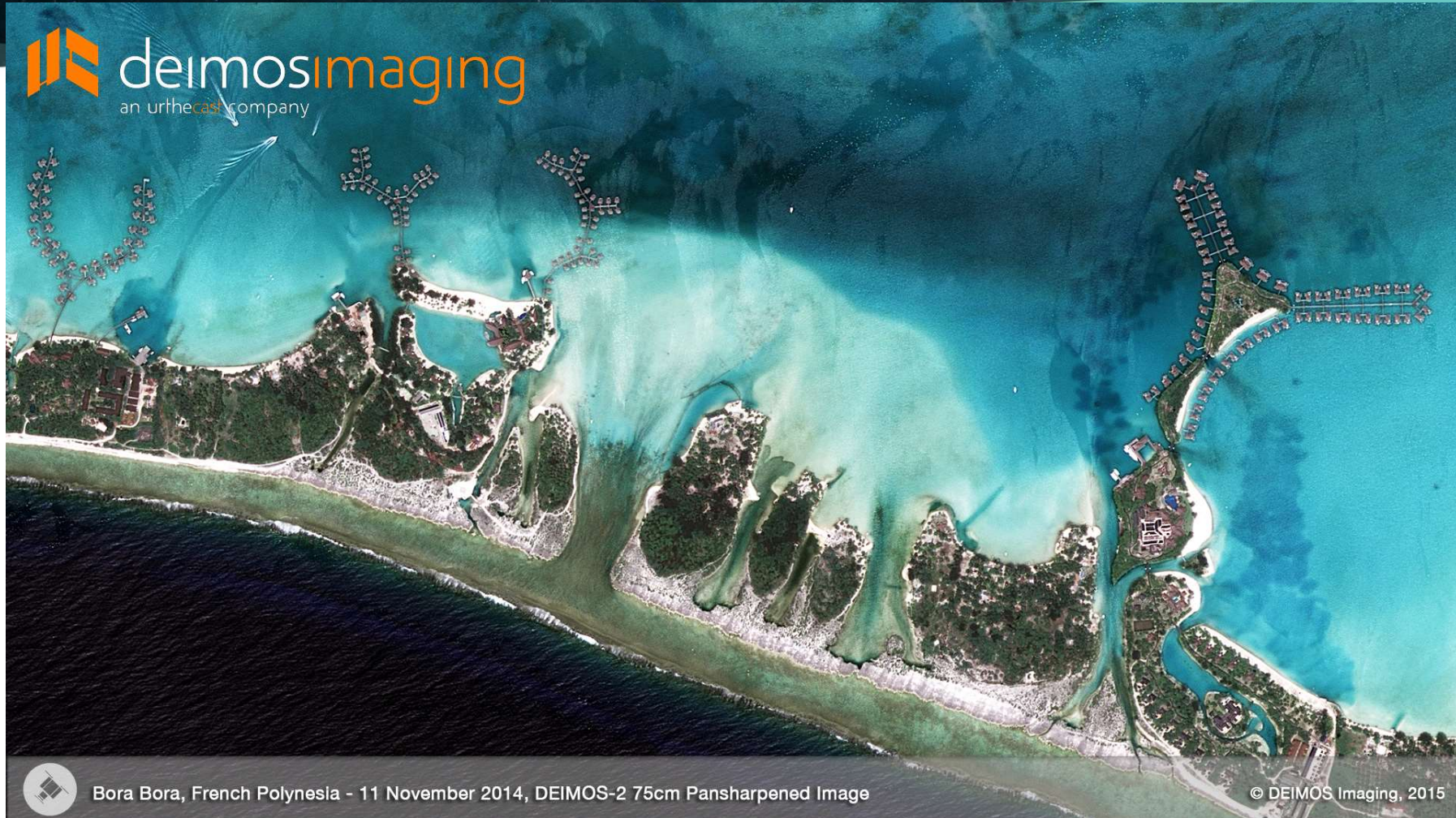


# COASTAL PROTECTION: MASPALOMAS NATURAL PARK





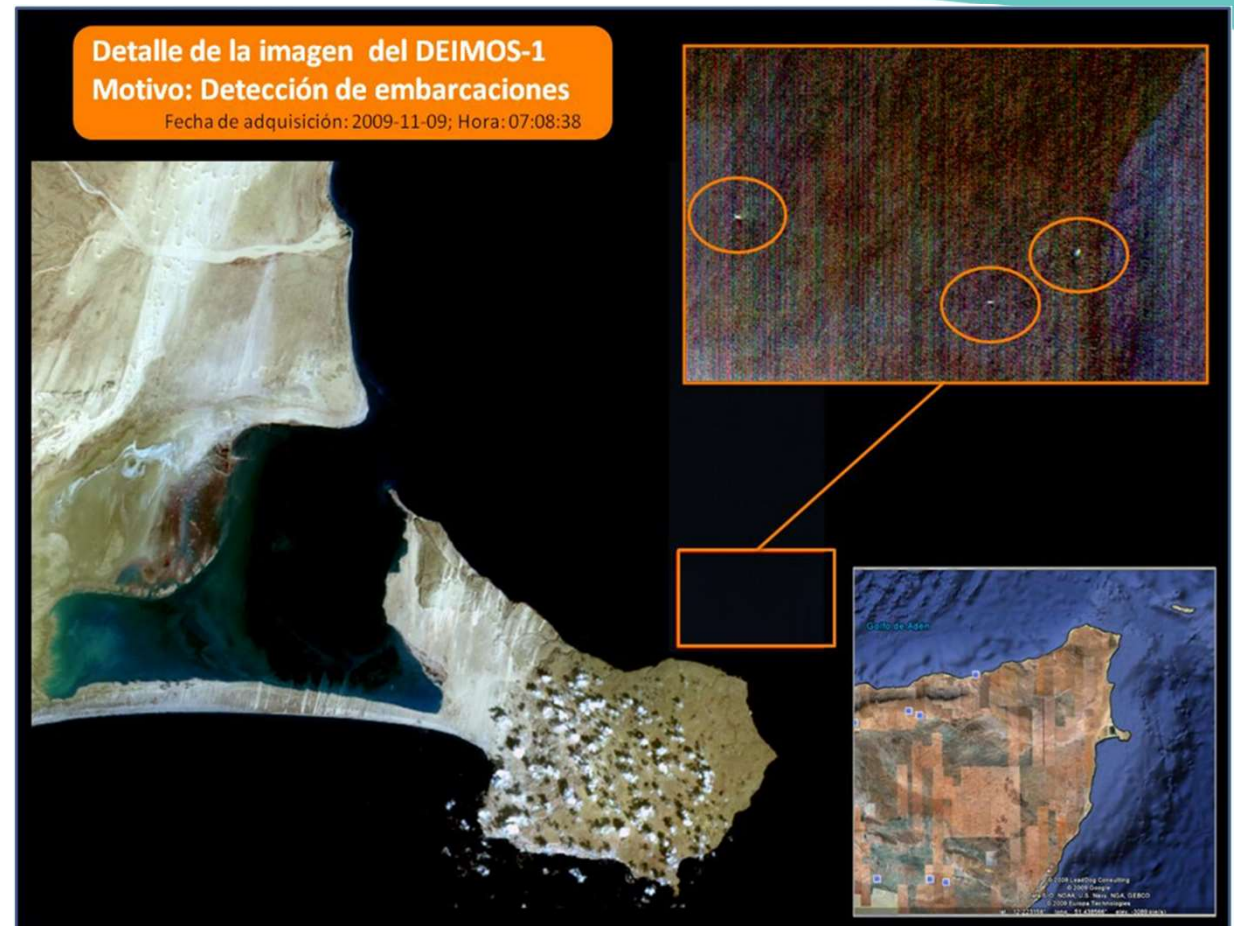
# COASTAL PROTECTION: SEA LEVEL RISE (BORA BORA)





# COAST SAFETY: FIGHT AGAINST PIRACY

- **Satellite and radar optical imagery are also used for coastal safety issues like fight against piracy**
- **The behaviour of the pirate boats can be identified thanks to Machine Learning techniques**
- **This image presents some pirates boats in the Indic Ocean waiting for vessels to attack**





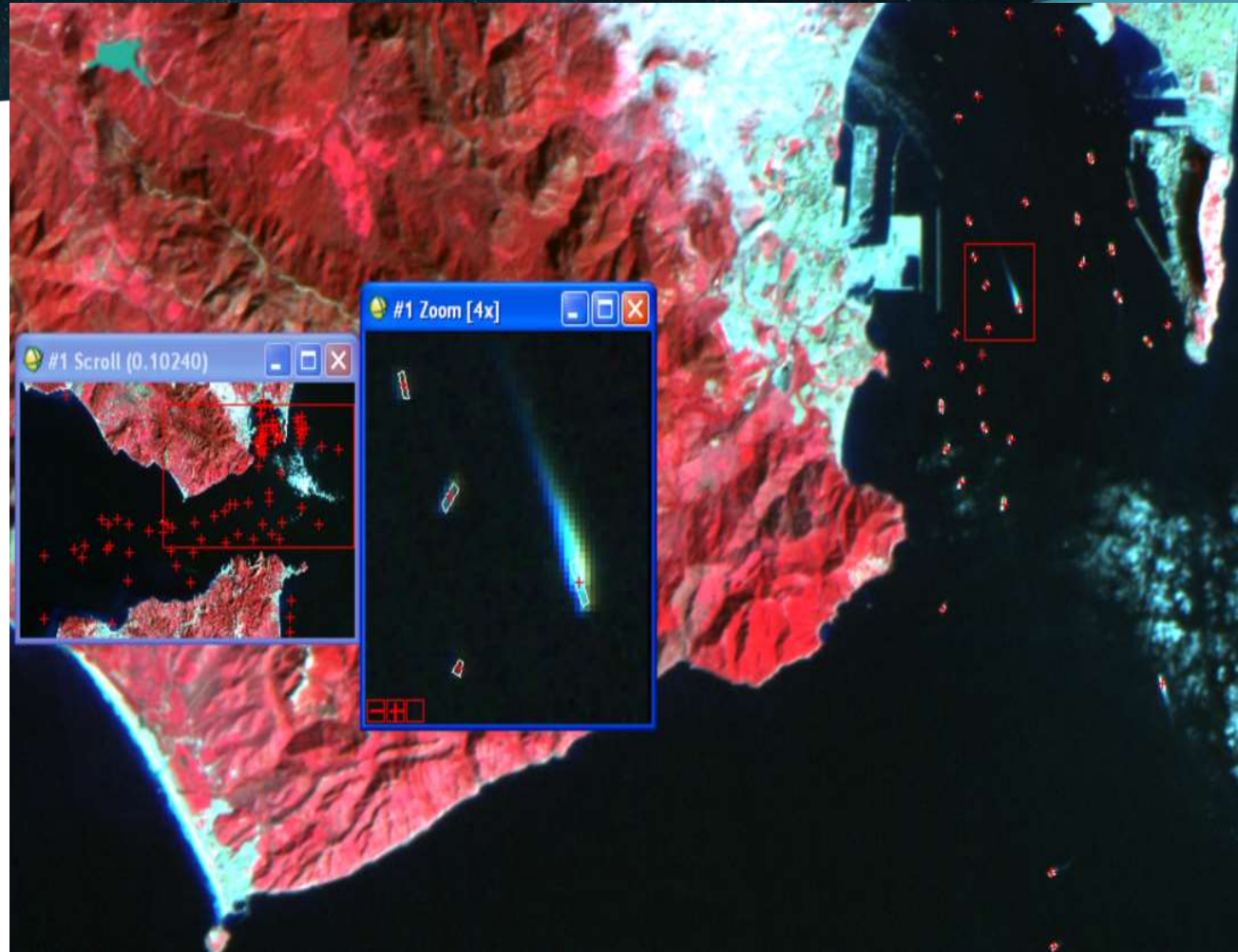
## COAST SAFETY: FIGHT AGAINST PIRACY



- It is also possible to monitor the ways used for the pirates to get in and out of the coast
- AI algorithms to detect changes in the chlorophyll signal received at optical satellites in the NIR spectral band can be used for this purpose
- This image presents some tracks in the Indic Ocean and some coastal infrastructure used by the pirates

# COAST SAFETY: CONTROL OF ILLEGAL VESSEL TRAFFIC

- The combination of AIS + satellite optical or SAR data + AI algorithms allows the identification of illegal vessel traffic
- This image presents the maritime traffic on Gibraltar strait, AIS data is overimposed on satellite optical imagery, allowing to detect unidentified vessels suspicious of illegal immigration or narcotraffic





# CONCLUSIONS

- AIR Centre has been consolidated as an important international network for technical and scientific collaboration for all countries in the Atlantic region
- Coastal Protection is one of the key elements of the AIR Centre Missions and the ESA\_Lab at Azores
- The use of Earth Observation data from space provides one of the most valuable tools to develop services for coastal protection (pollution, sea level rise, natural hazards, safety, marine spatial planning, ...)
- The expansion of the European Copernicus program and the development of new systems like the AIR Atlantic Constellation with better spectral and spatial resolution and a much better revisit time is an important enabler to provide the data required for coastal protection services

