High-level panel on Science, Technology, and Innovation for Sustainable Urban Development in a post-Covid19 world

AIR Centre for 25th CSTD
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• Introduction to AIR Centre:
  • Mission and Vision
  • Earth Observation Laboratory
• Space Data System for Sustainable Urban Development:
  • System overall description
  • Space Data Component
  • In-situ Data Component
  • Data Center Module
  • Applications Module
  • Capacitation and Training
• 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
AIR CENTRE NETWORK STATUS: AZORES HEADQUARTERS

Headquarters – Terinov, Terceira Island
Earth Observation Laboratory
Marine Biodiversity Observation Network
AIR CENTRE EARTH OBSERVATION LABORATORY
EARTH OBSERVATION LABORATORY & ESA_Lab
EARTH OBSERVATION LAB
DIRECT RECEIVING STATION

Estimated External Data Usage 10 Years (error +10%)

- Workstation upload/download
- Upload/download from in-house remote detection database
- IoT calls
- Auto-query external databases

Years: 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030

Data usage in Petabytes:
- 0
- 5,000
- 10,000
- 15,000
- 20,000
- 25,000
- 30,000
- 35,000
- 40,000
- 45,000
- 50,000

Satellites:
- Aqua
- Suomi
- JPSS-1
- FengYun-3
- Terra
- Suomi
AIR CENTRE PARTNER SATELLITES: GEOSAT-1, GEOSAT-2
LA PALMA VOLCANO

GEOSAT 1, La Palma, Canary Island, Spain

GEOSAT 2, Cumbre Vieja Volcano, La Palma, Spain
SPACE DATA SYSTEM FOR SUSTAINABLE URBAN DEVELOPMENT
Sustainable urban development, SDG 11, faces important challenges today:

- Inefficient and polluting energy systems
- Unsustainable production and consumption patterns
- Water scarcity
- Traffic congestion and vehicle emissions
- Limited access to decent employment
- Unaffordable and poor-quality housing
- Gender-based inequalities and violence against women and girls
- Inadequate planning practices
- Violence and insecurity
- Vulnerability to natural disasters
• Urban sustainability challenges requires the access to and the sharing of knowledge of science, technology and innovation.

• In this line, the AIR Centre proposes to the UN Commission on Science and Technology for Development (CSTD) the implementation of a technological system based on Earth Observation data from the space.

• This system shall help to achieve the sustainability goals for urban development by using data provided by several satellites combined with in-situ measurements, Artificial Intelligence algorithms and Big Data Science.

• The main components of this “Space Data System for Sustainable Urban development” are presented in the next slides.
The “Space Data System for Sustainable Urban Development” is composed of the following five elements:

- Satellite Data Acquisition Module
- In-situ Data Acquisition Module
- Data Center Module
- Applications Module
- Capacitation and Training Module
The Satellite Data Acquisition Module is able to provide data from four different types of satellites using the following components:

- Through the local installation of a “Direct Receiving Antenna” DRS, the system is able to get “real time” data from up to 6 direct broadcast satellites (from NOAA, NASA in USA and Fenyung from China), this is important data for urgent urban extreme weather events.

- With a specific software module, access to the free data generated by the Sentinels satellites of the European Copernicus program, those are optical and radar satellites with mid resolution.

- An additional software package shall get access to the very high resolution data provided by the commercial Geosat 1 and Geosat 2 satellites, down up to 75 cm resolution. This is of paramount importance for urban cartography and urban planning in high resolution.

- In the next future, from 2025, another additional software module shall be implemented to access the new Atlantic Constellation, which is able to provide data with an unprecedented frequency (every 2-3 hours).
• 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
• 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
The In-situ Data Acquisition Module is able to acquire data from different urban sensors to be combined with satellite data:

• Metereological stations to provide urban meteo data
• Atmospheric stations to provide air and atmospheric data
• Sensors under water (urban water bodies, rivers, seaside) to provide water parameters (water level)
• Soil sensors to provide soil parameters like humidity
• Traffic sensor data
The Data Centre Module shall archive all data (space and in-situ) in different formats (raw and processed) and make it available to all users for different applications, it must include:

- Well defined data models (data cubes)
- Storage servers to archive all data with enough room for several years of operations
- All type of API’s (Application Programming Interfaces) to access the data for users with diferente degree of sophistication
Data Centre Module: Data Architecture

Data Architecture
Microservices-based (API-first approach)

Software Packages
- Provide easier and concentrated access to APIs
- Provide access to data and to common operations
- For most common data science programming languages R & Python
- Open source
- Chronological Synchrony

Microservices (via API)
- Flexibility, scalability, performance
- Access and common operations (run close to data)

APIs (Application Programming Interfaces)
- Provide access to data (in a structured and safe manner)
- Preserve data integrity
- Provide scalability
- Enable automation
- Increase availability
- Increase efficiency

AIRCentre data lake (TERINOV etc.)

Web interface
- Available to any web user
- Complete catalogue

Human entry point
Machine entry point (Apps, AI, ML)

Other data
The Application Module is a set of software tools that processes all space and in-situ data with mathematical models, Artificial Intelligence algorithms and Big Data Science to produce the required output for services in the following five domains:

- Urban Planning
- Water Quality and Scarcity Monitoring
- Urban Air Quality Monitoring
- Waste Management (detection and control of garbage dumps)
- Vulnerability to Natural Disasters
The Urban Planning Application shall be able to provide as minimum the following services:

- Monitor urban sprawl and peri-urbanization processes
- Support updated urban cartography
- Detect illegal construction
- Identify risks in new populated areas
- Identify new settlements
- Report land-use activities
- Management of urban green areas
- Management of urban water bodies
The Vulnerability to Natural Disasters Application shall be able to provide as minimum the following services:

• Detection of areas vulnerable to flooding, sea level rise or other natural hazards

• Alert of extreme weather events (storms, hurricanes, typhoons, …)

• Detection, monitoring and evaluation of:
  • Fires
  • Tsunamis
  • Volcanoes eruptions
  • Earthquakes
The Capacitation and Training Module shall provide the following functionalities:

- Training Curse to the operators of the Direct Receiving Antenna such that they can be autonomous in the reception of satellite data (5 to 10 operators)
- Capacitation Course to a set of selected analysts in the use of data from Earth Observation satellites and the techniques of Remote Sensing (20 experts)
- Training Course to several experts in each of the selected application domains such that they can autonomously generate the final products and services (25 experts)
Conclusions and Proposals
• Sustainable urban development (SDG 11) presents important challenges that can be mitigated by using new scientific and technological tools.

• The AIR Centre proposes to the UN CSTD the development of a pilot project called “Space Data System for Sustainable Urban Development” to help achieving the sustainability goals by using data from four different types of satellites combined with in-situ data, Artificial Intelligence algorithms and Big Data Science.

• This project requires the development of five different modules, from the construction of a Direct Receiving Antenna down to the capacitation and training program to deliver products and services for five different types of applications: Urban Planning, Water Quality and Scarcity, Urban Air Quality Monitoring, Waste Management and Vulnerability to Natural Disasters.