

# Indices for Enhancing City Sustainability

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# Outline

- Introduction
- Sustainability indices
- Implementation of Territori Aperti
- Discussion and Future Works

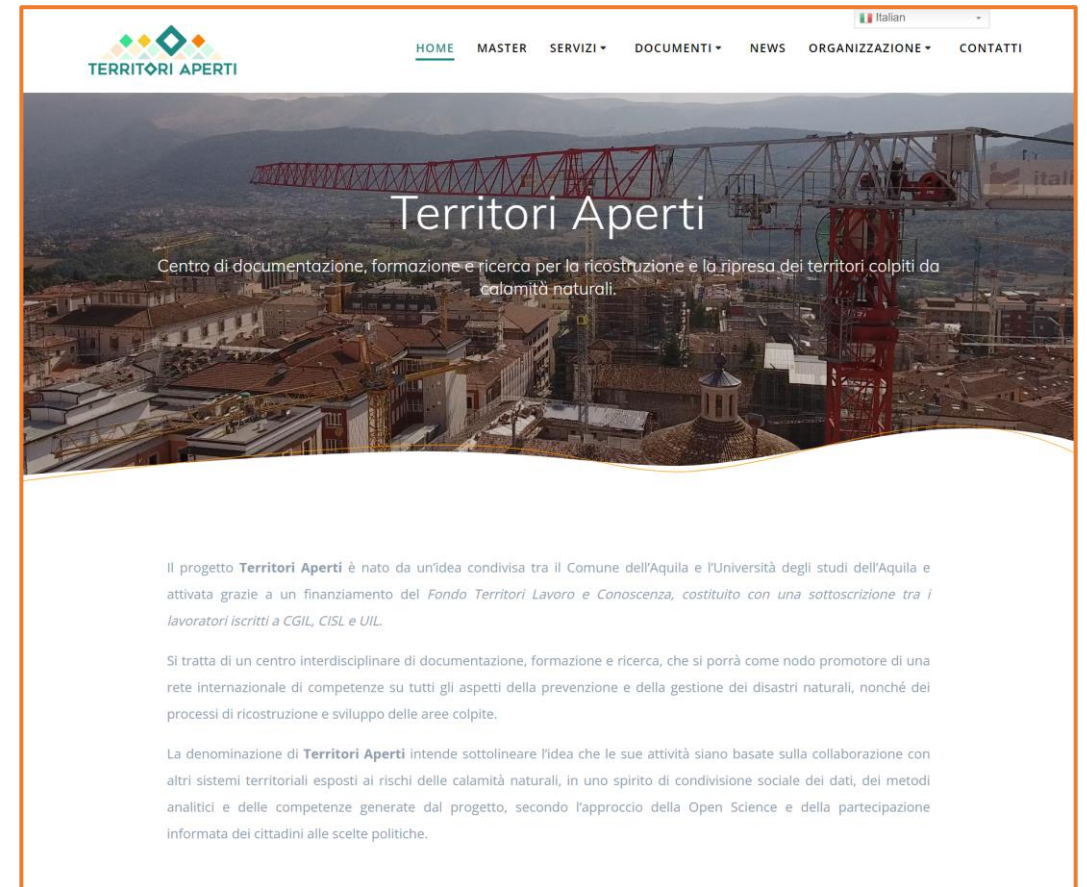
# Introduction and motivation

- City sustainability is becoming paramount to improving citizens' well-living.
- A data-driven monitor of the city life could be a building block to improve sustainability especially during disaster recovery.
- For this reason, in the *Territori Aperti* project we are working on developing a set of City Sustainability indices



# The *Territori Aperti* project

- This work has been conducted under the *Territori Aperti* project
- *Territori Aperti* is a documentation, training, and research center for sustainable territorial management with a particular focus on disaster recovery



# City Sustainability

- City sustainability can be approached from many points, which can be grouped in two macro-categories:
  - **Social sustainability:** focus on the wellness and well-living of the population
  - **Environment sustainability:** focus on the quality of the environment
- Each point of view must be measured properly and summarized by a relative quality index
- Collecting these indices, we can have a quantitative overview of the *city sustainability*

# Sustainability Indices

## Environmental sustainability

- **Air Quality**
  - Measures the amount of pollution in the air

## Social sustainability

- **Walkability**
  - How suitable a road is for the passage of pedestrians to move from one point of the city to another
- **Accessibility**
  - How local-level public services are accessible to pedestrians

Air Quality + Walkability + Accessibility = **City Sustainability Index**

# Indices implementation at Territori Aperti

- These indices can be implemented leveraging on AI and ML techniques since:
  - A huge amount of data is available free of charge
  - The application of AI and ML techniques enable revealing patterns across different heterogeneous data types (e.g., Earth Observations (EO) and in-place measurements).

Open Data allows us to overcome the infrastructural problems in case of natural disasters and to re-use resources already available, increasing the sustainability of the system

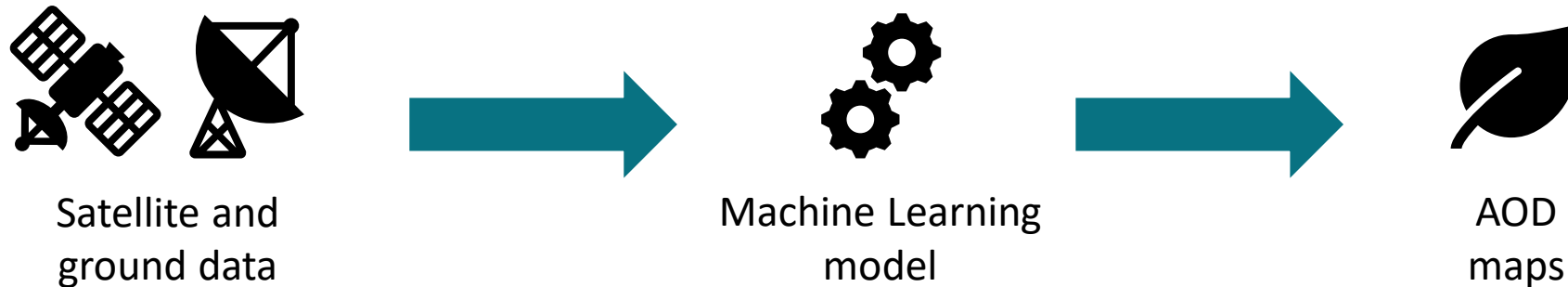
# Air Quality Index

- Air quality can be measured observing the daily variation of aerosols in urban or semi-urban environments
- **Aerosol Optical Depth parameter (AOD)** is a measure to assess the variation of aerosols, hence can be an indicator of air quality
- In place observations are the best way to compute AOD, however we are not able to observe spatial variation of parameters.



# Air Quality Index implementation

- For this reason, we developed a ML model to estimate AOD maps starting from satellite observations and ground measurements



- The results can be compared with the ones measured by in-place stations using the Root Mean Squared Error and the coefficient correlation as correctness metrics.

# Walkability Index

- In our context, Walkability of roads can be evaluated in two ways:
  - **Subjective:** perception of physical and social security and the aesthetics of the urban landscape of the road.
  - **Objective:** presence of sidewalks and obstacles, width, tortuosity, slope, and level of maintenance of the streets.
- Both aspects have been evaluated by citizens with a value from 1 to 5 to each road or portion of street.
- We developed a predictive model that, given as input the evaluations, the air quality index, roads shapefiles, satellite images of the involved areas, and a graph of roads predicts the same value from 1 to 5.

# Accessibility Index

- Same as Walkability, Accessibility is evaluated in a two ways:
  - **Subjective:** perception of physical and social security, and infrastructure degradation
  - **Objective:** presence of bus stops, parking lots, architectural barriers, and the level of service's access maintenance
- Both factors have been evaluated by citizens with a value from 1 to 5 to each infrastructure
- We developed a predicted model that, starting from the same values of Walkability, predicts the same values from 1 to 5

# Discussion and Future Works

- City Sustainability can be defined as the sum of Air Quality, Walkability and Accessibility indices.
- We implemented ML models to predict such indices relying on open data to overcome the infrastructural problems in case of natural disasters and to re-use resources already available.

## **Future Works in *Territori Aperti***

- Create a City Sustainability Index comprising all the indices described above.
- Create a dashboard showing all these sustainability indices, in an easy and informative way, both to the institutions and to the population.

# Thank you for your attention!

This work originates from the HACK@EO L'Aquila 2021 hackathon (<https://hackat.it/hackat-eo-laquila-2021/>, <https://territoriaperti.univaq.it/hackeo-laquila-2021-city-sustainability-indices-for-citizens/>), organized by Territori Aperti and Open Search Tech in collaboration with ESA (European Space Agency), AIXIA (Associazione Italiana per l'intelligenza artificiale) and GMatics.