Cities facing environmental issues: the Snap4city approach

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DISIT lab roadmap vs model and tools' usage

2013
Km4City Ontology 1.1

- Tuscany, Road Graph
- Mobility
- culture, tourism
- Events
- Parking
- Services
- Linked open graph

2014
- Weather Forecast
- Real Time Wi-Fi
- Entertainment
- LOD

- Twitter Vigilance
- Social Media Analytics, Sentiment Analysis

Km4City 1.4

2015
Km4City 1.5

- Resilience Decision Support
- Smart First Aid
- User Behaviour Analysis, predictions
- Risk Analysis

ckan resolute H2020 (2015-18)

2016
(2016-21) H2020 REPLICATE

- Smart Energy
- Sustainable Mobility Control Room Dashboard

Km4City 1.6.2

Sii-Mobility (2016-21) MIUR
SII-MOBILITY SCN

- Infomobility
- Mobile App
- Routing
- Multimodality

FIWARE

Km4City 1.6.4

Sii-Mobility

- Origin-Destination and trajectories
- Traffic Reconstruction
- Offer Analysis
- OBU, smart devices

E015 digital ecosystem Powered by EXPO MILANO 2015

(2016-19) MIUR
GHOST SIR

- Sardinia Region Smart City Strategies and plan

GREEN IMPACT C.A.P.A.C.I.T.Y.

2017
GREEN IMPACT
POR FESR 2014-2020

- Industry 4.0
- Critical Plant
- Monitoring

- IOT/IOE, IOT App
- Living Lab
- Maker Support
- IOT Edge
- Smart City IOT
- GDPR,
- Privacy & Security

life weee (2017-20)

- Smart Waste

2018
MOSAiC MObility 4.0 for SmArt (i) City (2018-20)

- Mobility Demand / Offer Analytics and Strategy

Sii-Mobility

- User engagement
- Bike Sharing
- Data Analytics ++
- Social Predictions
- OBD2

IOT/IOE

Km4City 1.6.6

Node-RED

SNAP4CITY SELECT for Cities H2020 (2017-19)

bee smart city

- Smart Lonato

Reverberi Enetec Gruppo MPES

5G (2018-21)

- 5G tech
- Energy
- Industry 4.0
- Synoptics

TRAFAIR CEF (2018-21)

- Traffic and Mobility Impact on Pollution
- NOX predictions

2019
EUROPEAN OPEN SCIENCE CLOUD

SIRIUS

LAID Smart Bed

- Smart Health

GREEN FIELD PEAS Soda4.0 Optimization and Automated Decision System 4.0

- Industry 4.0

- PCP Award

SELECT for Cities 1° place award to SNAP4CITY

2020
…2022

2021
- CAPELON
- Sweden

smartGARDAlake

Interreg MARITTIMO-IT FR-MARITIME MOBI MART

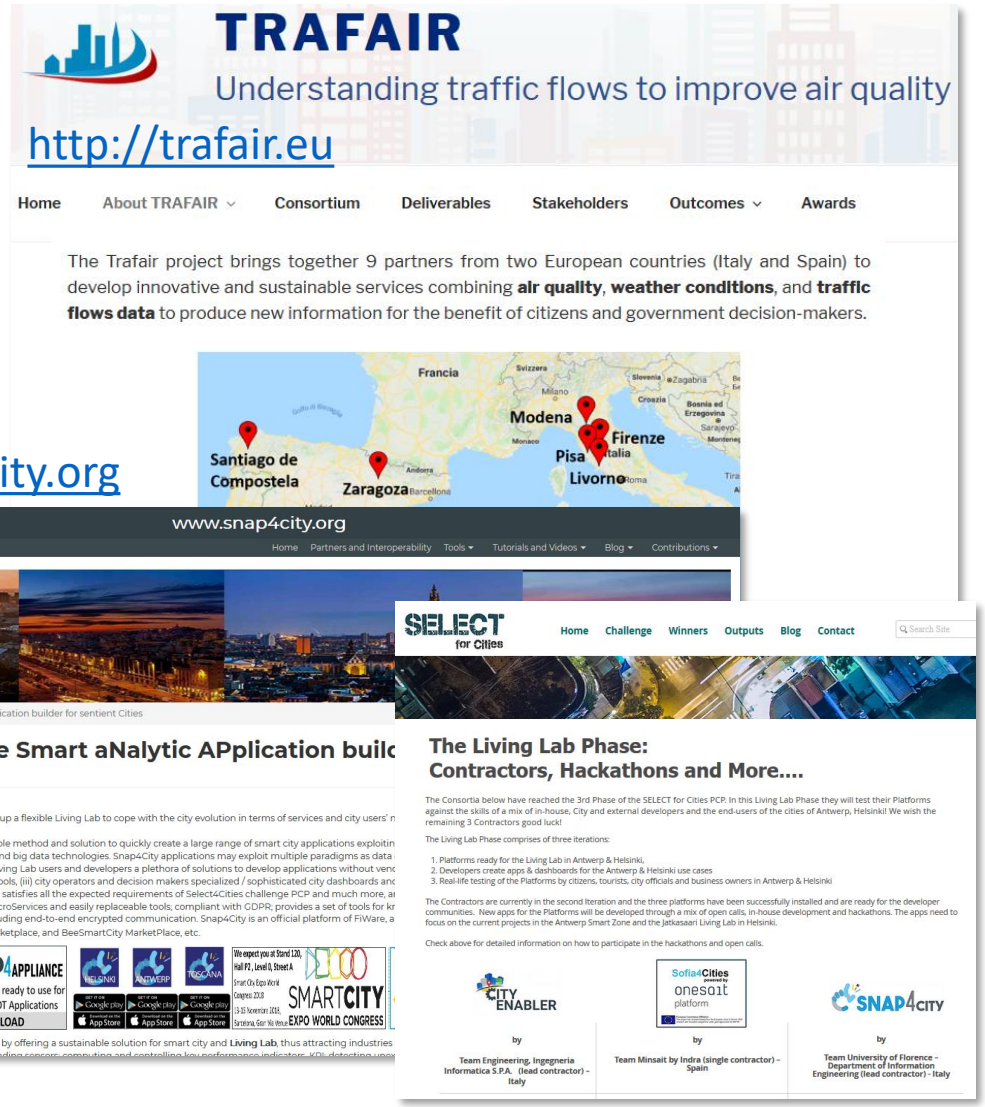
- Smart Mobility
- PISA, PUMS
- Living lab

Interreg Mediterranean HERIT-DATA

- Smart Tourism
- 6 Pilots
- Data Analytics
- Extended platform

National and EU projects

- Connection among pollution and air quality TRAFAIR possible thanks to:
  - Traffic model (real-time data) developed in the Sii-Mobility context
  - Snap4City infrastructure
  - Km4City model and tools in several cities of the European area



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https://www.select4cities.eu

Smart and Sustainable Cities Needs

- A Smart and Sustainable City is an innovative and human-centered city that tries to achieve the fusion of two **urban development** strategies with a greater respect for the **environment:**
  - achievement of sustainability
  - pursuit of smartness with the potential of ICT in order to provide the technological infrastructures, solutions and approaches needed for improving the quality of life
- City decisionmakers are increasingly oriented to use technology as a support for urban planning and to provide real time services allowing immediate and direct exchanges with citizens
- These issues are reflected in the Sustainable Development Goals (SGD) of the United Nations' 2030 Agenda for Sustainable Development

Smart Sustainable Cities: Big Data Solutions

- Big Data Solutions for the management of smart cities must:
  - be integrated in every aspect of city life
  - provide services for all the different types of users, starting from urban planners to tourists, commuters, students, citizens, etc.
  - preferably be adopted in other Smart Cities to allow the comparison with guidelines and solutions already widely discussed and approved
  - capable to ingest and analyze data coming from sensors (IoT/IoE), along with all the geospatial, political and social information

TRAFAIR: Relate Level of pollution to air quality

- http://trafair.eu INEA CEF, TELECOM PROJECT
- Problem to be solved:
  - **How much pollution affects the quality of the air that citizens breathe to properly regulate urban mobility** and give to all the **awareness** that they are living in a city that is increasingly technological and oriented towards focusing **on the health** of its citizens
- Cities involved:
  - Tuscany: Firenze, Pisa, Livorno
  - Emilia Romagna: Modena
  - Spain: Santiago de Compostela, Zaragoza

TRAFAIR
Understanding traffic flows to improve air quality

Snap4City Big Data Platform

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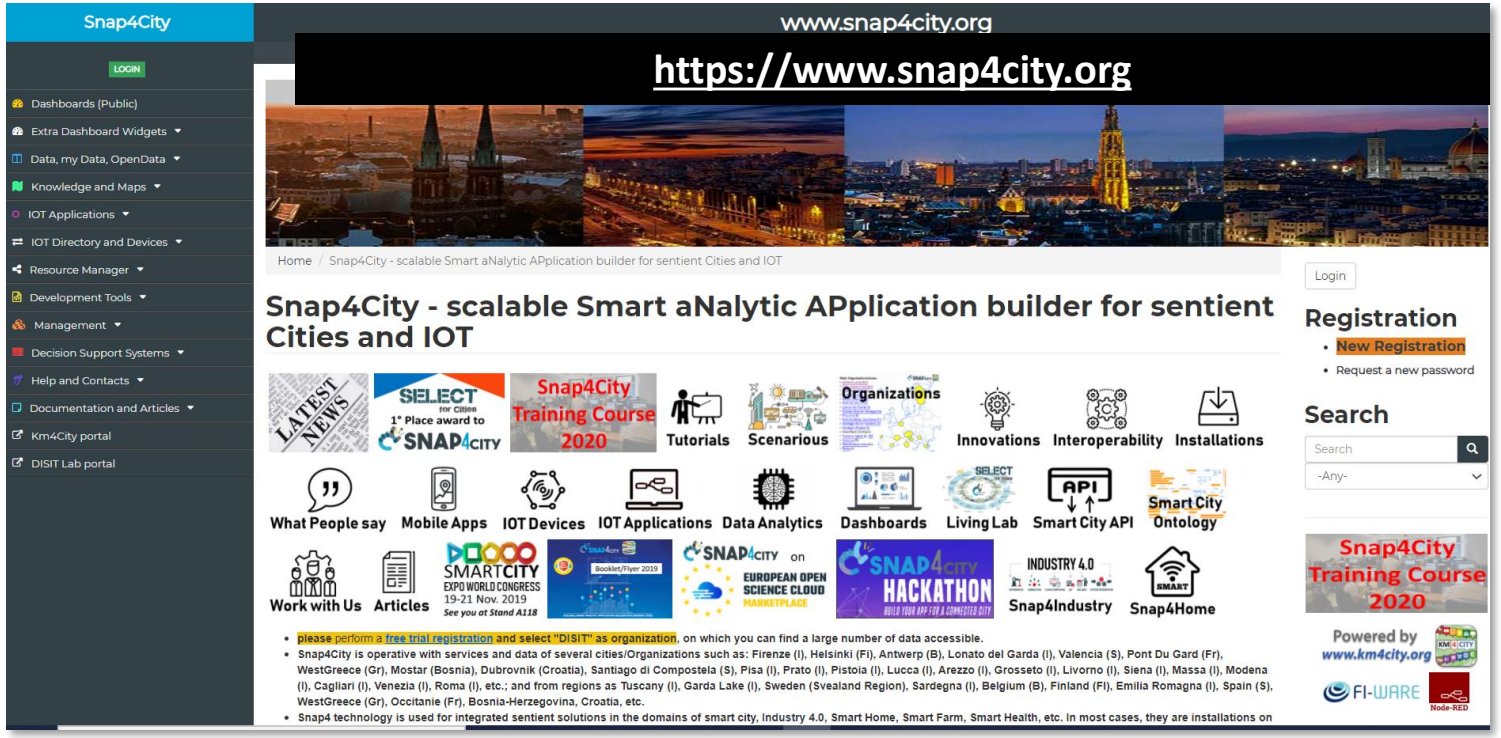
- Snap4City has been considered as the Big Data infrastructure starting point, both in terms of:
  - services provided
  - the reusable data necessary to reach the goal



- Snap4City semantically aggregates many different types of data coming from different European Smart Cities (and covering the area around them):
  - Florence, Pisa, etc. (all Tuscany), Helsinki (Finland), Antwerp (Belgium), Cagliari (Sardinia), Garda Lake, Venezia, Bologna, Valencia, Pont Du Garde, Dubrovnik, WestGreece, Mostar, etc.
- Snap4City semantically aggregates data in compliance with the smart city ontology KM4City

Snap4City BigData Metodology

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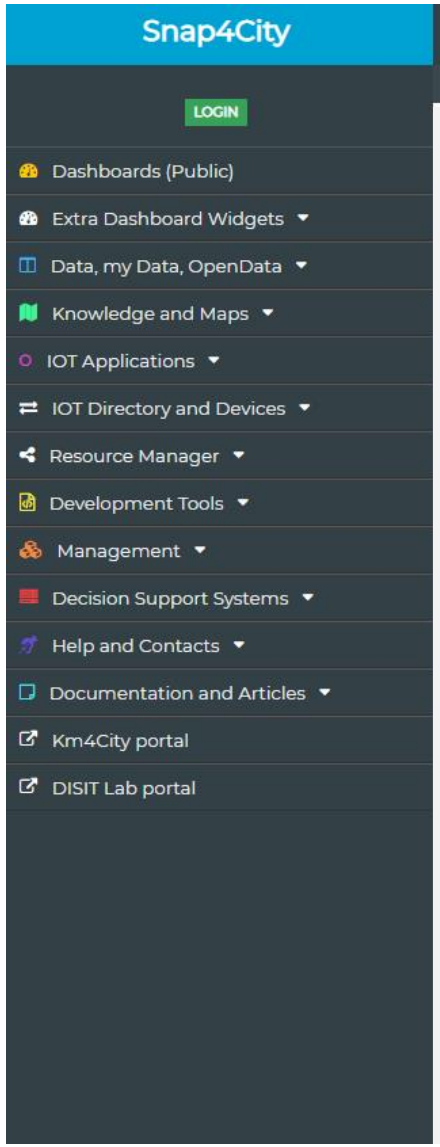
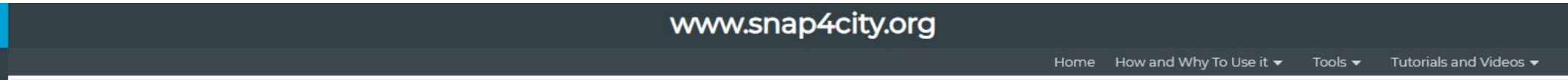




1. Snap4City methodology starts with the context analysis and the study of the goals to be reached to make the city smart and sustainable (Living Lab Support and co-working):
   - which are the main relevant aspects decision-makers want to keep under control?
   - which are the available resources?
2. The next step is the available data analysis:
   - Who are the city providers?
   - who collaborate with the municipalities by providing public or private services?
3. Data gathering and data aggregation in the Snap4City Big Data Platform, according to the objectives outlined in the first phase
4. Data analytic processes to production smart services

Snap4City Functional Architecture

Transport systems Mobility, parking

Public Services, Govern, events, …

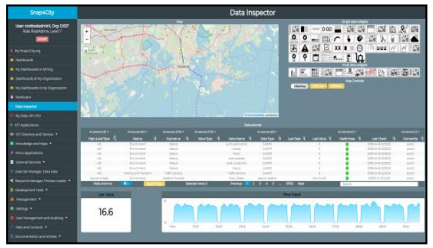
Sensors, IOT Cameras, Wi-Fi

Environment, Water, energy

Shops, services, operators

Social Media

Social Media Crawler and Manager



Back-End ← → Front-End

Data Sources, External Services *PULL Data*

Data Sources, Brokers, External Services *Data Driven, Real Time*

Data Ingestion, aggregation, regularization, reconcile: NIFI, IOT App

Knowledge base Semantic reasoners

Indexing and aggregating Elastic search

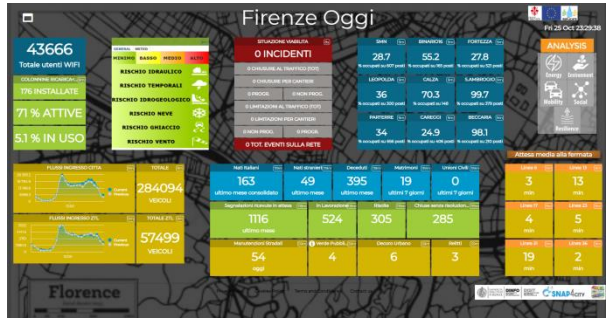
Search and Query, Smart City API Facet, semantic search

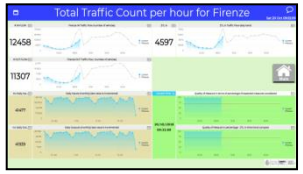
Data Analytics, Simulations R, Tensor Flow, Python, ….

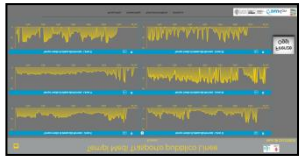
IOT Applications, Business Logic Node-RED + Snap4City MicroServices

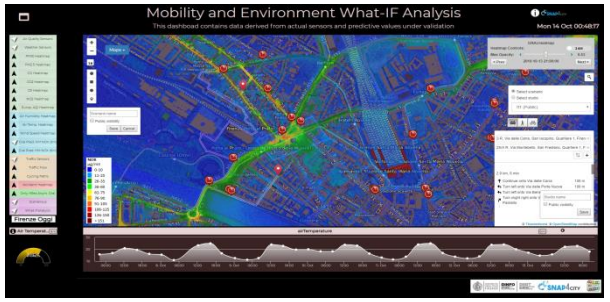
Rendering Acting, Widgets, MicroApps User interface, Interactive Dashboard, Drill down, maps, heatmaps

Inform, announce, Act!, warning, alarms, What-IF, ..









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Florence Scenario

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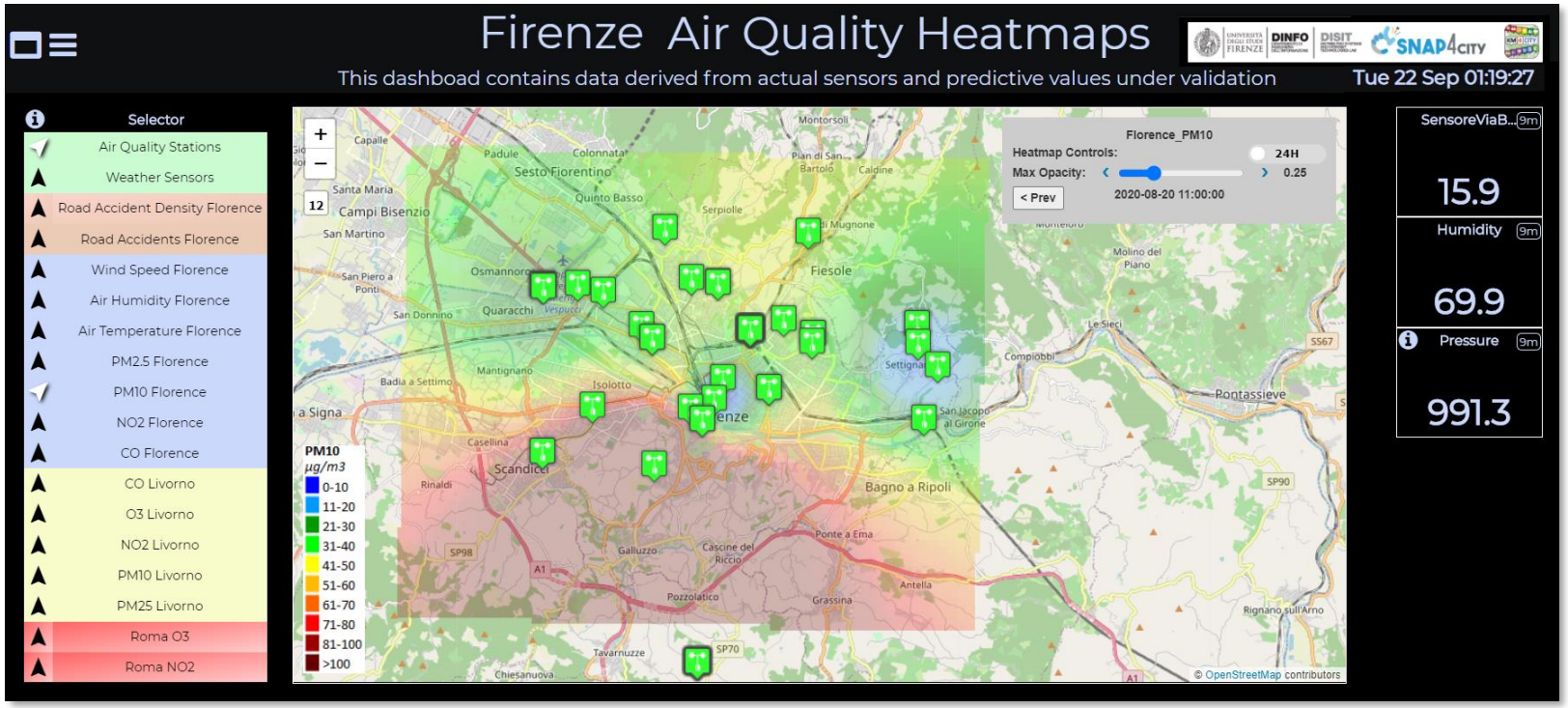
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTI2OA==

- Data comes from:
  - air quality stations (Agenzia Regionale Protezione Ambientale Toscana, ARPAT)
  - “AirQino” air quality low-cost sensors, (CNR IBE)



- Results obtained:
  - Algorithms to estimate heatmaps for each pollutant on PM10, PM2.5, NO2, CO, humidity, air temperature
  - Algorithms to obtain the European Air Quality Index, EAQI, based on the European Environment Agency guidelines the quality of air: index from 1 to 5 indicating air quality (good, fair, moderate, poor and very poor)

https://www.snap4city.org/drupal/node/508

Helsinki Scenario

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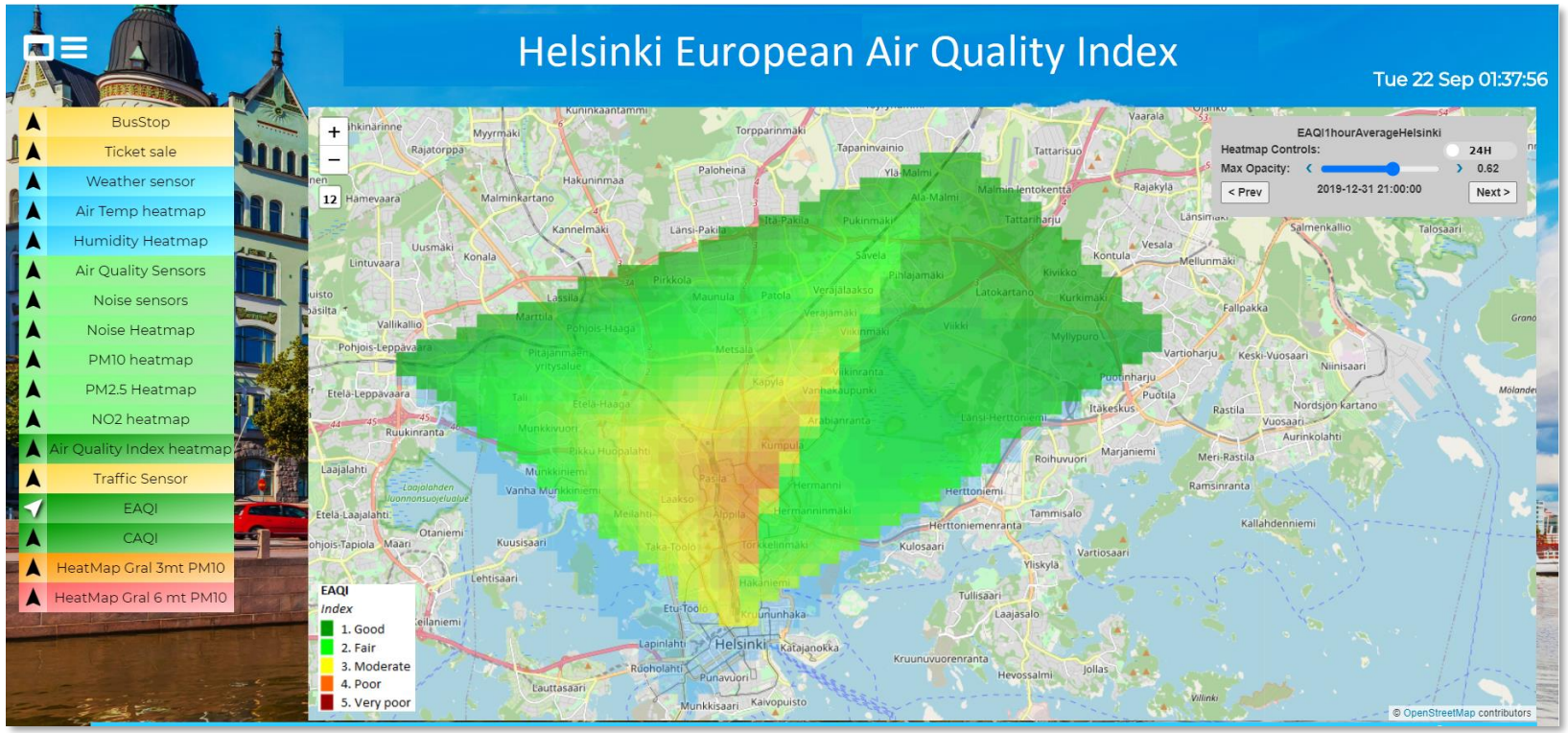
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTY4Ng==

- Data comes from:
  - about 25 AQ Burk low-cost installed by Forum Virium Helsinki (campaign to involve citizens in monitoring the air quality level)



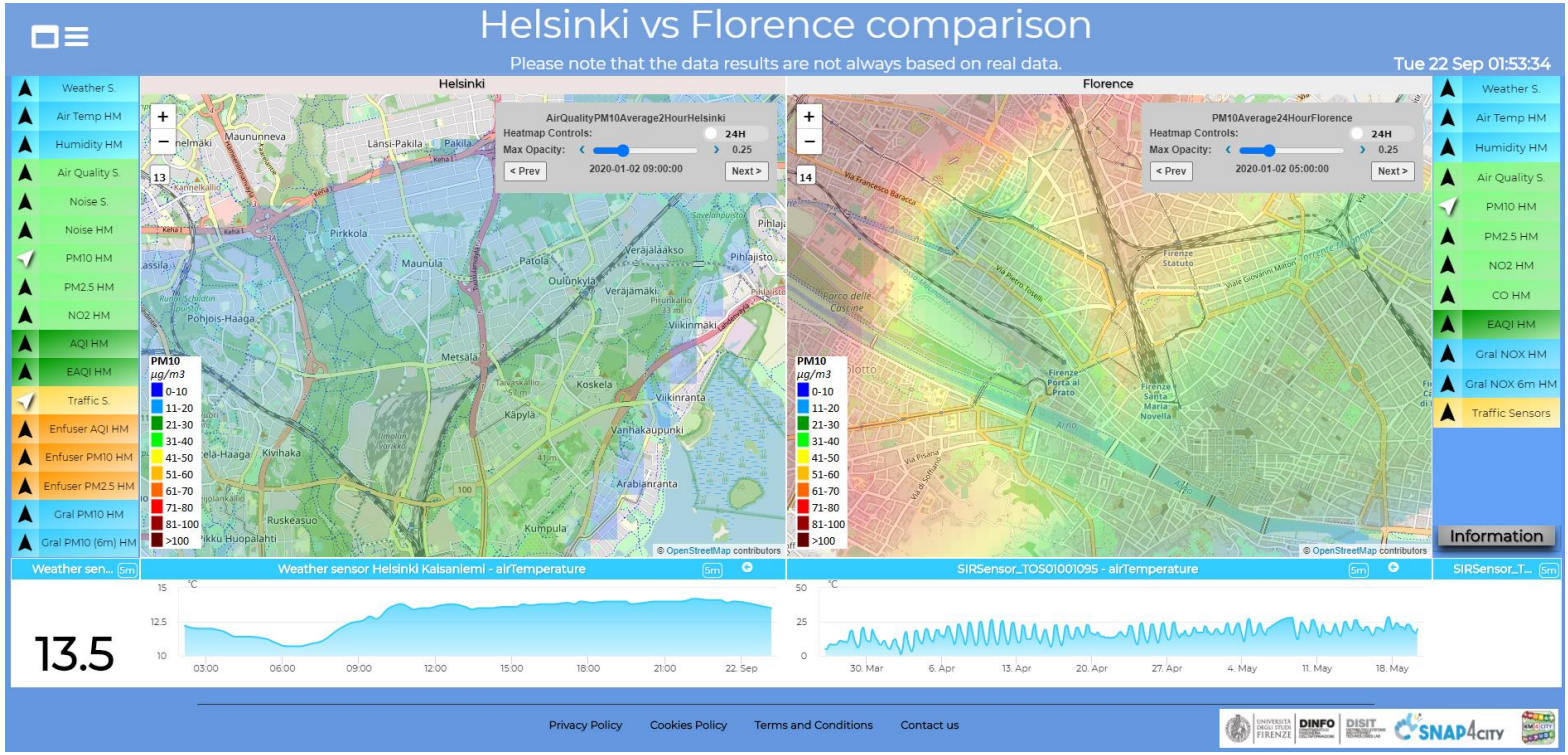
- Results:
  - Algorithms to estimate heatmaps for each pollutant on PM10, PM2.5, NO2, AQI, humidity, air temperature
  - Algorithms to obtain the European Air Quality Index, EAQI, based on the European Environment Agency guidelines

https://vekotinverstas.fi/aqburk

Helsinki and Florence: PM10 comparision

- Heatmaps are computed using a bilinear interpolation (Akima method) which consists of:

1. triangulation of the x-y plane
2. selection of several data points that are closest to each data point (sensor) and are used for estimating the partial derivatives
3. organization of the output with respect to triangle numbers
4. estimation of partial derivatives at each data point
5. punctual interpolation at each output point



- The z value of the function at point of coordinates (x,y) in a triangle is interpolated by a bivariate fifth-degree polynomial in x and y

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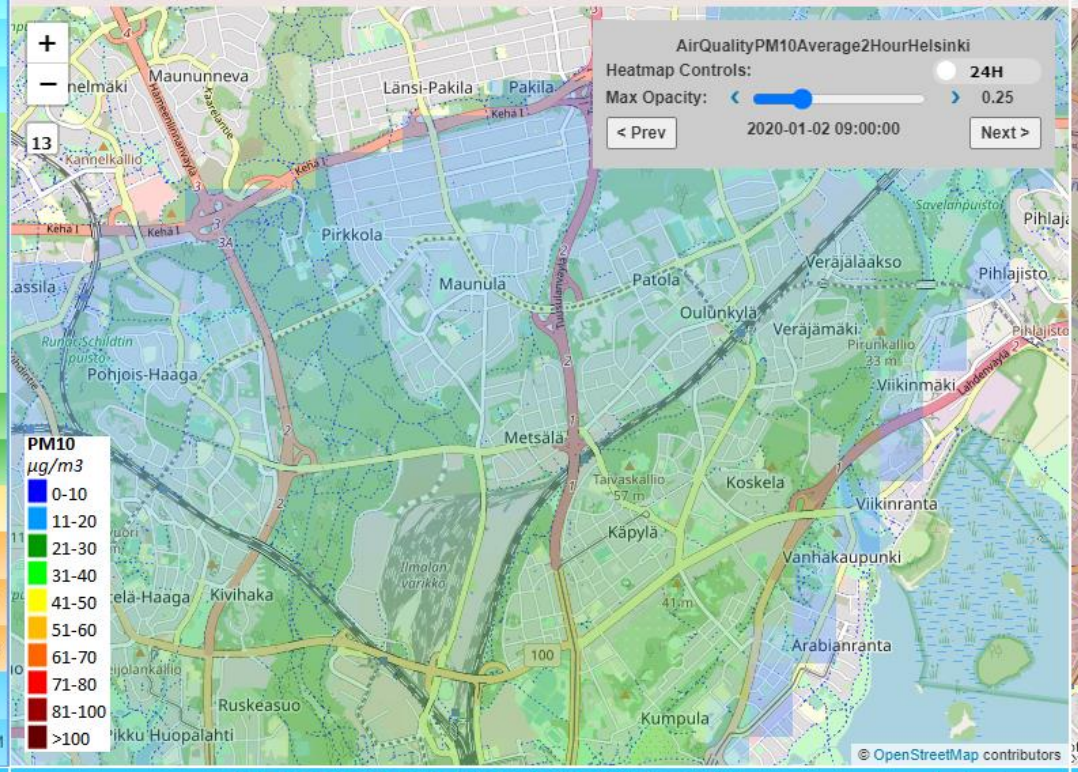
Helsinki vs Florence comparison

Please note that the data results are not always based on real data.

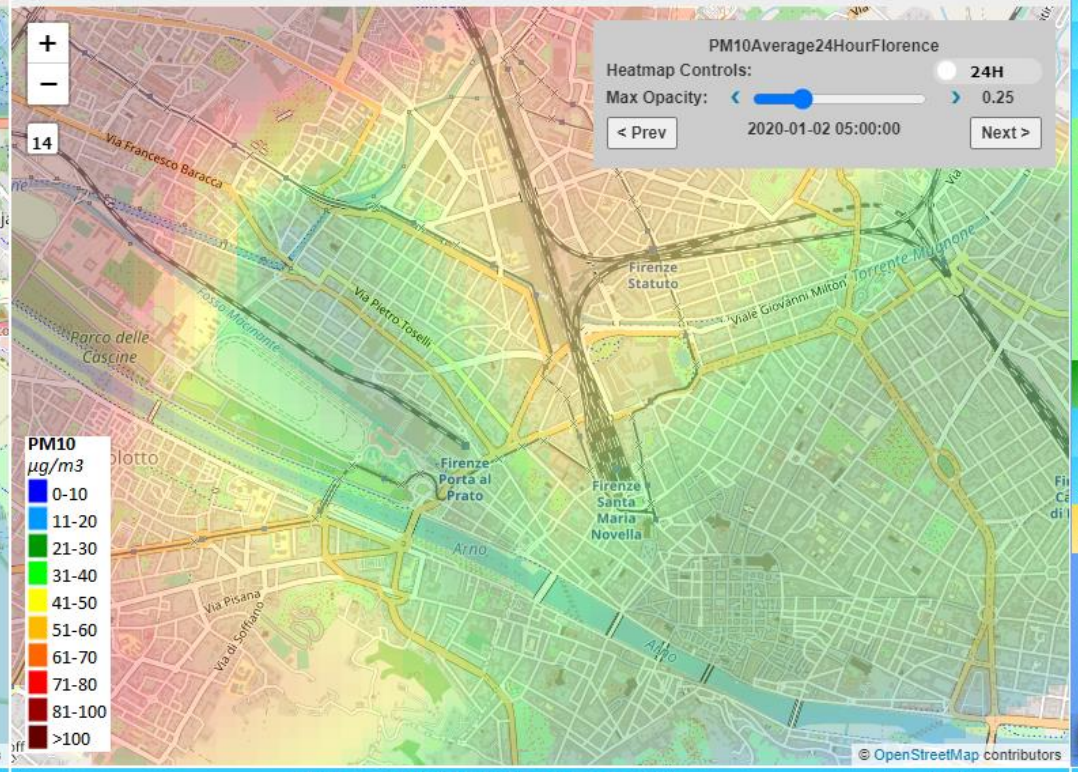
Tue 22 Sep 01:53:34

- Weather S.
- Air Temp HM
- Humidity HM
- Air Quality S.
- Noise S.
- Noise HM
- PM10 HM
- PM2.5 HM
- NO2 HM
- AQI HM
- EAQI HM
- Traffic S.
- Enfuser AQI HM
- Enfuser PM10 HM
- Enfuser PM2.5 HM
- Gral PM10 HM
- Gral PM10 (6m) HM

Helsinki



Florence



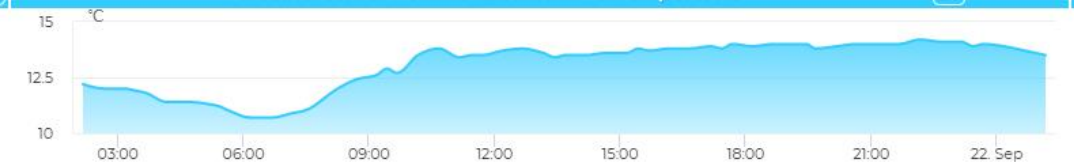
- Weather S.
- Air Temp HM
- Humidity HM
- Air Quality S.
- PM10 HM
- PM2.5 HM
- NO2 HM
- CO HM
- EAQI HM
- Gral NOX HM
- Gral NOX 6m HM
- Traffic Sensors

Information

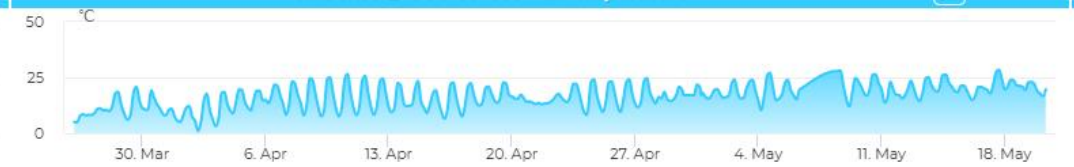
Weather sen... 5m

13.5

Weather sensor Helsinki Kaisaniemi - airTemperature 5m



SIRSensor_TOS01001095 - airTemperature 5m



SIRSensor_T... 5m

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Conclusions

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- Snap4city architecture, through experimentation conducted in different urban areas, highlights a paradigm shift:
  - it does not adopt an approach simply driven by technology but more specifically **driven by data**
- Big Data, open data, sensors, IoT, IoE for monitoring, controlling and managing urban developments, resources, urban infrastructure, energy consumption, traffic congestion, waste, pollution, risks and people, etc. are the **tools for governance and urban planning**, for which the expected changes are a consequence of a decision-making process based on the data

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