CITI-SENSE Citizens' Observatory Products and Tools for Air Quality Studies in Cities

IoT Week Belgrade

Session #A3 "IoT applications"

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CITI-SENSE project
Grant agreement nº: 308524

Development of Sensor-Based Citizens' Observatory Community for Improving Quality of Life in Cities

CITI-SENSE consortium

EU FP7-ENV-2012 Grant agreement nº 308524

INTRODUCTION

Air pollution stems from both anthropogenic and natural emissions that undergo further changes in the atmosphere.

It is a mixture of mixtures, not constant in level and composition, varies through space and time.

To warn against the harmful consequences of exposure to main pollutants WHO in 2006 established air quality guidelines.

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INTRODUCTION

- ✓ A decade after, air pollution is the single largest environmental health risk in Europe (EEA, 2015)
- ✓ Premature death, attributable to air pollution, happen mostly due to heart disease and stroke, followed by lung diseases and cancer, WHO (2014).
- ✓ In addition, air pollution is associated with increase in incidence of numerous additional diseases.
- ✓ The International Agency for Cancer Risk - IARC designated outdoor air pollution as a Group 1 carcinogenic substance, i.e., proven human carcinogen (IACR, 2013) .
- ✓ Respirable Particulate Matter - RPM mixture was evaluated separately and also classified as carcinogenic to humans, Group 1 (IACR, 2013).

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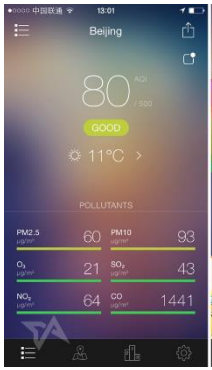
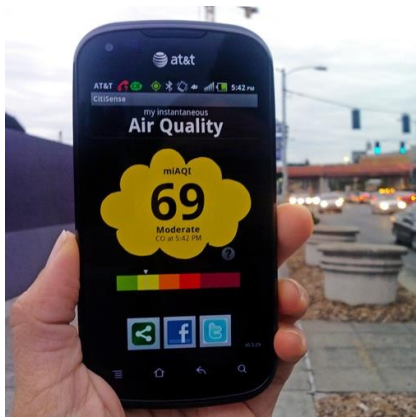
Estimation of AQ in European cities and information for public

Numerous publications estimated that level of regulated air pollutants in most European cities are far above the air quality guidelines values (EEA, 2015). As such, citizens are at risk to be exposed to potentially harmful levels of air pollutants.

More and more cities provide timely air quality information to the public through printed and electronic media including web pages and mobile apps





Question: How useful are such information ?

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Air quality data at individual level is still a rarity

- ✓ The information on the AQ and related hazards is currently mostly generic, and seldom personally relevant.
- ✓ It would be necessary to offer information to a person about AQ level in microenvironment, on the route and what does that mean for her/him.
- ✓ Ultimate importance for citizens to recognize the problem and to change behavior related to their contribution and their exposure to air pollution.

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The CITI-SENSE project aim

To develop a mechanism through which the public can easily be involved, a set of Citizen's Observatories (CO).

- ✓ *Using a combination of citizen science and environmental monitoring approaches, we have developed technological tools for public involvement*
- ✓ *We are testing these tools to investigate their potential for a large scale public use.*

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THE CITI-SENSE CONCEPT

CITI-SENSE is developing "citizens' observatories" to:

- ✓ *empower citizens to contribute and participate in environmental governance*
- ✓ *enable them to support and influence community and societal priorities and associated decision making.*

The concept of CITI-SENSE rests on three pillars:

(i) *technological platforms for distributed monitoring;*

(ii) *information and communication technologies;*

(iii) *societal involvement*

Three multi-center case studies focus on a range of services related to environmental issues of societal concern:

- *combined environmental exposure and health associated with ambient (outdoor and indoor) air quality,*
- *noise and development of public spaces,*
- *and indoor air at schools.*

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Outline

1. What is COT?
2. What does COT do?
3. Who is COT aimed at?
4. How does COT work?
5. What is innovative?
6. How open is COT?

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What is COT?

- Tools developed from CITI-SENSE project
- Can access via **http://co.citi-sense.eu**

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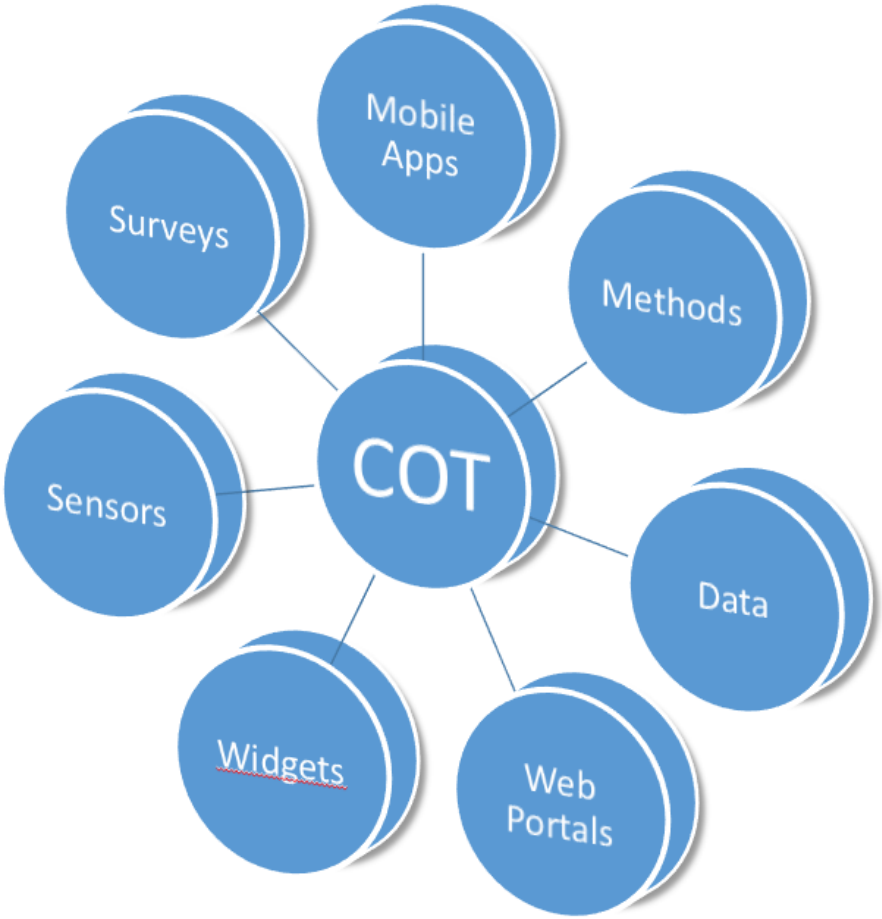
What does COT do?

- To support anyone in designing, setting up and carrying out their own Citizens' Observatories



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Citizens' Observatories Toolbox

http://co.citi-sense.eu/

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Who is it aimed at?

- Different stakeholders and end users
  - General citizens who is interested in AQ related environmental issues
  - Environmental NGOs
  - Authorities
  - Industries
  - Students
  - Teachers
  - Parents
  - School boards, etc.

In CITI-SENSE, we view COT as two perspectives on the same thing, i.e., as the head and the tail of a coin, the **Users' perspective** and **Developers' perspective**

- For different purpose, e.g., research, urban planning, environmental sensing, education, and citizen science related activities, etc.

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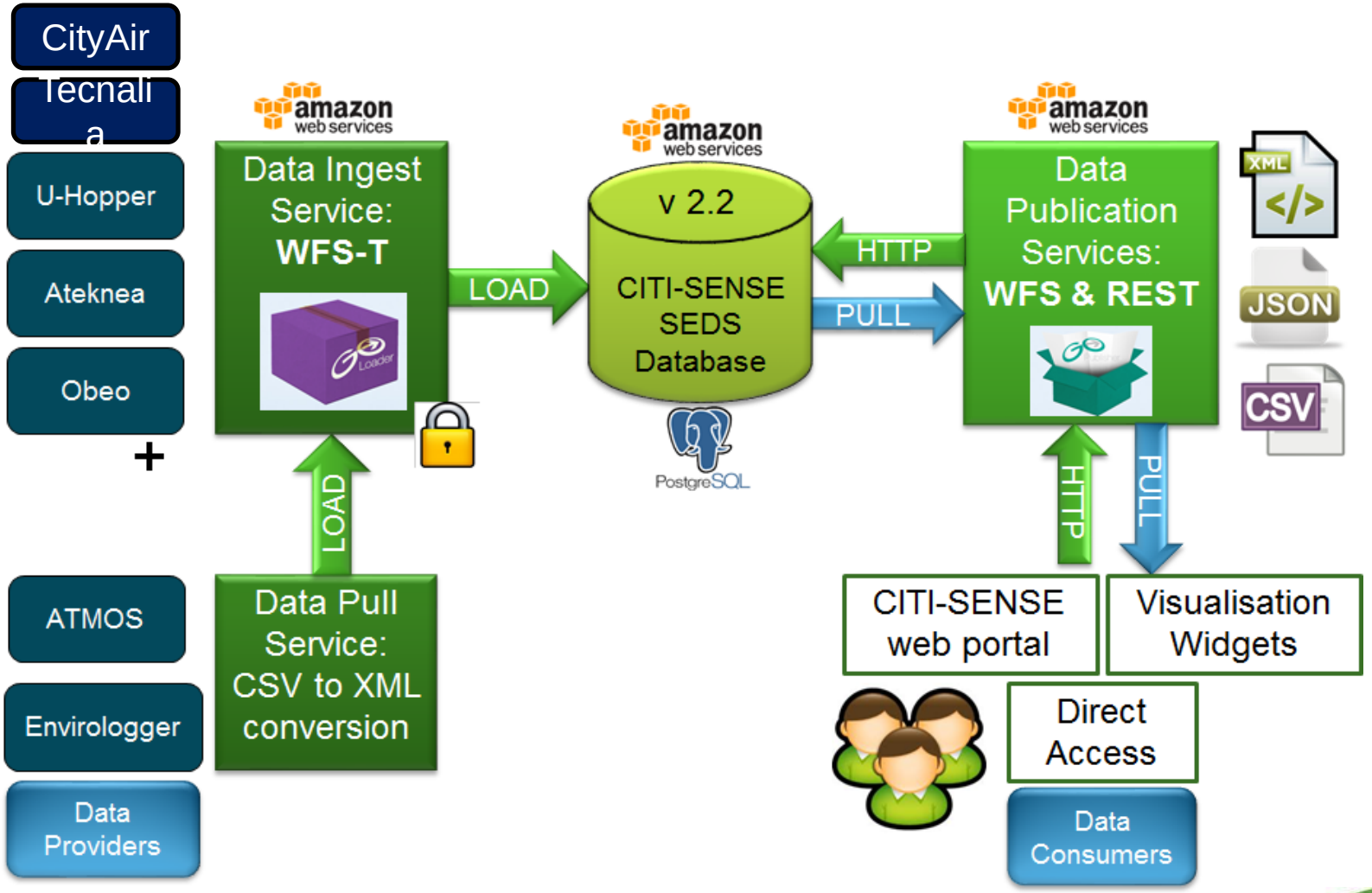
How does it work?



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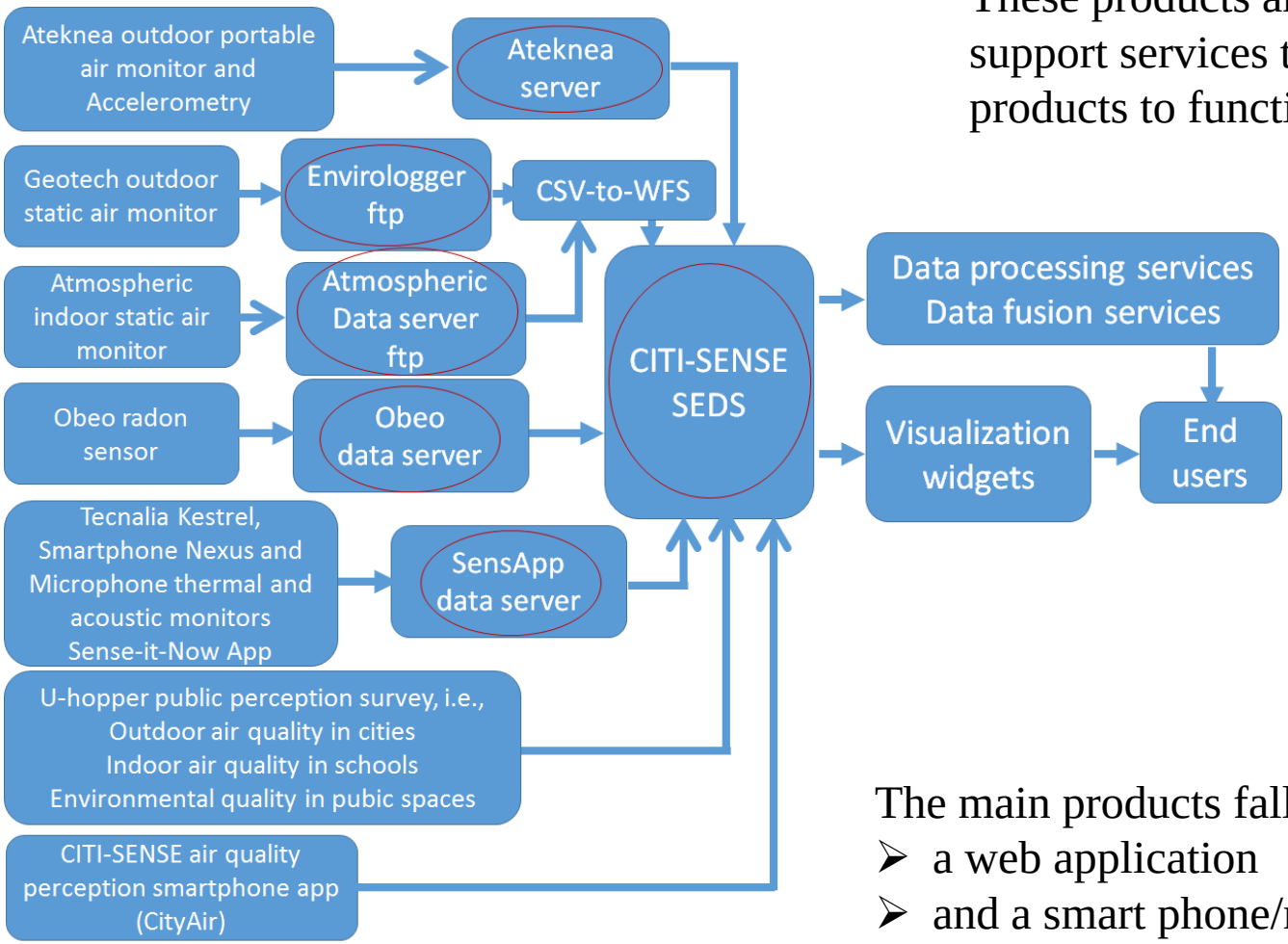
How does it work?

CITI-SENSE platform data flow



These products are building on the various support services that actually enable the products to function such as :

- ✓ sensor platforms,
- ✓ GIS,
- ✓ WMS,
- ✓ mathematical modeling

The main products fall into two basic types:

- ➢ a web application
- ➢ and a smart phone/mobile device application.

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What is innovative?

- Both theoretical and practical Citizens' Observatories implementation approach
- Innovative tools to monitor AQ, to process AQ information from and to citizens, and to improve AQ information and support a two-way interaction for developers/users

- Global competitiveness and strengthening GEOSS
- Social media platforms (Twitter, Facebook, LinkedIn, YouTube)

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How open is it?

- Data and information are open to everyone!
- Open source apps and widgets with good documentation for further use by SMEs
- Synergy and collaboration with GEOSS
  - Resources from the CITI-SENSE project are available in the GEOSS portal, which is the main entry point to Earth Observation data from all over the world.

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CITI-SENSE AMBIENT AIR QUALITY STUDY

There are two ways used for personal exposure assessment:

Direct assessment

A person carries a portable sensor device that detects concentrations and activity level while on move through the urban environment.

Indirect assessment

With application a network of static sensors distributed over the city. The sensor data is combined with statistical model using data fusion techniques, to provide air quality maps for the city for each hour with sufficient measurements. These maps can then be used to estimate individual exposure along a given pathway through the city

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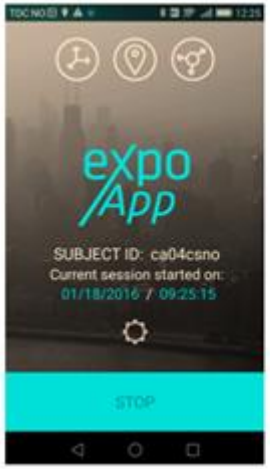
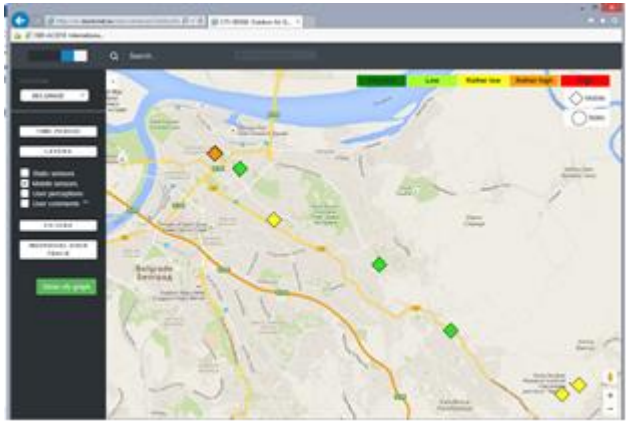
CITI-SENSE AMBIENT AIR QUALITY STUDY
Direct assessment





- ✓ Little Environmental Observatory - LEO (80x96x44 mm) with sensors for measuring NO, NO2, O3, t, RH.
- ✓ ExpoApp is a smartphone application for Android devices that communicates with the LEO sensor via bluetooth to read the data and upload it to Ateknea's platform. ExpoApp also collects information about physical activity by using the accelerometer already in the smartphone.
- ✓ The near-real-time and historical measured values of all mobile sensors in each of the cities are available on a web portal

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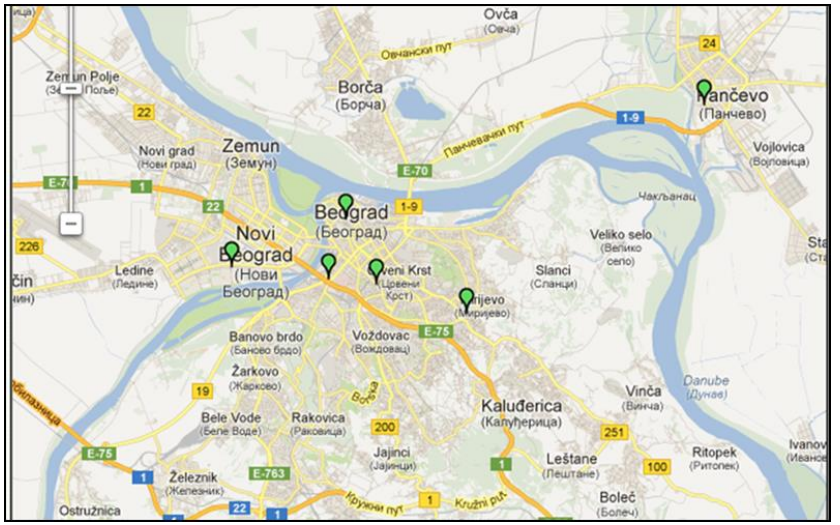
CITI-SENSE AMBIENT AIR QUALITY STUDY
Indirect assessment

- ✓ Current air quality monitoring networks aim at compliance monitoring and consist of a prescribed number of stations for selected locations.
- ✓ They employ rigorous standardized QA/QC protocols.
- ✓ These reference and equivalent ambient PM and gaseous monitoring units do not capture spatial gradients in the area for which they are representative, and cannot by themselves provide individualized personal information.



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CITI-SENSE AMBIENT AIR QUALITY STUDY

Indirect assessment

The low-cost sensors deployed with support of the CITI-SENSE project have a significant potential for improving high-resolution mapping of air quality in the urban environment.

The procedure of creating near-real-time maps consists of:

- ✓ Creation of a basemap that provides information about general spatial patterns:
- ✓ Establishing network of low-cost sensor that provide information about current status of atmosphere, air pollutants and meteorological parameters level, at sampling locations
- ✓ Fused map that is value-added product providing a best guess of current state of atmosphere for the entire domain.

Calibration of the static nodes in Belgrade was performed by co-locating with a reference instruments at an Automatic Monitoring Station (ATM) that is part of the state network run by the Serbian Environmental Protection Agency (SEPA).

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CITI-SENSE AMBIENT AIR QUALITY STUDY

Indirect assessment

- ✓ A static basemap is created for each city and each air pollutant of interest to show the long-term spatial patterns.
- ✓ For development of a basemap:
  - ➢ Dispersion model

    It is the best to use urban-scale dispersion model, as it is used for Oslo.
  - ➢ Land Use Regression (LUR)

    For most cities however, the detailed input information is not available, and Belgrade apply LUR modelling as an alternative technique.

- ✓ LUR is a statistical modelling technique used to spatially extrapolate concentration of air pollutant over limited observed area based on values of predictor variables. Underlying principle is that the concentration of air pollutants is strongly correlated to the predictor variables, and assumption that we know the values of predictor variables anywhere in the area of interest.

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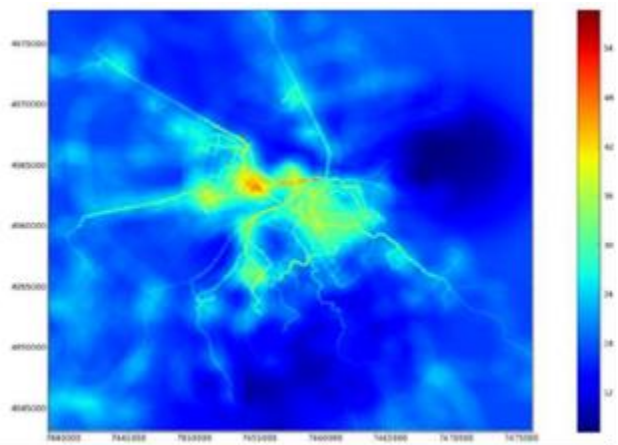
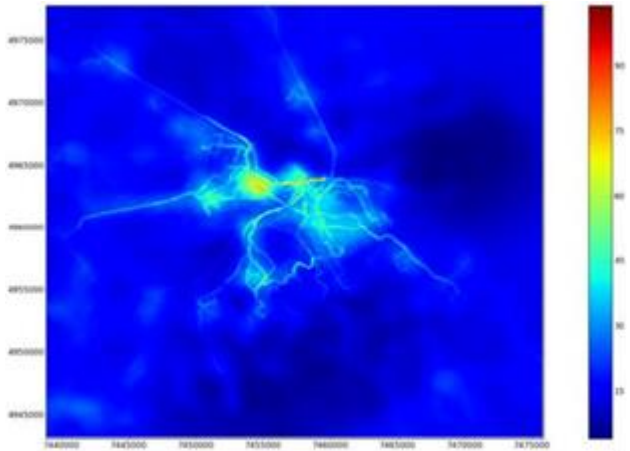
CITI-SENSE AMBIENT AIR QUALITY STUDY

Indirect assessment

- ✓ European multicity model, developed by Wang et al [2015], extended land use approach to model $PM_{2.5}$ and NO_2 pollutants for several European cities.
- ✓ This model was used to create basemaps over area of Belgrade Master Plan.
- ✓ LUR models often used to predict long-term average concentrations of air pollutants
- ✓ Figure presents an example of fused map for NO_2 over Belgrade Master Plan area, calculated data from Local monitoring network for NO_2 consisting of 14 sampling sites



Basemap for annual average of NO_2 over Belgrade Master Plan area



An example of NO_2 fused map for Belgrade

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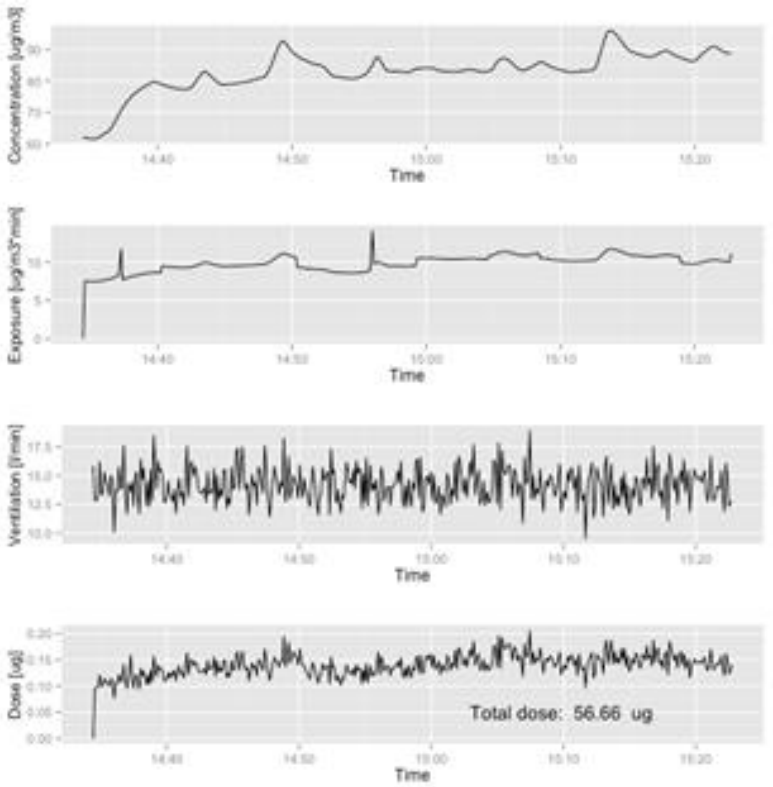
CITI-SENSE AMBIENT AIR QUALITY STUDY

Indirect assessment

Personal exposure and dose assessment according to observed and/or modelled concentration and approximated ventilation rate



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CITI-SENSE AMBIENT AIR QUALITY STUDY

Beograd

http://belgrade.citi-sense.eu/ПОЧЕТНАСТРАНА.aspx

CityAir is a smartphone application (App) for the public to express their perception of the outdoor air quality at their location.
https://play.google.com/store/apps/details?id=io.cordova.CityAir

On-line air quality perception questionnaire

Beograd
http://w.civicflow.com/task/participate/151

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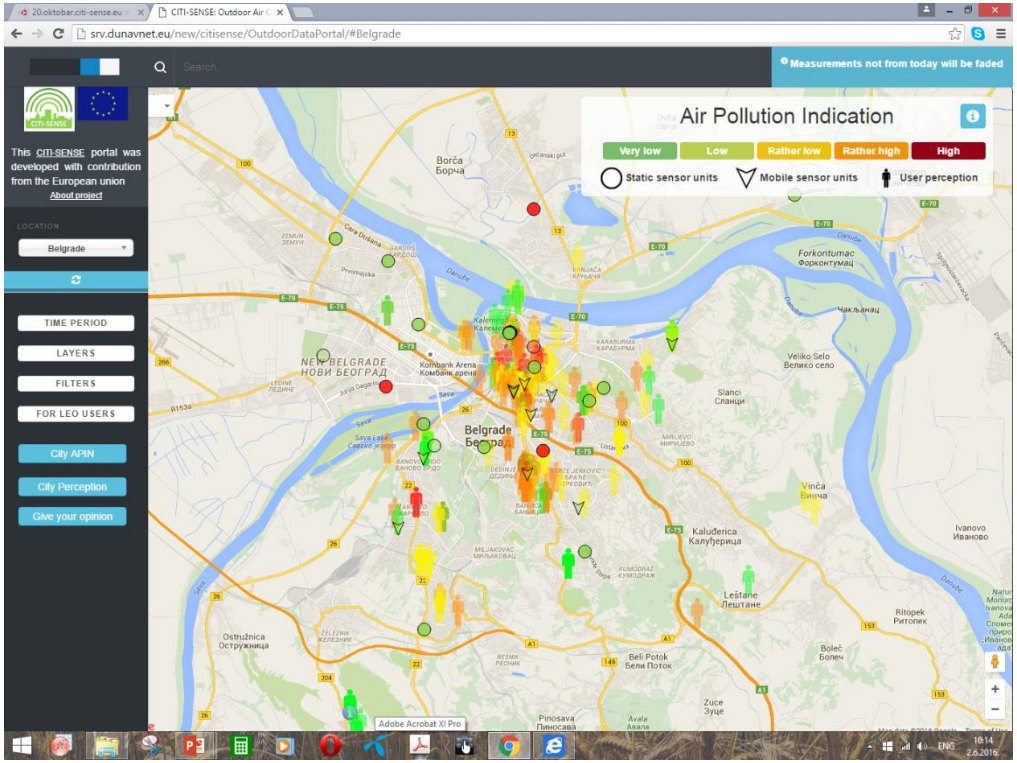
CITI-SENSE AMBIENT AIR QUALITY STUDY Beograd

http://srv.dunavnet.eu/new/citisense/OutdoorDataPortal/#



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Thank you for your attention

For more Information, http://co.citi-sense.eu/

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