

OpenSense Zurich: A System for Monitoring Air Pollution



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Goals

Increase public awareness of urban air pollution



Air pollution in the city of Zurich

Involve general public into environmental monitoring



Participants of a flash mob

Improve temporal and spatial resolution of current air pollution maps



Ozone concentration levels

Governmental Stations

Precise pollution recordings

- NABEL (National Air Pollution Mon.)
 - 1 station in Zurich
 - O₃, CO, NO₂, SO₂, PM₁₀, NMVOC
- OstLuft (Cantonal Air Pollution Mon.)
 - 4 stations in Zurich
 - O₃, NO, NO₂



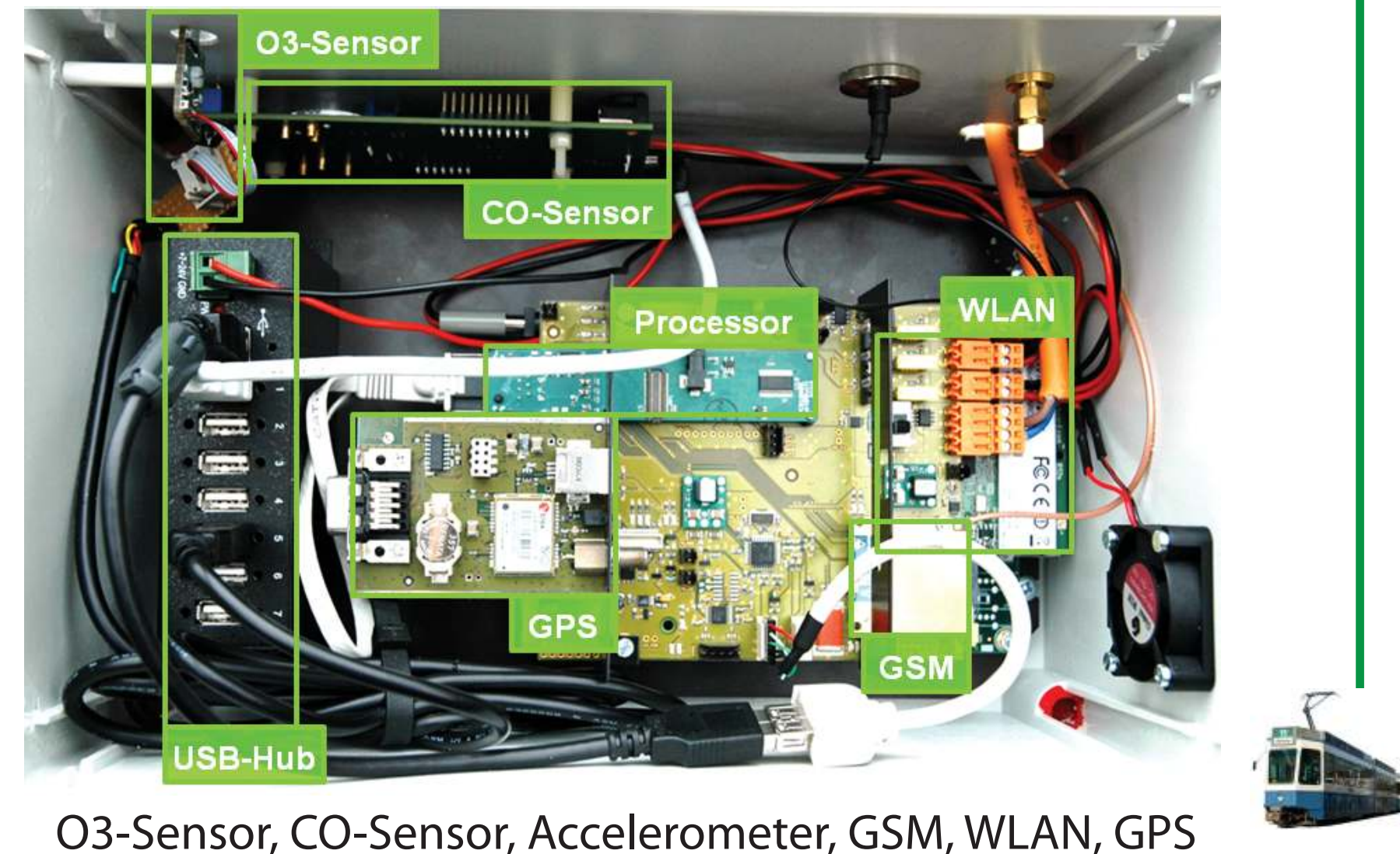
OstLuft stations in Balsberg and Winterthur



NABEL station in Duebendorf

OpenSense Nodes

Up to 10 nodes mounted on trams in Zurich



O₃-Sensor, CO-Sensor, Accelerometer, GSM, WLAN, GPS

Personal Data Collectors

Personal data collectors participate in environmental monitoring

- Common smart phones control gas sensors without any additional hardware
- Participants acquire data and upload these to the OpenSense platform
- Participants have access to real time air pollution data



Smart phone controls several gas sensors

Route Scheduling

Track selection for OpenSense nodes

- Utility function describes desired coverage in space and in time
- Verkehrsbetriebe Zurich (VBZ) operates 14 tram and 54 bus lines
- Over 15 vehicles are operating on each of the 68 lines
- Evaluation of all possible combinations is not feasible

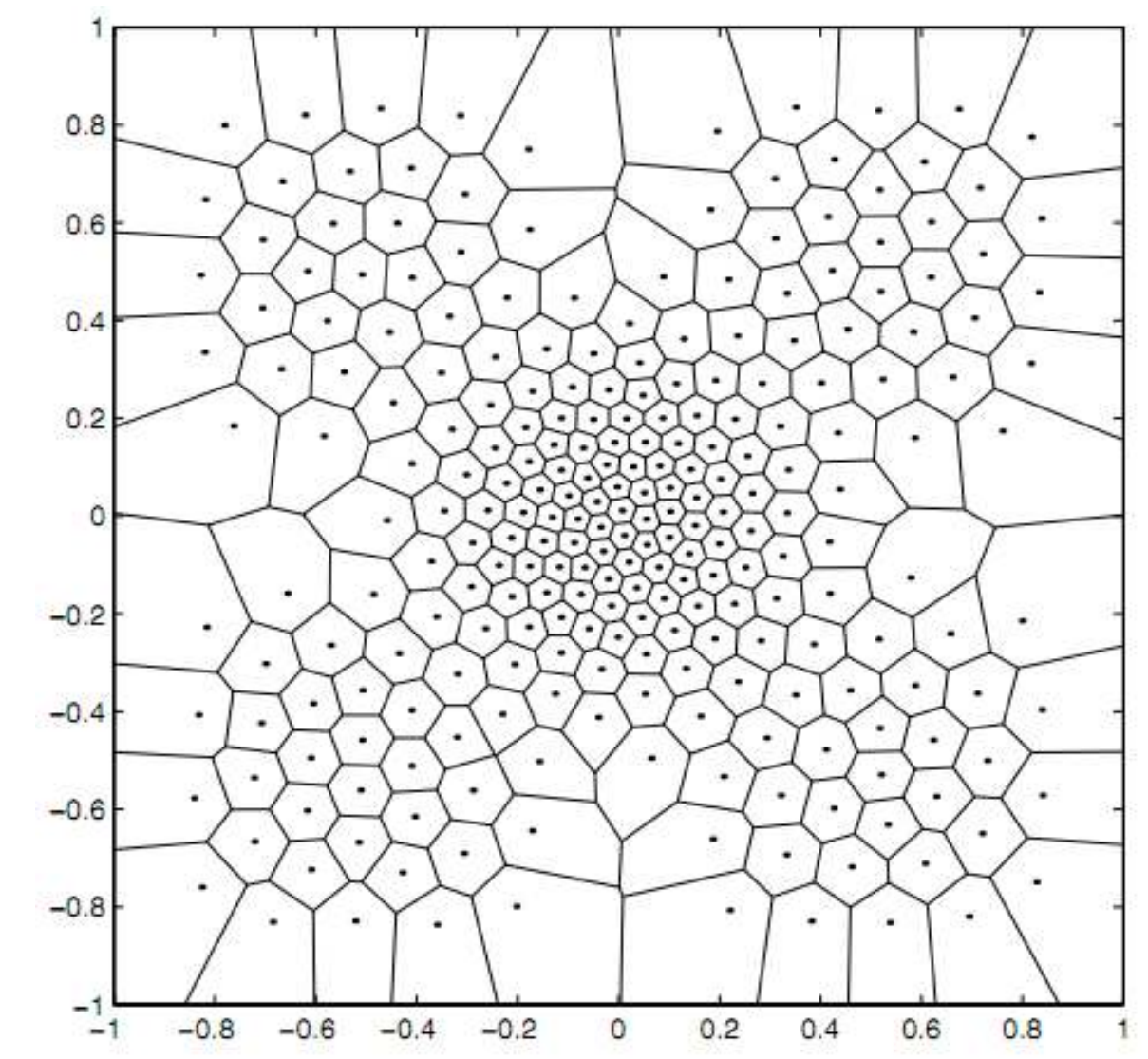


Tram and bus network of Zurich

Measurement Scheduling

Measurement scheduling to achieve required coverage

- Utility function specifies desired coverage in space and in time
- Energy budget and sensor aging limits number of measurements
- Centroidal Voronoi tessellation (CVT) optimally places measurement points

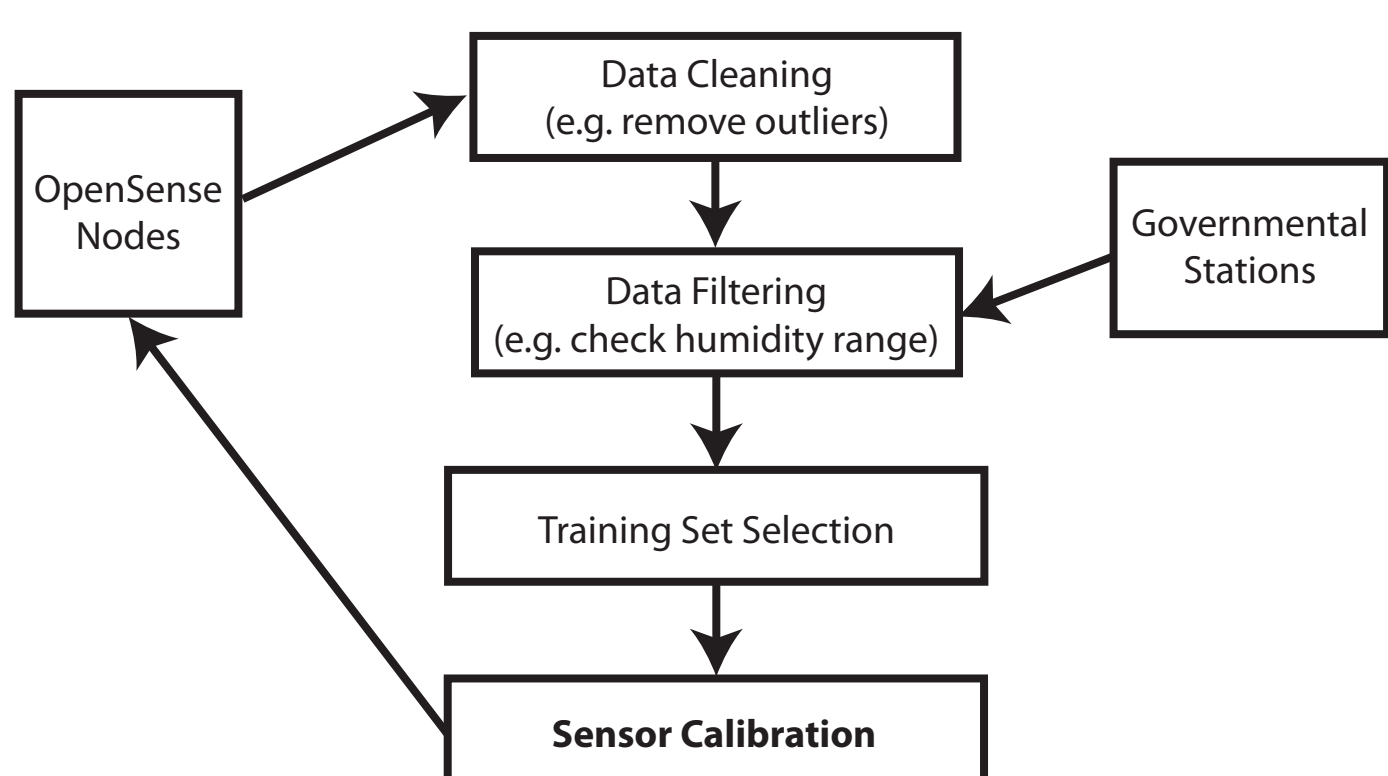


Two dimensional Voronoi diagram for a non-uniform utility function

On-the-fly Sensor Calibration

Low-cost gas sensors require frequent recalibration

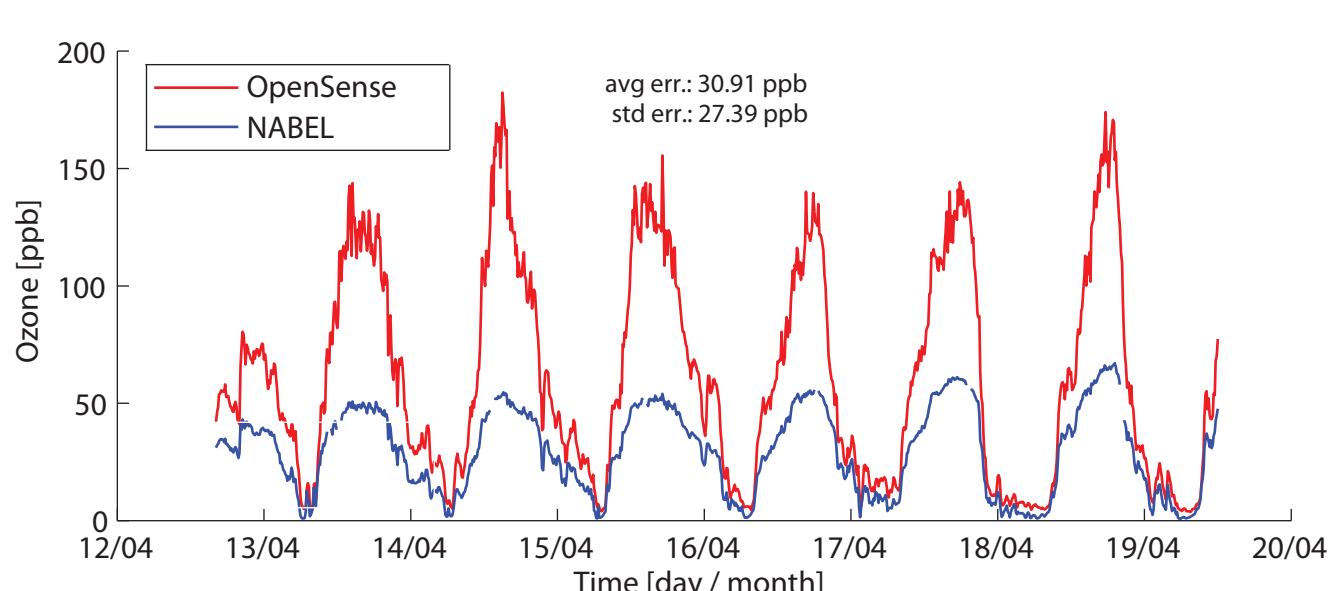
- Factory calibration range may not match project requirements
- Aging of low-cost gas sensors necessitates baseline adjustments
- Initial calibration: sensors are placed next to a static high precision instrument before deployment
- Runtime recalibration: OpenSense nodes are used to control baseline drift when deployed



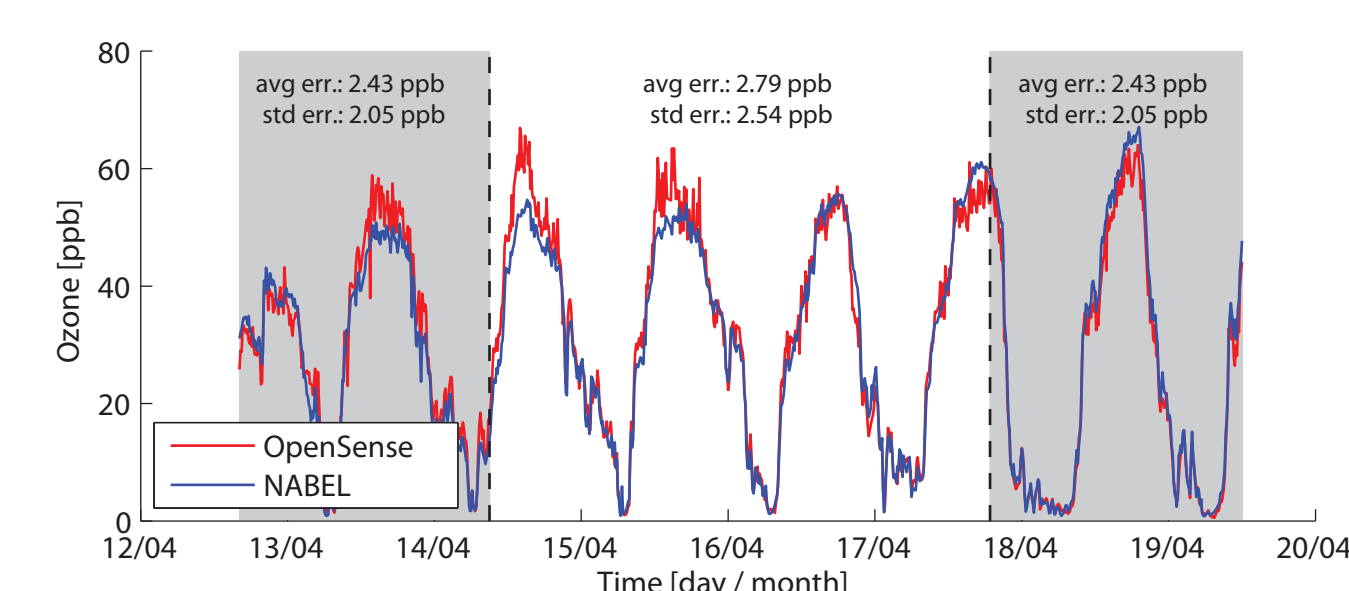
On-the-fly sensor calibration using data from accurate reference stations and OpenSense nodes



OpenSense node placed next to the NABEL station Duebendorf for initial calibration



NABEL measurements compared to OpenSense ozone sensor with original calibration



Recalibrated OpenSense ozone sensor based on NABEL data (grey areas)

The average measurement error is reduced from 31 ppb to 3 ppb

Raise Public Awareness and Involvement

Easy to access online platform for the public to get up to date pollution information as well as publish own measurements

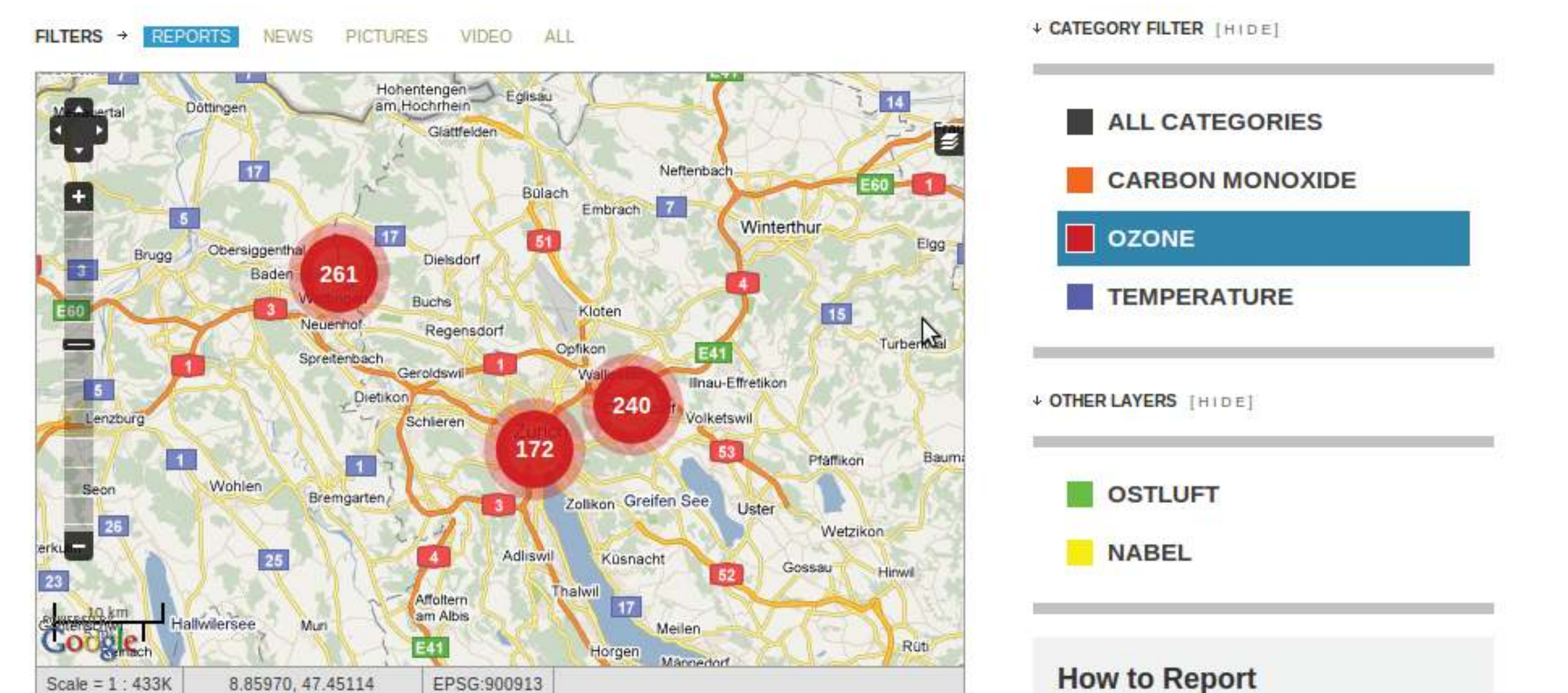
- OpenSense crowdmap is based on Ushahidi, an open source platform for information collection, visualization, and interactive mapping

OPENSENSE CROWDMAP

Open air pollution monitoring. Stay informed. Contribute.

SUBMIT A REPORT

HOME REPORTS SUBMIT A REPORT GET ALERTS CONTACT US ABOUT OPENSENSE



OpenSense instance of Ushahidi collects and visualizes air pollution data