## 4. DATA VISUALIZATION and DATA

4.1 Visualization Platform

To offer the possibility of a real time monitor of the status and data of the sensors we decided to send our data to the smartcitizem.me platform.

Thanks to the last year implementation of the Smartcitizen V0 API (https://developer.smartcitizen.me/) and the support of the developers of Fablab Barcelona we uploaded automatically our measurements on their server.

This is the data flow:
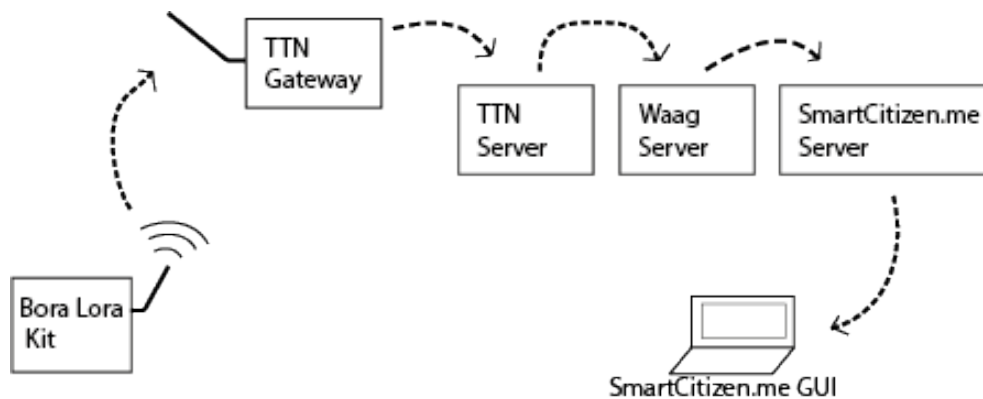
The spec of Waag side are the following:

Server: Ubuntu 15.10, 4 CPUs quadcores, 32Gb RAM

Mqtt broker: mosquitto

Back-end: Ruby, Postgres

The smartcitizen.me interface allows:

- geo-location on the map
- real time data on the low bar
- plot overtime with two data comparison
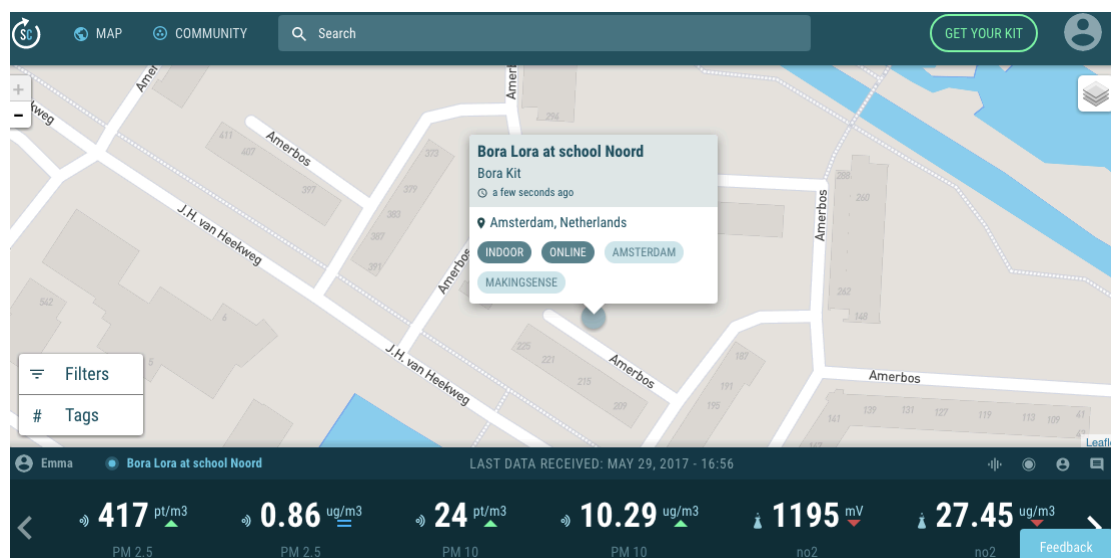- download the data, .csv format

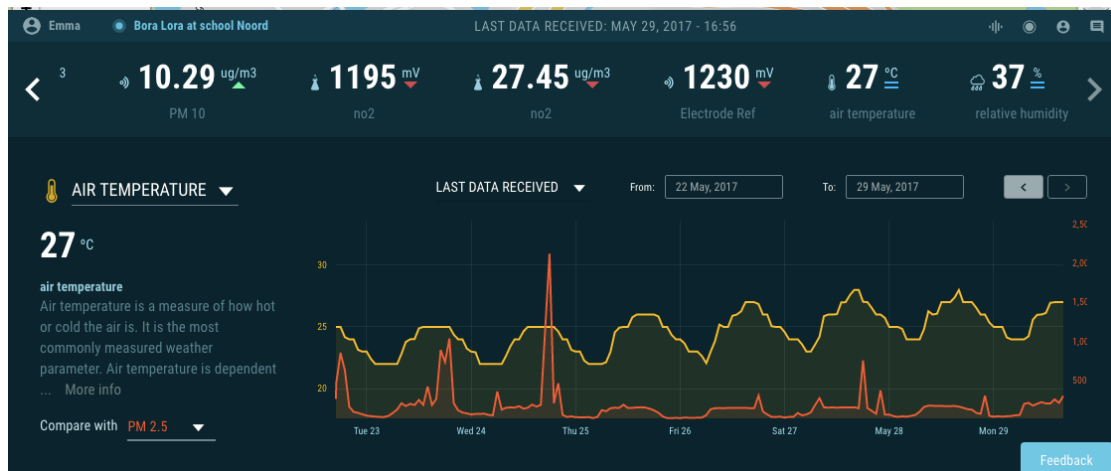*Fig4.1, smartcitizen.me of the Bora Lora kit in Noord.*

Fig4.2, Bora Lora Noord data history comparison.

4.2 DATA

The data that the sensor kits send, can't be directly visualize and they need to be filtered and understood. Electronic devices, measurements based on signal duration, low cost sensors, analog components, power supply are all error sources. They intrinsically introduce errors that in some cases can be estimated, for example: the 16bit ADC reads the NO2 sensor output with a worse case deviation of 0.5LSB and an integral non linearity of +/-3LSB. It's necessary to keep in consideration these kinds of errors during calibration/evaluation processes of the sensor and barley they give friendly feedback if the user is interested only in the result, such as the amount of dust or NO2 concentration; we didn't include these contributions in our platform.

The nature of the implemented sensors, optical and electrochemical, anyhow showed the need to eliminate wrong measurements. Fig4.3 reports the plot the original data set of the Dust Sensor in Noord, picks of 60.000 parts/cubicfeet are not credible; scaling the axis and zooming in, the plot shows indeed daily patterns that can be easily recognized and explained. The No2 sensor, on the other hand, is a slow device, it means that the first hours don't give valid data, it's highly affected by external factors, the linearity of the device is lost at temperatures higher than 30 degree Celsius and it need long calibration to avoid shift over time.

It's important to keep in consideration any possible source of inaccuracy to understand the number that we get from the sensors. They are not perfect tools.
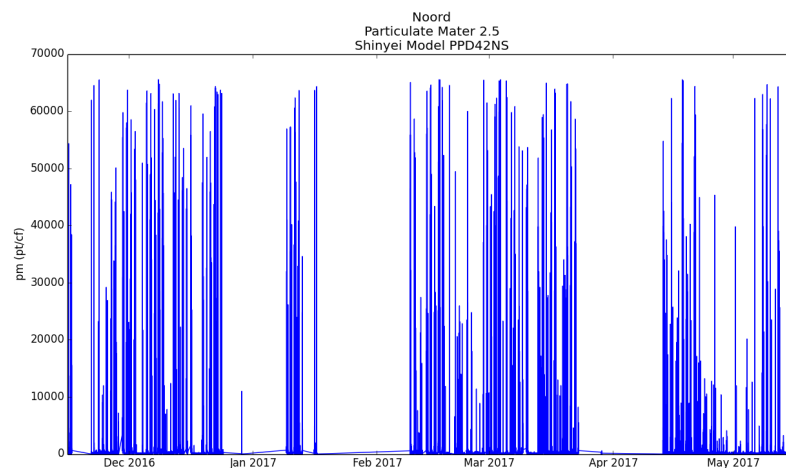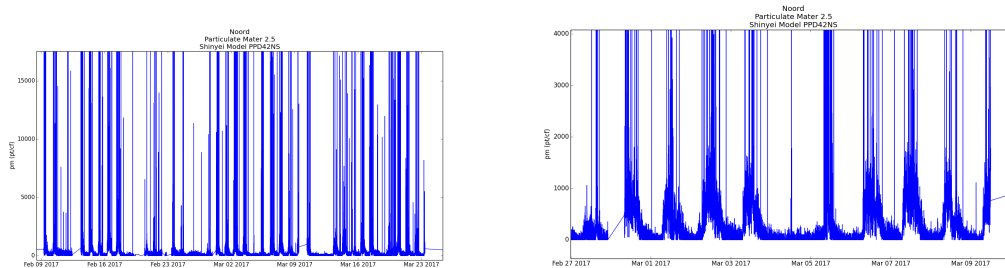

Fig4.3, Bora Lora raw data set.

Fig4.4, Bora Lora raw data set details.

The friendly accessibility of the data is also related to the unit of measure.

The raw data are expressed in parts per cubic feet and mV, respectively for particulate matters and the nitrogen dioxide, we decided to covert the data to the units used by European environmental standards that can be found at the link http://ec.europa.eu/environment/air/quality/standards.htm. The PM 2.5um, PM 10um and NO2 are defined in ug/m^3.

Fig4.4, Bora Lora PM2.5 data set on smartcitizen.me.

Everyone can have a look to the measurements following the links:
Noord -> https://smartcitizen.me/kits/3767
West -> https://smartcitizen.me/kits/3764
ZuidOost -> https://smartcitizen.me/kits/3766