An innovative dashboard for targeted policies in smart cities

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Introduction

We would like to go here a bit further into the details of our idea.

Our main contribution is an interface for the cities where they can visualize the air pollution and directly take action to reduce its impact.
The use of a pollution index, that can be modified to best match the needs of the users, allows for a quick comprehension of the current air quality.
Clusters, that do not necessarily follow district borders, are a great way to identify patterns and so to adapt infrastructure and take specific action to where the need is.
The adjustments offered for every district, tailored to its features, allows for a dynamic control of policies, to the best interest of the city.

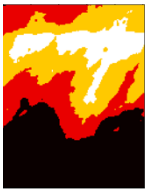
We will explain in this document the pipeline that takes raw data from the sensors all the way to a usable app, as we think it is very central in our idea. And also, the collection of policies we have come up with that are present in the interface.

In fact, we want this document to be an honest representation of what we did versus what we have in mind and demonstrate how our Proof of Concept shows the feasibility and interest of our solution. Please keep in mind that we have made choices -for example not include all pollutants in our calculations-, for simplicity sakes and because we focused on the steps where we could provide the most value.

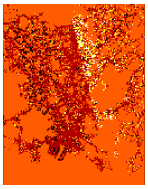
Step by step

Data

We have used the HELSINKI_100x100m_7d.nc4 file. Only the first day (288 entries) was taken into consideration. For every square, we used the mean value over the day.

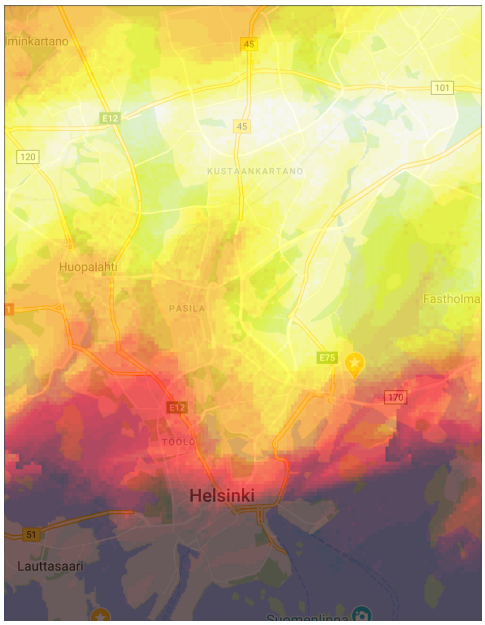


For FMI entries, where typically a value is provided for every square, we assigned a value from 1 to 9, where 1 denotes a small quantity of the pollutant.



For Megasense entries, where only some squares contain information, we considered the extreme values: very high values get a positive modifier (0.5 or 1) while very low get a negative one (-0.5, -1).

To merge these results, we summed them. We then manually added an overlay of a map, matching the coordinates of our data.



<u>How to improve:</u>

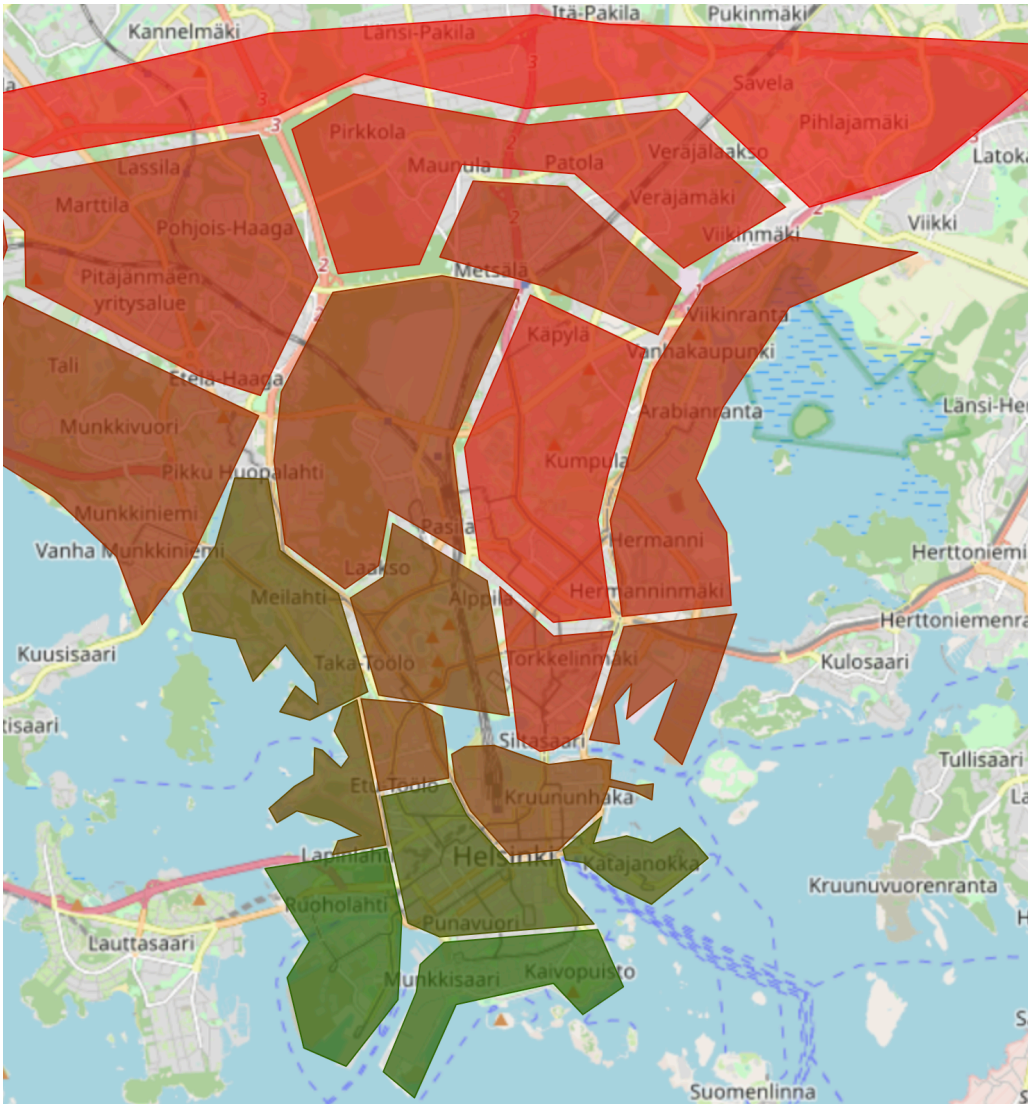
- use a more precise dataset (eg: 20x20m)
- consider different timeframes (eg: 6am to 11pm, locate peak...)
- use real scales to determine if a pollutant is or is not present in excess
- for megasense entries, interpolate the data to fill the missing values, with a better way than the average.

Clusters

We have manually drawn clusters on top of the regions that had a similar pollution index, using the image generated above.

<u>How to improve:</u>

- generate these clusters automatically, for example using Labelling Connected Components techniques
- have constraints on clusters, regarding their size, or so that they could match existing district lines
- compute clusters over a date range, to make sure that the area in a cluster does in fact really behave like the cluster in average



Prediction

We did not tackle the prediction aspect as there are countless models and resources available. Yet, we are confident that by using the preprocessing of the data and the aggregation by clusters, both described before, the prediction can be very accurate for up to a few days in advance, at a cluster scale.

<u>How to improve:</u>

- in addition to the data provided for this challenge:
- use of historical data
- weather forecast
- traffic forecast

Here are a few publications that offer models for predicting air pollution, that we think would fit our use case.

X. Xi et al., "A comprehensive evaluation of air pollution prediction improvement by a machine learning method," 2015 IEEE International Conference on Service Operations And Logistics, And Informatics (SOLI), Hammamet, 2015, pp. 176-181, doi: 10.1109/SOLI.2015.7367615.

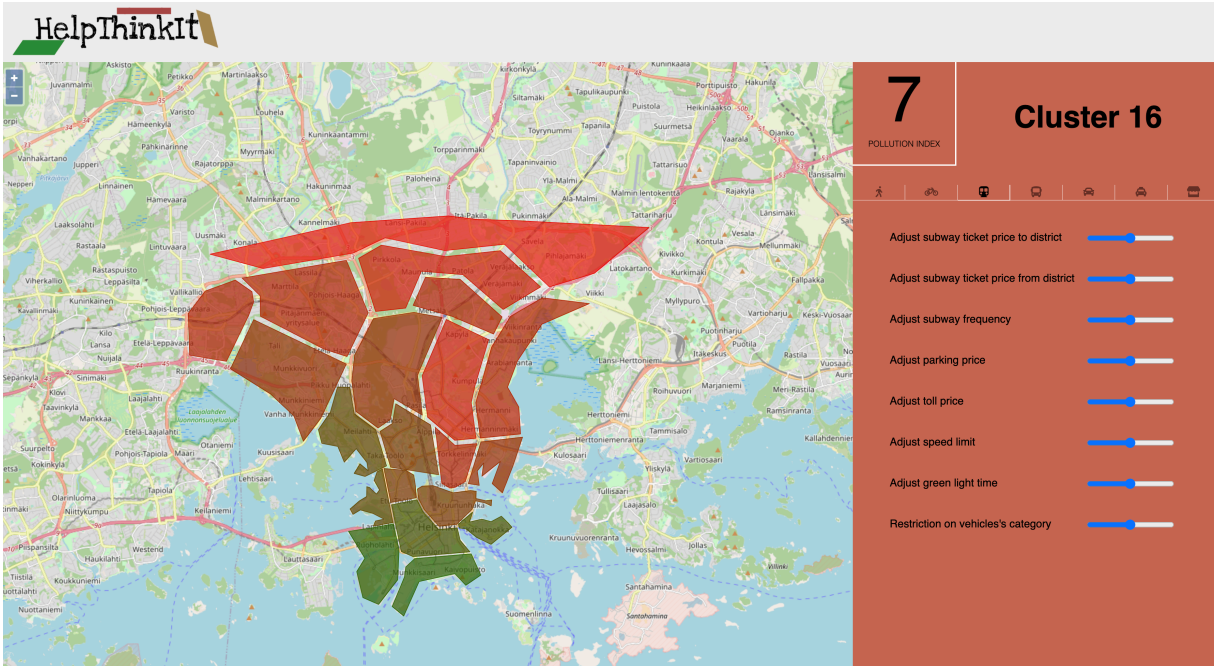
Maleki, H., Sorooshian, A., Goudarzi, G. *et al.* Air pollution prediction by using an artificial neural network model. *Clean Techn Environ Policy* **21,** 1341–1352 (2019). https://doi.org/10.1007/s10098-019-01709-w

Interface

The interface is designed for cities so that they can have a tool to monitor the air quality and a way to fight the pollution. Visually, you can quickly identify zones more affected by pollutants. For every cluster, officials can take targeted action, for example reduce speed limit for cars, reduce the price of the subway in a district, increase the number of buses...

<u>How to improve:</u>

- break the interface into two,
    - historical view, to assess the long-term needs of certain parts of the city
    - prediction view, to take short-term action, cluster by cluster
- have different Air Quality Index to display, filter by pollutant
- take action for different clusters at the same time, save the adjustments.
- Once cluster have been defined, have experts determine in what capacity the different adjustments can me made (in case of a pollution peak, can we reduce the speed limit in this district by 5km,10km? ...



Policies

- Reduce the price of public transportation/bike rental according to the pollution index
- Adjust the frequency and the reach of public transportation network
- Restrict access to certain areas according to category of vehicle (electric, old diesel, ...)
- Restrict use of ride shares/taxis, or add a pollution index fee
- Limit waiting times engine on, adjust the duration of traffic lights
- Adjust the price of parking, tolls, speed limits
- Issue advice to avoid area for pedestrians, bikes
- Restrict the use of heating/AC for businesses

<u>How to improve:</u>

- for every cluster, establish with experts a list of policies that can be applied, and to which extent
- ideally, they should be put in place in less than a day when needed
- have a way of broadcasting these policies to the public, for example through a city app, or screens in the city

Conclusion

A peak of pollution is predicted in two days over one cluster. Let's increase public transportation frequency, make it free for those parking outside the city. Ban cars over 10 years ago and reduce the speed limit. Synchronize with Waze and Uber and send a notification on the HelpThinkIt app.

In our mind, this is the future for cities, and it's done in a few minutes on our interface. Proactive, dynamic and connected, we believe our project can be a weapon for fighting short-term pollution and be the tool for long-term improvement.

While we want our app to be futuristic, it can start helping cities from tomorrow. All the policies won't probably be integrated at launch, but already having this one dashboard and getting the targeted response mindset will make the impact our cities need today.