



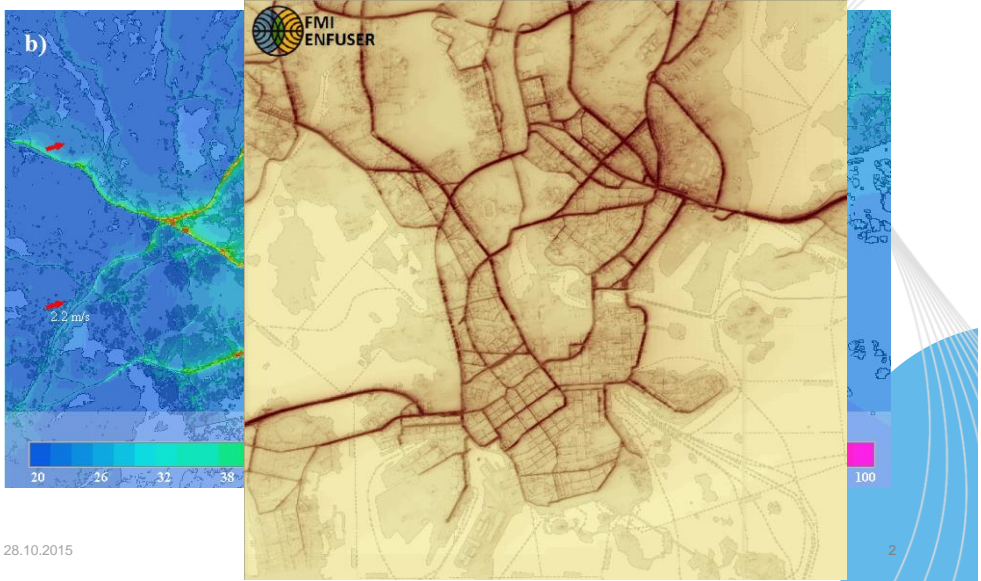
Evaluation of Air Quality using Fusion of Environmental Information

23.6.2015

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Ari Karppinen
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FMI-ENFUSER approach (1/3)



28.10.2015



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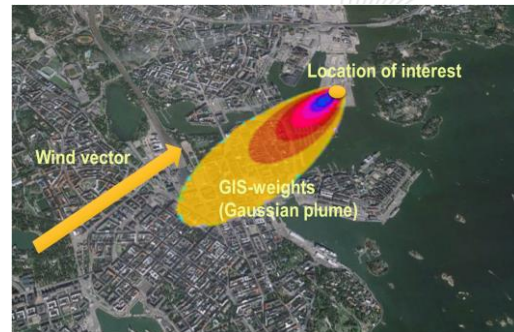
Dynamic land use regression

- Combines **land-use regression (LUR)** and **dispersion modelling** into a novel approach named as "**dynamic land-use regression**"

LUR: Calibration methodology without knowledge of local emission sources

Dispersion modelling: Meteorology, wind profiles, 3D (height-differences!)

- Fusion algorithm:** adaptation to sensor measurements & modelled data
 - Assimilation of these 3 techniques into one
 - **on-going process since 2011**



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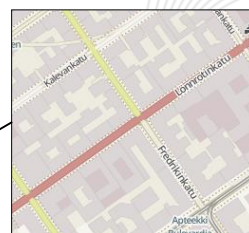
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OpenStreetMap & street canyons

OpenStreetMap (OSM) is an open access map service provider that offers high resolution maps world wide.

Together with **Population density mapping**, this yields a good mapping of **vehicular traffic**.

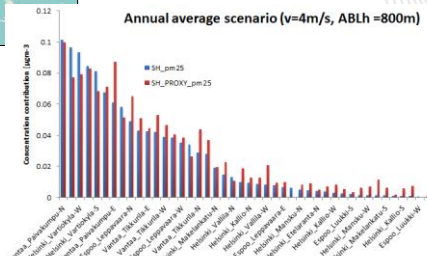
Alongside with OSM, other information sources can be used (CORINE, satellite images)



Street canyons and buildings can be analyzed from the image

Annual average scenario ($v=4\text{m/s}$, $ABLh=800\text{m}$)

Even households (buildings) that act as sources for PM_{2.5} can be detected from OSM

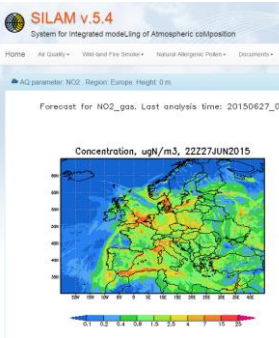


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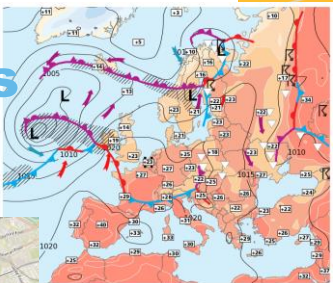
Available data sources for MobileAirQual

OpenStreetMap – the backbone of our LUR-approach is **freely available**

FMI-SILAM: regional air quality in Europe – implemented in our approach (**free**)

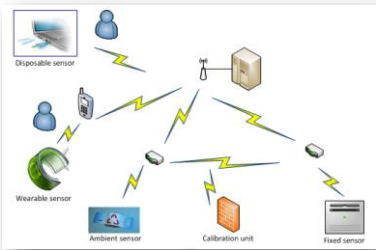
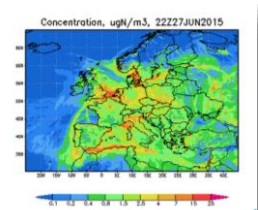
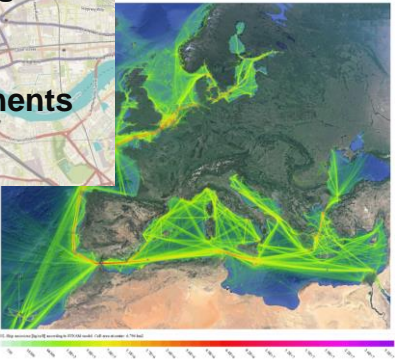


All we need is sensor data for a cutting edge real-time system.
(At least the components for one are all here)



Open access weather

FMI-STEAM: Shipping emissions in Europe (up to 25 x 25m x 6min resolution), **implemented**

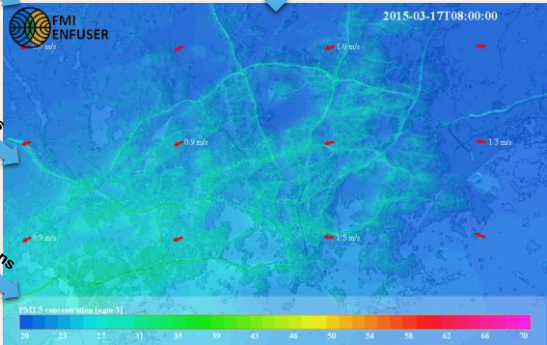
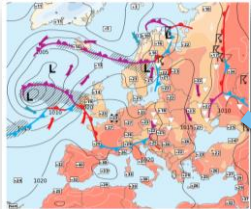


Air quality sensor network

Regional AQ forecasts

Weather forecasts

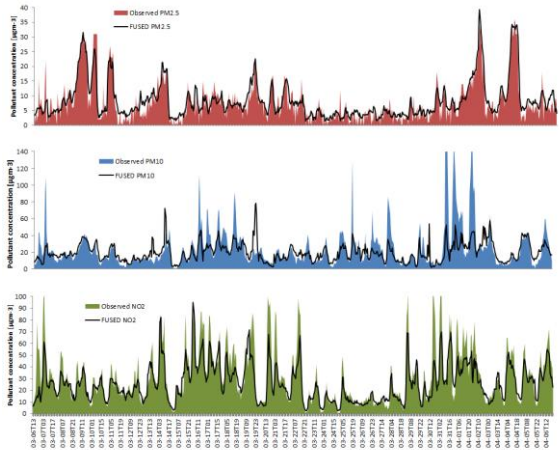
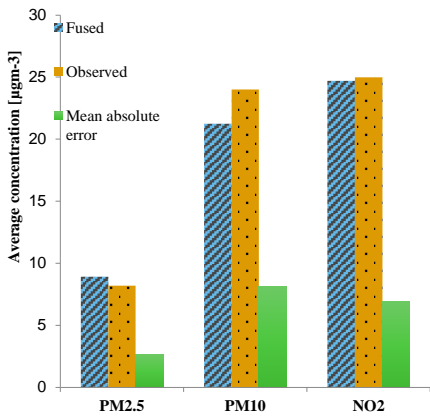
Shipping emissions



Integrated air quality system (NRT)

In Finland it Works (1/2)

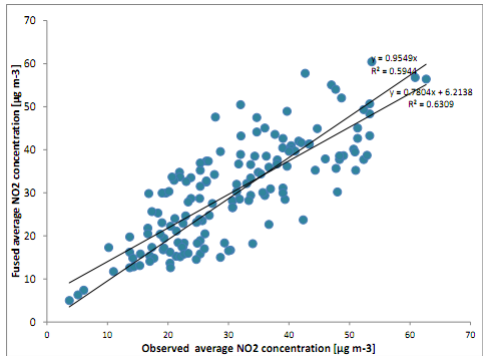
• Estimation of hourly PM2.5, PM10, NO2 at selected urban measurement site (Leppävaara, one of the sites used in the study)



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In Finland it Works (2/2)

ENFUSER was calibrated with 2011 data from another region. Then, ENFUSER predicted hourly concentration of NO2 in 38 locations near Helsinki in 2010. Predicted seasonal averages were compared against measured averages.



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★ = street canyon

Observed 2010				Fused 2010			
Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall
53.3	51.3	42.0	48.3	50.6	42.6	41.6	37.7
53.3	50.7	46.0	44.3	48.3	40.1	37.9	35.2
33.7	22.5	17.0	26.0	29.4	17.6	15.3	17.0
39.7	38.0	39.7	31.3	48.9	36.7	36.2	32.0
36.0	35.3	33.7	31.3	45.0	34.4	33.4	30.2
22.0	26.3	25.3	23.0	50.5	37.4	26.9	21.6
25.3	19.7	18.3	17.3	35.2	29.9	25.3	25.6
51.3	39.0	35.7	39.0	45.0	31.1	30.1	30.0
42.7	32.0	28.7	31.7	57.8	38.9	39.6	36.7
62.7	52.3	49.0	51.0	56.4	37.7	38.6	35.2
53.7	43.3	39.0	41.0	60.4	41.4	42.6	39.7
47.0	44.7	37.7	40.0	55.1	44.9	43.6	39.6
52.3	40.3	34.3	36.7	49.3	40.9	38.5	35.9
48.7	33.3	43.3	48.3	52.0	43.2	41.3	38.6
34.7	26.7	21.0	26.3	44.1	37.3	32.9	32.8
34.7	26.3	20.7	25.3	47.5	32.5	33.7	31.5
27.7	19.0	13.7	16.7	34.2	23.0	19.7	20.5
33.7	23.3	16.7	22.5	36.6	27.9	21.8	22.9
27.3	17.3	11.0	17.0	27.5	17.3	11.7	14.1
36.0	22.7	13.7	21.3	29.4	18.3	12.6	15.3
48.0	36.7	25.3	30.3	30.2	22.7	15.8	16.7
39.3	29.3	20.3	30.0	28.5	18.4	13.7	16.5
30.7	21.7	14.3	22.0	26.5	18.4	12.8	15.1
33.3	22.3	15.3	22.7	28.2	17.4	13.1	15.8
33.0	19.3	13.7	19.3	32.1	19.4	16.2	17.2
42.3	34.0	24.7	28.7	23.7	18.2	14.5	15.0
25.7	25.3	17.7	23.3	23.5	18.9	14.8	15.9
39.0	30.7	21.1	24.7	40.4	26.6	24.0	23.1
15.4	6.1	3.7	5.1	15.8	7.4	5.0	6.3
30.6	21.4	14.2	20.3	23.1	21.1	14.8	16.2
27.3	21.9	23.8	19.0	40.6	34.8	33.5	29.9
22.1	22.0	16.8	20.1	43.2	33.7	29.8	30.3
47.7	41.6	40.4	36.2	54.0	42.0	40.2	38.5
60.8	52.9	50.9	47.8	56.8	38.7	39.5	35.7
34.9	25.2	20.4	22.9	34.8	28.7	22.2	24.6
23.8	18.7	18.7	10.2	28.7	20.4	12.6	17.3
36.9	26.1	19.2	24.8	30.9	20.5	16.8	18.3
38.1	31.8	25.2	26.8	37.6	28.5	23.8	24.7

Will it work in London, other places?

- **Availability of population density mappings?**
- **Sufficient calibration material for the ENFUSER model available?**
 - Full annual time series in several locations needed.
 - Then again we are placing a large number of sensors to provide such data.
- **Contribution of local industrial sources of emissions?**
 - Manual mapping if nothing else available?
- **Other sources of local emissions that cannot be analysed based on the available GIS-datasets?**

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Johansson, L., Epitropou, V., Karatzas, K., Karppinen, K., Wanner, L., Vrochidis, S., Bassoukos, A., Kukkonen, J. and Kompatsiaris I. *Fusion of meteorological and air quality data extracted from the web for personalized environmental information services*. Environmental Modelling & Software, Elsevier, [Volume 64](#), February 2015, Pages 143–155, 2014.



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