

# Smart Emission

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## Smart Emission

### Inclusive Citizen Sensing:

- Citizen-sensor-networks for fine-grained measurements, with new low-cost sensing devices;
- Transparency and democracy of pollution monitoring, 'making the externalities (e.g. noise, air pollution) visible';
- Cost-effective environmental monitoring, Open Data.

### The smart residents well-informed residents create solutions themselves



# Case: Environmental health in Nijmegen



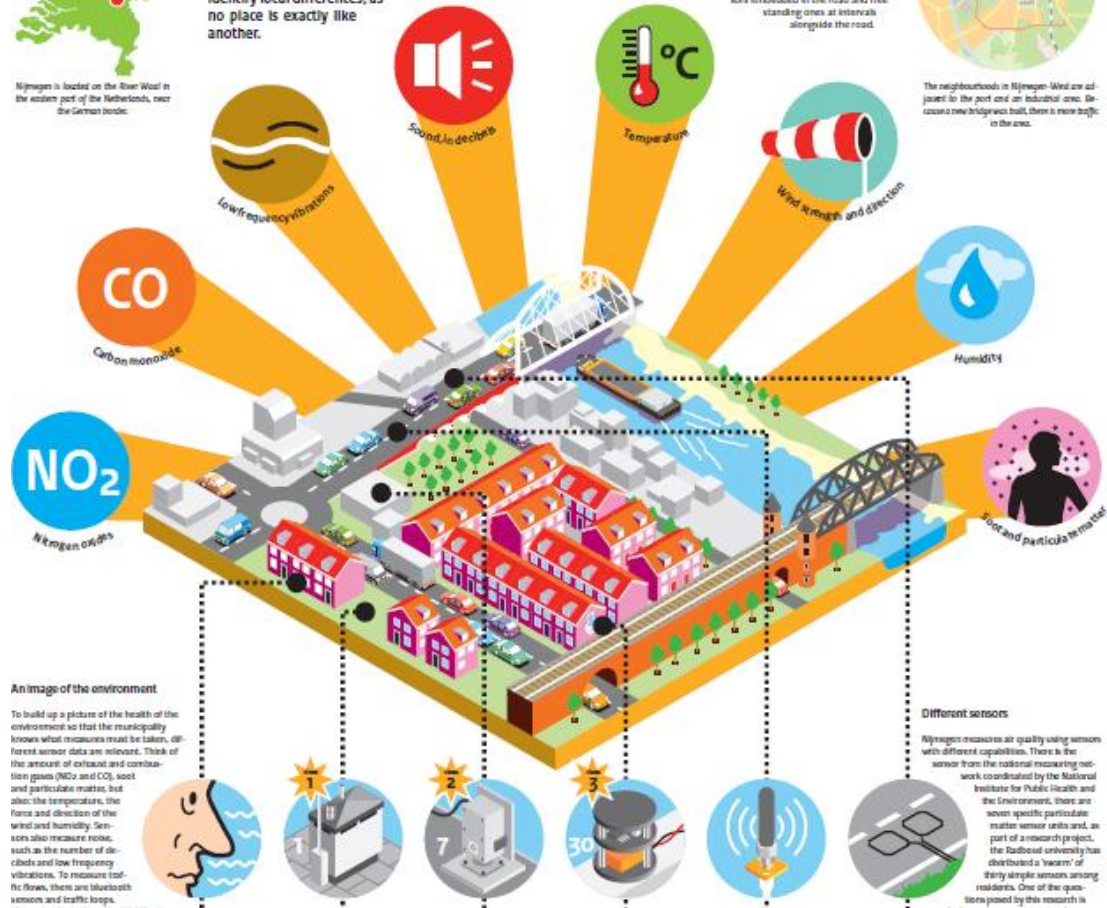
Nijmegen is located on the River Waal in the eastern part of the Netherlands, near the German border.

The environment is very important for people's health. That's why standards are set for the concentrations of pollutants. Sensors measure whether we keep within these standards using national monitoring networks. In addition, several municipalities and regions have their own sensors to identify local differences, as no place is exactly like another.

Nijmegen also monitors local environmental quality. With the advent of a new bridge and the construction of a ring road, the traffic situation in the western part of Nijmegen has changed. Developments in the port and the industrial area by the River Waal have been made, and residents in the nearby neighbourhood are worried about the health of their environment. The municipality is taking their concerns seriously and has placed sensors in the neighbourhood to measure the air quality and noise level. Nijmegen also wants to collate reports about bad odours. To monitor traffic flows, the municipality uses sensors embedded in the road and free standing ones at intervals alongside the road.



The neighbourhoods in Nijmegen-Waal are adjacent to the port and an industrial area. Because a new bridge was built, there is more traffic in the area.



## Issues and questions to deal with

- 1. Deployment of a local air quality network using a low-cost sensors:**
  - What is the quality of low-cost sensors in general?
  - Which type of low cost sensors to deploy?
  - How to calibrate the low-cost sensors?
  - How many and at what locations (spatial pattern) to deploy the sensors?
  - What data platform for data collection and distribution?
  - Which standards for data acquisition and distribution?
  - Which (interpolation) models for further processing air quality data?
  - How to visualise the results?
  
- 2. Involvement of citizens in the deployment and maintenance of the sensor network:**
  - Which method to use for citizen engagement?
  - Do we need to training citizens to deploy and maintain the sensor?
  
- 3. Involvement of citizens in the analysis of the results of local air quality monitoring:**
  - How to engage citizens?
  - How to preprocess and visualise the data for citizens?
  - How to interact with citizens?
  - How and when to meetup with citizens?
  - What applications need the citizens?

# Which type of low cost sensors to deploy?

Quality and price

National Air Quality stations



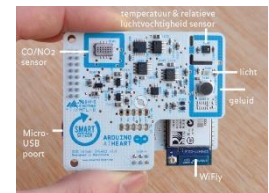
Aireas  
"Airbox"



Smart emission  
"Jose"



"Smart Citizen Kit"



Number of sensors applied in a city

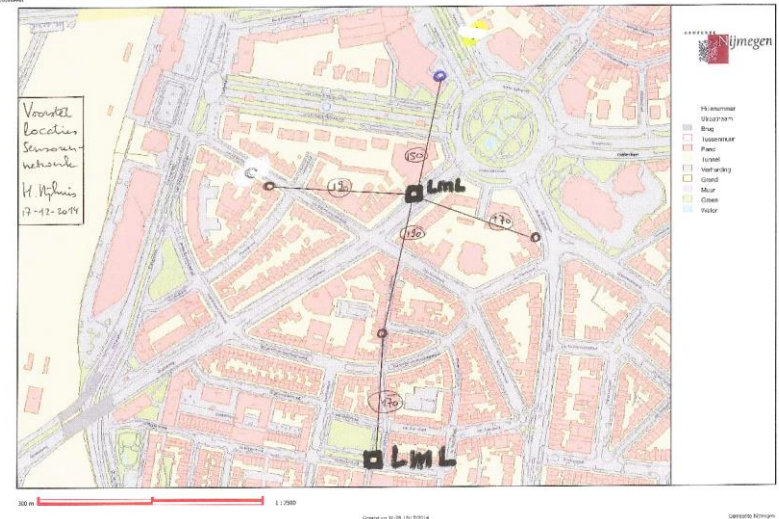


## Multi-purpose environmental sensor installation



# How many and at what locations (spatial pattern) to deploy the sensors?

- How many?
  - Goals to achieve?
- Where to locate?
  - Covering the whole City or certain parts of the city (e.g. potential problem areas)
  - Financial resources (also in case of many low-cost sensors)!



Dilemma: research versus politics

- Professionals: put sensors at high risk areas for what-if analysis
- Politicians say: no clustering of sensors in potential high risks areas, because they rather do not want to specify 'problem areas' as such!

# Citizens decision making of deployment of sensors?

**DEZE WEEK** Gemeente Nijmegen  
25 november 2015

## Nijmegen maken wij

Op zondag 17 januari 2016 vindt in de Kube (Wingmangalerie, Buislandlaan 20) het Festival Nijmegen plaats. Een festival voor én door bewoners. Aan het festival staan ook verschillende organisatievormen. In de aanloop naar 17 januari nemen we er een aantal onder de loep. Deze keer is het woord aan Nijmegen Dinsdag.

Mieke Mitterburg en Cora van der Kolk van Nijmegen Dinsdag. Een Dinsdag is een soort maatschappelijk netwerk voor gemeen- en clubleden en is een vorm van sociale cohesie en inclusie. Het netwerk bestaat uit een verscheidenheid aan activiteiten die bijdragen aan de samenleving. Dit kan zijn: een avond met een thema, een avond met een thema, een avond met een thema, een avond met een thema.

**Meester?**  
Wilt u ook meedelen met het festival Nijmegen maken wij? Meld u aan op de website van de organisatie. Dit kan tot 15 november op [www.nijmegenmakenwij.nl](http://www.nijmegenmakenwij.nl).

## Laat het brein niet induttten: beweging slim!

Ruudboom en gemeente Nijmegen werken samen in onderzoek naar demeritie

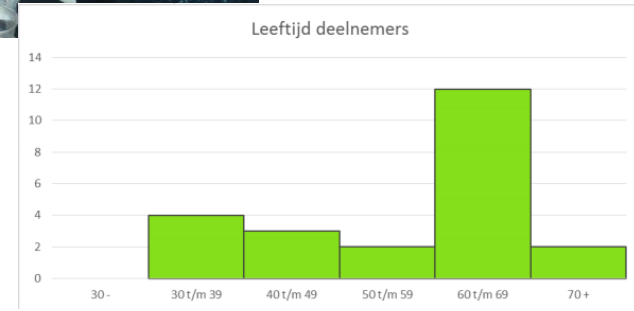
Het onderzoekslaboratorium van de Universiteit van Nijmegen heeft een onderzoek gedaan naar de relatie tussen beweging en de hersenen. Het onderzoek is gericht op de hersenen en de hersenen. Het onderzoek is gericht op de hersenen en de hersenen. Het onderzoek is gericht op de hersenen en de hersenen.

## Leer zelf een sensor bouwen tijdens Sensing the City in Nijmegen!

Hoe verhoudt de lucht in het Koningrijksplein? Kan ik meten in de stad? Hoe verhoudt de lucht in het Koningrijksplein? Kan ik meten in de stad? Hoe verhoudt de lucht in het Koningrijksplein? Kan ik meten in de stad?

## Deelname aan de Smart Emission Case

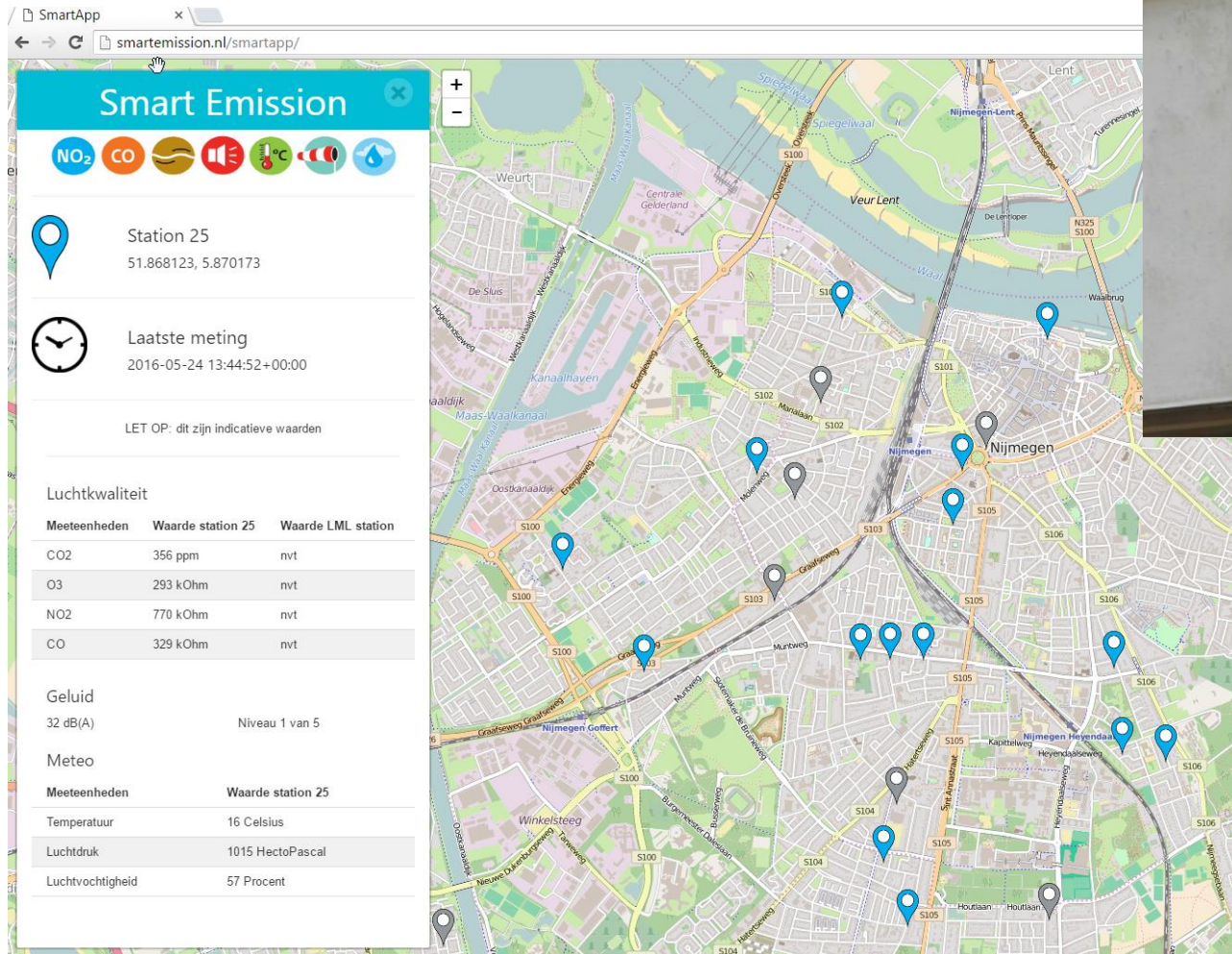
De Smart Emission Case is een project van de gemeente Nijmegen. Het project is gericht op de Smart Emission Case. Het project is gericht op de Smart Emission Case. Het project is gericht op de Smart Emission Case.



Know the citizen? Basic citizens statistics from the Nijmegen Smart Emission case.



# Citizen participation



## How to calibrate the low-cost sensor for air quality?

Calibration at two national air quality locations by and in the City of Nijmegen and in laboratory setting at the National Institute of Environment and Health (RIVM)



Rijksinstituut voor Volksgezondheid  
en Milieu  
Ministerie van Volksgezondheid,  
Welzijn en Sport





## Open data?

Radboud Universiteit

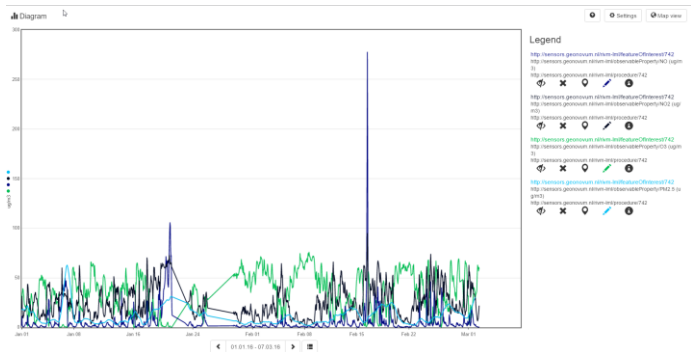
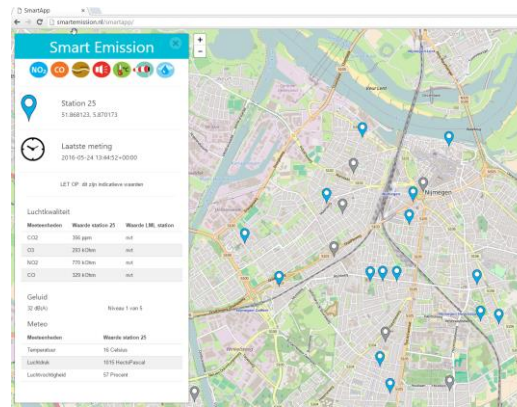
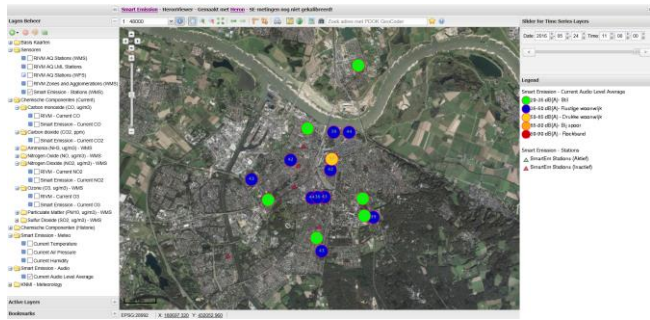


Data open available for citizens, researchers, students, government, companies, ...

Data available for download in tabular and geospatial formats!

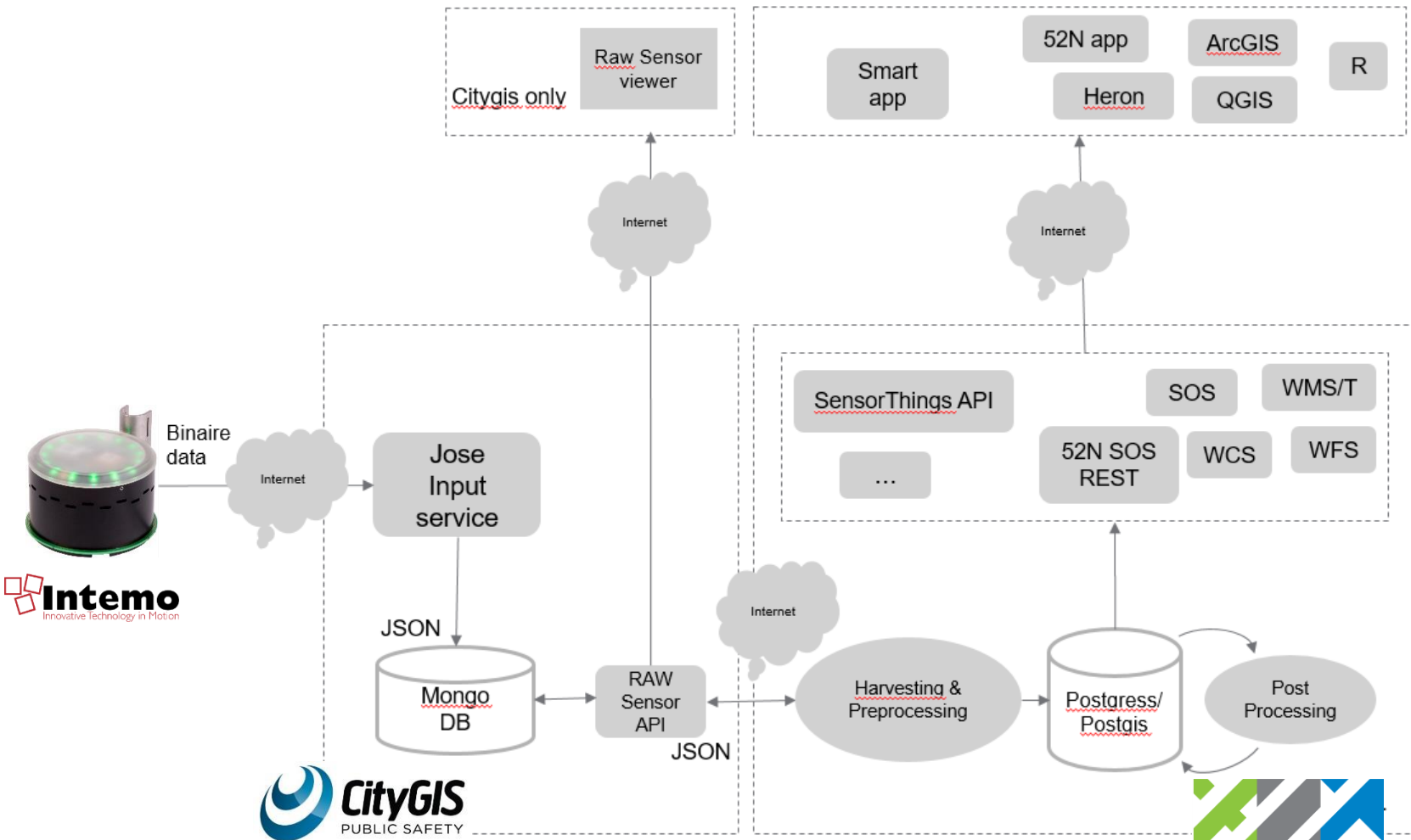


# Clients for data exploration and processing



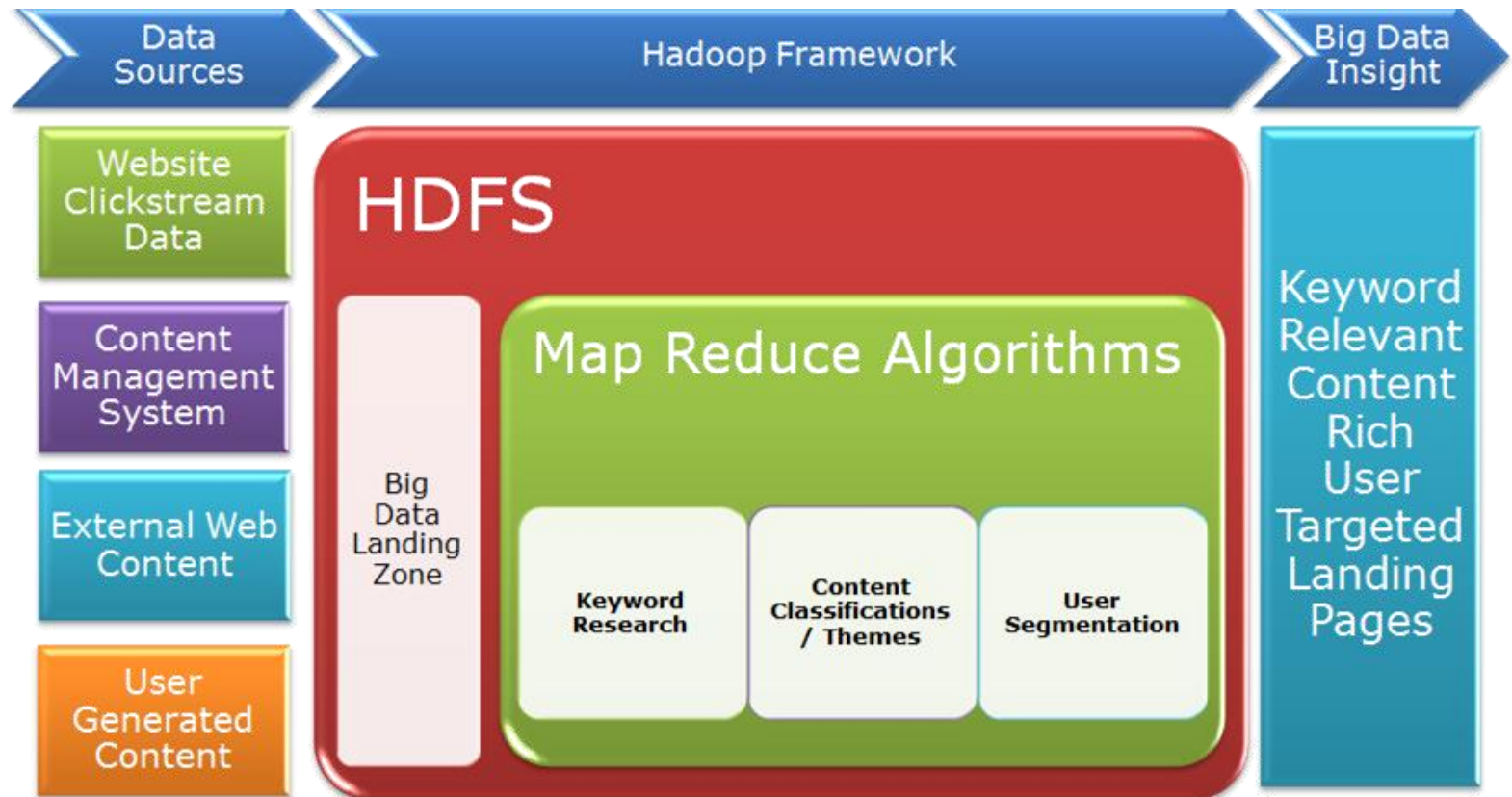
<http://smartemission.nl> (data platform)

## Data architecture: geospatial data infrastructure





## Data architecture: BIG data infrastructure



## Final Remarks

- The interest in low-cost sensor networks in cities is increasing. In the Netherlands several cities are more or less exploring local (air quality) monitoring with low-cost sensor networks.
- There are still several issues to be solved and research questions to be answered. There is need for multidisciplinary experts in these environmental sensing initiatives with strong citizen engagement.
- The geospatial data approach is an obvious start of a citizen-sensor-network for environmental monitoring for sustainable cities.

## With Smart Emission towards sustainable cities



Air Quality



Noise disturbance



Light pollution



Climate adaptation



Heat stress

# Thank you for your attention!

More information:

Smart emission

<http://smartemission.ruhosting.nl/> (citizens)

<http://smartemission.nl> (data platform)

Making Sense for Society

<http://www.geonovum.nl/onderwerpen/sensor-geo-informatie/algemeen-living-lab-internet-everything>

I would like to acknowledge for their valuable input:  
All partners of the Smart Emission Consortium



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# Data architecture with ETL Steps

