



European Network on New Sensing Technologies for Air Pollution Control and  
Environmental Sustainability - *EuNetAir*

COST Action TD1105

**Does the evolution of sensor technology and  
computational methods lead to a revolution in AQ-  
environmental monitoring and to a new generation  
of quality of life information services?**

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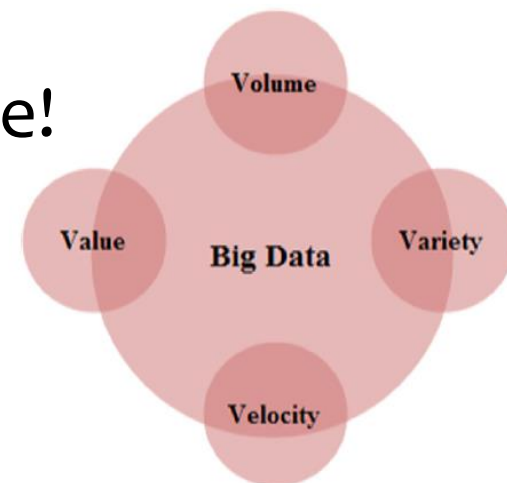
*[kkara@eng.auth.gr](mailto:kkara@eng.auth.gr), <http://isag.meng.auth.gr>*

# Sensors everywhere

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The emerging big data paradigm:

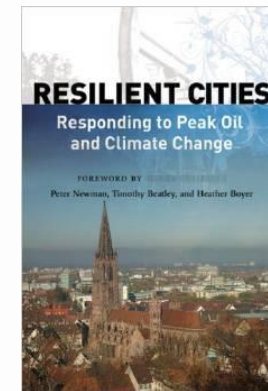
- A new scientific research area defined as:  
**Methods and technologies ... to uncover large hidden values** from large datasets that are diverse, complex, and of a massive scale.
  - “4V” data:
    - Volume, Variety, Velocity, and Value!



# Sensors everywhere... reloaded

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- Air quality oriented “big data:
  - **Data shadows** of people, machines, commodities, and nature, that can **reveal** difficult-to-understand or previously unknown physical, social or other **processes**, related to the **quality of the atmospheric environment**
    - The vision for a resilient urban environment (Newman et al., 2009)



# Who is interested in AQ monitoring?

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## – Organizations

- Governmental bodies/authorities
  - For regulatory & permit purposes (EEA, ISO14000, LCA, etc)
  - Due to monitoring and management legal mandates
- Cities
  - As above
  - Operational purposes
    - » Sustainable management
    - » Optimization (Env. Efficiency)
- Environmental institutes, NGOs, etc
  - Information collection
  - Information dissemination
  - Complement above
- Research Institutes/Organizations
  - Science development
  - STEM education provision

## – Individuals

- Citizen Science, Participatory Sensing, VGI...
- Personal interest
- Passive collection
- Other

# And who is using AQ data?

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- **Information/data users**
  - All information/data producers
    - Environmental monitoring
    - Env. Management & control
    - Decision making
    - Reporting
    - Sustainable production
    - Other

# Big data lead to big challenges



**Social media and networks**  
(Everybody is generating data)



**Scientific instruments**  
(collecting all sorts of data)



**Mobile devices**  
(tracking all objects all the time)



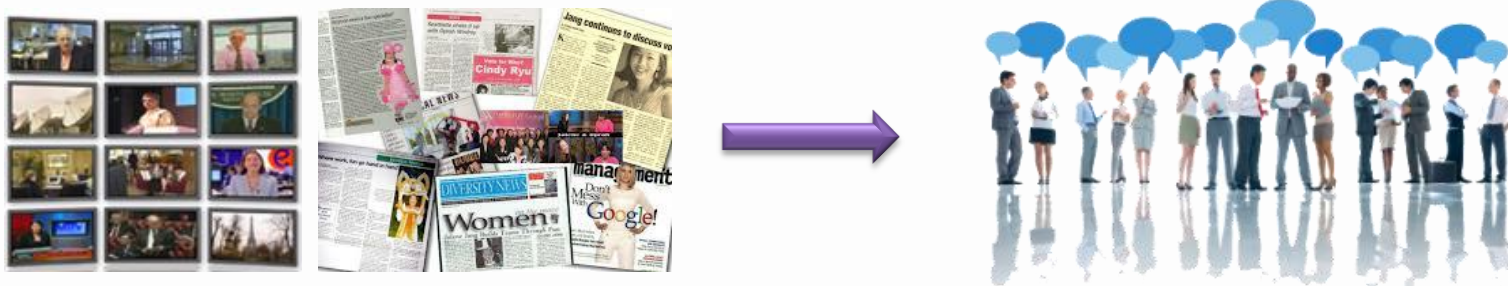
**Sensor technology and networks**  
(measuring all kinds of data-IoT)

- Innovation is no longer hindered **just by the ability to collect data.**
- But **also by the ability to manage, analyze, summarize, visualize, and discover knowledge** from the collected data in a timely manner and in a scalable fashion.

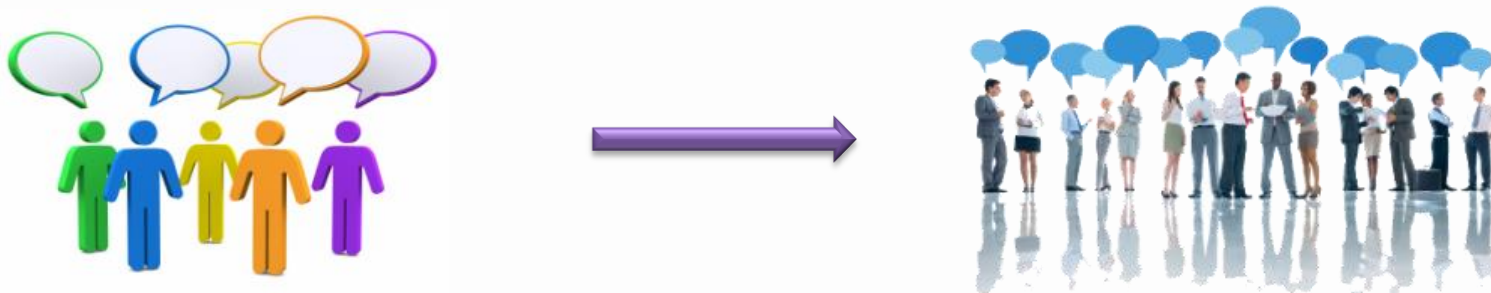
# The Data Producing Model Has Changed...

## New AQ sensor technologies change the scene:

**Old Model:** Few are generating data, all others are consuming data



**New Model:** all of us are generating data, and all of us are consuming data



# Focusing on citizens

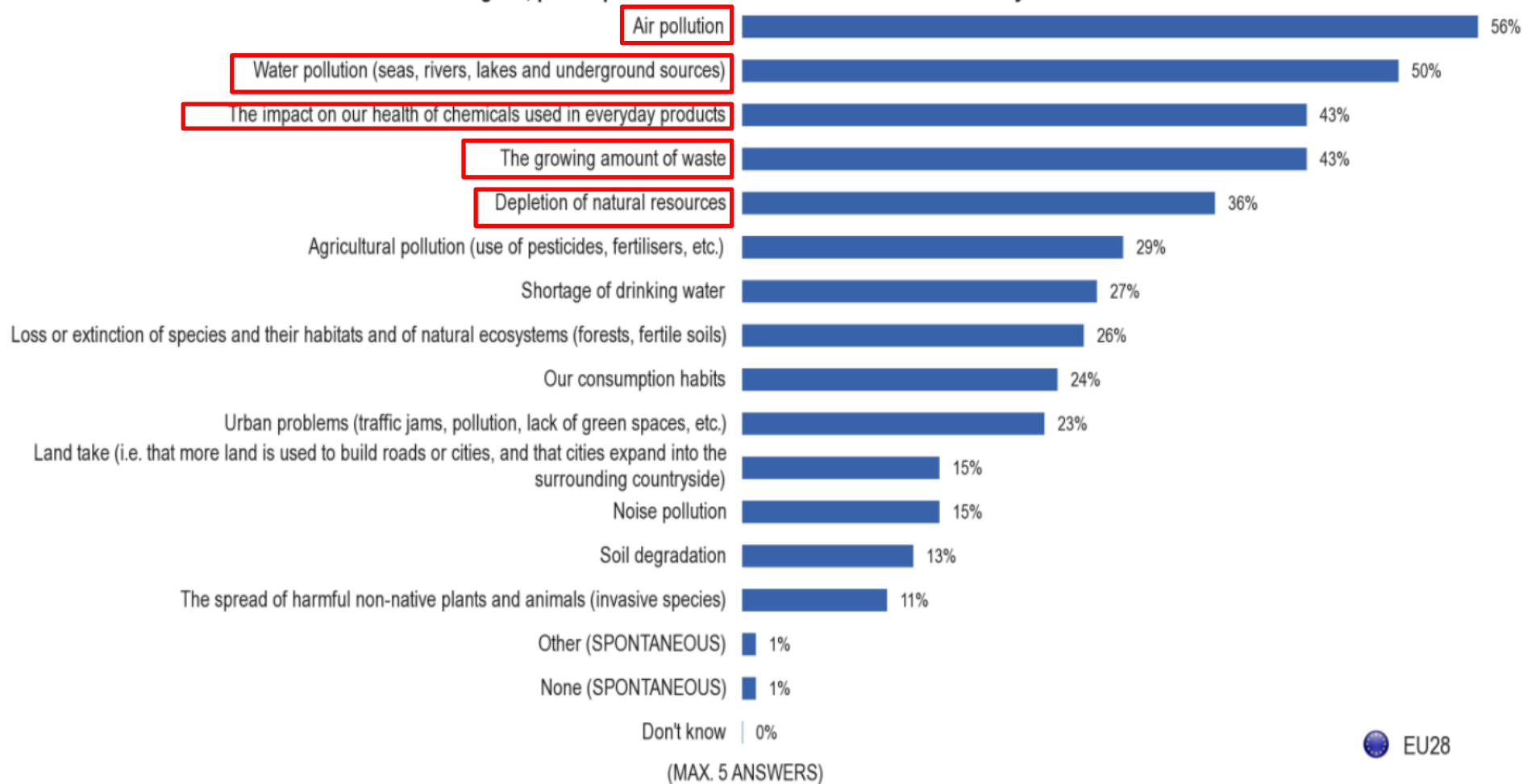
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- Over three-quarters of respondents feel that environmental problems have a direct effect on their daily lives (*Eurobarometer, Sept 2014*)



# Main environmental issues

QA2. From the following list, please pick the five main environmental issues that you are worried about.



# New AQ related service concepts

- Increased data collection and processes will enable self-learning digital services

[CLEEN strategic research agenda for the theme Sustainable city](#)

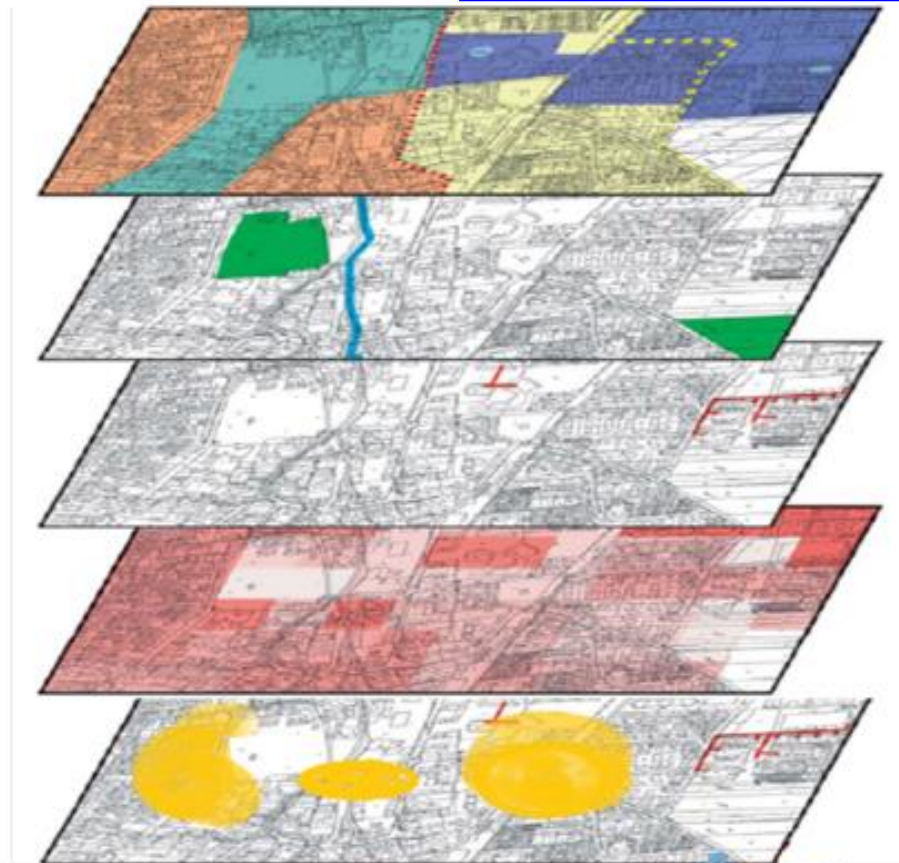
Energy use and peak power demand

Potential of local renewables

Existing energy and other infrastructure networks

Preferred living and working areas

Air quality



# Learning from others: The CAFE Directive

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- Annex XVI: information to be provided to the public should include
  - information on **observed exceedance(s)**
  - **forecast** for the following afternoon/day(s)
  - information on the **type of population concerned, possible health effects and recommended behaviour**

Personalized, user tailored,  
area specific, activity related,  
impact oriented,  
information provision

# The VGI dimension in AQ monitoring

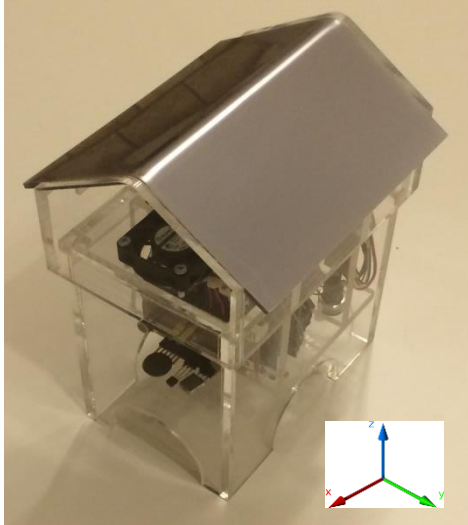
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## Information types:

- **Structured**
  - Machine generated
    - Direct: **AQ sensor data->"hard sensors"**
    - Indirect: use of common sensors to extract scientific info (atm. blurness form photos)
  - Human-generated on the basis of a collection protocol ("soft sensors") (example: [Atmos platform](#))
- **Unstructured**
  - From social media ([twitter](#) etc)
  - From multimedia "containers" (youtube, flickr, etc)

# Our VGI-AQ related project examples

**Mobile AQ monitoring unit**



**EnvironmentObserver: an Android-based software applications for participatory AQ visualization and information provision created in the frame of an MSc thesis supervised in Edinburgh University**



**EnVisensor: Arduino-based air quality sensor module created in the frame of an MSc thesis supervised in Edinburgh University**



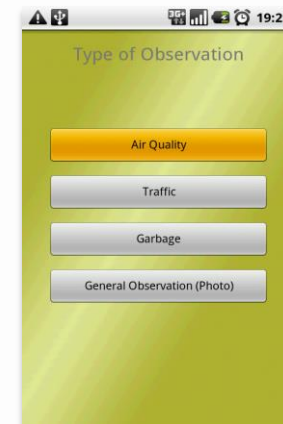
**ISAG BlueToothSensor: An Android based generic application for micro sensor interfacing and monitoring**

| Connections | Devices | Sensor | D.I.                |
|-------------|---------|--------|---------------------|
|             |         |        | 21.094789 23.9 44.9 |

**ThessByBUS: an Android based participatory application for public transportation**



**EnviDroid & AllergyObserver  
2 Android-based applications for the collection of environmental data and info on hay-fever allergy symptoms**



- **Problem analysis and modelling.** Selected publications:
  - Karatzas K. (2010), **Artificial Intelligence Applications in the Atmospheric Environment: Status and Future Trends**, Environmental Engineering and Management Journal 9, No.2, 171-180
  - Rönkkö M., Kotovirta V., Karatzas K., Bastin L., Stocker M. and Kolehmainen M. (2012), **Proactive Environmental Systems: the Next Generation of Environmental Monitoring**, International Environmental Modelling and Software Society (iEMSs), 2012 International Congress on Environmental Modelling and Software
  - Riga M. and Karatzas K. (2014), **Investigating the Relationship between Social Media Content and Real-time Observations for Urban Air Quality and Public Health**. In “Proceedings of the 4th International Conference on Web Intelligence, Mining and Semantics (WIMS '14)”.
- **Personalized, QoL information services provision.** Selected publications:
  - Karatzas K. (2009) **Informing the public about atmospheric quality: air pollution and pollen**, Allergo Journal 18, Issue 3/09, pp 212-217
  - Karatzas K. (2011), **Participatory Environmental Sensing for Quality of Life Information Services**, in *Information Technologies in Environmental Engineering*, Proceedings of the 5<sup>th</sup> International Symposium on Information Technologies in Environmental Engineering, Poznan, 6-8 July 2011, (Golinska, Paulina; Fertsch, Marek; Marx-Gómez, Jorge, eds.), ISBN: 978-3-642-19535-8, Springer Series: Environmental Science and Engineering, pp. 123-133
  - Stefanis I., Tsavlidis I., Mavros S., Karamanlis D., Bassoukos A., Voukantsis D., and Karatzas K. (2012), **Community-powered advancement of public transportation with the use of mobile technologies: a participatory environmental sensing approach**. In: Protection and Restoration of the Environment XI, International Conference Proceedings (Katsifarakis K.L., Theodossiou N., Christodoulatos C., Koutsospyros A. and Mallios Z., eds), Thessaloniki, Greece, ISBN:978-960-99922-1-3, pp. 1973-1982
  - Berger U., Karatzas K., Jaeger S., Voukantsis D., Sofiev M., Brandt O., Zuberbier T. and Bergmann K.C. (2013), **Personalized pollen-related symptom-forecast information services for allergic rhinitis patients in Europe**, *Allergy* (68), pp. 963-965
  - Moumtzidou A., Epitropou V., Vrochidis S., Karatzas K., Voth S., Bassoukos A., Moßgraber J., Karppinen A., Kukkonen J. and Kompatsiaris I. (2013), **A Model for Environmental Data Extraction from Multimedia and its Evaluation against various Chemical Weather Forecasting Datasets**, Ecological informatics, doi: 10.1016/j.ecoinf.2013.08.003
  - Voukantsis D., Berger U., Tzima F., Karatzas K., Jaeger S., Bergmann K.C (2014), **Personalized symptoms forecasting for pollen-induced allergic rhinitis sufferers**. Int. J. of Biometeorology. accepted

# Conclusion

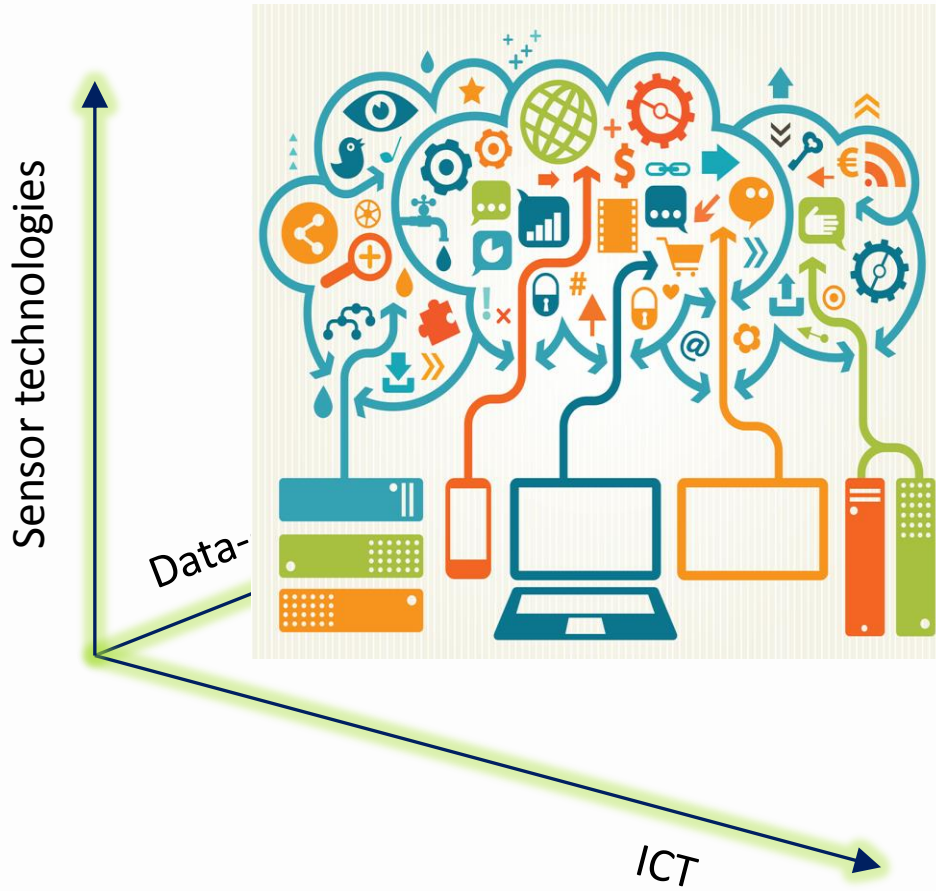
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## Developments in

- sensor technologies,
- data-oriented computational methods and
- ICT

may revolutionize environmental monitoring and thus lead to a new generation of information services, with strong QoL orientation.

# QoL information services!

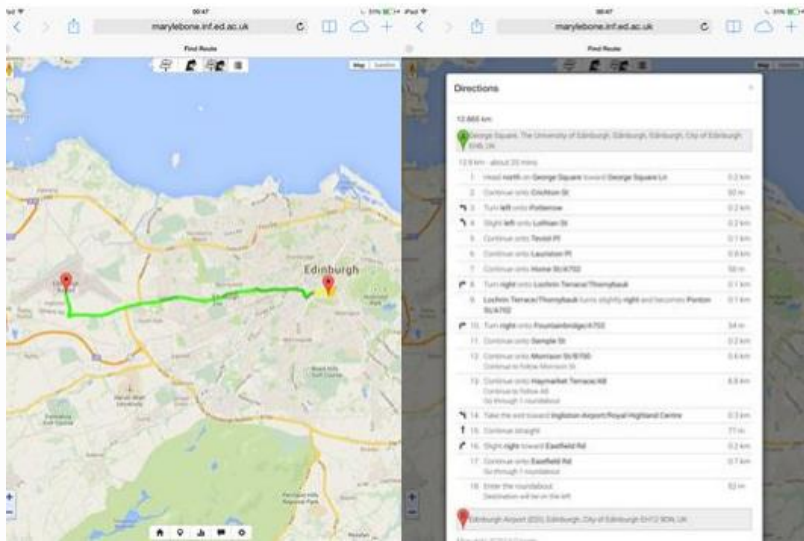




# A simple example



Figure 19: Route changed by user. Yellow areas are more polluted than green areas



Sustainable urban mobility: Avoiding polluted areas in cities

Beatrice Dong, MSc thesis, MSc design and Digital Media, Edinburgh, August 2014

Thank you!

Questions?