Real-time crowd-sourcing, data and modelling

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1. Abstract

QCumber is a usable and fast city data platform integrating interactive maps, crowd-sourcing, and real-time data. QCumber combines official data with crowd-sourced data, allowing the public to collectively edit and manage data, and increasing feedback and communication between city authorities and the public. Integrated scientific modelling tools allow assessment of impacts such as noise, odour nuisance and air quality. This paper describes two recent case studies: a study for Innovate UK proving the feasibility of QCumber for UK cities, and the use of QCumber by Italian cities for real-time assessment of odour nuisance.

In a 2014 feasibility study funded by Innovate UK, CERC and Algebra worked with local authorities in five UK cities (Belfast, Birmingham, Cambridge, Ipswich and London), creating private prototype platforms for each city. These platforms contained more than one hundred datasets from over thirty data providers, and demonstrated the integration of scientific models with real-time data to produce output such as air quality forecasts. All five cities were enthusiastic about the potential benefits of the system, and proposals are being developed for the public deployment of the platforms.

QCumber has been adopted in Italy by municipalities and companies for decision-support and monitoring, such as real-time assessment of odour nuisance. Citizens can report odour problems in the QCumber map interface. QCumber then mines the crowd-sourced data by combining meteorological data with the state-of-the-art dispersion model ADMS (developed by CERC) to identify likely sources of the issue and facilitate corrective action.

2. Introduction

With over half the world's population already living in urban areas, making cities work better is a critical challenge for this century. Cities are struggling to find a sustainable response to challenges such as migration, demographic change, congestion and pressure on resources. Increasingly cities are using a 'smart city' approach to respond to these challenges, creating innovative integrated solutions using new technologies.

Impact assessment – identifying the future consequences of a current or proposed action – will be a vital part of these solutions. New technologies and instant access to information offer the opportunity to assess impacts more quickly than ever before. Another new opportunity is presented by 'crowd-sourcing' and social media, enabling public feedback and issue reports to be 'mined' as a new source of information in its own right.

- *Crowd-sourcing* is 'the practice of obtaining needed services, ideas, or content [information] by soliciting contributions from a large group of people and especially from the online community rather than from traditional employees or suppliers.'[1]
- *Social media mining* is 'the process of representing, analyzing, and extracting actionable patterns from social media data.'[2]

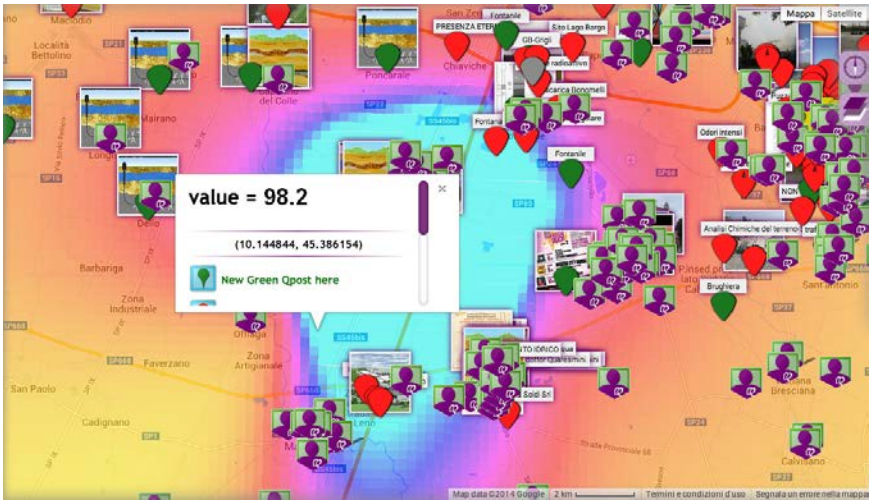

Figure 1. The QCumber web interface, showing output from a scientific model (ADMS) and crowd-sourced information from the public

QCumber (www.q-cumber.org) is an interactive platform for monitoring an area and the sustainability of the local environment through the integrated use of environmental data, simulation models and direct participation of citizens on Google Maps (Figure 1). In 2012 QCumber was selected as one of the 100 most interesting ideas in the world at the 'Start-Up Games' organized by UK Trade & Investment's TCIO during the 2012 Paralympic Games.

QCumber contains scientific models (such as CERC's state of the art air pollution and odour model ADMS[3][4] and the noise model SOUND32) validated by the major international agencies that work on environmental impact, to allow the user to study an area scientifically. QCumber's social media and crowd-sourcing features also allow the user to learn and participate in the growth of a new consciousness which is necessary for a new environmental and social sustainability that grows 'from the bottom'.

Today QCumber is a growing reality in Italy and internationally. It allows administrators to assess environmental impacts in the geographical area for which they are responsible. It suggests concrete corrective actions for improving the conditions for sustainability and allows dialogue between citizens, businesses and institutions.

In particular, the platform:

- Supports the activities of planning, programming and management of a region with respect to the opportunities and critical environmental issues identified by the citizens (crowd-sourcing);
- Manages the monitoring of specific and cumulative environmental impacts and risks, in accordance with the legislation in force, due to human activities in the geographical area.

The system allows correlation of the impact values calculated by scientific modelling in the platform with the information posted by users. In Italy, the system has been adopted:

- By some municipalities as a decision support system for sustainable planning and management, based on the impact of human activities;
- By some companies to support the identification and activation of corrective actions for the reduction of impacts on environmental resources, ecosystems and human communities.

3. Case Study: Feasibility study for Innovate UK

In 2013-14 CERC and Algebra conducted a study for the Innovate UK competition *Future City Solutions* entitled 'QCumber: Feasibility of an enhanced open city data platform with crowd sourcing.'[5] The study proved the benefits of QCumber as a city management platform that can connect the disparate data sets and data sources to be found within a city.

The study involved local authorities in five UK cities (Belfast, Birmingham, Cambridge, Ipswich and London) as 'test-bed' users, who provided data for the trial and gave invaluable feedback on the platform through workshops, meetings and phone calls. Private prototype platforms were created for each city, containing over one hundred datasets from over thirty data providers (Figure 2).

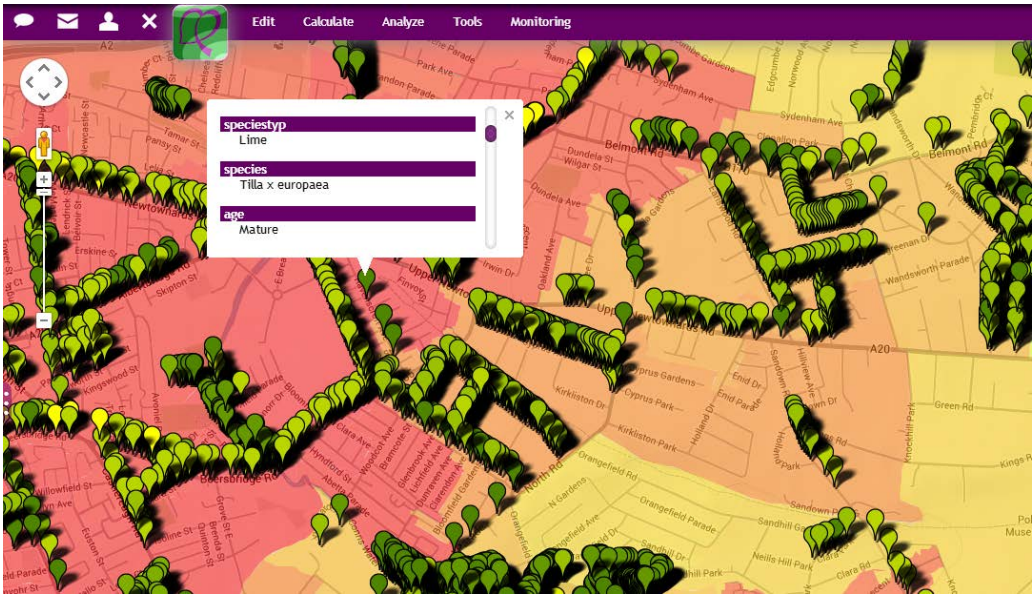

Figure 2. Data visualisation in QCumber. A dataset of 27,000 city trees in Belfast coloured by tree age, overlaid on a measure of the quality of the outdoor physical environment.

Private prototype smartphone apps were also created which connected to QCumber using its open APIs. An API (Application Programming Interface) is 'a set of rules and specifications that a software program can follow to access and make use of the services provided by another software program or system.'[6] QCumber's APIs allow external apps to be embedded in the QCumber platform, and allow external systems and apps to access QCumber's data and services.

The QCumber prototype for London included near real-time output from scientific models: specifically, air quality forecasts for London produced by CERC's state of the art atmospheric dispersion model ADMS-Urban. These air quality forecasts were taken from the *air*TEXT service for London, which is operated by CERC with support from the Mayor of London, the GLA and the London boroughs (www.airtext.info). It provides free forecasts of air quality, ultraviolet radiation (UV), pollen and temperature.

The conclusions of the feasibility study were:

- the QCumber platform is fully transferable to different cities;
- all five test-bed cities are enthusiastic about the potential benefits of the system;
- city authorities have limited resources and welcomed and needed support from CERC and Algebra;
- city authorities are keen to see continuity of the platform;
- open API standards are powerful tools to encourage API usage by standardising APIs across different providers and are entirely suitable for use with QCumber;
- digital inclusion and accessibility are important challenges in the use of new technologies to help cities adapt to modern pressures.

4. Case study: Odour nuisance in Italy

QCumber's core engine, DCGIS (Dynamic Computational Geographic Information System) is an integrated system for identifying, predicting, evaluating and monitoring environmental impacts. It has been adopted by a number of institutions and municipalities in Italy, including provinces of Lombardia, the Lombardia Region, and the Regional Environmental Protection Agency of Lombardia (ARPA Lombardia).

Since 2011 DCGIS has become the methodology used in training at the Department of Brescia Regional Environmental Protection Agency (ARPA Lombardia) as a support system for analysis of environmental impact of projects, plans and programmes.

The computational modelling platform DCGIS WORKSTATION was licensed in 2013 by ARPA Lombardia and the application DCGIS Screening Tool was licensed in 2010 by the Lombardia Region

and by the provinces of Lombardia and adopted as the official model of screening (Environmental Impact Assessment, EIA) for recovery facilities and/or waste disposal.

One example usage is real-time assessment of odour nuisance. Citizens can report odour problems, providing an estimate of the odour nuisance level on a simple scale of five levels (Table 1) by clicking on a point on the map display (Figure 3). At the time of publication (June 2015) there have been over 3,800 such citizen reports of odour through QCumber: 20% at level 1, 14% at level 2, 29% at level 3, 22% at level 4 and 15% at level 5.

Odour Level	Explanation
1	Absent
2	Weak
3	Intense
4	Very Intense
5	Insufferable

Table 1. Levels of odour nuisance used in QCumber

QCumber enables the user to mine the crowd-sourced data through statistics, such as the number of alerts per day of the week per level, and the number of alerts per hour of the day per level (Figure 4). The user can also combine: the crowd-sourced data on odour nuisance; official data on possible sources of odour; near-real time meteorological data; dispersion modelling using ADMS to identify likely sources of odour nuisance for corrective action (Figure 5).

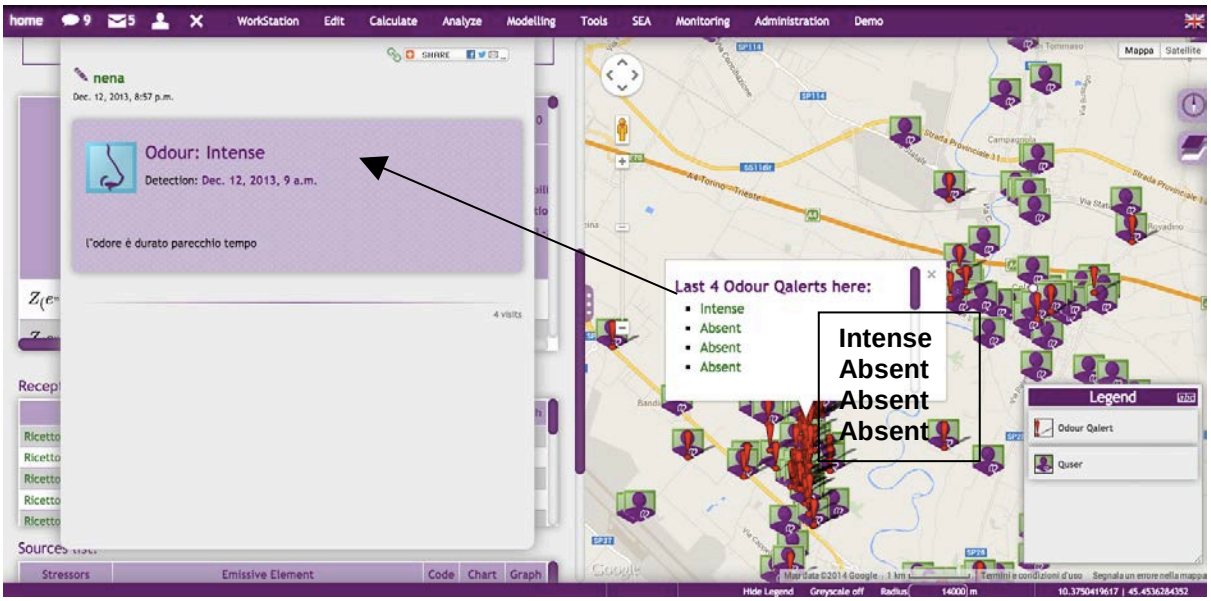

Figure 3. Four reports of odour problems with dates and times and different nuisance ratings and comments. The highlighted comment says "The smell lasted a long time"

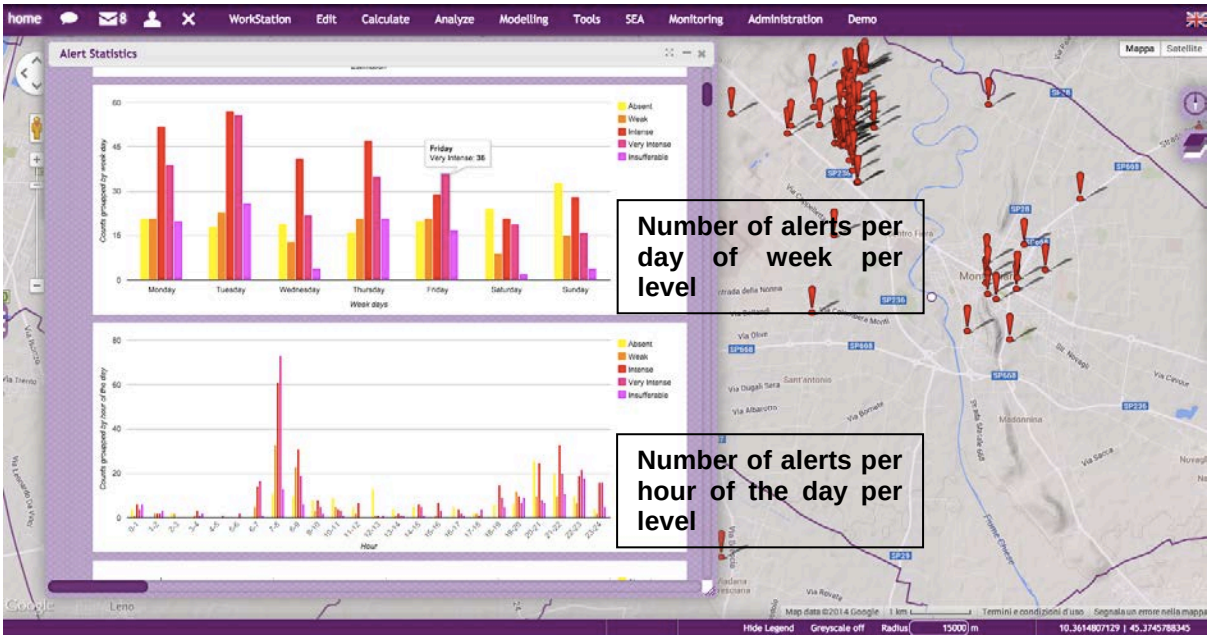

Figure 4. Mining crowd-sourced reports of odour nuisance in QCumber.

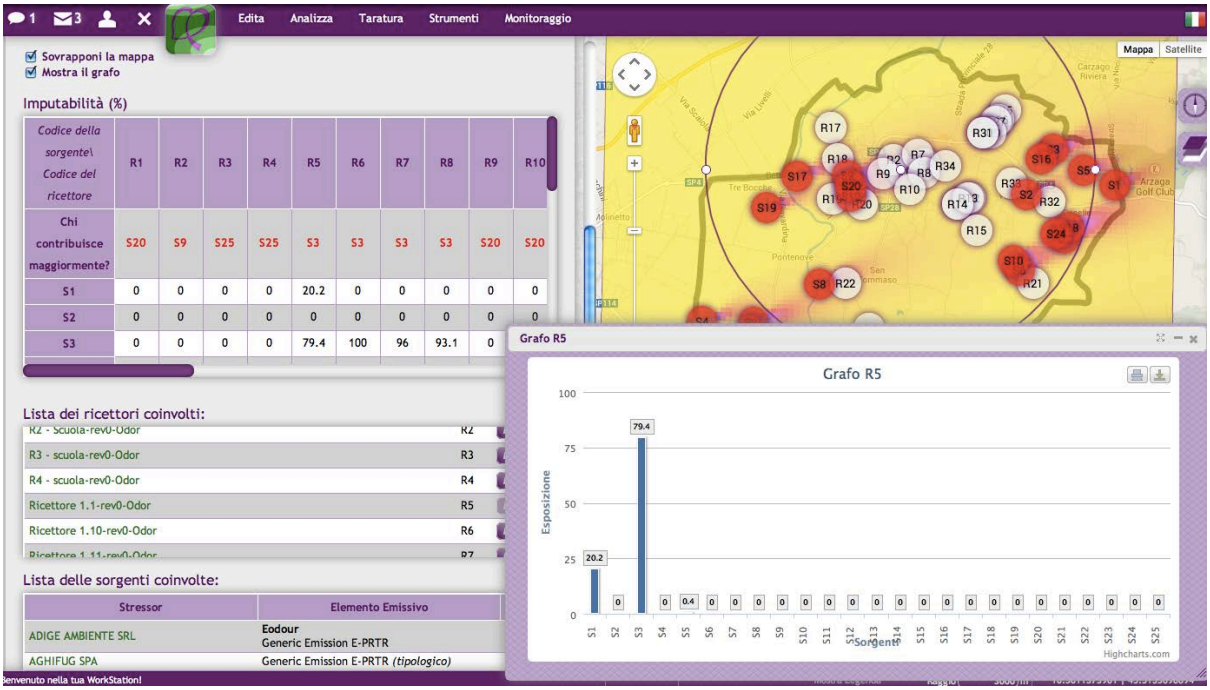

Figure 5. Dispersion modelling for odour in QCumber using ADMS. Multiple sources and receptors have been modelled, and the contribution from each source at each receptor is reported.

5. Conclusions

QCumber has been successfully applied as an operational platform which integrates interactive maps, crowd-sourcing, real-time data, and impact assessment. In the Innovate UK feasibility study the platform was used to integrate real-time data with scientific modelling to provide air quality forecasts for London. In Italy it has been adopted by municipalities for decision support and modelling for real-time assessment of odour problems. QCumber is a growing reality, creating new ways to understand and assess impacts in the context of a 'smart city' approach to sustainability.

6. References

[1] "Crowd-sourcing." *Mirriam-Webster.com* (2015). http://www.merriam-webster.com (6 Feb 2015).

[2] Zafarani R., Mohammad M. A., Liu H. (2014) Social Media Mining: An Introduction. *Cambridge University Press*.

[3] Carruthers D. *et al.* (1994) UK-ADMS: A new approach to modelling dispersion in the earth's atmospheric boundary layer. *J. of Wind Engineering and Industrial Aerodynamics*, vol. 52, pp. 139-153, DOI: 10.1016/0167-6105(94)90044-2

[4] ADMS 5 (2015) www.cerc.co.uk/ADMS (6 Feb 2015)

[5] Jackson M., Magro G., (2014) Future Cities: unleashing the data. *GIS Professional,* issue 57, April 2014, pp 10-12. bit.ly/1qePX4o

[6] Ebbers M. *et al*. (2011) Introduction to the New Mainframe. *IBM Redbooks.*