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Smart Cities: Environmental Aspects and Opportunities

Marcus R Wigan, *Oxford Systematics*



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Smart Cities: Environmental Aspects and Opportunities

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Introduction

- **My thanks to Wuxi and IEEE for being invited here**
- **The text in your package is an early set of speaking notes, and far from the final text, supplied only for early comment**
- **I hope it will at least be helpful to complement my talk**
- **The SSIT Division of IEEE asked me to be sure to address the wider social impacts of Smart City technologies**
- **This requires attention to be paid to more than sensors...**

Contribution from the SSIT part of IEEE (Social Impacts of Technology)

- Environment **includes** social, infrastructure, pollution, impacts
- Medical and Transport issues are critical (see other speakers)
- Technology has major social and organisational impacts
- Smart Cities are no exception
- There are lags in securing the full benefits.....
- Due to the socio-technical system (the society as a whole) adapting in response to the need to integrate new capacities
- Smart cities are emerging from many different directions

Key Points for Environmental gains

- **Time scales matter**
- **Environmental sensors offer real time data**
- **Response mechanisms are not solely technical**
- **Goals and standards are fine, but pathways critical**
- **Big Data flows emphasise algorithmic importance**
- **Isolating “what matters” in short and long term**
- **Governance highlights how these choices are identified, modified, and implemented**
- **Urban Design is a key part of smart cities**
- **Smart infrastructure can mediate bad Urban Design – but only for a while. Ideally integration from the start**

Environmental domains in Smart Cities

- Smart cities are defined many ways
- The common factor is a wider and deeper deployment of ICT
- Enhancing each individual system is only one step
 - transport, energy, waste, water all examples
- Changing to integration affects all the organisations
- Objectives for each area of the City will tend to vary
- There are distributional impacts on **different age groups**, and in their physical and social environment
- Physical infrastructure monitoring needs to be an explicit component

What can we observe from current Smart Cities?

- **Some cities are aiming to minimize costs, often governmental or supragovernmental initiatives**
 - **Santander, Spain with the EU (a 40% cut in lighting \$)**
- **Others: Global multinational ICT company engagements**
 - **Rio de Janeiro, Brazil.**
- **Smart Cities generally began with transport – but now add waste, water, energy, lighting, floods and crime**
 - **Rio contralises data flows into a central control centre**
- **This initiates a second stage of Smart City: sensors and communications-> Command and Control**
- **This raises real inter-organisational conflicts, software standards and, inevitably, governance outcomes**

More observations

- **IBM (and to a lesser extent Cisco and Intel) are driving their ICT-framed Smart City concept with cash and support**
 - **16 new cities this year alone with IBM consulting support; Is this ICT framing environmentally sound?**
- **Some cities are or have been built up from green fields**
 - **Examples Songdu: South Korea, Masdar: Abu Dhabi**
 - **Lessons learned: skills and resources shortages**
 - **Environmental gains subordinated to cost reductions**
- **There are clear lessons here for Wuxi to work to avoid**
 - **clarify and make explicit the environmental goals**

Time scales; how long for major impacts?

- **The history of technology shows that lags are normal**
- **E.G. The boosts in productivity from microcomputers took nearly a decade to be fully realised**
- **The reasons for slow ICT realisation of gains and to secure final positive impacts are mainly organisational**
- **Organisational changes are needed to reflect potential**
- **Change is always difficult and requires both a critical mass of understanding plus organisational responses**
- **For ITC - central to Smart Cities - the growing legal, privacy, Intellectual Property barriers are not trivial**
- **The relative importance of these issues are cultural and these differ widely across countries and systems**

Smart Cities and securing the gains

- **We can learn from the experience of the 1990s computerisation of firms**
- **MIT studied how long it took 600 firms to secure the full benefits and productivity from computerisation**
- **The results were 5-10 years from the installation as organisational adaptation and other factors all took time to develop and complementary investments**
- **Smart Cities will inevitably encounter corresponding adaptation lags before the full benefits are secured**
- **These will differ from subsystem to subsystem**
- **Environmental gains from transport will be the most rapid as the regulatory tools are largely in place**

Tactical and Strategic gains

- **The technical tasks for a full Smart City are very substantial with the many streams of city functioning**
- **The (initial) tactical gains are cost reductions, plus performance enhancements - but not larger changes**
- **The strategic gains are not only for Smart City citizens, but also for the city as a whole**
- **Global development is increasingly placing global competition as City v City ..**
- **The social and physical environment is a critical attraction and competitive aspect of this competition**
- **Smart City overall environmental gains are key assets**

Progress of mass (city) data access

- **Early 2000's Data Observatories (ROMULUS, Norfolk) and own Napier Knowledge Base and now overtaken now by the data creation explosion of ITC**
- **Pressed by citizens for access – led to Open Gov Open Data and Open GIS data**
- **The next question is how best to use it once we have it: the central Smart City issue**
- **Already a Key question is how Big Data analytics can be realised for social gain with personal privacy**
- **The sensors are all feeding on-and being fed by - the Private Data Commons (Wigan and Clarke 2013)**

M. R. Wigan & R. A. Clarke 201 "Big Data's Big Unintended Consequences," *IEEE Computer*, vol. 46, pp. 46-63

M.R.Wigan, Kukla, R, Benjamins, M Grapshoff ,P (2007) RKB: A Knowledge base to support research documentation, data, GIS, spatial data and communications for a major rail freight project, European Transport Conference, 24p

Data Ownership an essential component

- You **do not own** your own data - even that which legally defines your identity

M.R.Wigan 2010 "Owning identity - one or many - do we have a choice?". *IEEE Technology and Society* 2 (29), 33-38

- All data is contestable
- Cumulative risk potential to individuals
- Sensors for air pollution **appear** to be neutral here
- But Water and Energy are forensically accurate- even the brand of TV in use were identified in NY
- The energy sector with Smart Meters took a massive formal citizen effort to admit it was "private data"

M. R. Wigan, 2014 "Smart Meter Technology and User Issues," *IEEE Technology and Society Magazine*, vol. 33, pp. 49-53

- Similar pressures to commercialise environmental Open data as it emerges could undermine the gains

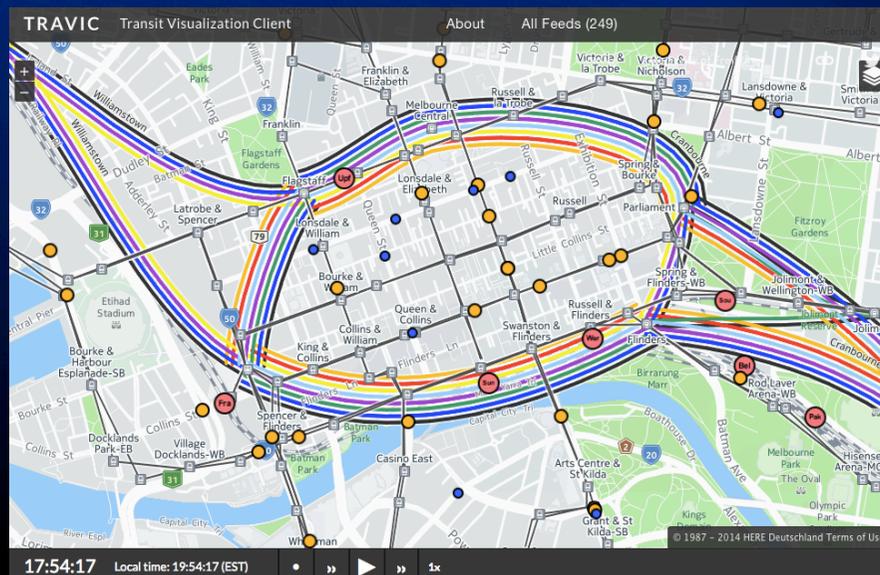
City Open Big Data and results of access to it

- Speedy global community responses to Open Data
- A GTFS release for one city led to live action within four weeks by a student on the other side of the world

<http://tracker.geops.ch/?z=15&s=1&x=16137258.9342&y=-4553302.4957&l=here>

- Contestability of public policy is empowered by this

Legacy, C, Sturup, S., Curtis, C and Wigan, M. 2009. "Delivering infrastructure and Land use-transport integration policy: Examining good governance issues in Melbourne and Perth". Australian Transport Research Forum

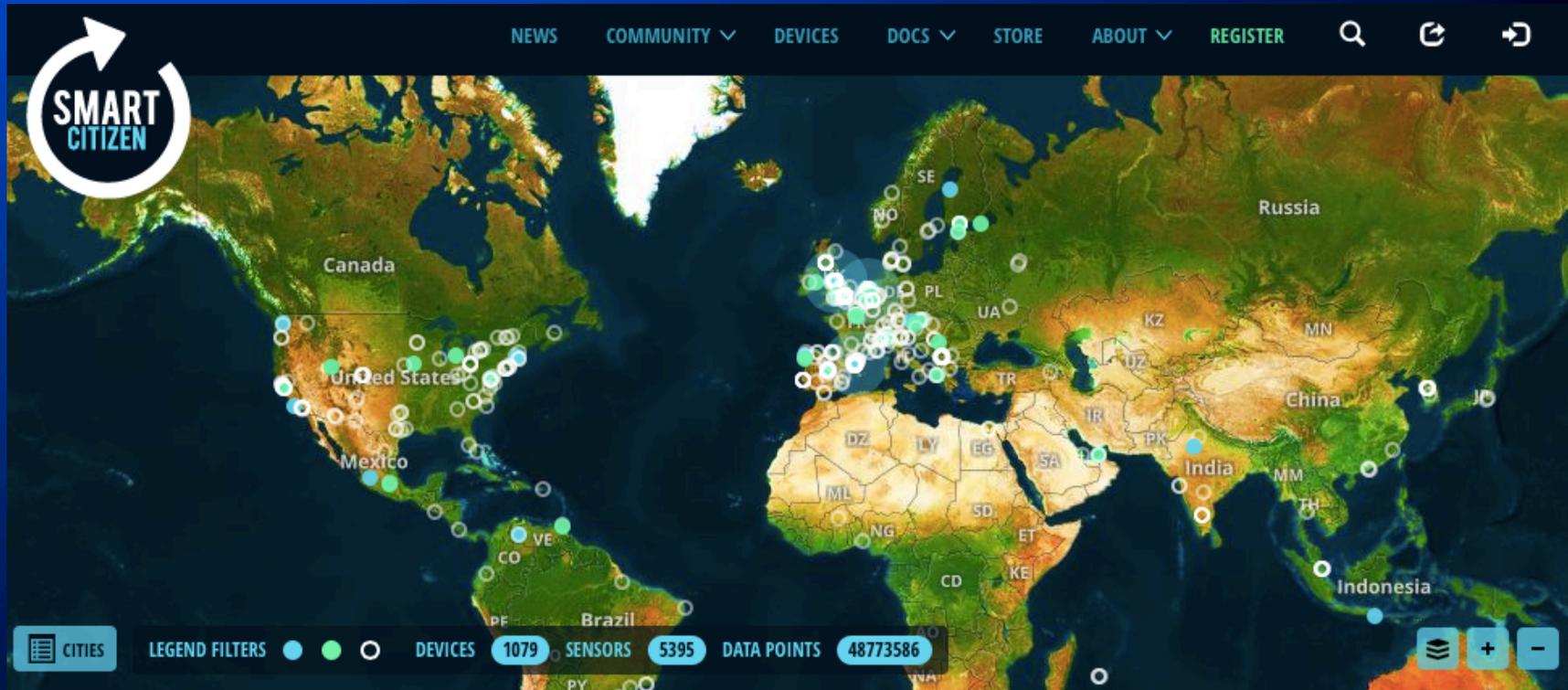


Environmental Citizen Science

- **The players in Smart City environmental capacities**
 - **Operational bodies making use of sensor data**
 - **Provision of Open Data is a key issue**
 - **Big Data analysis valuable to identify issues +action?**
- **A new player has emerged: citizen science**
 - **Personal communicating environmental sensors**
 - **COBWEB EU project addresses citizen sourcing**
 - **Open Source data creation: Not just using others data**
 - **Open Analytics events are already a reality**
 - **The first two used Open Environmental sensor data**

Open Citizen Science: Environmental Sensor growth

<https://smartcitizen.me>



Open source technology for citizens' political participation in smarter cities

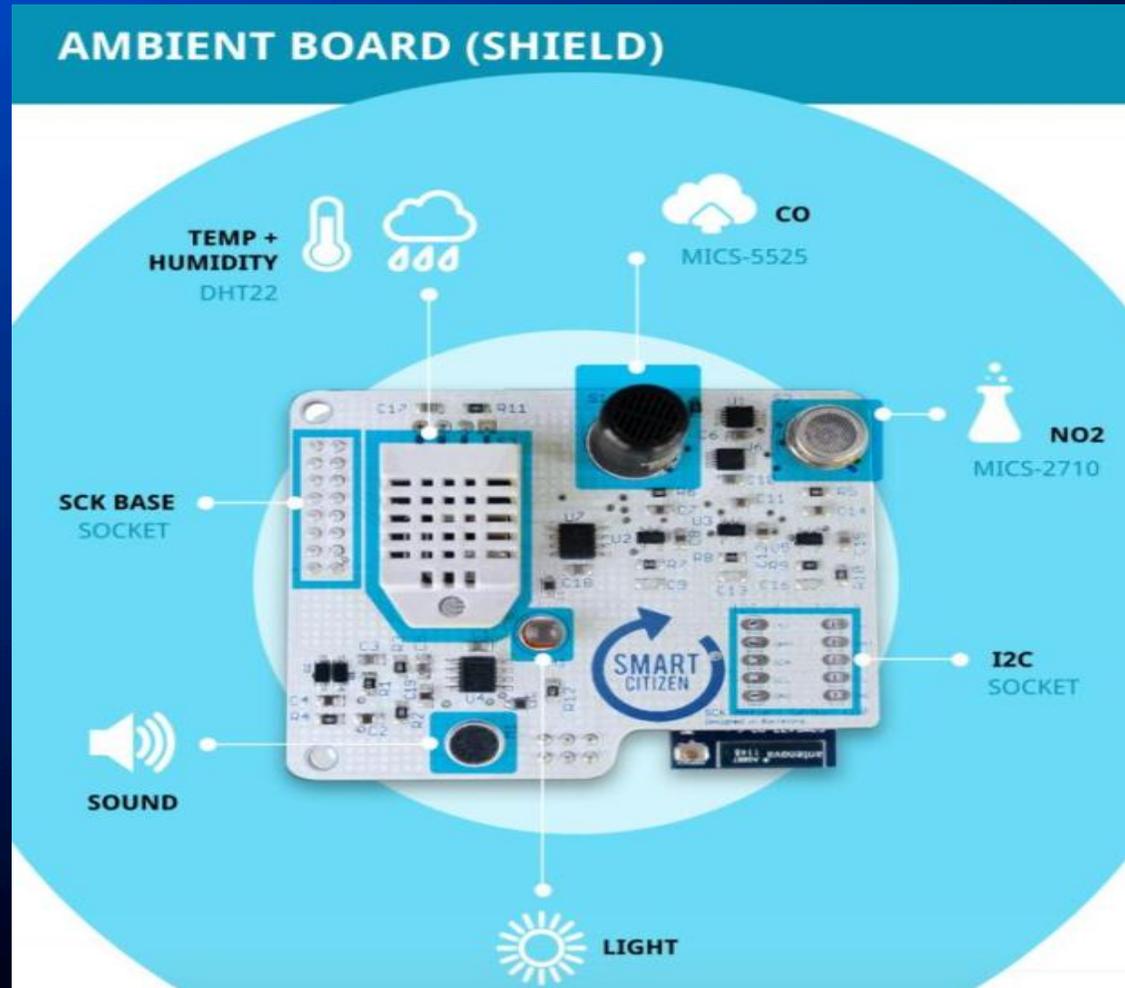
Based on geolocation, Internet of Things, Open Source hardware and software for data collection and sharing

SIGN IN

REGISTER

Ambient Board (Fab Lab, Institute for Advanced Architecture of Catalonia)

- One example of Citizen Open Source Sensor initiative



Infrastructure Environment Sensors

- **Environmental aspects of Smart Cities also require serious attention to infrastructure Smart monitoring**
- **Civil Engineering has recently taken rapid steps here**
- **Used in underground major projects such as CrossRail**
- **A top innovation development in UK programs**



- **Unterberry is tiny Wifi enabled 15mw micro power micro sensor, long life robust and with submillimeter detection**

Overseas socio-technical developments

- The resistance to, and concerns about, many of the components of Smart Cities now have real attention
- The socio-technical area of environmental studies have developed the concept of community acceptance or virtual permission as a key requirement
- This is now subject of an EC Project, with multi-country engagement. The term used is ‘**environmentality**’
- A Key tool as Smart City sensors and data systems move steadily to **at least** partially-automated control systems.
- **Early collaboration in and between Smart Cities – Valuable**

P. Newton, "Liveable and Sustainable? Socio-Technical Challenges for Twenty-First- Century Cities," *Journal of Urban Technology*, 2012.

J. Gabrys, "Programming environments: environmentality and citizen sensing in the smart city," *Environment and Planning D: Society and Space*, vol. 32, pp. 30-48, 2014.

Modelling organisational interactions

- **One way to learn from Smart City projects is to build agent based models of the interactions**
- **This will expand the range of specialists involved and include both people with ABM skills and others skilled in determining the organisational interactions**
- **Koen et al (2012) is a typical edited book resource on recent work in this area**
- **Water has long led the way in having to address inter organisational environmental conflicts, is a core requirement for Smart Cities, and has moved this way**

H. v. D. Koen, I. Nikolic, and Z. Lukszo, Eds., *Agent-based modelling of socio-technical systems*. Springer, 2012

Water exmples: <http://watersensitivecities.org.au/programs-page/society-program-a/project-a4/project-a4-3-socio-technical-modelling-tools-to-examine-urban-water-management-scenarios/>

A gentle warning

- **The cumulative scale of a full Smart City is undoubtedly that of a MegaProject**
- **Flybjerg's three iron laws of megaprojects are: “*Over budget, over time, over and over again*”**
- **Sturup found governance always a problem ‘but things tend to work out with ‘*survival of the unfittest*’**
- **All these are governance issues, at root due to mismatches between the expectations with**
 - **different disciplines and levels,**
 - **time horizons, and**
 - **nature of responsibilities of different stakeholders.**

Checklist: Maximising environmental gains

- Integrate citizen science as discussed
- Design from the start for privacy where possible
- CoDesign with segments **like the elderly**
- Support Open Data and Open Standards
- Play an active role in Standards in Smart Cities for Sensors and Protocols (largely done for ITS)
- Involve socio-technical expertise to ensure maximum transfer and takeup of Smart City initiatives as they mature, and
- Perhaps use Agent Based and models in support
- Bring in Urban Design specialists and their horizons