"Distributed Sensor Networks - the Key to Democratising Environmental Regulation Enforcement"

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ICT for Environmental Regulation Workshop
School of Law, NUI-Galway
20-21 June 2013

'It is not possible to evaluate improvements if one cannot measure the original and final situations'

Lord Kelvin (Sir William Thompson)

If you can't measure it, you can't improve (or regulate) it

Examples of Legislation (water only)

- **Bathing Water Directive,**

- **Drinking Water Directive**

- **Environmental Impact Assessment Directive**

- **Sewage Sludge Directive**

- **Urban Waste Water Treatment Directive**

- **Nitrate Directive**

- **Integrated Pollution Prevention Control Directive,**

  - cost recovery for water use,

  - measures to promote efficient and sustainable use of water,

  - protection of drinking water sources,

  - authorisation of discharges to groundwater,

  - control of point source discharges and diffuse source pollution,

  - prevention or reduction of accidental pollution

Internet-scale sensing and control

(Ron Ambrosio & Alex Morrow, IBM TJ Watson)

'Water European Innovation Partnership'

- **To be launched 2013**
  - European Water sector has a turnover of about €100 billion p.a.
  - boost the competitiveness and growth of the European water sector
  - 9000 active SME's
  - 600,000 direct jobs in water utilities alone

- **key barriers to innovation in the sector highlighted in this research proposal has been the 'predominance of existing technological solutions (choosing existing tested technologies)'**

- **Sector is characterised by conservative attitudes to new technologies – H2020 sets out to change this!**

http://ec.europa.eu/environment/water/innovationpartnership/pdf/Draft Consultation Document.pdf

Recent Developments

- **INSIGHT – Big Data (Science Foundation Ireland)**

  – Biggest single investment by the state in an ICT research programme; €45 million + €30 million industry contribution

  – Health & exercise focus – but the sensing challenges and informatics framework (cloud based data) apply also to remote environmental monitoring

- **Need to develop national capacity NOW!**

  – Development of existing environmental monitoring capabilities

  – Expanding and strengthening partnerships, **National and International**

  – National investments (metering infrastructure, water charges, septic tank monitoring, nutrient recovery…), opportunities for PPP investments..

Water is political!!!

Programme for Government (2010)

- 'Water services cost over €1.2 billion to run in 2010, of which operational costs amounted to some €715 million, with capital expenditure of over €500 million.

- We are the only country in the OECD where households do not pay directly for the water they use. Our current model of water provision, where unlimited quantities of an expensive product are provided at no charge, is simply not sustainable.'

Irish Water

First water meters to be installed next month as part of national roll-out

Irish Water chief says levels of water investment are 'simply unacceptable'

IT, June 19th 2013

John Tierney, chief executive of Irish Water, yesterday. Mr Tierney said the new semi-State body hoped to have 100,000 water meters installed by the end of the year. Photograph: Maxwells

Ronan McGreevy

Topics: News Environment Fergus O Dowd John Tierney
Mr O Dowd Shannon River Department Of The Environment

Fri, Jun 7, 2013, 12:03 ▾   **f** Recommend 25   **y** Tweet 22   **g** +1 ✂

The first domestic water meters will be installed next month with a national roll out beginning in September, the new chief executive of Irish Water John Tierney has said.

Speaking at the Engineers Ireland annual conference yesterday, Mr Tierney said the new semi-state hoped to have 100,000 water meters installed by the end of the year.

The ultimate goal will be to have 1,050,000 households in the State metered by the end of 2016.

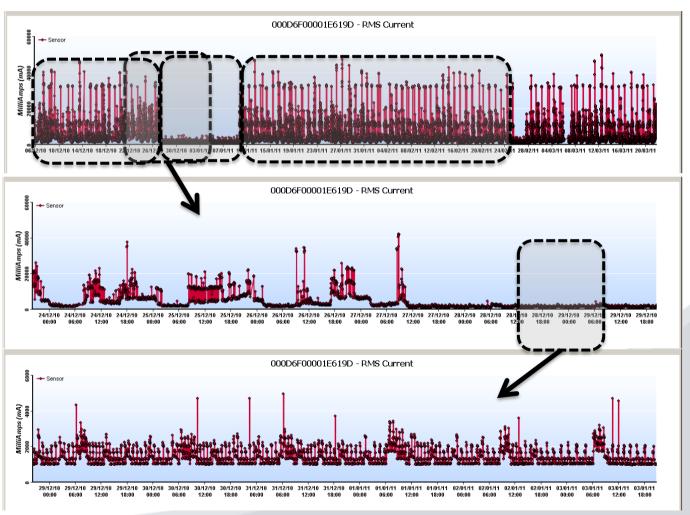**Jobs in call centre support (400) and meter installation (1600)**

Independent.ie ▾ Wednesday 19 June 2013

News   Sport   Business   Woman   Entertainment   Lifestyle   Videos

Independent.ie › Irish News

Irish Water to create 2,000 jobs with roll-out of metering system

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RALPH RIEGEL - 31 MAY 2013

MORE than 2,000 jobs are to be created by Irish Water as part of the controversial roll-out of the new water metering system.

No information about the meter specifications –
- **At what frequency will the data be monitored?**
- **How will the data be harvested?**
- **Where will it be stored?**
- **Who owns it? Who gets access?**

Life Patterns from Home Metering

- **Home/Away**
- **Repetitive Patterns**
- **Specific Appliances**
- **Totally unobtrusive**
- **Who owns the data?**

Do we need to monitor the environment? River Tolka….

- **River Tolka sampling trip July 14th 2009**
- **Article in 'The Northside People'**
- **Fingal Council has rectified the situation; river appears to be much cleaner**

Do we need to invest in infrastructure? Portrane

Portrane waste water outfall at low tide September 17th 2009

Portrane

Portrane waste water outfall at low tide on September 17th 2009: Measured E.coli in this vicinity was 700,000 and 140,000 CFU/ 100 mL EU E. coli Bathing Water Max Limit: 500 CFU / 100 mL

2nd Generation Analyser: Design
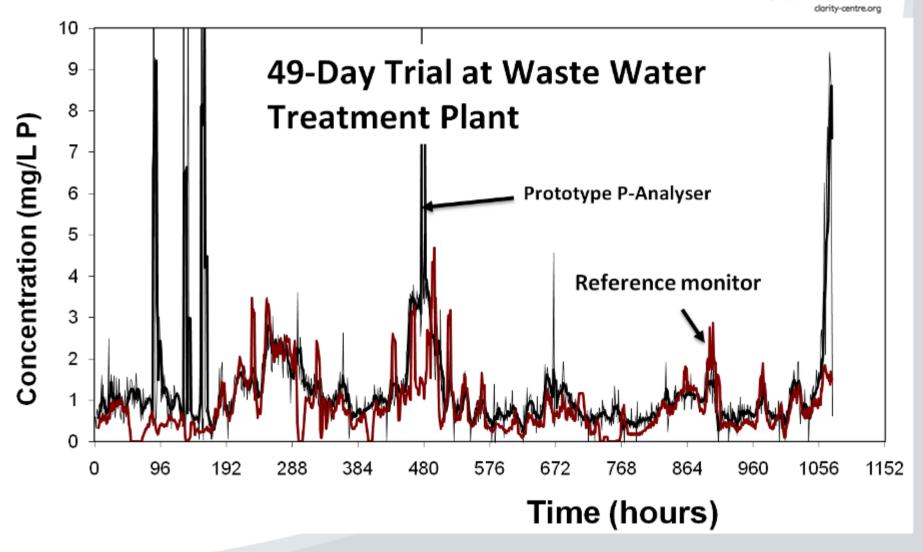

Sampling port
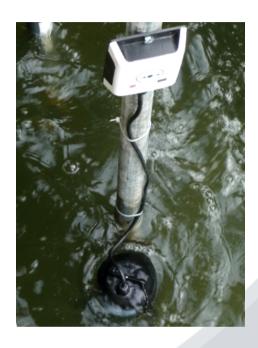
Deployment at Osberstown WWTP

- **Phosphate monitoring unit deployed**
- **System is fully immersed in the treatment tank**
- **Wireless communications unit linked by cable**
- **Data transmitted to web**

Autonomous Chemical Analyser

49-Day Trial at Waste Water Treatment Plant

Cocaine in Dublin Waste Water

Using environmental analytical data to estimate levels of community consumption of illicit drugs and abused pharmaceuticals†

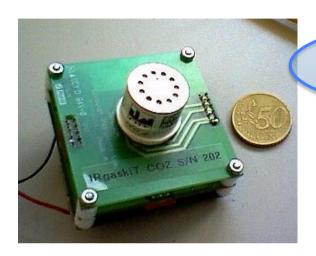Jonathan Bones,[a] Kevin V. Thomas[b] and Brett Paull*[a]

A solid phase extraction (SPE) method has been developed and applied in conjunction with a previously reported liquid chromatography tandem mass spectrometry (LC–MS–MS) procedure for the determination of illicit drugs and abused pharmaceuticals in treated wastewater and surface water samples at the ng L^{-1} level. A full method validation was also performed and determined levels of analytical sensitivity were found to lie in the 1–10 ng L^{-1} range using river water as a test sample matrix and a sample size of 500 mL. The developed procedure was successfully applied for the determination of the chosen analytes in wastewater treatment plants in Dublin, Ireland and rapidly expanding commuter towns in the surrounding counties. Cocaine was detected in 70% of the collected samples in the range of 25–489 ng L^{-1}, its primary metabolite, benzoylecognine (BZE) was also detected in the range of 22–290 ng L^{-1}. Other substances detected included morphine, Tempazepam and the primary metabolite of methadone.

Gas Sensing

Non-dispersive infrared sensors supplied by Edinburgh Instruments. Capable of detecting their target gas in the range 0-5 %.

Approx price:

CH4 sensor: €435

CO2 sensor: €346

IRceL® is available in two versions
CO2 - range: 0 - 5% CO2 @ 2360 cm^{-1}
HC - range: 0-100% LEL n-pentane* @ 3019 cm^{-1}
Power: ~6mA over 2V

Range (nominal): 0-2% vol CO2
Range (overload): 5% vol CO2
Resolution: 0.01% vol CO2
Accuracy at 20 degrees C : within 5% of range
Temperature range: -20C to +50C
Humidity range: 5 - 99% RH
T90 Response: <30 sec
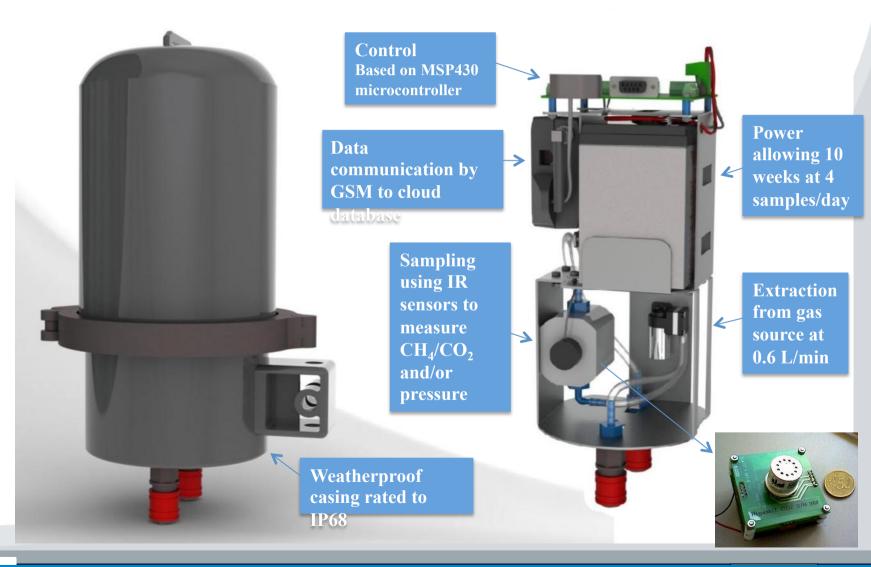Long term drift: <+/-0.05% vol CO2 / month
Size: 4 Series
Weight: 23g
Dimensions: 20.4mm x 16.6mm

The relative humidity sensor is used in the unit. Significant changes in humidity and temperature affect gas migration in the landfill, so this is being monitored as well.

Technology: GEN2 platform

Control
Based on MSP430 microcontroller

Data communication by GSM to cloud database

Sampling using IR sensors to measure CH_4/CO_2 and/or pressure

Power allowing 10 weeks at 4 samples/day

Extraction from gas source at 0.6 L/min

Weatherproof casing rated to IP68

Gas/Air Sensing

1. Reduction in greenhouse gas pollution[1, 2]

2. Optimised management / utilisation of gas-generative sources

3. Eliminate hazardous, costly and controversial social risks
   - €33M Kildare landfill fire clean-up [3]

Kerdiffstown, Kildare: Jan/Feb 2011

[1] Directive 2008/50/EC of 21 May 2008 on ambient air quality and cleaner air for Europe, European Parliament and Council of the European Union, 2008.

[2] Kyoto Protocol, Information Unit on Climate Change, United Nations,1998

[3] SKM Enviros, Appendix 7: Cost scenarios. Evaluation of environmental liabilities at Kerdiffstown landfill. Available online: http://www.epa.ie/downloads/pubs/other/envlia/ker/ (accessed 29 July 2011).
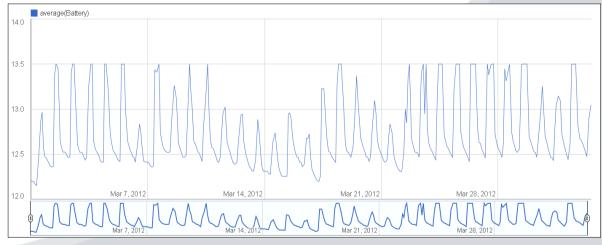
Camila at DCU

- Training in the NCSR (left); on site with Fiachra and Dylan (top); Effect of Solar Panel, data from this deployment (Bottom)
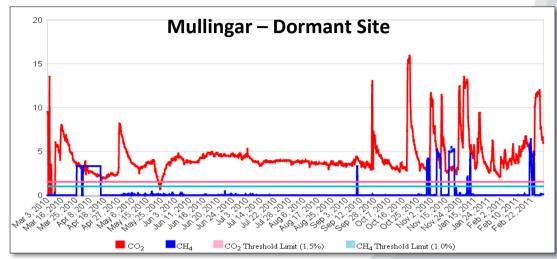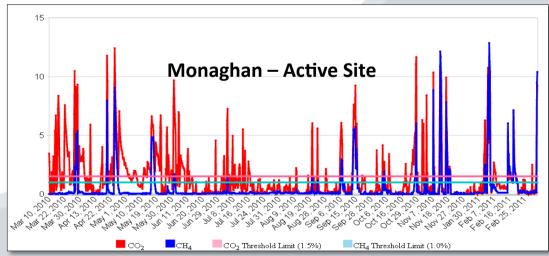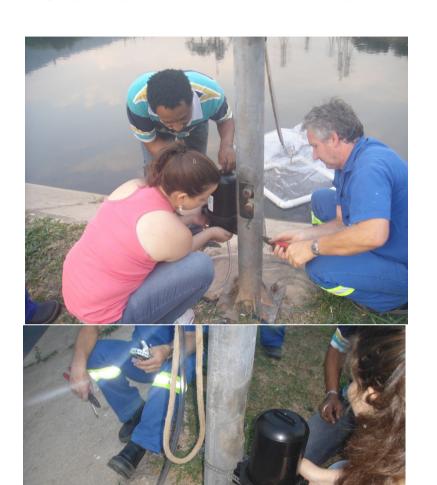
Two Deployments running continuously for > 12 months

Mullingar – Dormant Site

Monaghan – Active Site

To Mairiporã City
anaerobic lagoon of a SABESP (Ernane, Diego and Ademar)

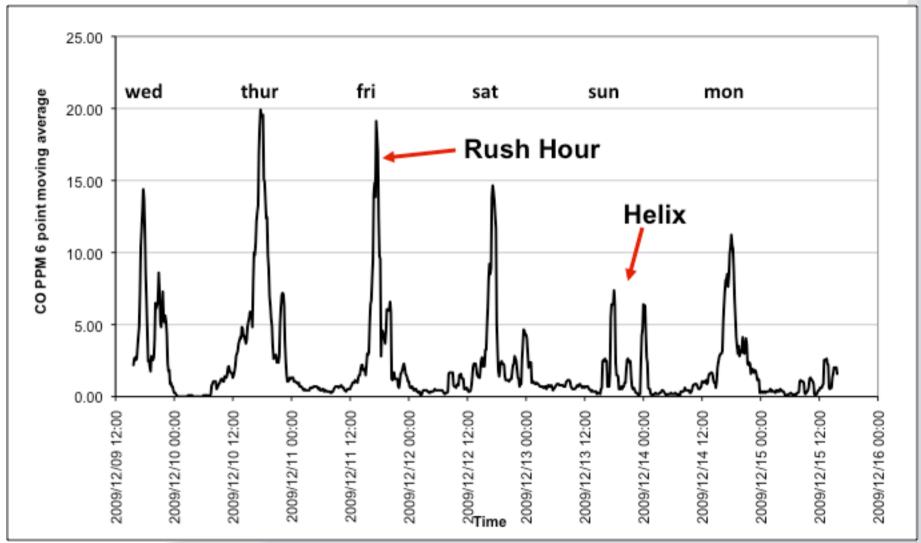# Sensor Installation

Data from Mairiporã City, Sao Paulo, Brazil

Brazil01

File   View   Edit   Visualize   Merge   Labs

Showing **all rows**   options   Showing 111 rows

Date   SenseDate ⇕

Name   ⇕

Value   CO2
        CH4
        Battery

Get embeddable code

https://drive.google.com/#shared-with-me

Zoom: 1' 5' 1h 1d 5d 1m 3m 6m 1y Max   ● CO2 0 ● CH4 12.82 ● Battery 12.19 | 00:57 November 03, 2012

CO Emissions at DCU Car Park,

Conclusions

- **The Environment has become very political – metering, fracking, septic tanks…..**

- **The capability to monitor key target parameters is improving rapidly**

- **The tools & infrastructure needed to harvest, store, analyse and visualise cloud-based data are available**

- **Ireland is well-placed to benefit enormously from emerging environmental technologies**

- **BUT!!!! An appropriate legal framework is needed urgently to deal with security, trust, privacy, access rights….**

Thanks to…..

Thanks for Listening!