UK Progress Report

Project Meeting

Katholieke Universiteit Leuven

17th April 2012

ICL Team

CONTENTS

1. Role of UK partners & observers

- Partners: Met Office, ICL, LGFF
- Observers: Local authorities, emergency services, GLA, EA, software developers, engineering consultants, researchers

UK PARTNERS

Model Assembly for Pluvial Flood Modelling, Forecasting and Management

Rainfall Estimation / Forecasting

Flood Modelling / Forecasting

Urban Planning / Emergency management

Met Office

Imperial College London

Local Government Flood Forum

MET OFFICE

- UK's national weather service
- A trading fund of the Department for Business, Innovation and Skills
- **Role within RainGain:** activities which make part of WP2, dealing with improvement of accuracy and resolution of rainfall estimates and forecasts.
- **Specific Activities:** upgrade of existing C-band radar network, signal processing improvement aiming at improving resolution of radar-based rainfall estimates, rainfall data merging.

LOCAL GOVERNMENT FLOOD FORUM

- The LGFF works to ensure that councils have a strong voice on flooding and, increasingly, the management of water resources as a key local natural resource. It provides a forum for local government, central government, national agencies and the private and voluntary sector to share best practice on managing flood risk and coastal erosion.
- **Role within RainGain:** focused on supporting WP3 – supporting the use of fine-scale urban pluvial flood prediction models by professionals at the local and regional level → WP4

IMPERIAL COLLEGE LONDON

Imperial College London

- UK academic partner
- **Role within RainGain:**
  - Coordination of UK partners
  - Leading WP3: Urban pluvial flood modelling and prediction

WP3: Urban pluvial flood modelling and prediction

Objective:

- To develop and test new methodologies, the associated software tools and application guidelines for short-term, fine scale, real-time pluvial (also called surface) flood forecasting.

Outcome:

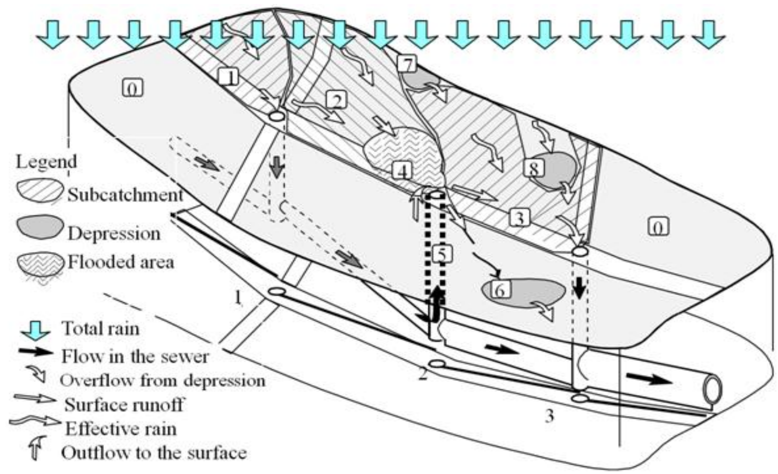
- Customised flood models to predict expected flood locations and flood depths in pilot locations based on rainfall data

WP 3 - Actions

- **A10:** Adoption, customisation and automatic linkage of rainfall forecasts to pluvial flood models
- **A11:** Improvement and customisation of models for urban pluvial flood forecasting at fine scales in each of the pilot locations.
- **A12:** Full-scale testing of the models for pluvial flood prediction in each of the pilot locations
- **A13:** Development of guidelines and training material for capacity building and training of future end-users

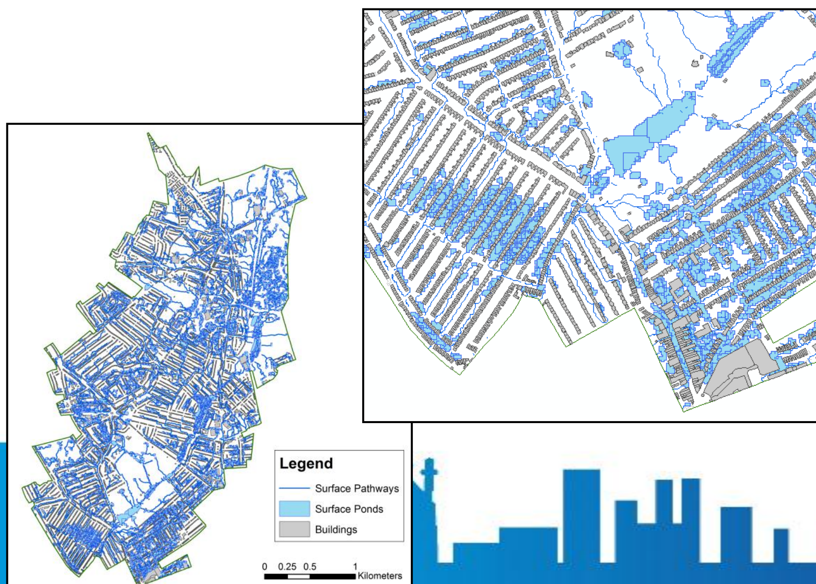
Modelling of Urban Pluvial Flooding

Dual-drainage concept: overland network + sewer network (1D)



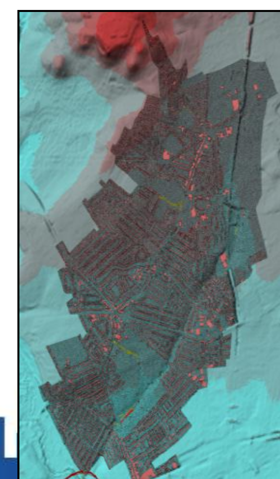
1D overland flow modelling

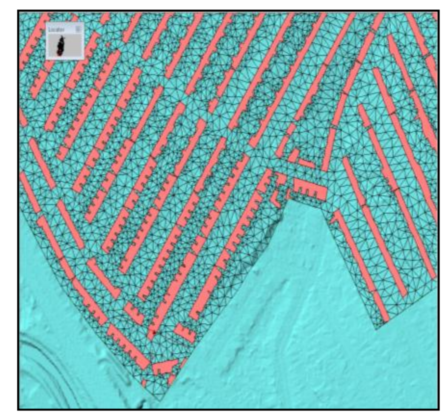
Nodes (ponds) and links (flow paths)



2D overland flow modelling

Surface divided into small elements (squares or irregular triangles)



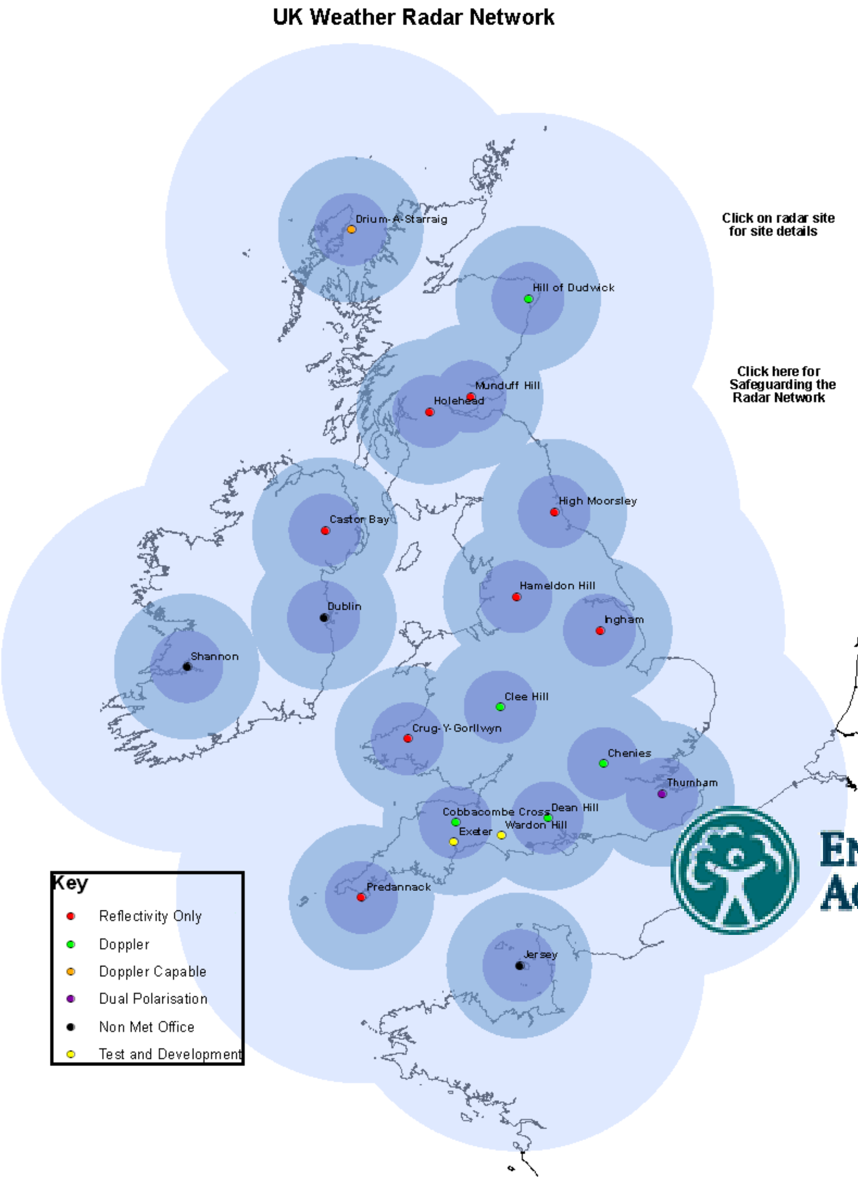


NATIONAL OBSERVERS

- **Observers:** Local authorities, emergency services, GLA, EA, software developers, engineering consultants, researchers
- **Roles:**
  - Data provision
  - Feedback regarding needs and potential benefits of developed tools
  - Testing of developed tools
  - GLA: collaboration in development of Community Flood Plans

2. UK C-band Radar Network & Potential X-band radars

UK Weather Radar Network



- Location of radars
- 5km resolution coverage
- 2km resolution coverage
- 1km resolution coverage

•A diverse range of stakeholders and users

Potential X-band Radar in London

- Single Polarisation
- Light weight (~32 kg)
- Potential sites: Imperial College campus, Barbican Estate or NHS buildings
- Installation depends on safety regulation/planning permission

RAINSCANNER®
WEATHER RADAR

X-band radar in Leeds

- Doppler, Dual polarisation
- Light trailer weight (< 2.8 tons)
- Operated by National Centre for Atmospheric Science in University of Leeds (Prof. C. Collier)

METEOR 50DX
COMPACT WEATHER RADAR

3. Rainfall data processing activities in the UK (WP2)

Urban Rainfall Processing

- **Focus:** improving rainfall estimates for hydrological modelling using conventional weather radars
- Improved spatial/temporal resolution
  - Signal processing approach (Met Office)
  - Statistical (post-) processing approach
- Improved suitability for urban hydrology
  - Gauge-based adjustment approach

Hardware and software upgrade

- C-Band Siemens-Plessey Radars
  - Oldest ~ 30 years old
  - Mechanically sound but control systems & transmitters increasingly facing obsolescence issues
- Renewal project installing new modern Motors, Drive systems and Transmitters – keeping pedestals and antennas – upgraded to Dual Polarization
- In-house signal processing and control system
  - Cyclops
    - Currently 14 bit ADC @ 100MHz
    - Upgrading to 16 bit ADC @ 200MHz
    - Allows access to whole of signal processing chain

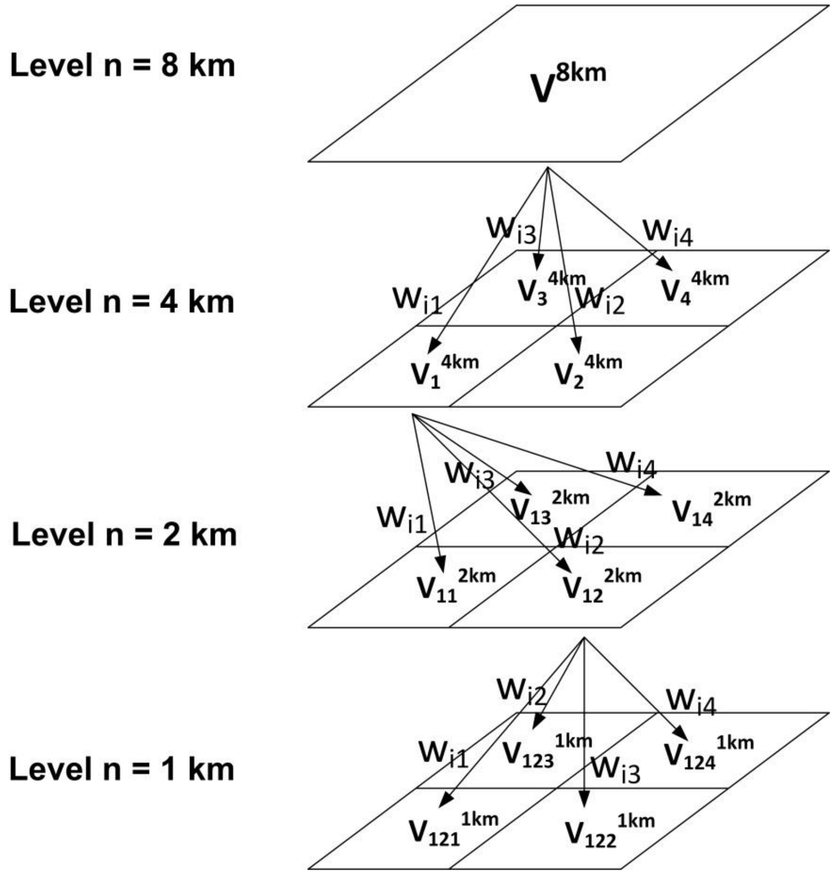
Signal Processing: Improved processing algorithm

- Azimuthal Resolution
  - Beam width usually degraded by scanning motion of antenna
  - Sharpen beam by applying suitable weighting function
- Range resolution
  - Oversample data and process
    - Can be used to increase number of independent samples available to reduce measurement variance in averaging stage
      - Scan speed could then be increased with reduced degradation of measurement error

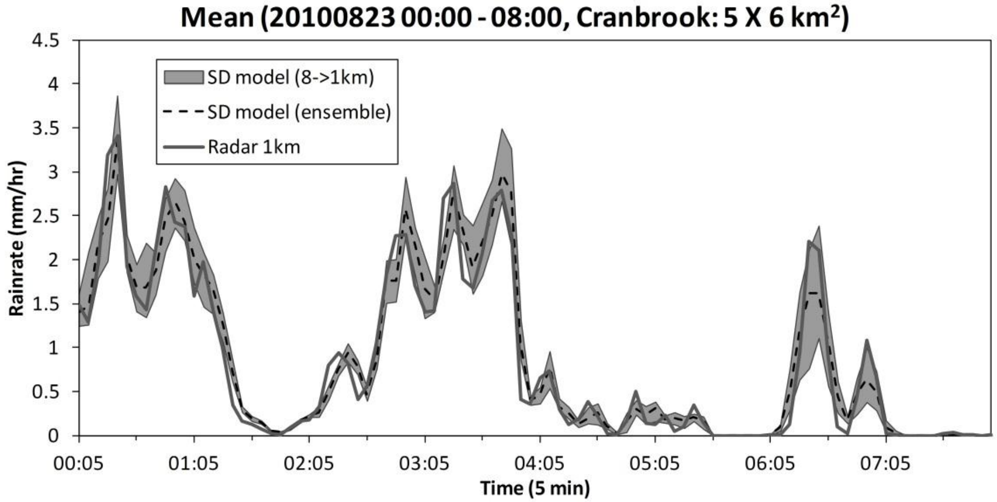
Or

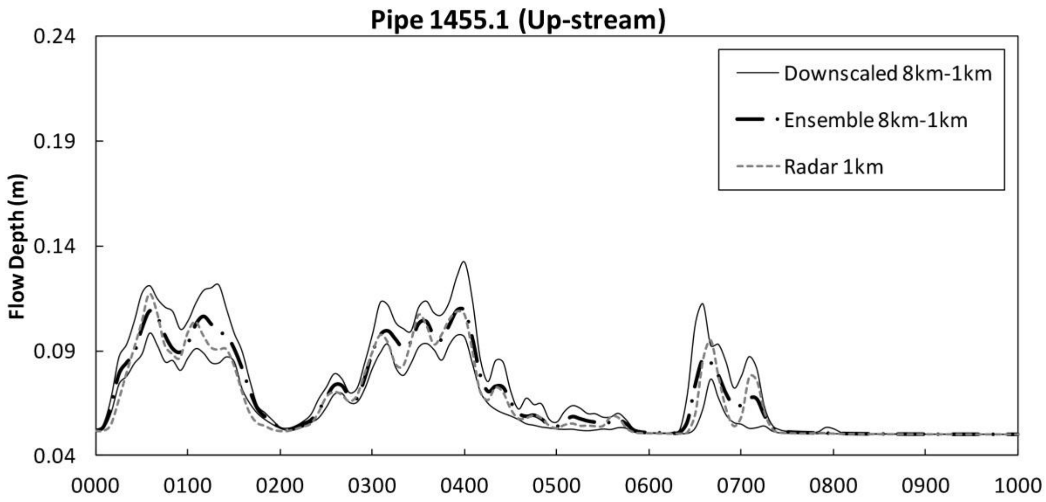
- Can be used to increase range resolution (?)

Statistical Processing: Cascade-based Downscaling



Statistical Processing: Applications in small-scale urban areas

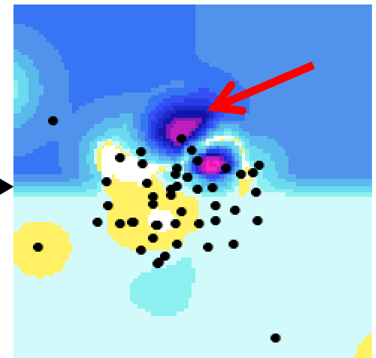




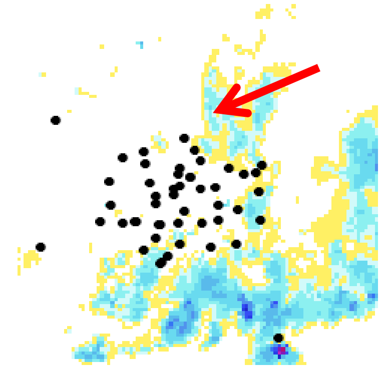
Gauge-based adjustment: Bayesian-based combination method

Point raingauge data

Interpolation

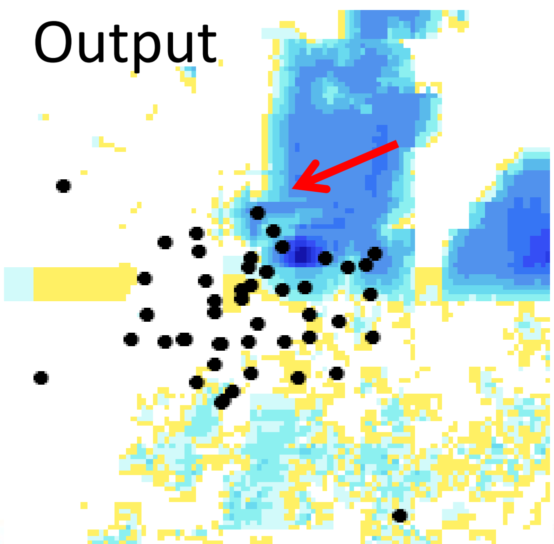


Kriged Rain field



Radar image

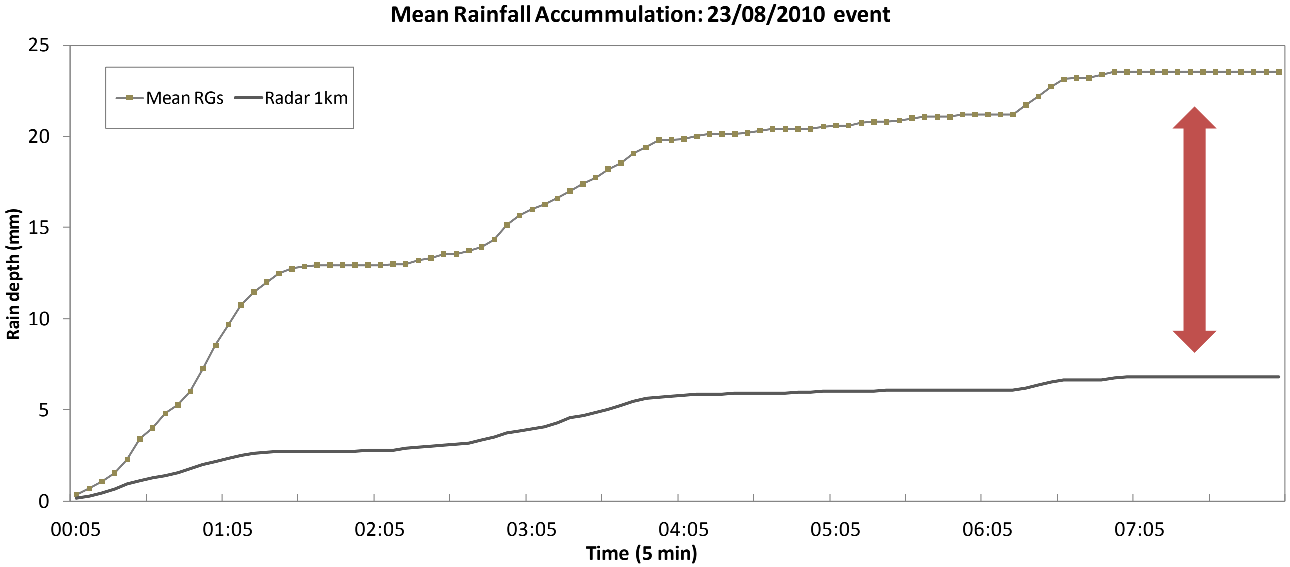
Output

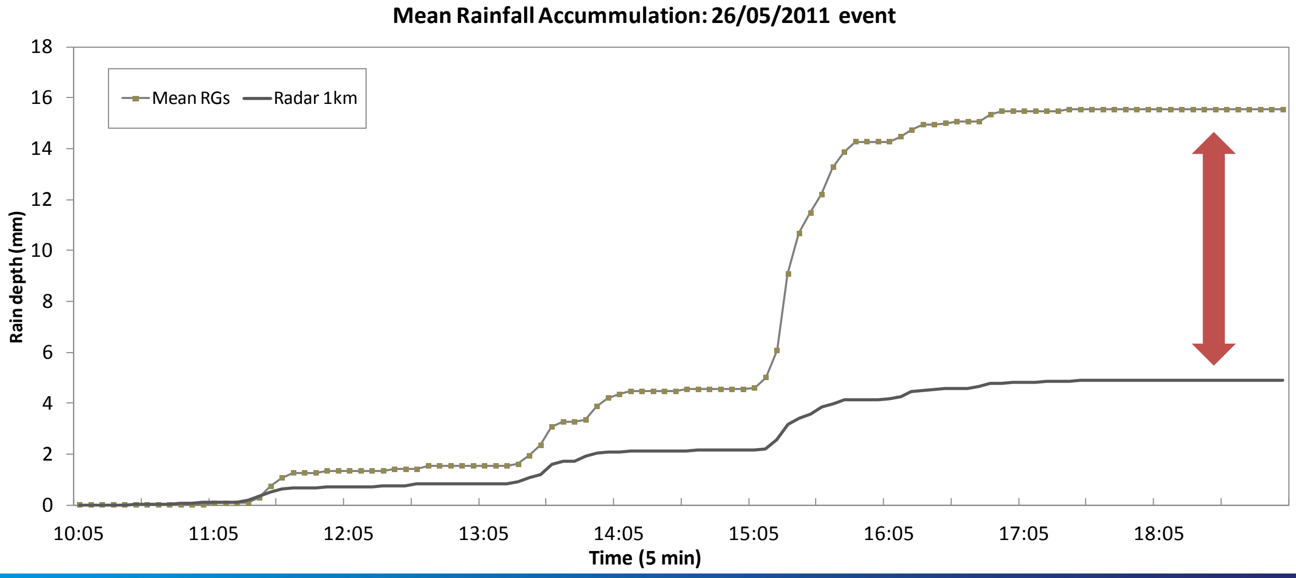


Kalman Filter

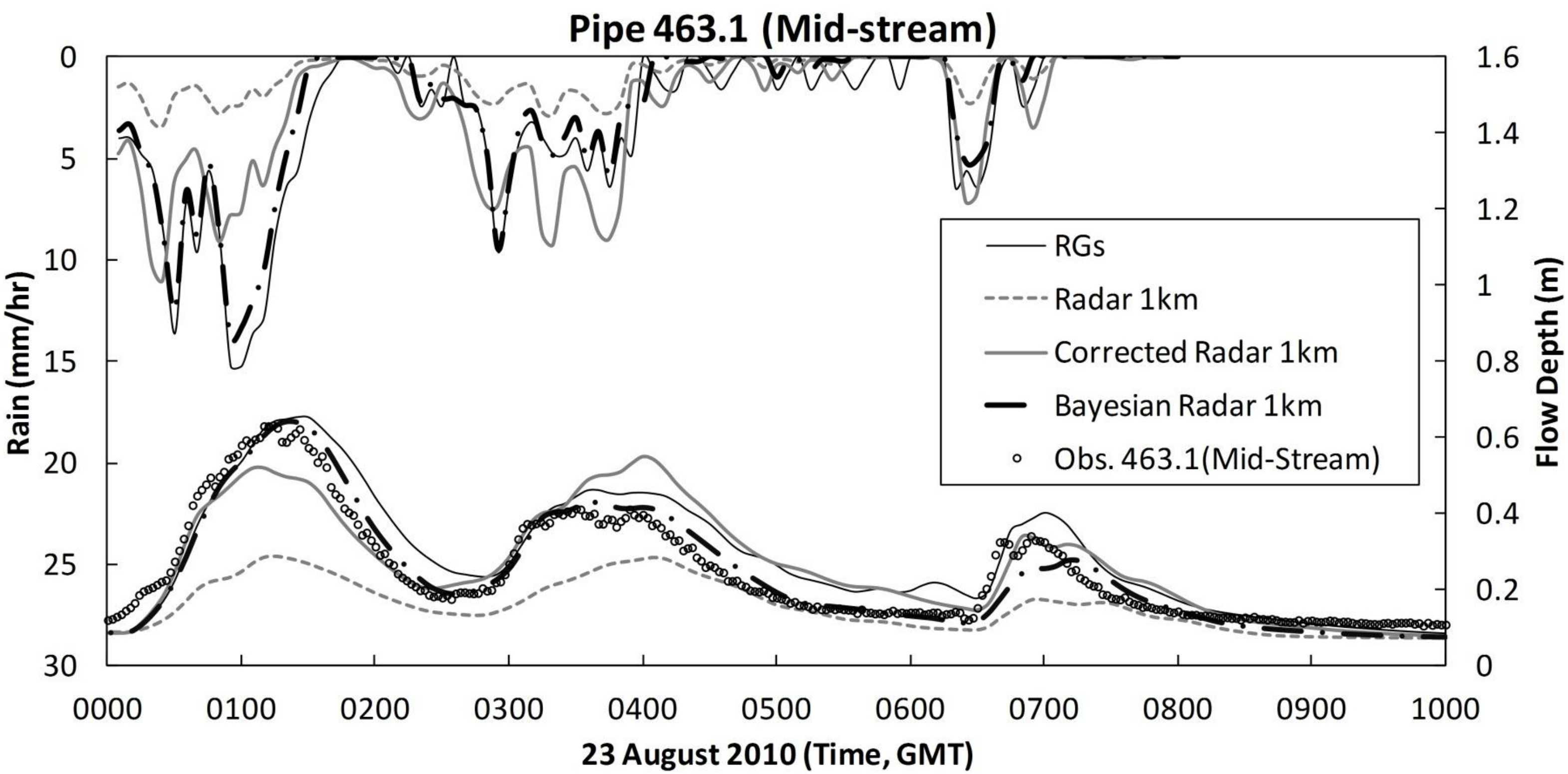
Mazzetti, C. (2004) and Todini, E. (2001)

Why radar rainfall estimates needs to be adjusted?





Gauge-based adjustment: Applications in small-scale urban area

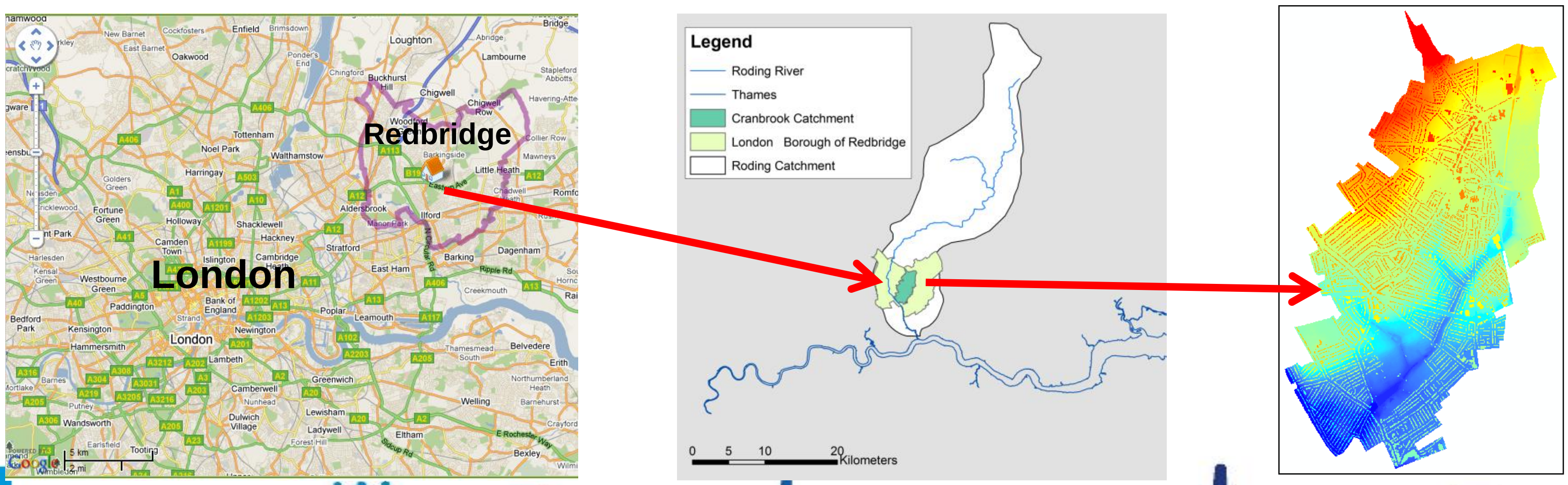


4. UK case studies (dataset, needs, action plan)

- Cranbrook (London Borough of Redbridge)
- Purley (London Borough of Croydon)
- Torquay City Centre (Torbay, Devon)

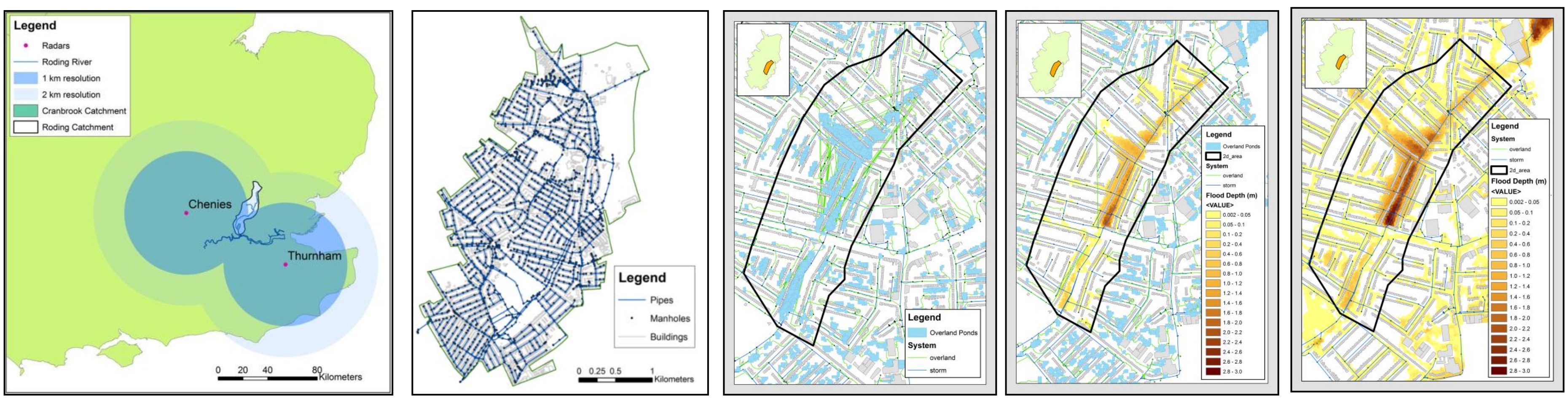
Cranbrook
(London Borough of Redbridge)

- **Area:** aprox. 900 ha
- **Water course:** 5.75 km (5.69 km are piped/culverted)
- Predominantly urban
- Sub catchment of Roding River catchment
- Has experienced **severe fluvial and surface flooding** in the past
- **Aim:** improved modelling & forecasting of surface flooding – to support urban planning and emergency management



Dataset

- Dual-drainage model setup in InfoWorks CS
- Radar / Nimrod data: the area is in the coverage of two radars, Chenies and Thurnham
- "Own" monitoring system deployed in 2010



Monitoring System

- **3 tipping bucket rain gauges**

  With 1 min data “sampling”

- **1 pressure sensor for monitoring water levels in the Roding**

  Real time frequency: 5/10 min

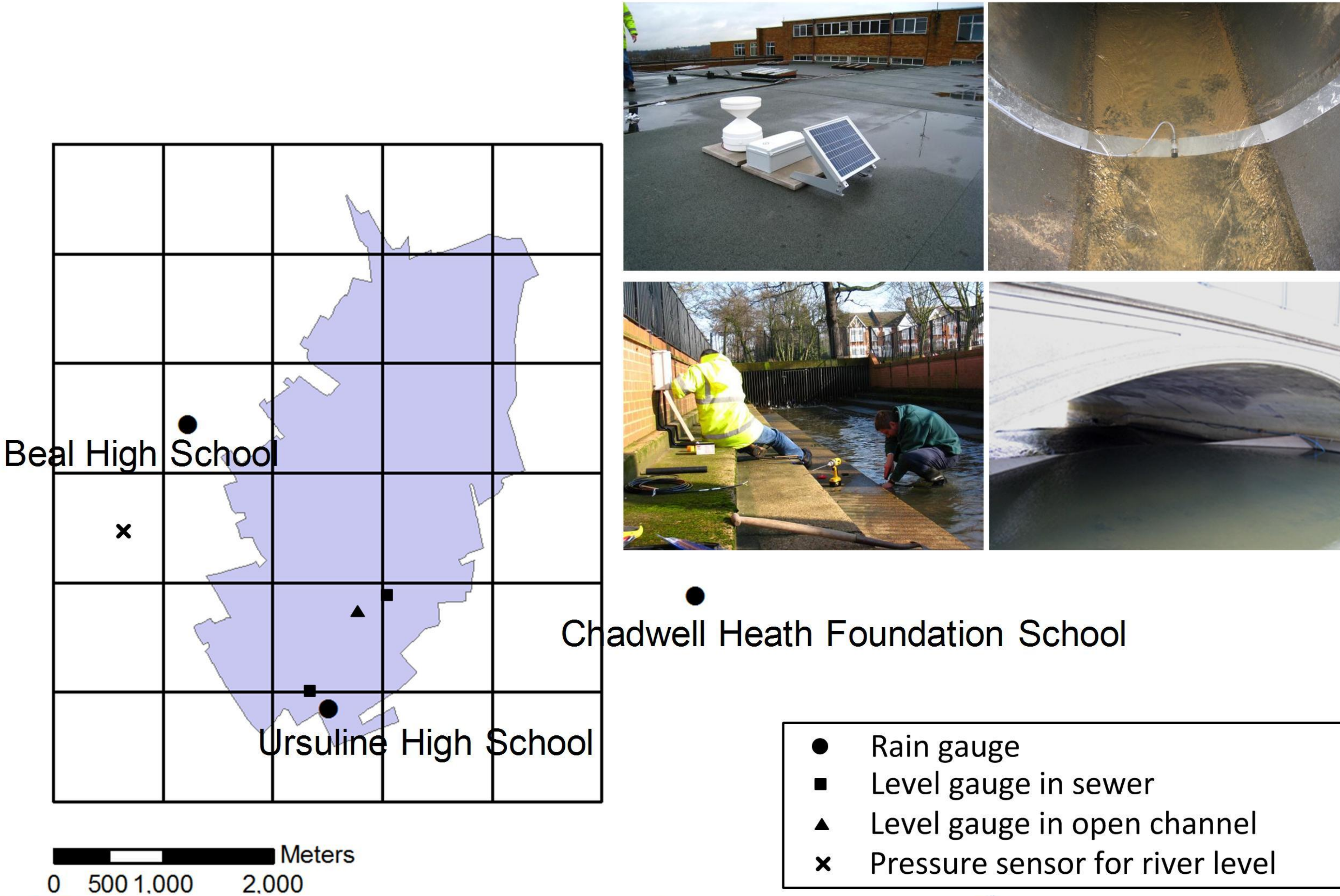
- **2 sensors for water depth measurement in sewers**

  Real time frequency: 5/10 min.

- **1 sensors for water depth measurement in open channels**

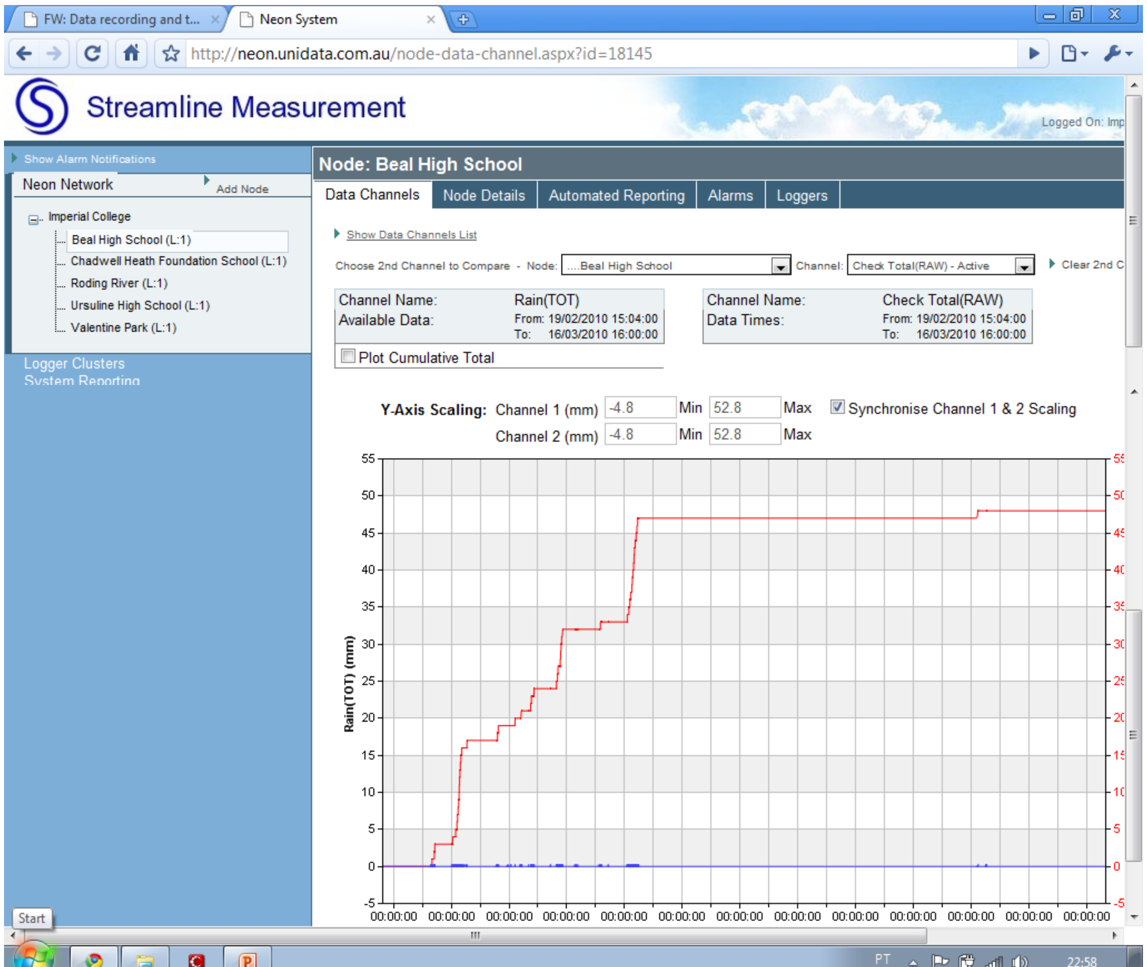
  Sampling frequency: 5/10 min

All sensors are equipped with data acquisition and real-time access wireless communication units



Beal High School
Chadwell Heath Foundation School
Ursuline High School
Meters
0 500 1,000 2,000
Rain gauge
Level gauge in sewer
Level gauge in open channel
Pressure sensor for river level

Real-time accessible tipping bucket raingauges



Pressure sensor for Roding river (frequency: 5-10 min)

Sensors for water depth measurement in sewers (frequency: 5/10 min)

Sensor for water depth measurement in open channel (frequency: 5-10 min)

Planned Upgrades to Monitoring System (Early May 2012)

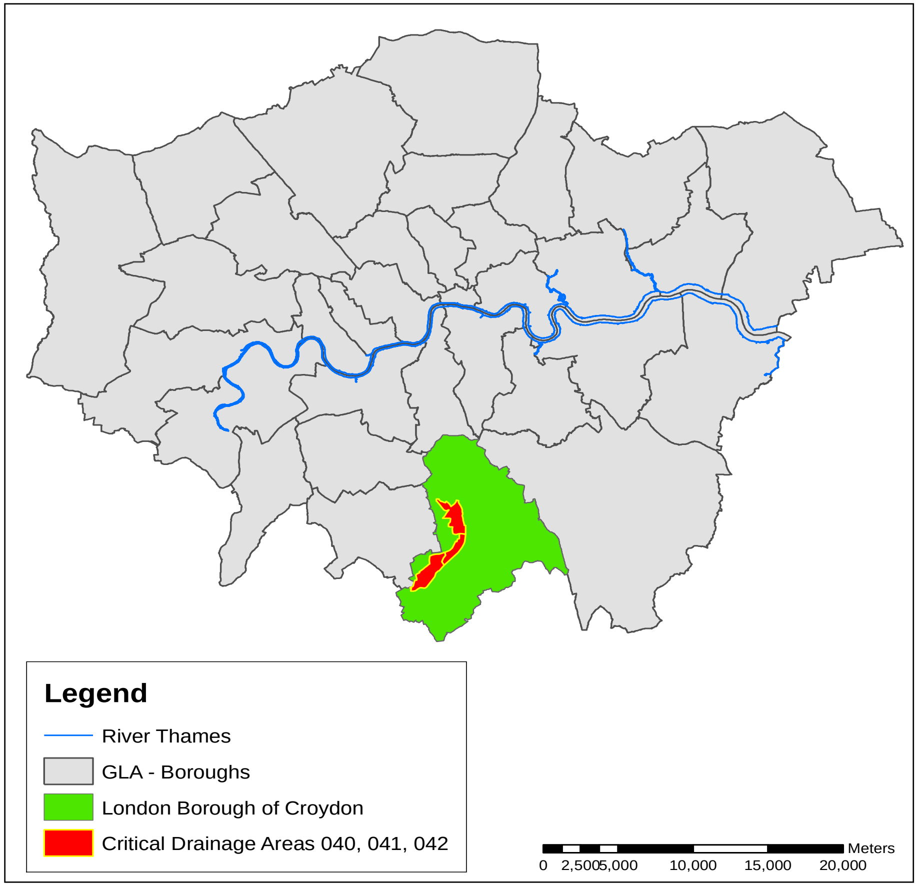
- **Relocation of one water depth sewer sensor**, which is being significantly being affected by vibration.
- **Installation of a sensor to monitor water depth at the exact outfall** of the sewer system into the Roding river (this constitutes the downstream boundary condition for this urban catchment)
- **Maintenance** of sensors currently installed

Activities to date & Future Work

- **Setup of urban pluvial flood models (in InfoWorks CS 10.5):** 1D-1D, 1D-2D and hybrid models
- Manual calibration of flood models
- **Development and testing of techniques for improving rainfall estimates and forecasts for urban applications, including:** downscaling techniques, raingauge-radar adjustment techniques
- **Future work:** acquisition of improved sewer model, analysis of uncertainty propagation, development of pilot surface water flooding forecasting systems, improved radar signal processing, amongst others.

Purley
(London Borough of Croydon)

- Croydon is ranked the **4th** settlement in England **most susceptible** to surface water flooding (Defra)
- The Purley area has been identified as having the highest risk of surface flooding within the London Borough of Croydon (SWMP)
- **Area:** Approx. 652 ha
- Highly urbanised, high density of receptors
- Recent surface/sewer flood events: 2007 (approx. 320 properties and 26 schools flooded), 2008, 2009 and 2010.

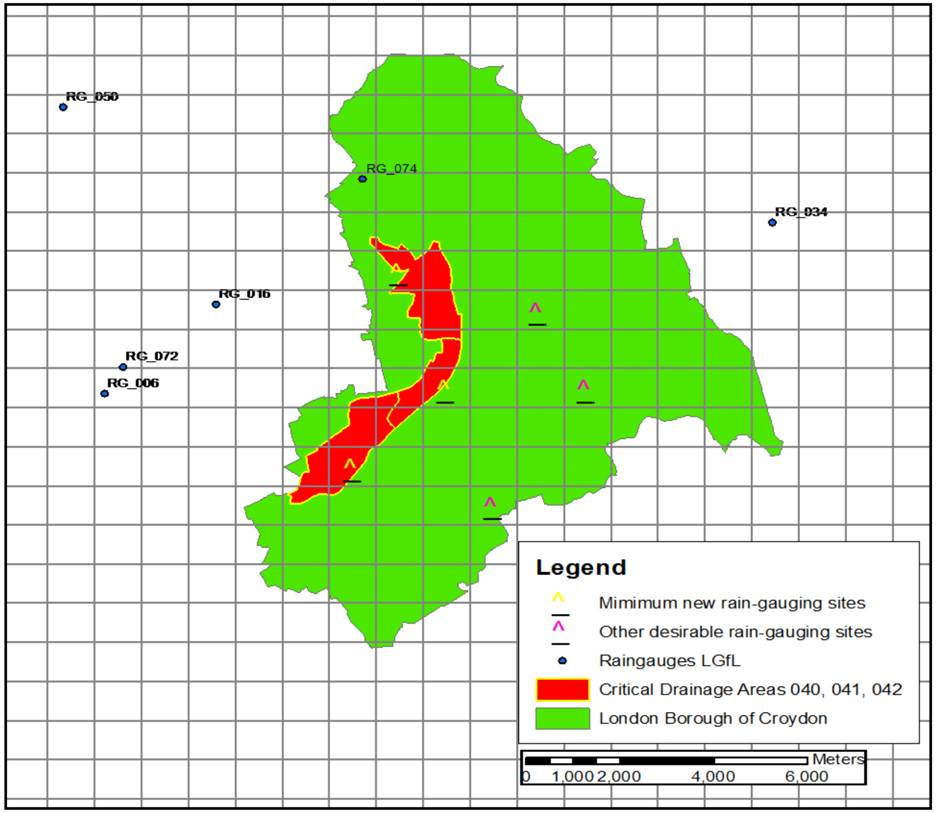


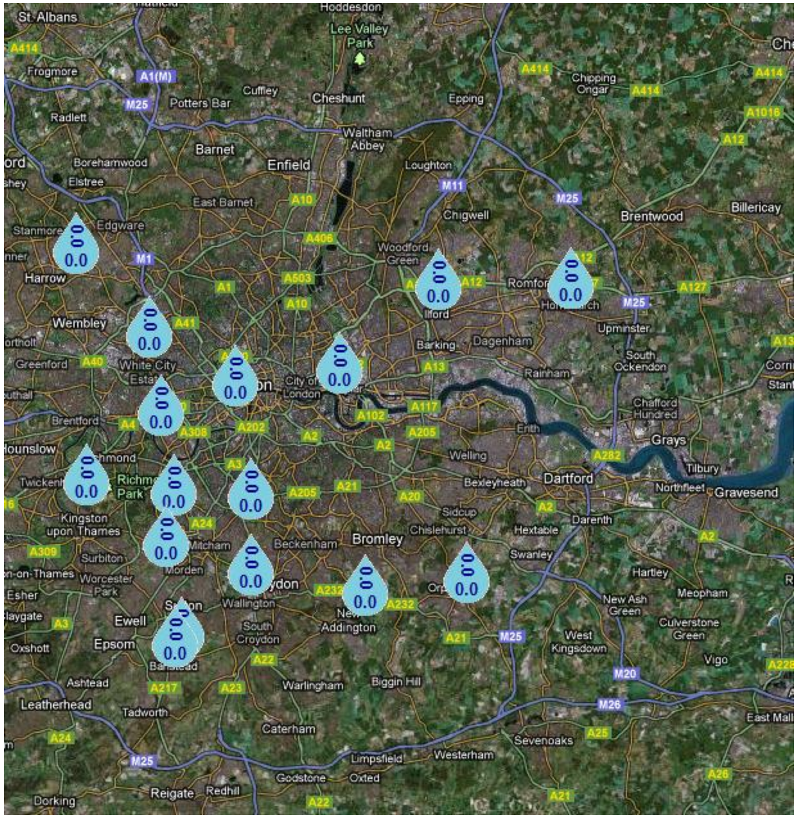
Activities to Date

- Meetings with Local Authorities (planning, drainage and resilience teams) & identification of needs:
  – **Planning Division:** better models and flood risk maps, which support planning decision making
  – **Drainage Division:** better models which help them in targeting maintenance and assessing the capacity of existing drainage system.
  – **Emergency Planning Division:** flood forecast and warnings which allow implementing actions for protecting population, properties and critical infrastructure. Warnings with even 30 min lead time could be helpful.

Activities to Date

- Identification of data requirements, official request of the following:
  - Sewer model from Thames Water (through FWMA) & rainfall and level/flow records
  - LiDAR data and 2D surface model from Scott-Wilson, consultants who recently produced SWMP
- Together, we formulated a bid for funding for monitoring equipment from the GLA, including 3 tipping bucket raingauges, 2 level gauges, 1 velocity+level gauge
- Identification of RG of the London Grid for Learning around the area


RG_050
RG_074
RG_034
RG_016
RG_072
RG_006
Legend
Mimimum new rain-gauging sites
Other desirable rain-gauging sites
Raingauges LGfL
Critical Drainage Areas 040, 041, 042
London Borough of Croydon
0 1,000 2,000 4,000 6,000
Meters


St Albans
Harrow
Wembley
Barnet
Enfield
Cheshunt
Epping
Chigwell
Romford
Brentwood
Billericay
Dartford
Gravesend
Bromley
Kingston upon Thames
Epsom
Leatherhead
Reigate
Redhill
Caterham
Sevenoaks

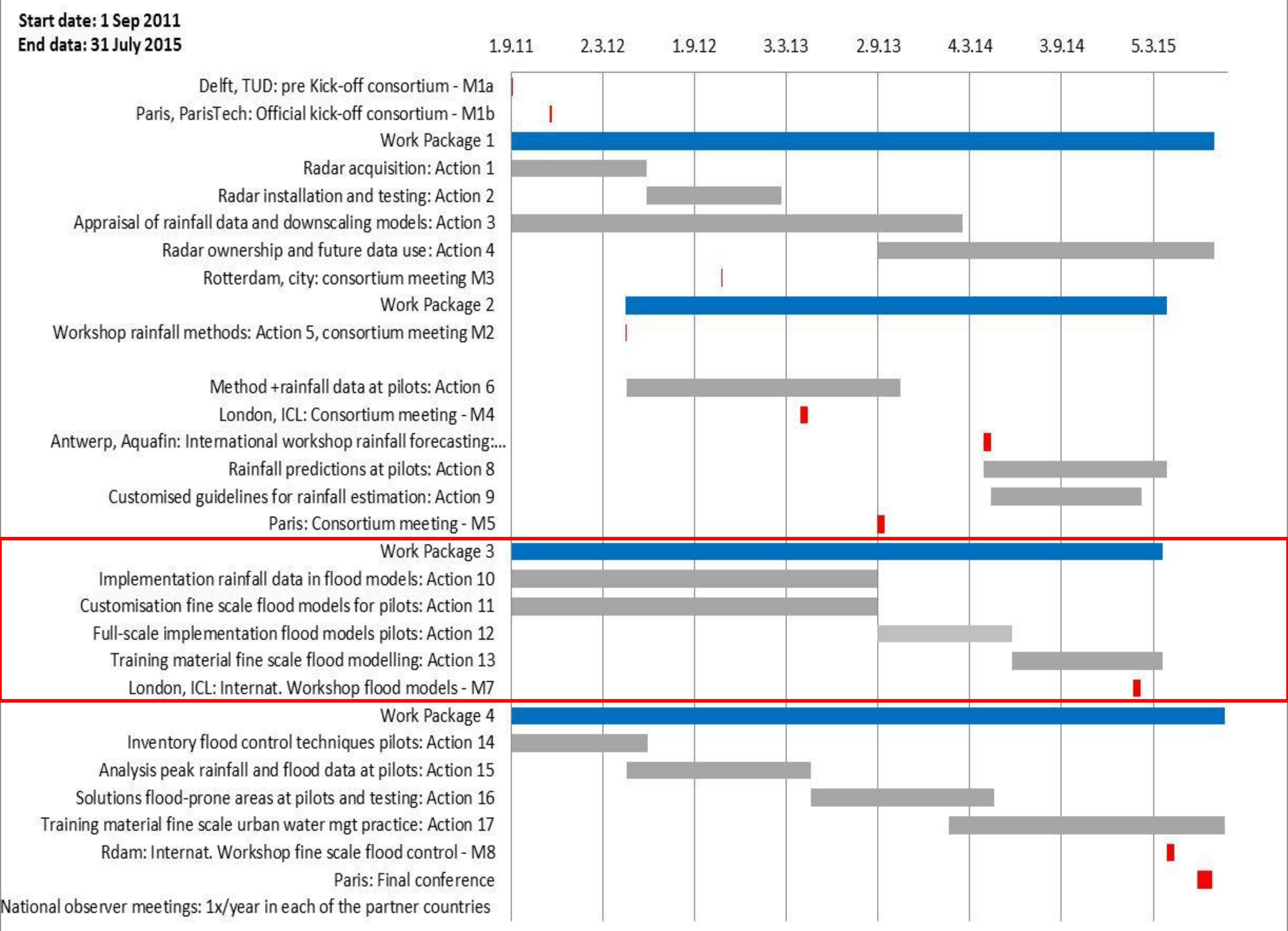
Torquay City Centre (Torbay, Devon)

- "British Riviera" – tourist place
- Highly urbanised, high density of receptors
- Severe pluvial flooding in the last few years: October 1999, May 1999, October 2004, August 2007
- Tides may generate back water effects
- Special case: local council in charge of management of sewer system
- Very complete dataset: including flood records (CCTV, level and rain records)
- Main interest: flood forecasting, RT control, many control elements!

Activities to Date

- Meeting with local authorities, identification of needs and existing datasets
- Information request:
  - Local council will provide LiDAR data and 2D model of the surface (in InfoWorks ICM) (1 month)
  - The sewer model is currently being verified by consultants (AECOM) and has been requested by the Local Council through the FWMA (3 months)
  - Level and rain records, CCTV footage of flooding – from Local Council (1 month)

5. ACTION PLAN / TIME FRAME


Start date: 1 Sep 2011
End data: 31 July 2015
1.9.11
2.3.12
1.9.12
3.3.13
2.9.13
4.3.14
3.9.14
5.3.15
Delft, TUD: pre Kick-off consortium - M1a
Paris, ParisTech: Official kick-off consortium - M1b
Work Package 1
Radar acquisition: Action 1
Radar installation and testing: Action 2
Appraisal of rainfall data and downscaling models: Action 3
Radar ownership and future data use: Action 4
Rotterdam, city: consortium meeting M3
Work Package 2
Workshop rainfall methods: Action 5, consortium meeting M2
Method +rainfall data at pilots: Action 6
London, ICL: Consortium meeting - M4
Antwerp, Aquafin: International workshop rainfall forecasting:...
Rainfall predictions at pilots: Action 8
Customised guidelines for rainfall estimation: Action 9
Paris: Consortium meeting - M5
Work Package 3
Implementation rainfall data in flood models: Action 10
Customisation fine scale flood models for pilots: Action 11
Full-scale implementation flood models pilots: Action 12
Training material fine scale flood modelling: Action 13
London, ICL: Internat. Workshop flood models - M7
Work Package 4
Inventory flood control techniques pilots: Action 14
Analysis peak rainfall and flood data at pilots: Action 15
Solutions flood-prone areas at pilots and testing: Action 16
Training material fine scale urban water mgt practice: Action 17
Rdam: Internat. Workshop fine scale flood control - M8
Paris: Final conference
National observer meetings: 1x/year in each of the partner countries

Actions & Time Frame

- **WP2 Related Activities:**
  - MAR 2013: theoretical framework & coding for de-convolutional processing (signal processing)
  - MAR 2014: pilot testing of upgraded radar network & signal processing tools
  - MAR 2015: operational testing of developed tools

Actions & Time Frame

- **WP3 Related Activities:**
  - AUG 2012: Model data collection & setup
  - SEP 2012 (project meeting): Design linking platform
  - APR 2012: Pilot linking platform & “firstly” implemented models for all case studies
  - SEP 2013: Finished / tested linking platform & first results using fine-scale rainfall in case studies
- **WP 4 Related Activities:**
  - Throughout the project, as deliverables become available

6. Summary of UK NOG meeting

UK NOG MEETING

- **Date & Time:** 29th Feb 2012, 09:30 – 15:30
- **Venue:** WSP House, London
- **Audience:** 46 attendees, including specialists, practitioners, academics and local and central government policy-makers
- **Purpose of the meeting:**
  - Introduce the RainGain project to national observers
  - To discuss the observers' expectations from the RainGain project, regarding potential improvements in modelling, forecasting and management of urban pluvial flooding
  - To give the observers the possibility of getting involved in the RainGain project

FORMAT OF NOG MEETING

- **Session 1: Presentations**
  - Introduction to the RainGain project, UK Partners and their role in the project
    - Marie-Claire ten Veldhuis, TU Delft
    - Cedo Maksimovic, Imperial College London
    - Timothy Darlington, The UK Met Office
    - Laurie Thraves, Local Government Flood Forum
- **Session 2: Break-out session to discuss 3 topics:**
  - Rainfall as an input for urban pluvial flood modelling and forecasting *(Chair: Malcolm Kitchen, Met Office)*
  - Hydrological/hydraulic models for urban pluvial flooding and forecasting *(Chairs: Cedo Maksimovic, Susana Ochoa & Neil McIntyre, ICL)*
  - Improved management of urban pluvial flooding

    (Chairs: Laurie Thraves, LGFF & Marie-Claire ten Veldhuis, TU Delft)

MAIN CONCLUSIONS

- Great interest on the RainGain project
- After NOG – follow-up meetings with several interested observers to analyse potential collaboration
- **Topic 1: Rainfall**
  - Improved accuracy of rainfall forecasts was ranked as the main challenge that must be overcome before we can have effective urban pluvial flood forecasting.
  - Improved data accuracy could be attained by merging rainfall estimates from different sensors (mainly raingauges and radars).
  - Improved rainfall resolution is also a need, but rainfall data users consider accuracy to be more important than resolution.

MAIN CONCLUSIONS

- **Topic 2: Hydrological & Hydraulic models**
  - Existing modelling tools can create models which represent pluvial flooding fairly accurate
  - Dual-drainage models are a "must"
  - Need to "socialise" models to understand flooding mechanisms
  - Critical challenges include:
    - Reduction of runtimes, while keeping reasonable accuracy – hybrid models can be the solution
    - Overall estimation and management of the uncertainty associated with the forecast & Effective communication of uncertainty
    - Organisational barriers

MAIN CONCLUSIONS

- **Topic 3: Management**
  - Engagement of the public must be increased – challenging task!
  - Provision of information on property level flood risk by local government can help drive interest in flooding resilience measures.
  - Need for local government to provide clear next steps for the residents concerned
  - Councils will need to play a leading role in the development and co-ordination of community flood plans.
  - Need for clear definition of roles of flood authorities
  - Harnessing the power of new technologies is an important aspect
  - Pluvial flood warnings with lead time as short as 30 min are considered of great use
  - Sharing of information at early stages with the public seen as beneficial
  - Effective communication of flood risk remains a challenge

7. LGFF

- Background
- Topics discussed
- Next steps
  - Clarify the need
  - Identify council responses
  - Role of cities
  - Feedback to other work packages
  - Contact networks in France, Belgium & Netherlands

QUESTIONS?