RainGain National Observers Group (NOG) Meeting, UK

London, 29th February 2012

Investing in Opportunities

This project has received European Regional Development Funding through INTERREG IV B.

INTERREG IVB

CONTENTS

1. AGENDA FOR THE DAY

- 10:00 – 11:00: Introduction to the RAINGAIN project (RainGain partners)
- 11:00 – 12: Presentations
  - Louise Clancy (Greater London Authority)
  - Stephen Merrett (Environment Agency)
  - David Lees (Defra)
- 12:00 – 13:00: Lunch
- 13:00 – 14:00: Break-out:
  - 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 (Chair : Čedo Maksimovic - ICL)
  - Improved management of urban pluvial flooding (Chair: Laurie Thraves – LGFF)
- 14:00 – 14:30: Coffee break
- 14:30 – 16:00: Summary / Conclusions
  - Report from break-out session (3 x 10 min)
  - Discussion (15 min)
  - Conclusions and close (10 min)

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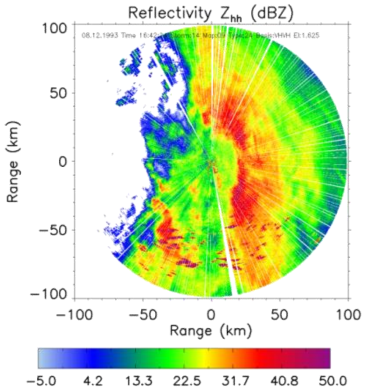
2. Introduction to the RainGain Project

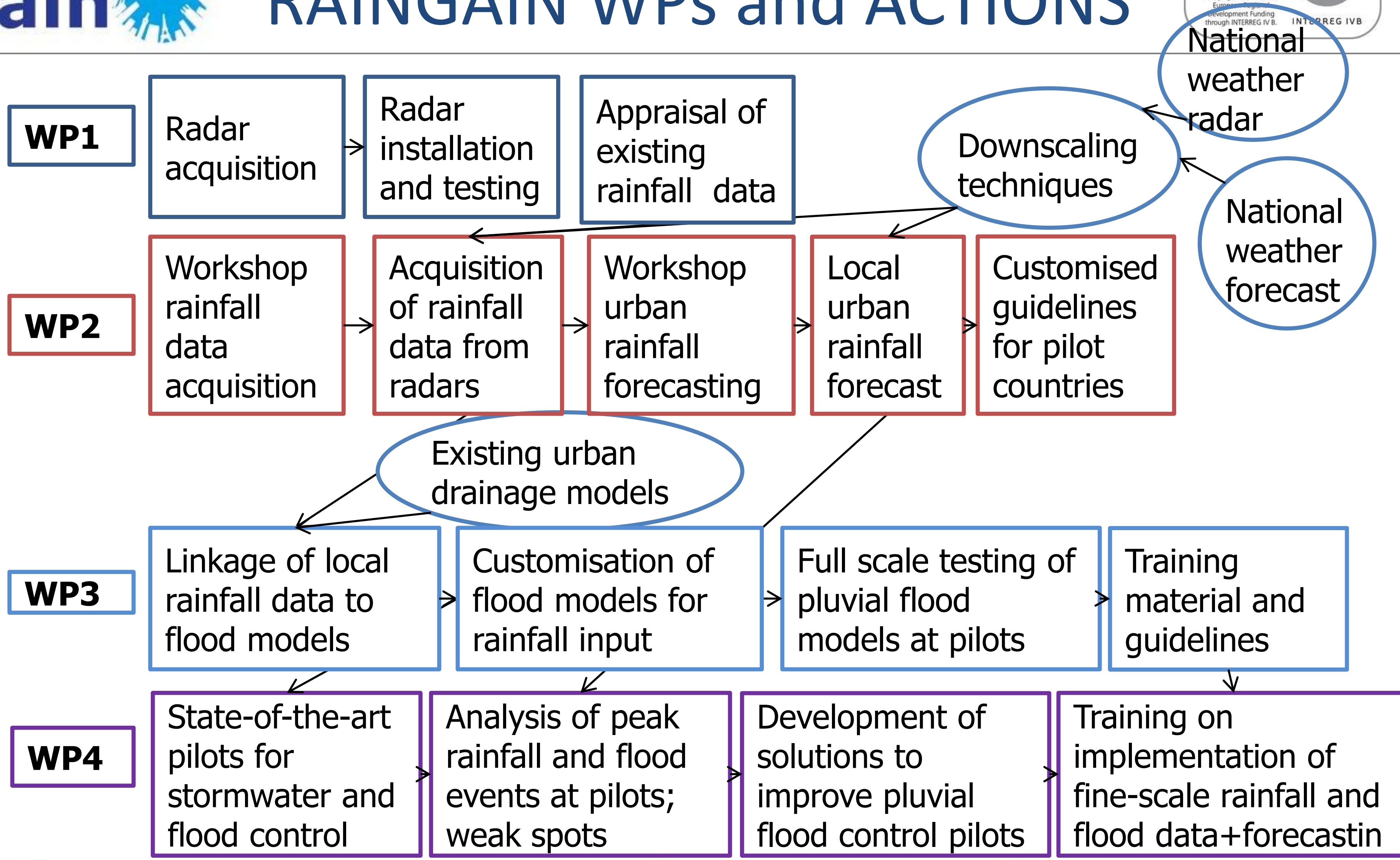
Marie-Claire ten Veldhuis



RAINGAIN – Project Objective

Objective: to improve fine-scale measurement and prediction of rainfall and to enhance urban pluvial flood prediction in order to enable urban water managers to adequately cope with intense storms, so that the vulnerability of populations and critical infrastructure can be reduced.

RAINGAIN WPs and ACTIONS



RAINGAIN WP1

WP1	A1 Radar acquisition	A2 Radar installation and testing	A3 Appraisal of existing rainfall data	A4 Future use and ownership of radar
	Output: Radars NL, F	Output: report on testing	Output: presentations at pilots (Nat Obs Groups)	Output: agreement with future owner (NL)

RAINGAIN WP2

WP2	A5 Workshop rainfall data acquisition	A6 Acquisition of rainfall data from radars	A7 Workshop urban rainfall forecasting	A8 Local urban rainfall forecast	A9 Customised guidelines for pilots
	Output: methods for fine-scale rainfall measurement	Output: Rainfall estimates for pilots	Output: method for fine-scale rainfall prediction	Output: technology for fine-scale rainfall prediction in pilots	Guidelines+ training material for pilot countries

RAINGAIN WP3

Existing urban drainage models

WP3	A10 Linkage of local rainfall data to flood models	A11 Customisation of flood models for rainfall input	A12 Full scale testing of pluvial flood models at pilot locations	A13 Training material and guidelines
	Output: platform for automatic linkage	Output: Customised flood models for pilots	Output: tested and implemented flood models for pilots + reports	Output: Training material and guidelines for pilots

RAINGAIN WP4

	A14 State-of-the-art pilots for stormwater and flood control	A15 Analysis of peak rainfall and flood events at pilot locations; weak spots	A16 Development of solutions to improve pluvial flood control at pilots	A17 Training on implementation of fine-scale rainfall and flood data and forecasting in water mgt. practice
WP4	Output: Report current flood control in pilots	Output: List of flood-prone locations, flood causes and characteristics	Output: Customised solutions for flood-prone locations at pilots + test results	Output: Training material, manuals, guidelines for implementation

Project management and WP Leaders

Project coordinator: scientific content
Marie-claire ten Veldhuis

Project management: financial and administrative procedures
Alwin Wink, Regina Edoo

WP1: Installation and testing of radars
Lead: ParisTech, Daniel Schertzer

WP2: Fine-scale rainfall data acquisition and prediction
Lead: KU Leuven, Patrick Willems

WP3:Urban pluvial flood modelling and prediction
Lead: Imperial College of London, Cedo Maksimovic

WP4:Implementation of fine-scale rainfall data, flood modelling and prediction into urban water management practice
Lead: TU Delft, Marie-claire ten Veldhuis

RAINGAIN: 13 Partners

1) TU Delft (NL)
2) Zuid-Holland Province (NL)
3) Gemeentewerken Rotterdam (NL)
4) KU Leuven (B)
5) Aquafin NV (B)
6) Ecole des Ponts ParisTech (F)
7) Marne-la-Vallée (F)
8) Seine-St.-Denis (F)
9) Météo France (F)
10) Imperial College London (UK)
11) Met Office (UK)
12) Local Government Flood Forum (UK)
13) Véolia (F)

4 Pilots:

Rotterdam (NL)

Leuven (B)

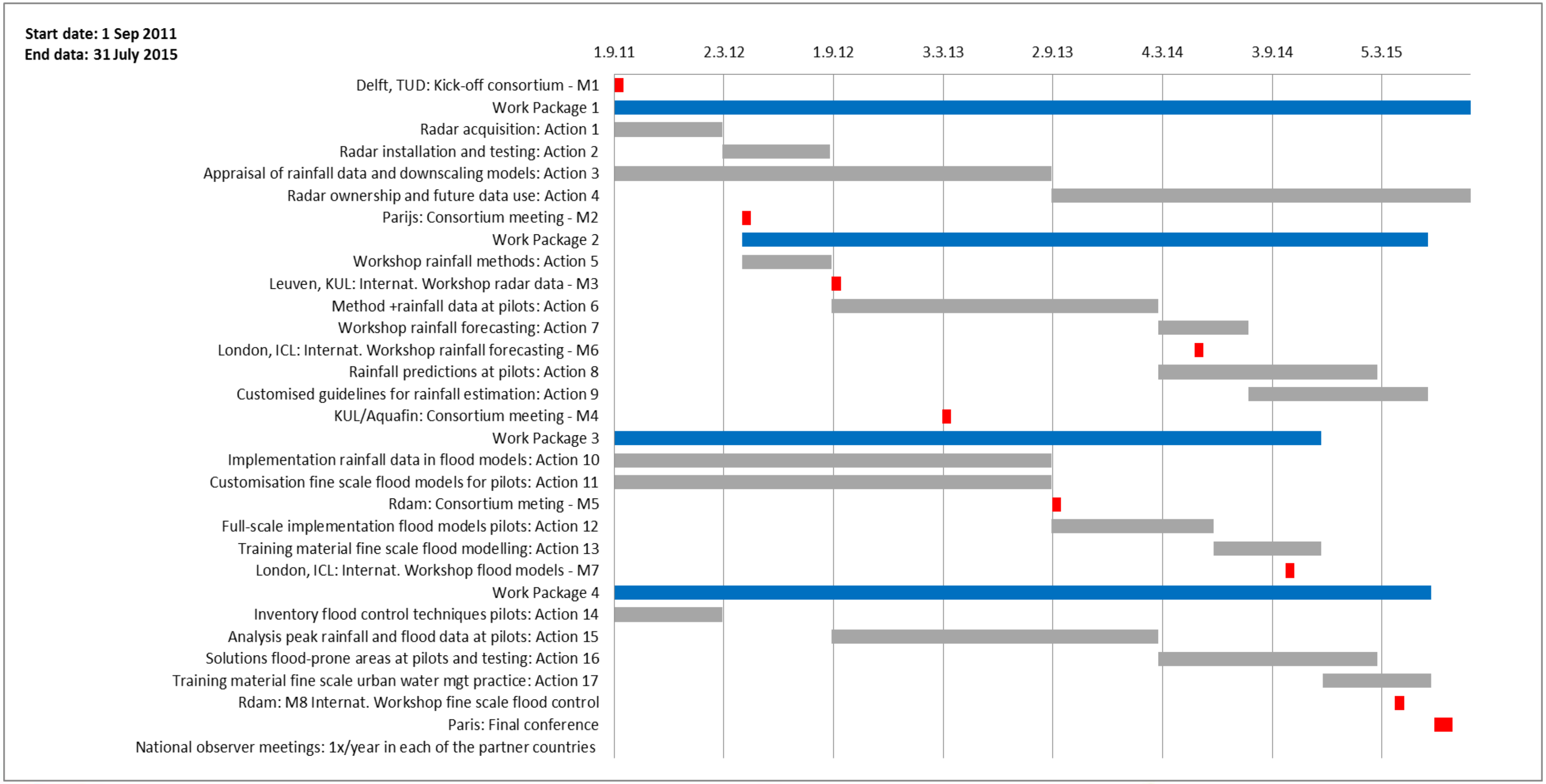
Marne-la-Vallée (F)
Seine-St.-Denis (F)

Croydon (UK)
Redbridge (UK)

RAINGAIN – 13 partners in cooperation

- Knowledge exchange between partners
- Field visits pilot locations
- Workshops on development of common methods and training for practical application
- Demonstrations of tools (radar, flood model), applications (radar results, model results), solutions (early warning systems, operational control, storage basins) to other partners

Planning


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: Kick-off consortium - M1
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
Parijs: Consortium meeting - M2
Work Package 2
Workshop rainfall methods: Action 5
Leuven, KUL: Internat. Workshop radar data - M3
Method +rainfall data at pilots: Action 6
Workshop rainfall forecasting: Action 7
London, ICL: Internat. Workshop rainfall forecasting - M6
Rainfall predictions at pilots: Action 8
Customised guidelines for rainfall estimation: Action 9
KUL/Aquafin: Consortium meeting - M4
Work Package 3
Implementation rainfall data in flood models: Action 10
Customisation fine scale flood models for pilots: Action 11
Rdam: Consortium meting - M5
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: M8 Internat. Workshop fine scale flood control
Paris: Final conference
National observer meetings: 1x/year in each of the partner countries

Start date: 1 September 2011
End date: 31 July 2015

Pre-Kickoff:
29-30 Aug 2011

Official Kickoff: 17-18 Nov 2011

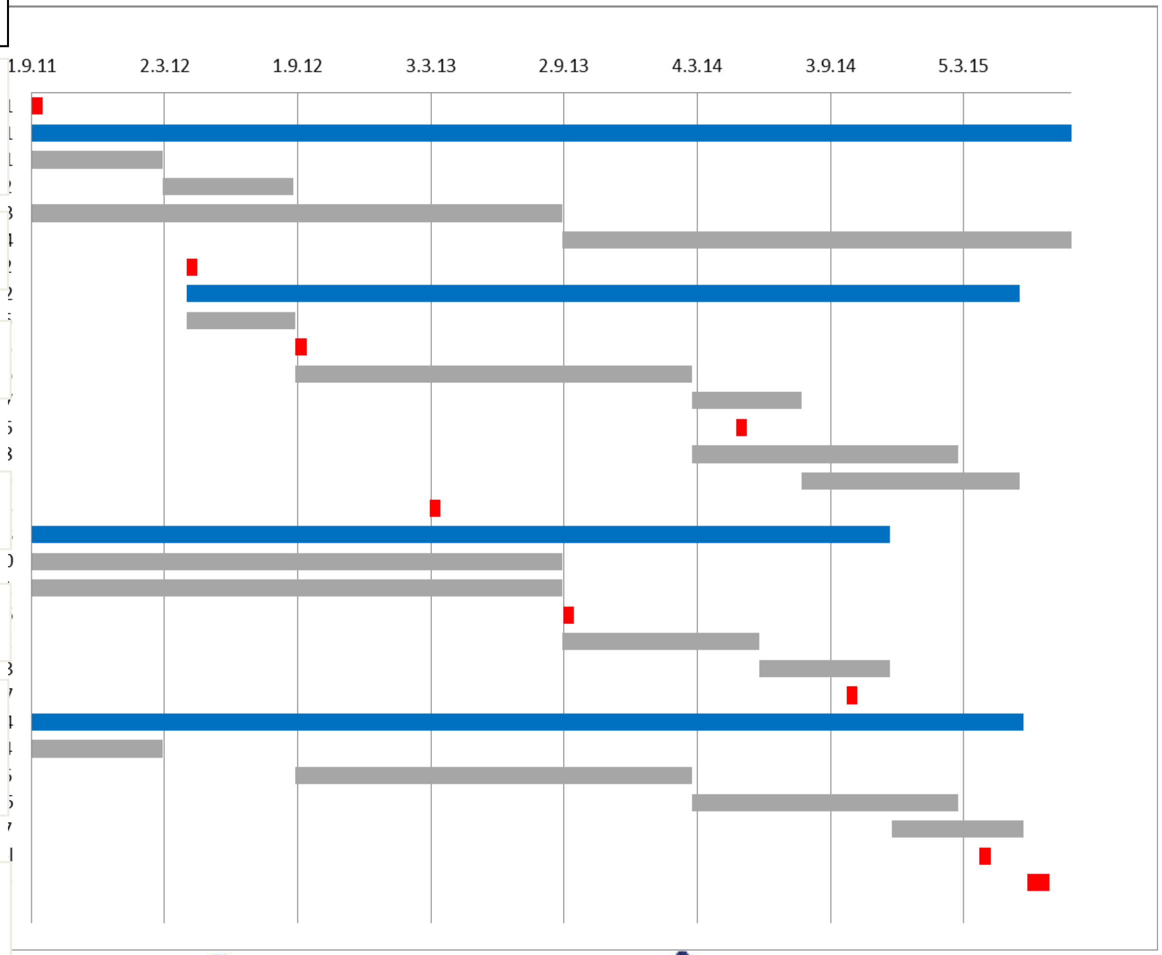
Project consortium meetings

Workshops for WPs

Small Technical meetings

Nat. Observer Group meetings:
4 per pilot/country

International conference: June 2015



RainGain

Investing in Opportunities

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3. The role of the UK partners in the RainGain Project

3.1. The UK Met Office – Timothy Darlington

3.2. Imperial College London – Čedo Maksimović

3.3. Local Government Flood Forum – Laurie Thraves

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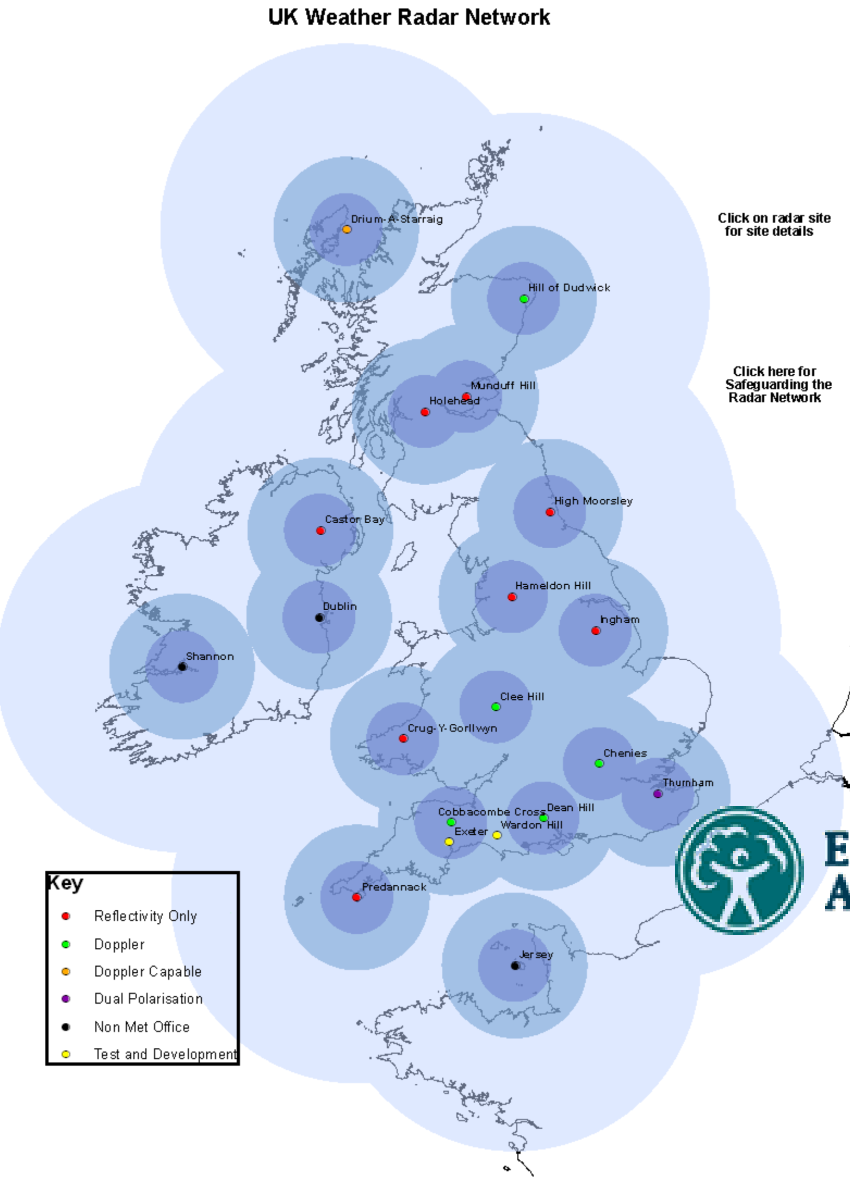
3.1. The UK Met Office

Timothy Darlington

UK Weather Radar Network



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

- A diverse range of stakeholders and users

Environment Agency

Met Office

Northumbrian Water Group

ScottishPower gas and electricity

UK Weather Radar Network

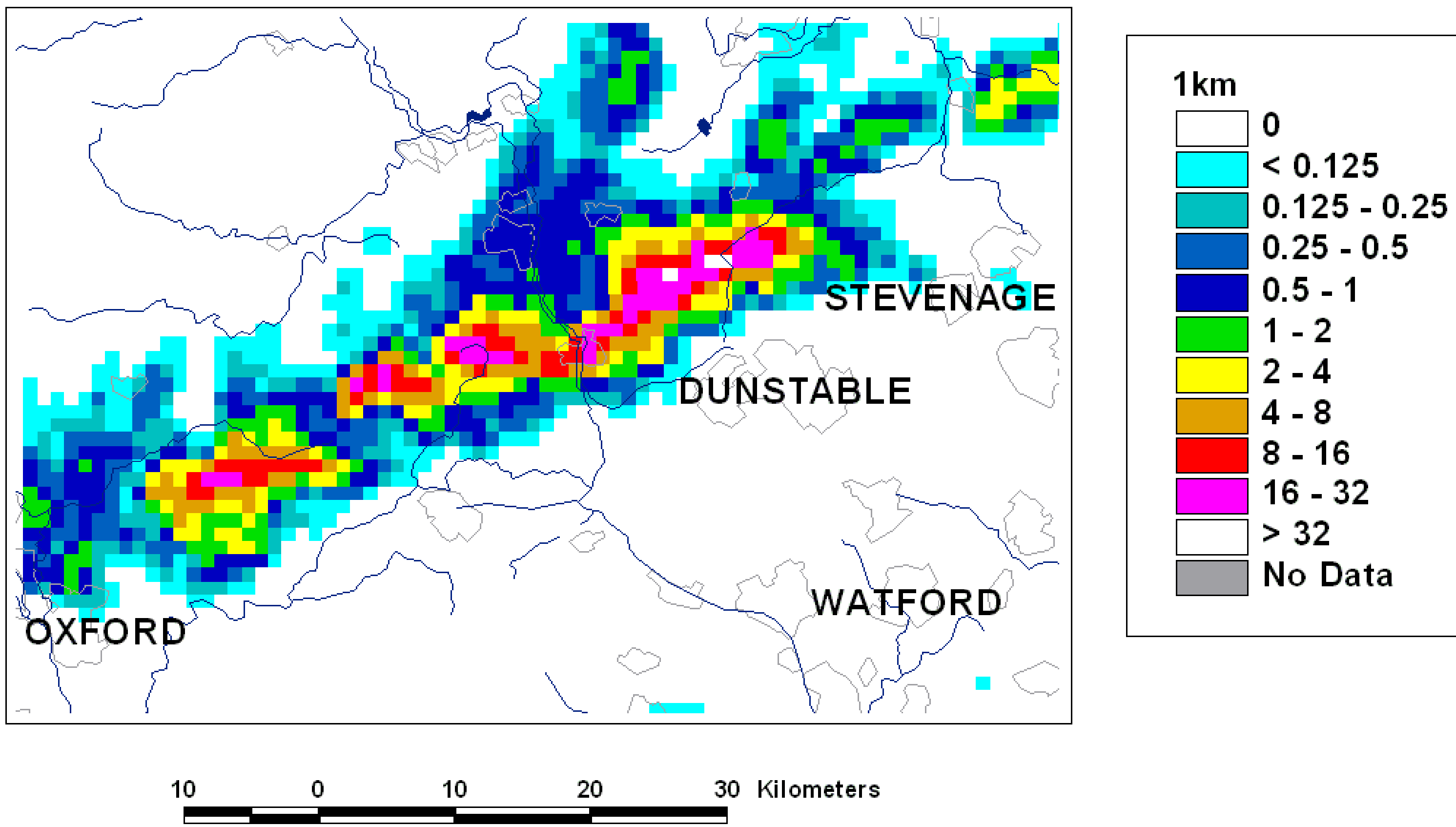
- C-Band Siemens-Plessey Radars
  - Oldest ~ 30 years old
  - Mechanically sound but control systems & transmitters increasingly facing obsolescence issues
- Renewal project installing new modern Motors, Drive systems and Transmitters – keeping pedestals and antennas – upgraded to Dual Polarization
- 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

Research focus:
Improving rainfall estimates for hydrological modelling using conventional weather radars

- Improved Spatial resolution
- Improved Temporal resolution
- Improved target type discrimination / quality control
- Improved gauge merging scheme

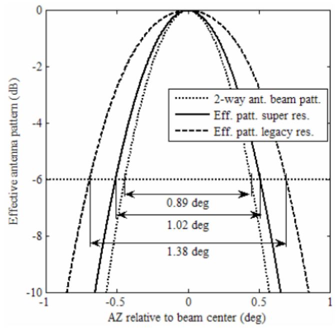
Benefits of increased spatial resolution

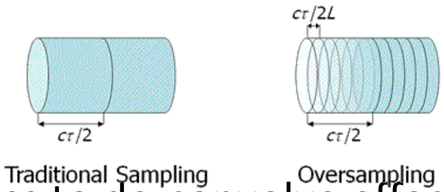
Chenies 1km radar data



Improved Spatial Resolution

- Azimuthal Resolution
  - Beam width usually degraded by scanning motion of antenna
  - Sharpen beam by applying suitable weighting function





- Range resolution
  - Oversample data and process to de-convolve effects of transmitter pulse and receiver
    - Can be used to increase range resolution

  Or

    - 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

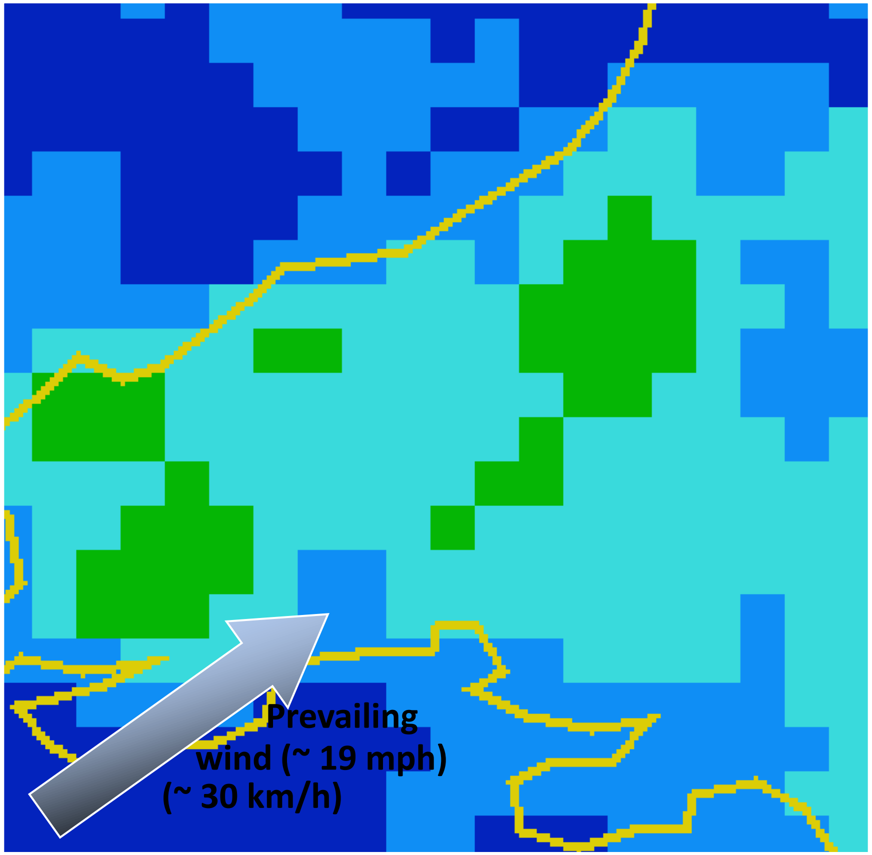
Expected Benefits of Improved Temporal Resolution

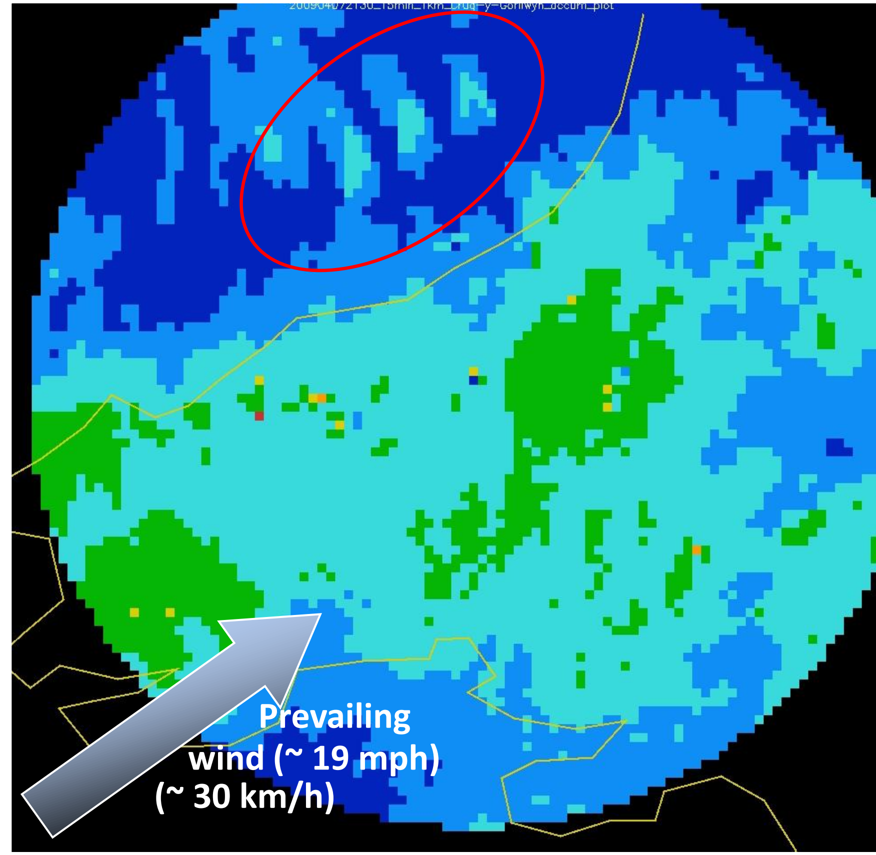
Demands on Weather Radars

- Different users place different (and increasing!) demands on weather radar time resources
- Hydrological users want best rainfall estimate
- NWP community want Volume Reflectivity, Radial Velocity and relative humidity
- Forecasters want a combination of the two

A problem of spatio-temporal resolution

15 min accumulation for Crug-y-Gorllwyn





5 km

Not noticeable

1 km

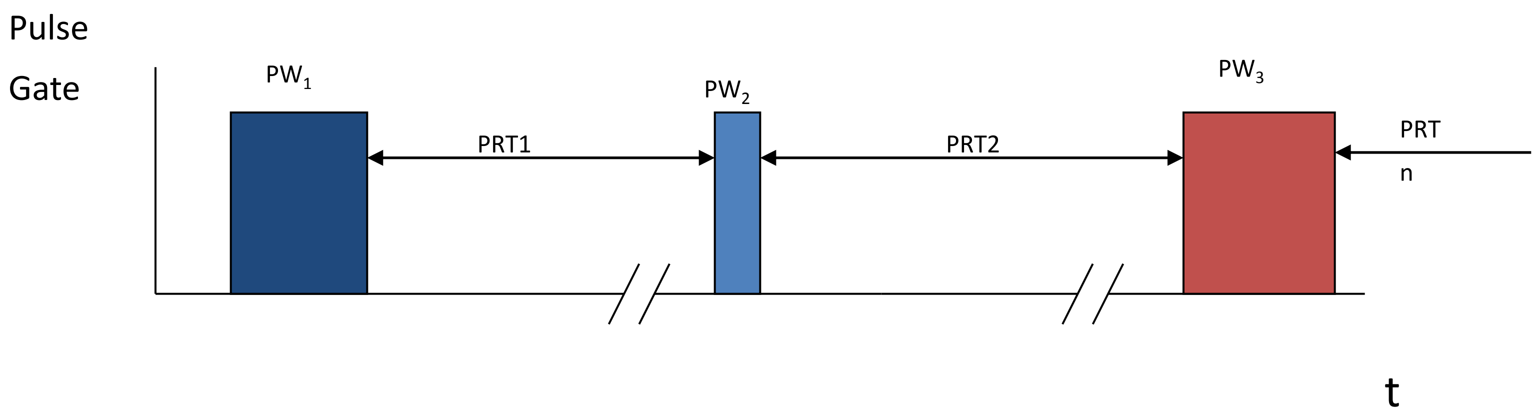
Highly noticeable

Threshold wind velocities for stroboscopic banding to occur

- 5 km radar resolution
  - 60 km/h (~ 37 mph, ~ 32 knots) – Rarely observed.
- 2 km radar resolution
  - 24 km/h (~ 15 mph, ~ 13 knots) – Observed fairly frequently and sometimes causes banding.
- 1 km radar resolution
  - 12 km/h (~ 7.5 mph, ~ 6 knots) – Regularly observable and frequently causes pixel jumping even in non-extreme precipitation events.

Can we combine Doppler and reflectivity scans/please everyone?

- New Transmitter has novel control interface
  - Trigger pulse from DSP controls pulse length and repetition frequency simultaneously
  - Possibility of Mixed pulse lengths and PRFs



- Can we use this to maximise transmitted power (for best reflectivity) at same time as having high PRF (for best Doppler) within the duty cycle of the Tx?
- Take advantage of the fact that the rain does not fully de-correlate between pulses

Gauge radar merging project

The aim is to recommend and implement the most appropriate method for merging gauge and radar data and to produce a real time 15 minute gauge radar merged rain accumulation product at 1km resolution.

Key stages:

- Develop a real time gauge QC system suitable for use with MO and EA gauge data
- Design, develop and evaluate the merging technique.

The merged accumulation product will be used:

- As input to the G2G rainfall runoff model (key input is a 15 minute accumulation).
- As “ground truth” for near-real-time verification of STEPS and NWP precipitation forecasts
- As an hourly rainfall accumulation input to the UKPP-MOSES-PDM: improving on the current use of hourly radar rainfall accumulations.
- As information for forecasters' guidance, using a range of accumulation periods.

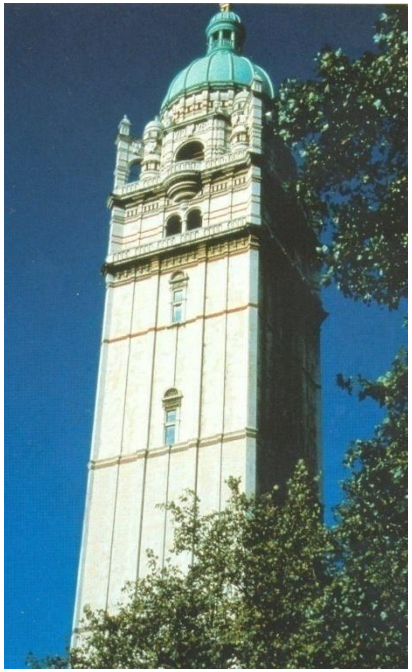
Goals

- Currently producing 500m composite over London
  - Determine limits of this with current C band hardware
- Decrease current volume scan times by factor of two
- Maintain operational network with diverse user requirements
- Share information on the relative merits of X and C band radars

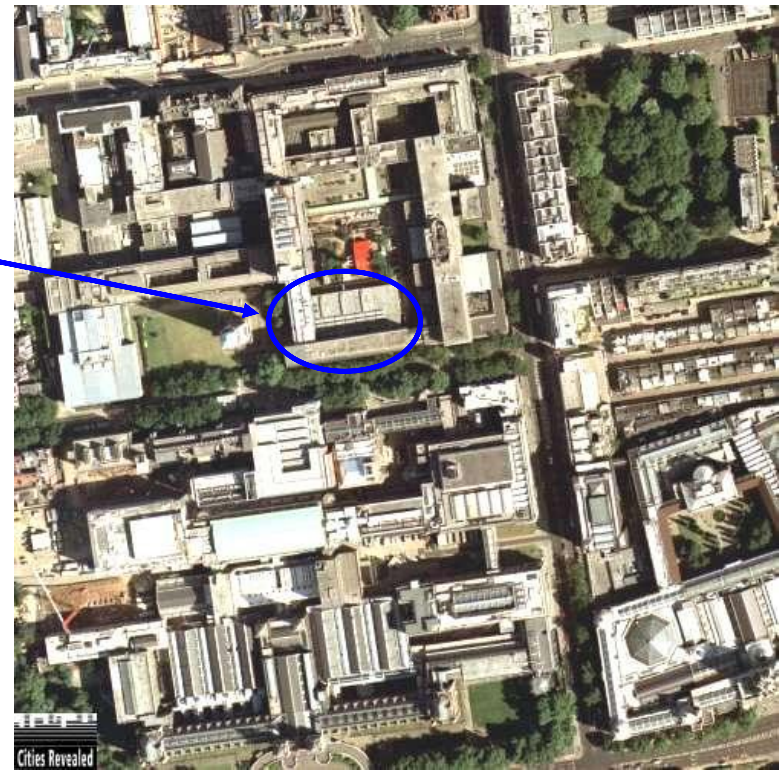
3.2. IMPERIAL COLLEGE LONDON

Čedo Maksimović

Environmental and Water Resource Engineering (EWRE) at Imperial College London



Department of Civil & Environmental Engineering



Integrated Urban Water Solutions

For solving local problems and
for developing technologies for experts

Urban Pluvial Flooding

Extreme rainfall events exceed the capacity of the drainage system!

Urban Pluvial Flooding

- Poor drainage capacity of minor (sewer) system
- Surface flow (major system)
- Dynamic interactions (exchange of mass) between the two systems
- Everything happens quickly – “flash floods”

Urban Pluvial Flooding

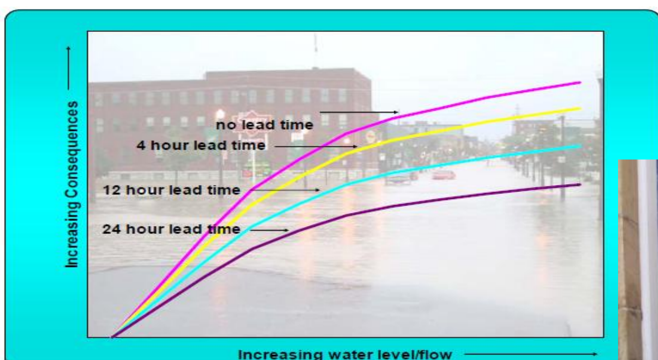
Mitigation solutions?

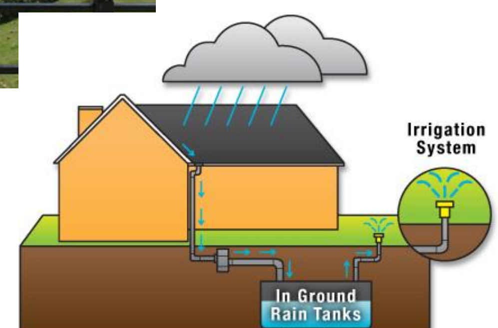
WP3

Improved Forecasting and Event Management

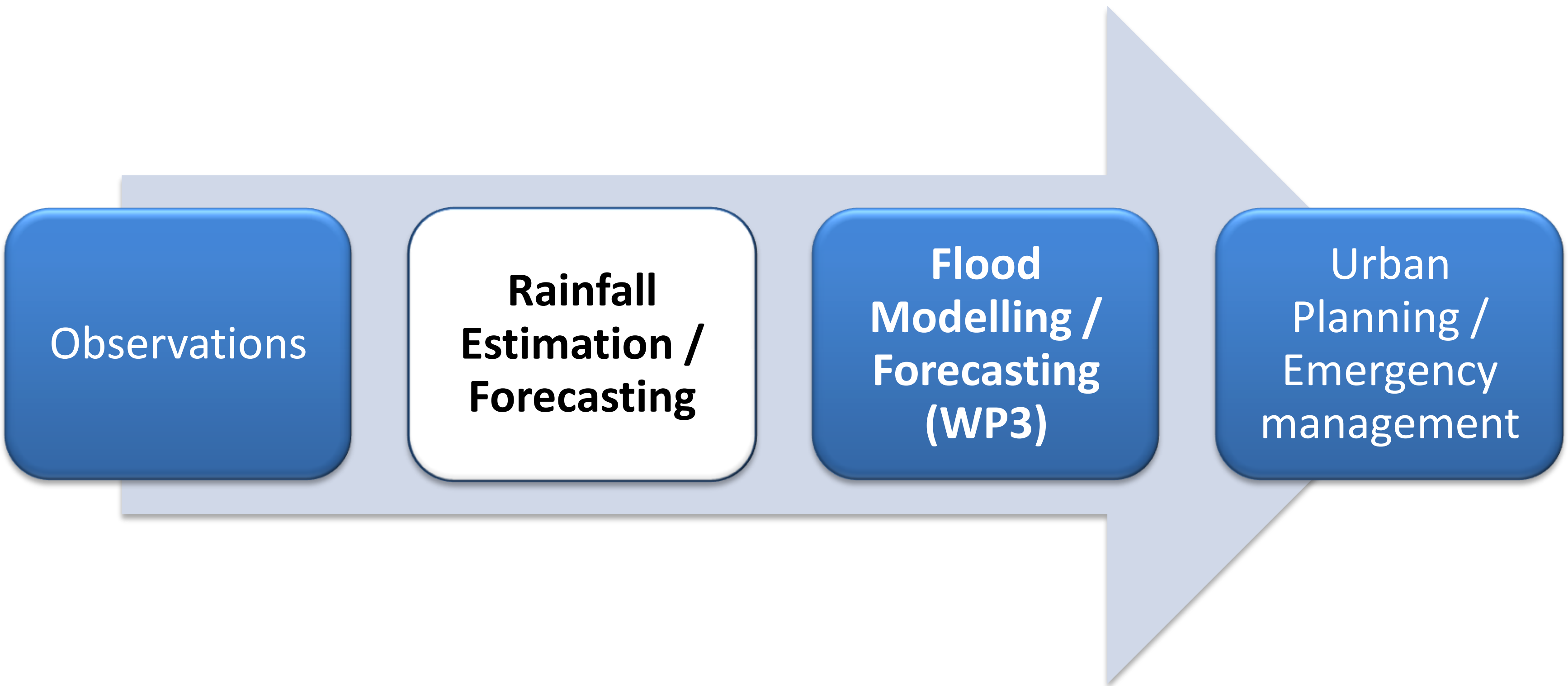
WP4

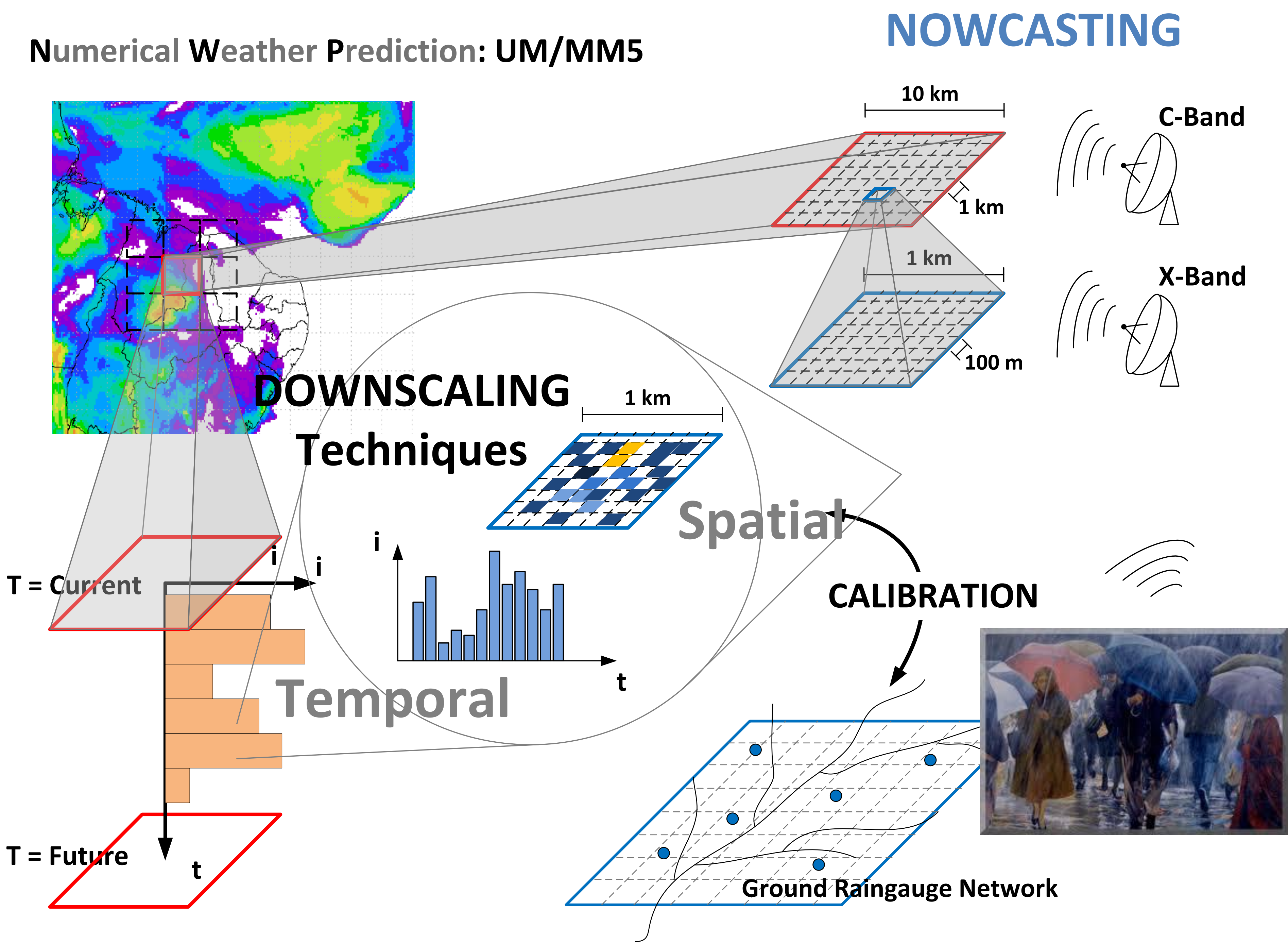
Advanced (Water Sensitive) Urban Planning + Improved Management





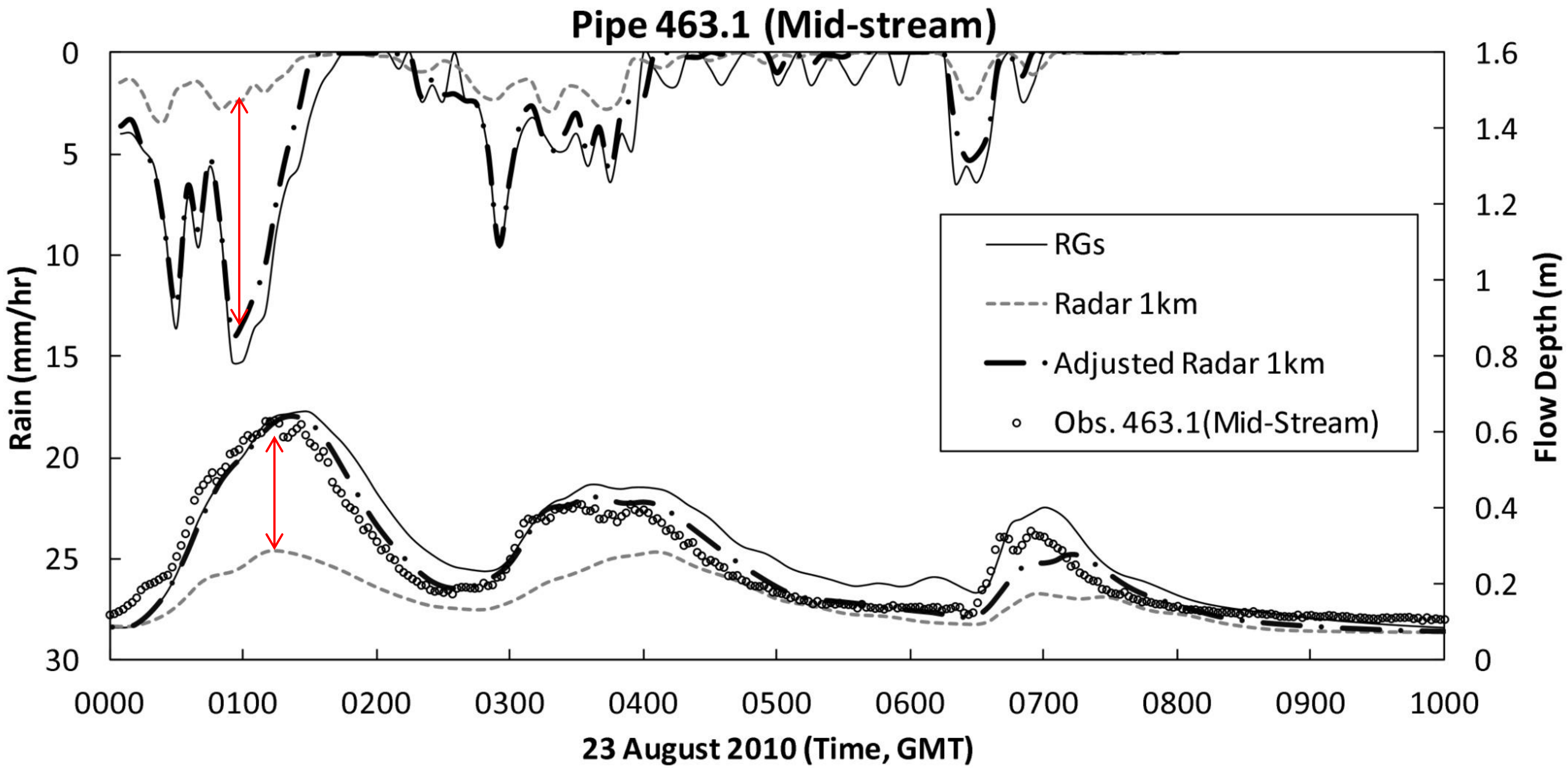
Model Assembly for Pluvial Flood Modelling, Forecasting and Management



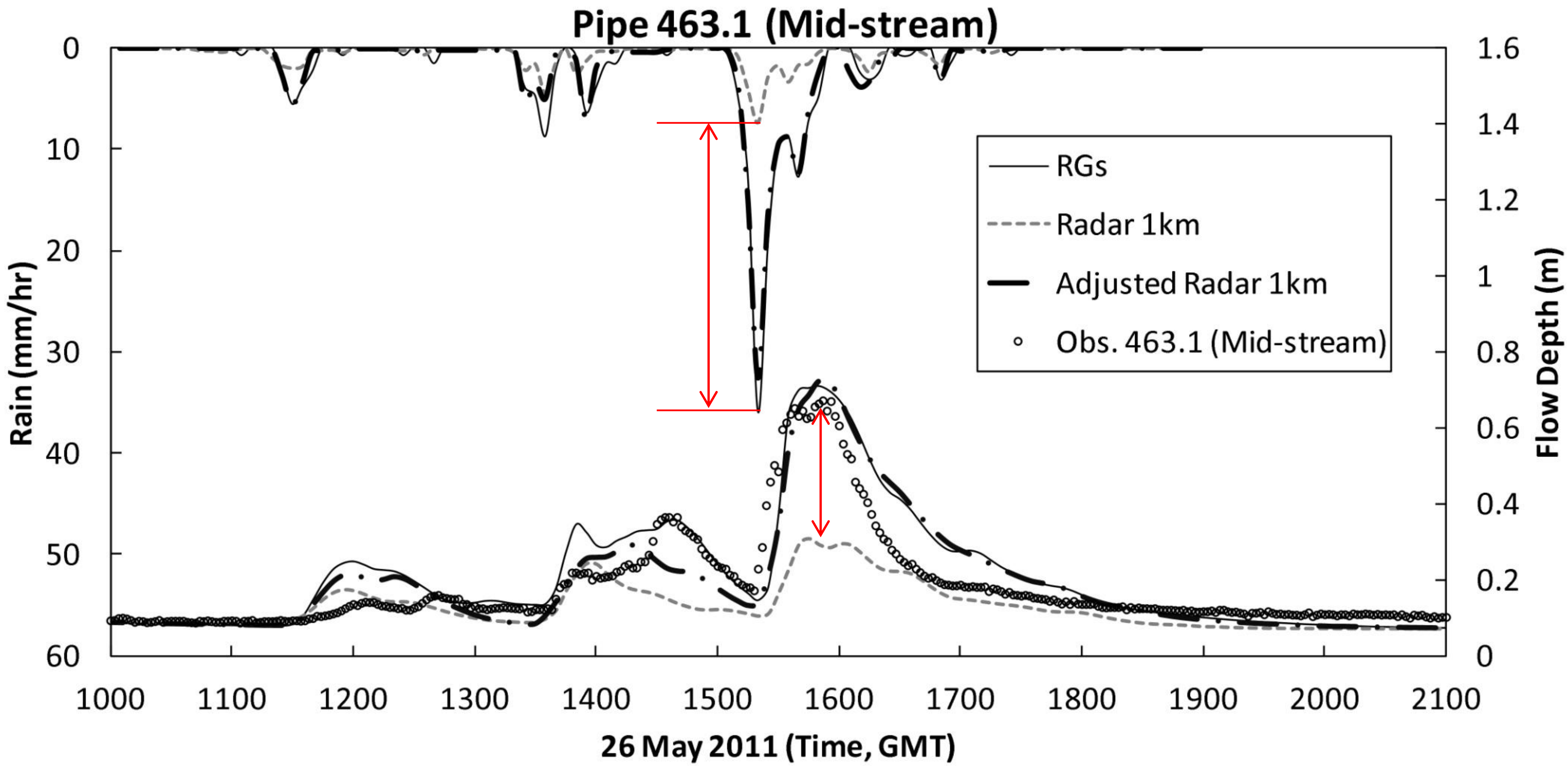


Numerical Weather Prediction: UM/MM5
NOWCASTING
10 km
1 km
C-Band
1 km
100 m
X-Band
DOWNSCALING
Techniques
1 km
Spatial
i
t
Temporal
T = Current
i
i
T = Future
t
CALIBRATION
Ground Raingauge Network

Benefits of gauge-based rainfall adjustment for flow simulation



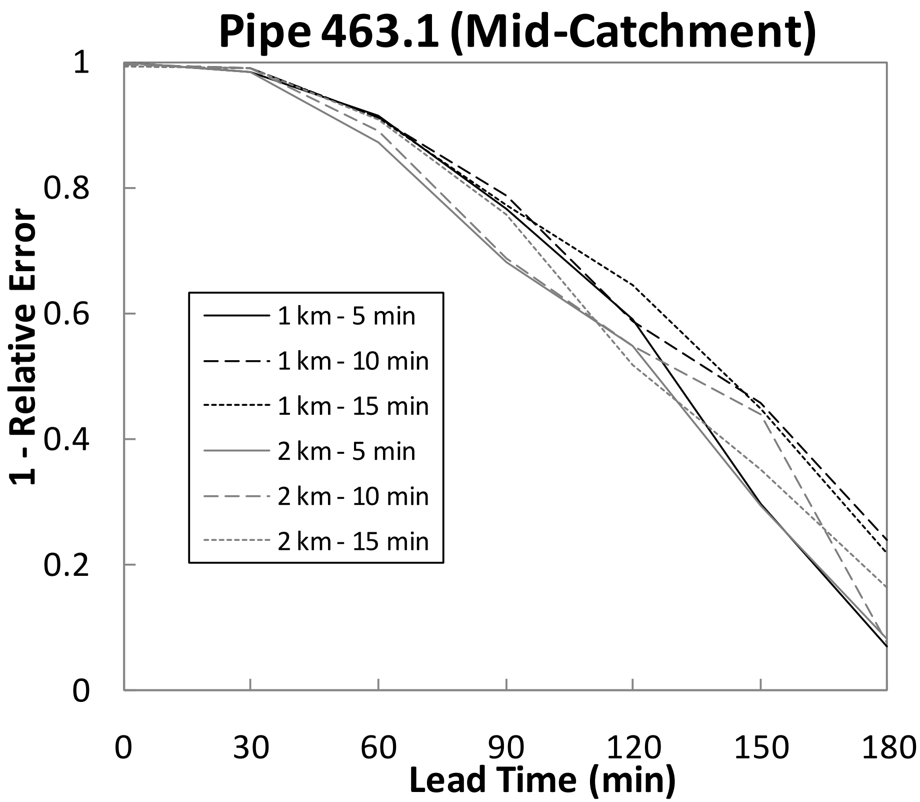
Benefits of gauge-based rainfall adjustment for flow simulation



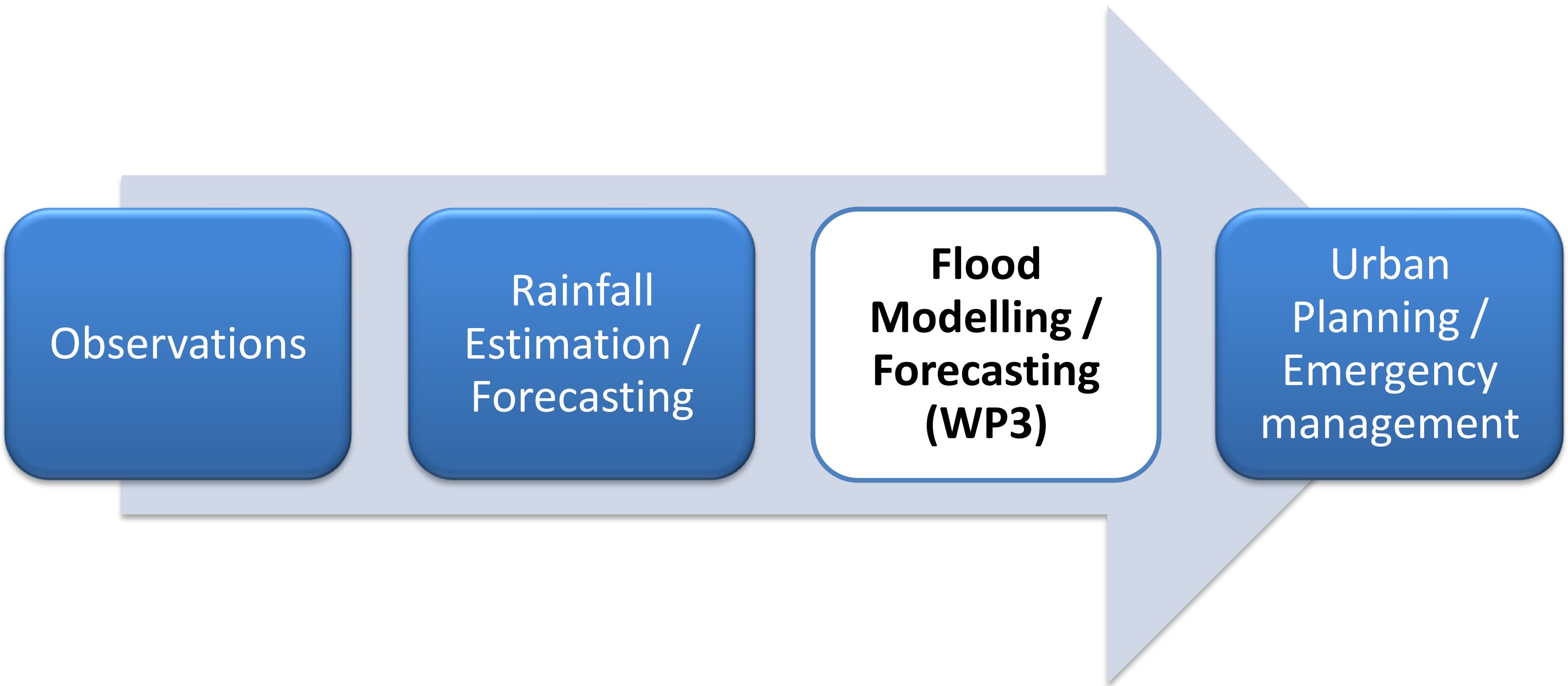
Effect of rainfall resolution and forecast lead time

$$1 - \text{Relative Error} = 1 - \left\langle \frac{\left| Y_{Nowcast} - Y_{Nimrod} \right|}{Y_{Nimrod}} \right\rangle$$

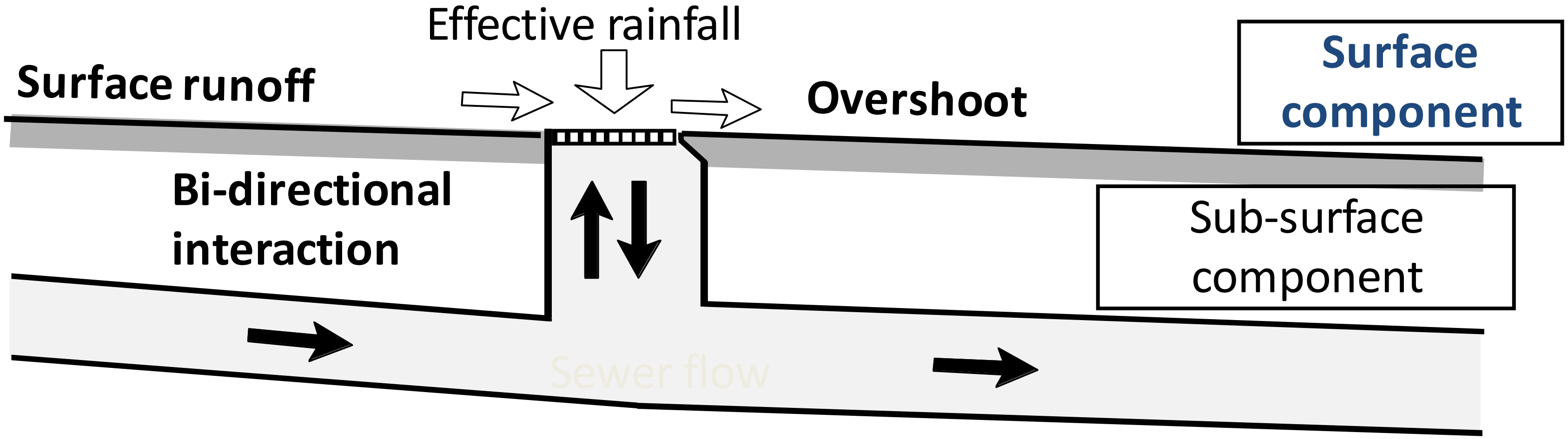
The results suggest that rainfall with finer resolution produces better results in flow estimates



Model Assembly for Pluvial Flood Modelling, Forecasting and Management



Modelling of Urban Pluvial Flooding – Dual Drainage Concept



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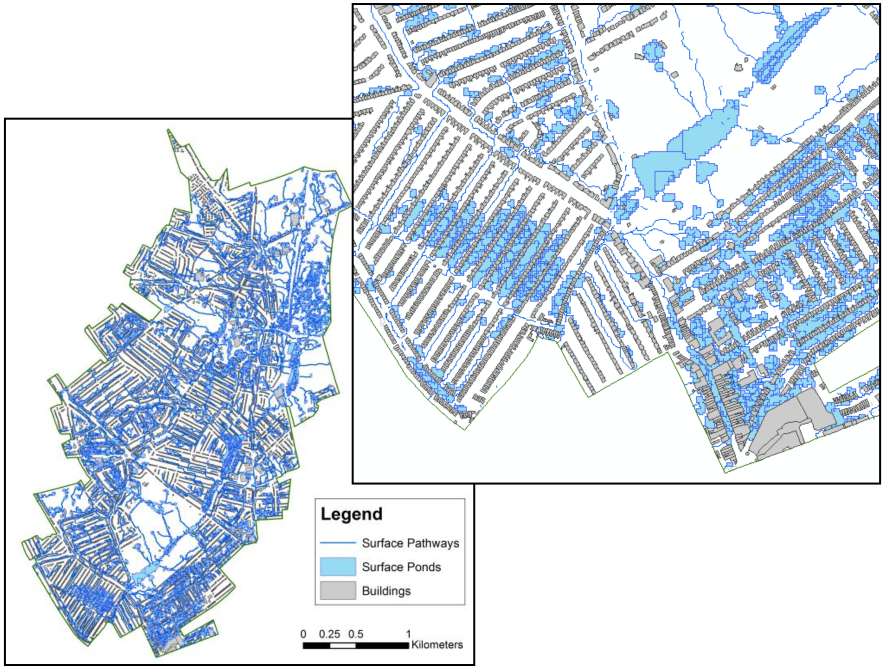
Modelling of Urban Pluvial Flooding

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

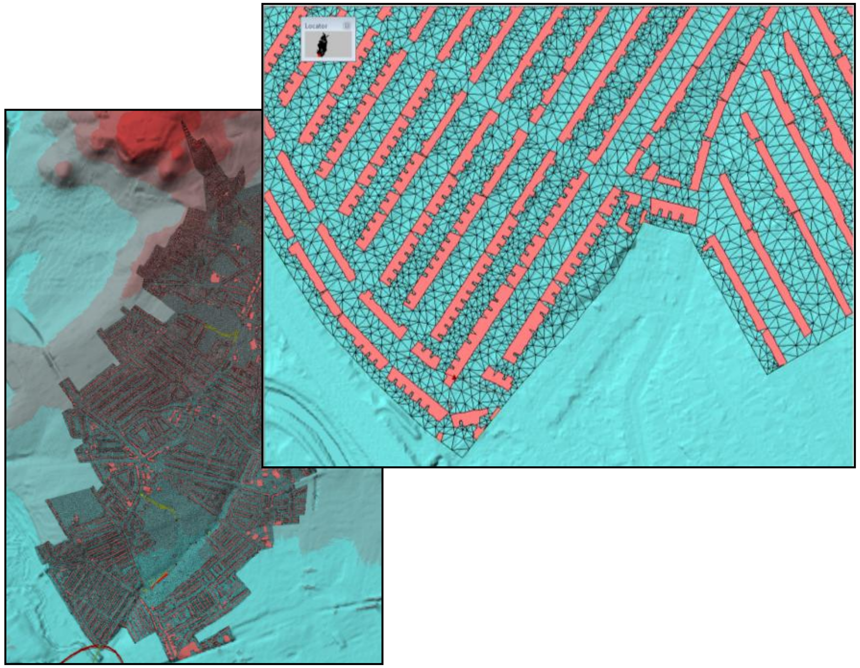
1D overland flow modelling

Nodes (ponds) and links (flow paths)



2D overland flow modelling

Surface divided into small elements
(squares or irregular triangles)



Modelling of Urban Pluvial Flooding

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

1D overland flow modelling

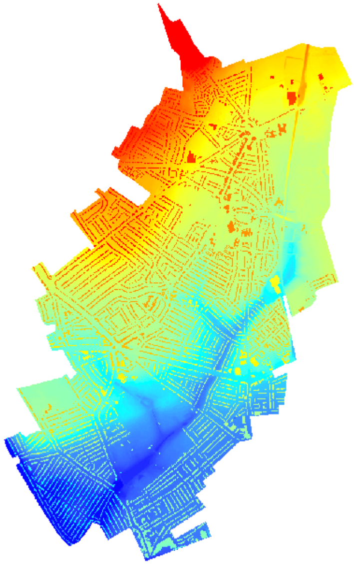
-Generated based on DEM

-Can be created manually (simplified, subjective and time consuming) or using the AOFD tool developed at Imperial College London

2D overland flow modelling

-Generated based on DEM

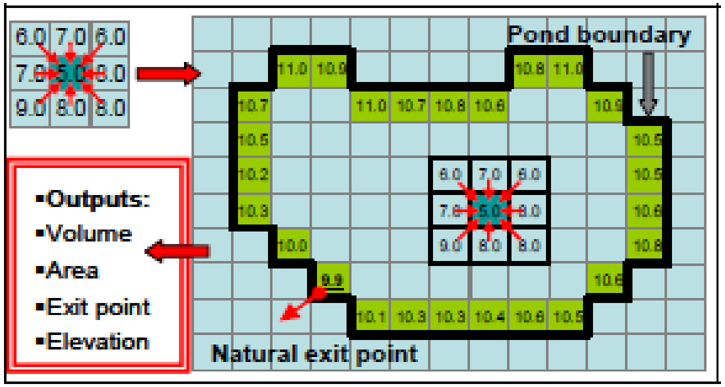
-Generated using routines available in commercial software packages



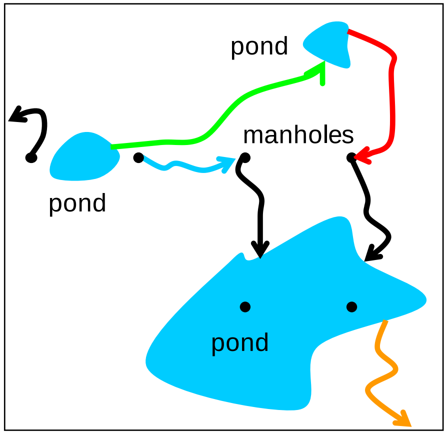
- Both overland models are based on DTM
- Quality of the DTM is critical (*desirable: 1 m horizontal resolution*)
- Airborne and terrestrial LiDAR

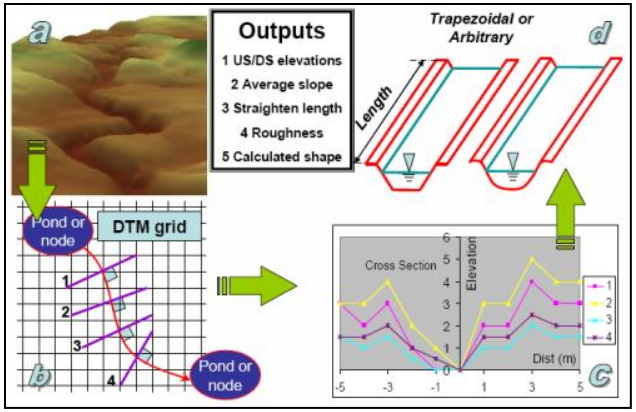
Automatic Overland Flow Delineation (AOFD)

1. Pond delineation

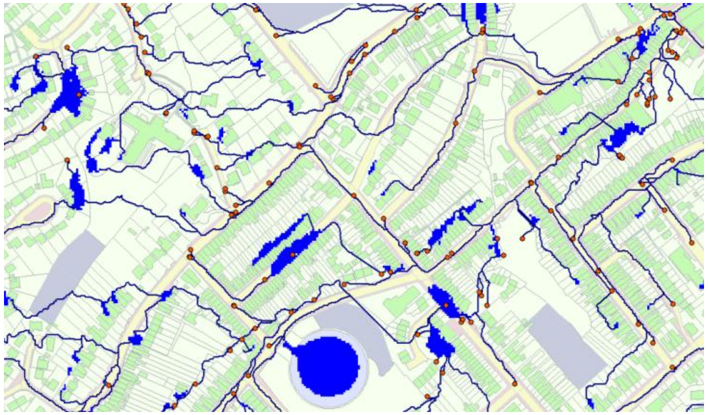


2. Pathway delineation





3. pathways' geometry



4. 1D overland network

Model Requirements

- **For urban pluvial flood modelling – planning purposes:**
  - Scenario/alternative analysis to support decision making
  - Very detailed models are required
  - Running time is not critical
  - **Input:** design storms, historical storms
  - **Output:** flow and level in pipes, flood extent and depth with fine resolution for different scenarios

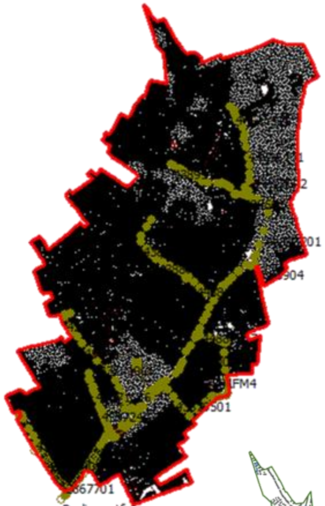
- **For urban pluvial flood forecasting:**
  - Pluvial flooding is localised and happens quickly – detail and time are both critical!
  - **Input:** rainfall forecast with fine temporal and spatial resolution
  - **Output:** predicted flow and level in pipes, flood extent and depth with fine resolution
  - Models must be fast (to allow longer lead time and constant update of the prediction), but also detailed!

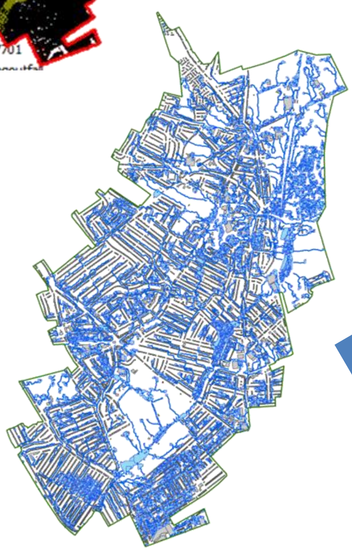
1D-1D Models vs. 1D-2D Models

	1D-1D	1D-2D
Detail and Accuracy		✓
Computational time	✓	
Vizualization of results		✓

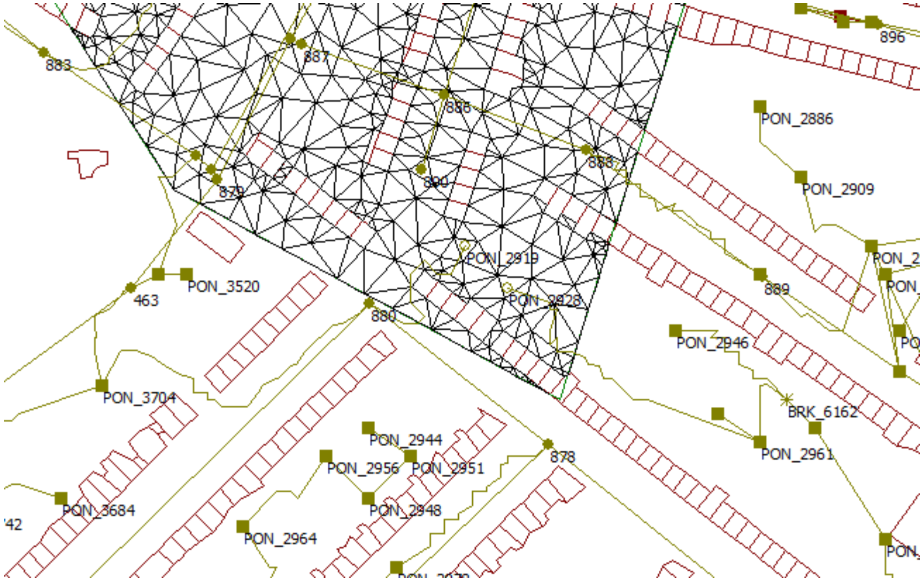
To combine their advantages and overcome their disadvantages…

1D / 2D





1D / 1D

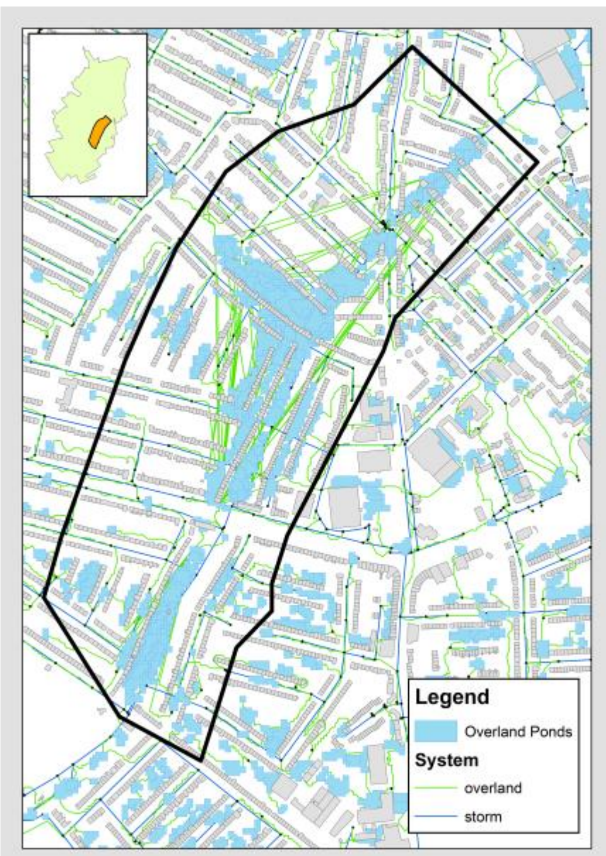


Hybrid

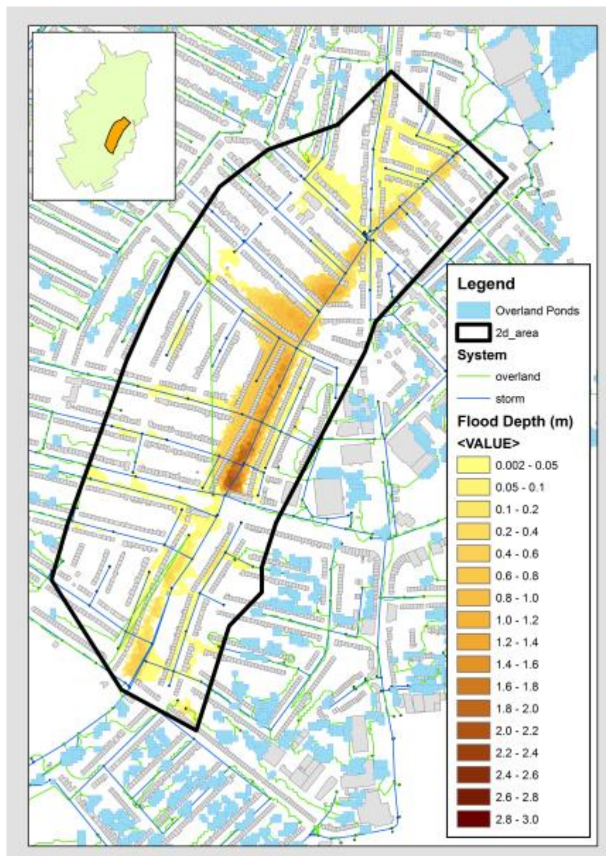
1D/1D + 1D/2D simulation

Do hybrid models perform well?

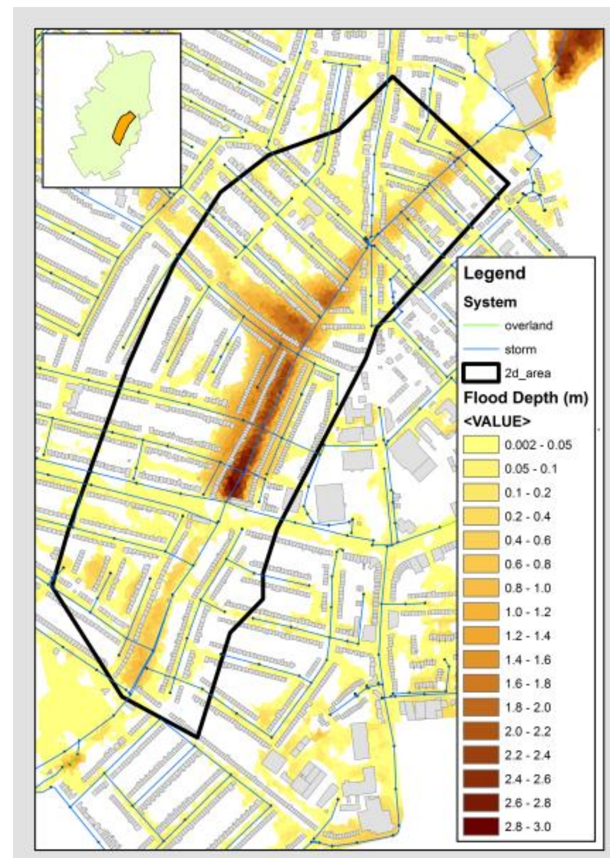
1D1D



Hybrid



1D2D



Simulation Time

Return Period	1D1D	Hybrid	1D2D
30 yr	01m 46s	04m 31s	45m 23s
100 yr	02m 11s	05m 20s	01h 11m 10s
200yr	04m 40s	05m 49s	01h 16m 05s

300 min event

The new hybrid models can be almost as good as 1D-2D models but much faster!

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

3.3. The Local Government Flood Forum

Laurie Thraves

4. Wrap Up, Questions

1. AGENDA FOR THE DAY

- 10:00 – 11:00: Introduction to the RAINGAIN project (RainGain partners)
- 11:00 – 12: Presentations
  - Louise Clancy (Greater London Authority)
  - Stephen Merrett (Environment Agency)
  - David Lees (Defra)
- 12:00 – 13:00: Lunch
- 13:00 – 14:00: Break-out:
  - 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 (Chair : Čedo Maksimovic - ICL)
  - Improved management of urban pluvial flooding (Chair: Laurie Thraves – LGFF)
- 14:00 – 14:30: Coffee break
- 14:30 – 16:00: Summary / Conclusions
  - Report from break-out session (3 x 10 min)
  - Discussion (15 min)
  - Conclusions and close (10 min)