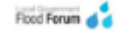




# RainGain

High resolution rainfall radar  
for urban flood modelling and prediction



Xband/Improved Cband  
radars in 4 Cities:

Rotterdam (NL)

Leuven (B)

Paris (F)

London (UK)





## Four cities gain rain

RAINGAIN is a transnational project aimed at improving the prediction of pluvial floods in our cities. The frequency and the damages of pluvial floods in urban areas are expected to increase as a consequence of climate change and urban development. New solutions are needed to cope with intense storms and to reduce the risks for populations and infrastructures. RainGain develops and tests innovative tools and practices based on the use of high resolution radars in four pilot cities: Leuven, London, Paris, Rotterdam. The project is funded by the European program Interreg IVB NWE.

[Read More](#)



# Coping with extreme rainfall impacts: urban floods and damage



*Rotterdam,  
July 2012*





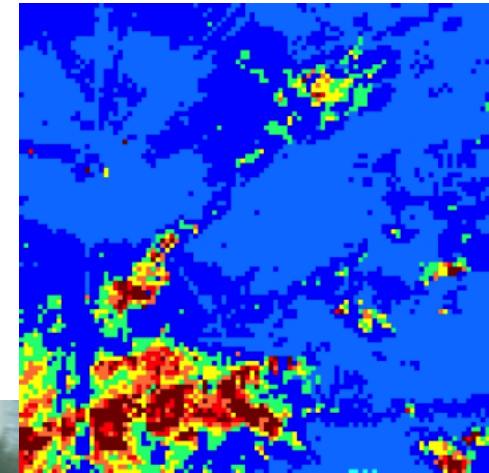
# Extreme Rainfall in the City, towards Flood Resilience



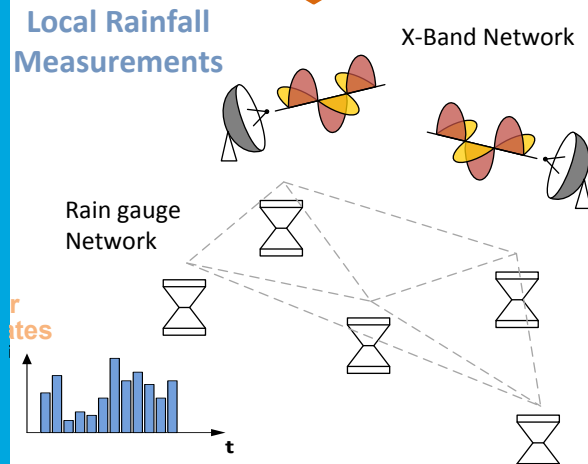
What we want:

High resolution weather information

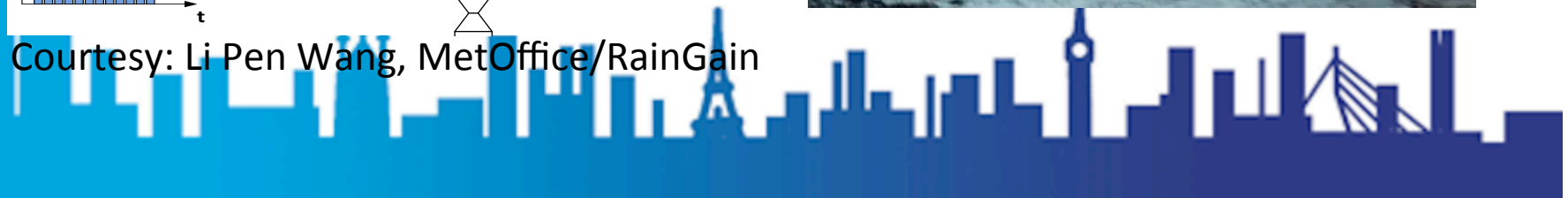
- Street level (30x30m)
- Every minute
- Up to a day in advance



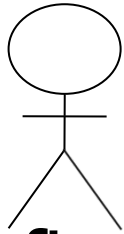
Local Rainfall  
Measurements



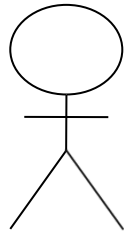
Courtesy: Li Pen Wang, MetOffice/RainGain



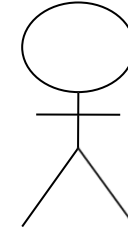
## Urban weather: dynamic, diverging information needs



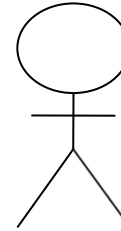
fire  
brigade



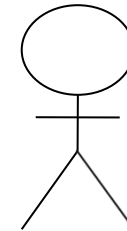
restaurant  
owner



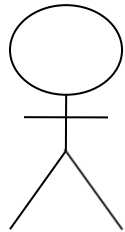
commuter



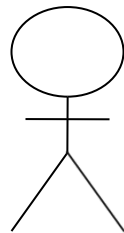
water  
authority



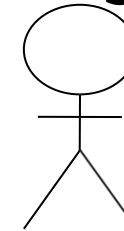
shop keeper



large event  
organizer



local  
government

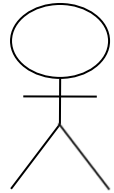


police





# Extreme Rainfall in the City diverging information needs

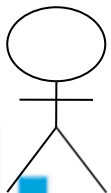


- Predictions (hour-days forecast)
  - how much rain will fall on this shopping street, square, vital crossroads?

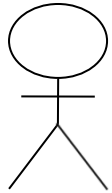


- Real-time (nowcast)
  - where are floodings and which are critical?

- Analysis (hindcast)
  - How did models perform/hydrological system react?

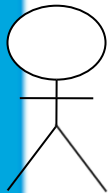


## Extreme Rainfall in the City diverging information needs



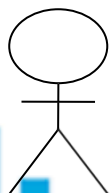
- Predictions (hour-days forecast)
  - how much rain will fall on this shopping street, square, vital crossroads?

*Issue warnings,  
Operational control of weirs/pumps  
Planning of emergency services*



- Real-time (nowcast)
  - where are floodings and which are critical?

*Assess severity,  
Focus emergency efforts,  
Operational control*



- Analysis (hindcast)
  - How did models perform/hydrological system react?

*What can be improved,  
Who is to blame for claims*





# RAINGAIN: 4 Cities



## Rotterdam:

- Current population: 0.62 M; 2500people/km<sup>2</sup>
- Land area 531 km<sup>2</sup>
- Largest port in Europe (Europoort)
- Main city Rhine delta protected by Maeslantkering
- Elevation: approx -6m to +6 m MSL



Photo: Massimo Catarinella



©MOLiver





# RAINGAIN: 4 Cities



## Greater London:

- Current population: 8 million+, 5100 people/km<sup>2</sup>
- Land area 1623 km<sup>2</sup>
- Major financial centre
- Main city Thames delta protected by Thames barrier
- Elevation: approx 0 - 80 m +MSL





# RAINGAIN: 4 Cities

## Paris agglomeration:

- Current population: 9.6 million+, 3550 people/km<sup>2</sup>
- Land area 2723 km<sup>2</sup>
- Capital, economic and political centre of France
- Main city Seine river basin
- Elevation: approx. 13 - 130 m +MSL





# RAINGAIN: 4 Cities



## Leuven:

- Current population: 97,000, 1700 people/km<sup>2</sup>
- Land area 60 km<sup>2</sup>
- Historical city; oldest university in Benelux (1425)
- City on Dijle river, upstream branch Schelde river
- Elevation: approx 20-60 m +MSL





# RAINGAIN - 4 Cities

## Flash flood control strategies



Photo: Massimo Catarinella



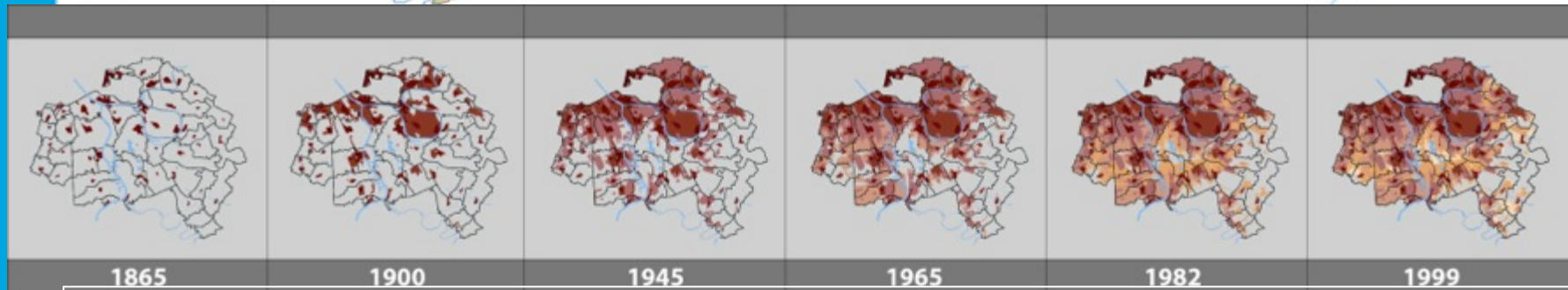
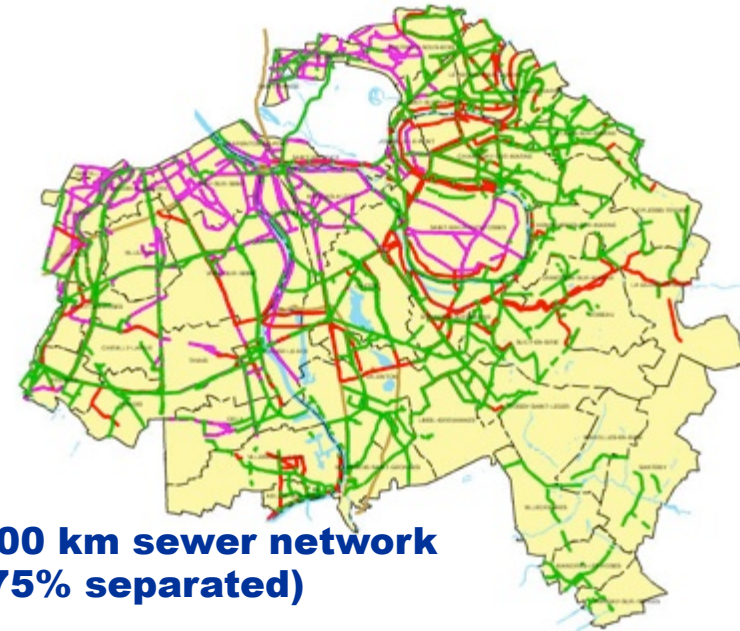


# Val-de-Marne County

- 245 km<sup>2</sup>
- 47 municipalities
- 1,35 million inhabitants



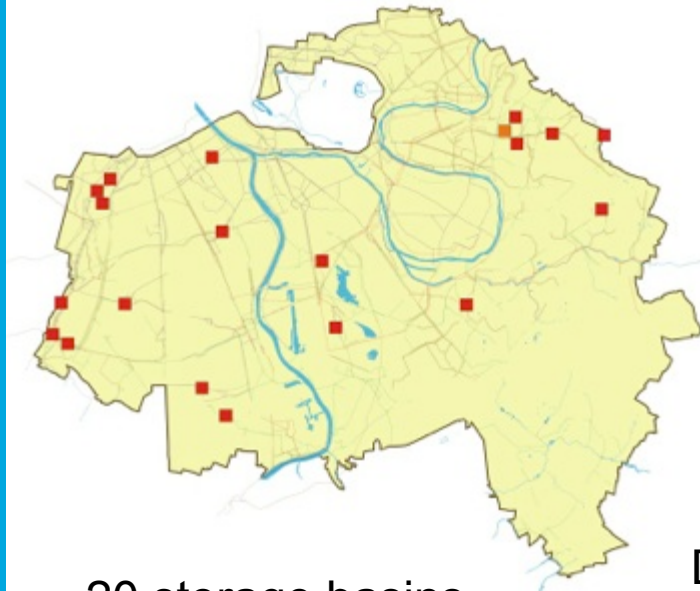
## - Flat Topography



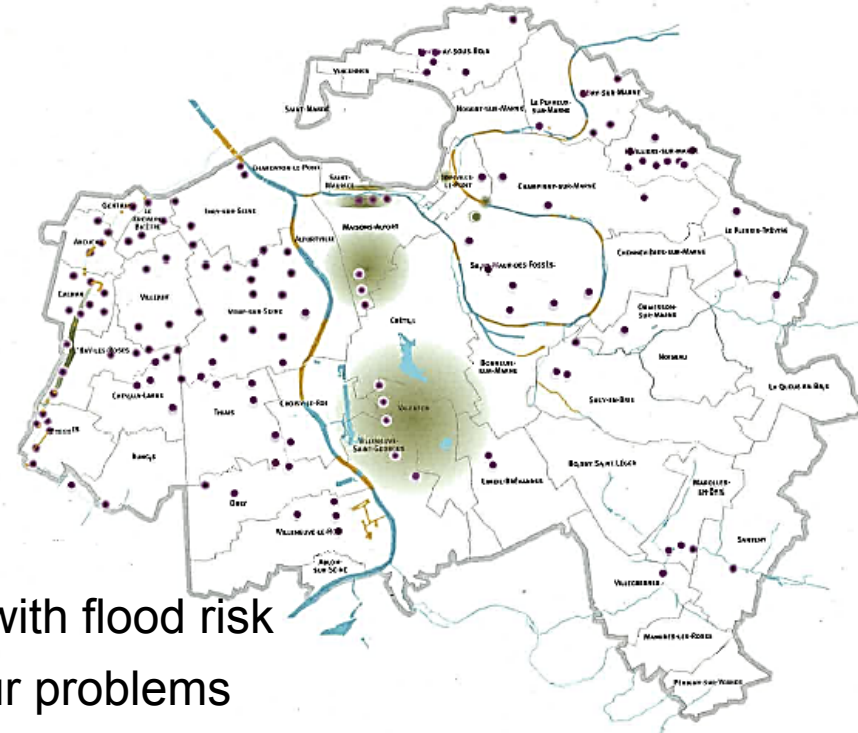
**Evolution of urbanisation : A new colour represents areas urbanised since the previous step**



## Characteristics of the sewage system and problems encountered



20 storage basins, from 200 to 75000 m3



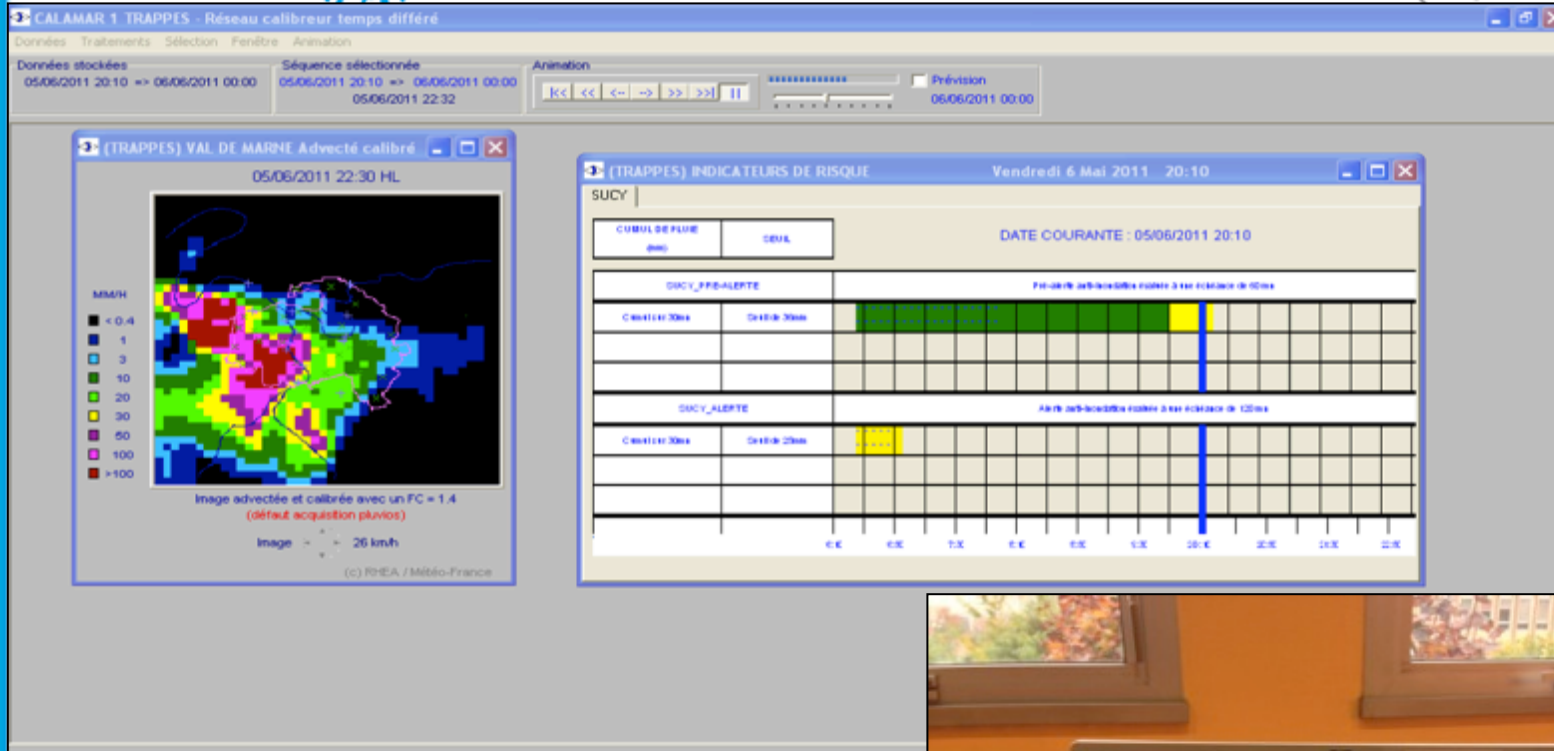
Dots: Areas with flood risk

Clouds: odour problems

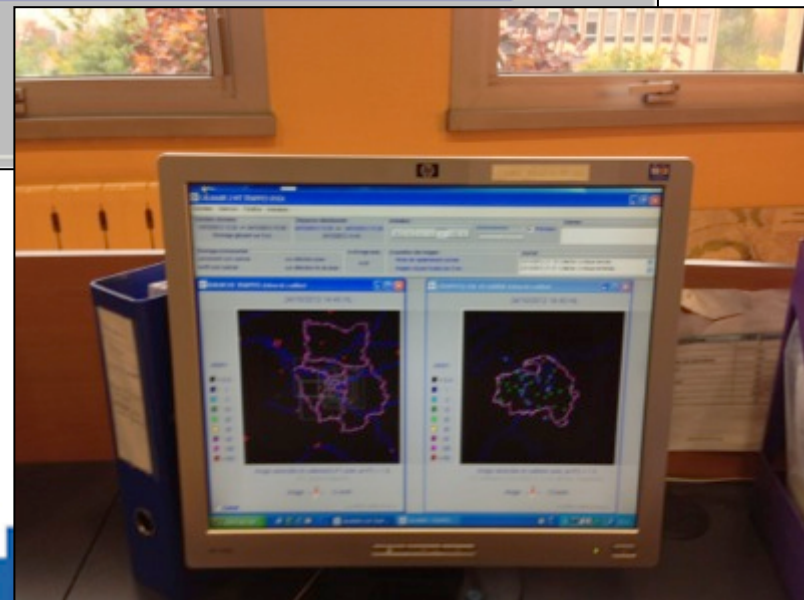
Yellow river stretches: receive combined sewer discharges

The system also includes: 24 pumping stations, 222 water and flow level monitoring points in pipes, > 200 electromechanical installations





- A forecasting system (during the next hour) with 2 levels of alarm (1<sup>st</sup> : 36mm on a 4km<sup>2</sup> area at less than 20 km; 2<sup>nd</sup>: 25 mm on the catchment)
- Real time calibration
- A lot of false alarm exists on the first level, not on the second



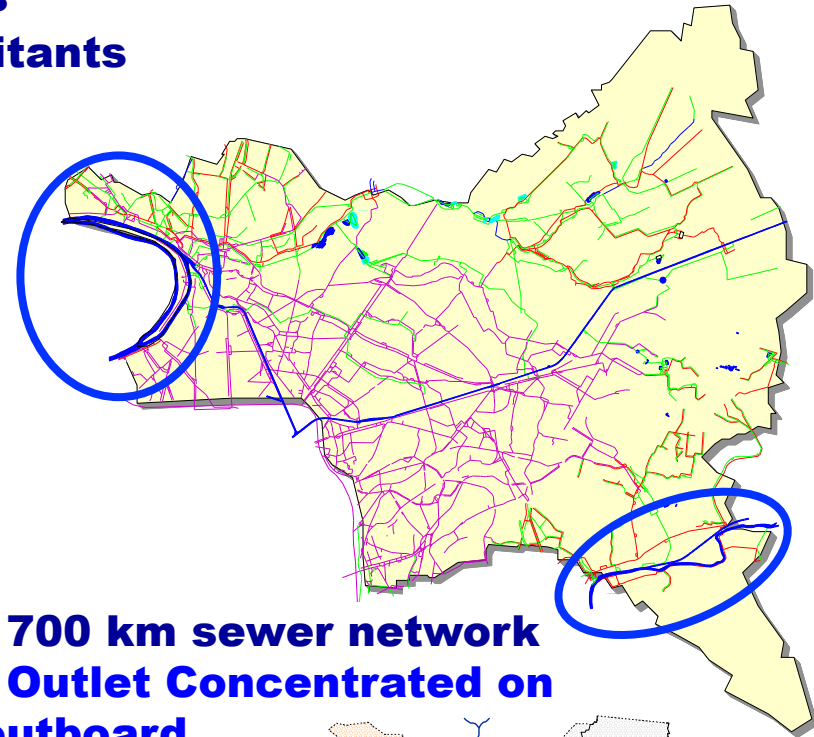
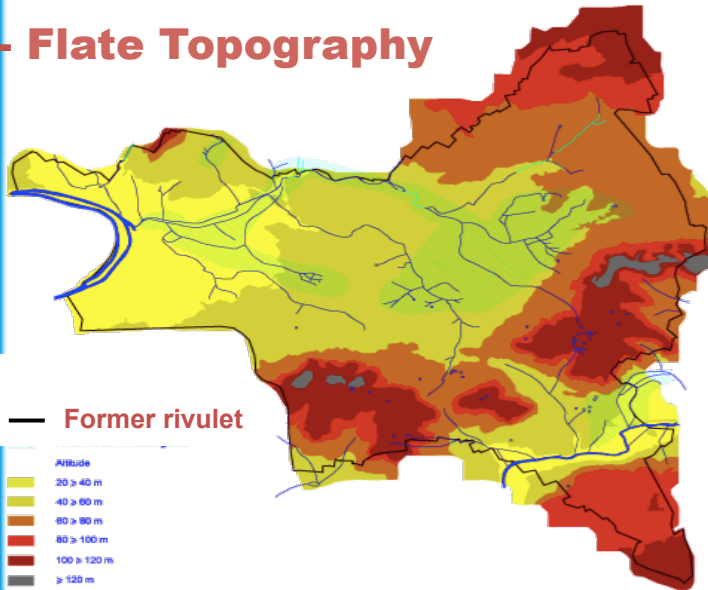


# Seine-Saint-Denis County

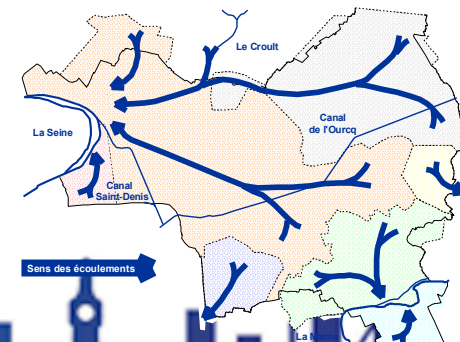
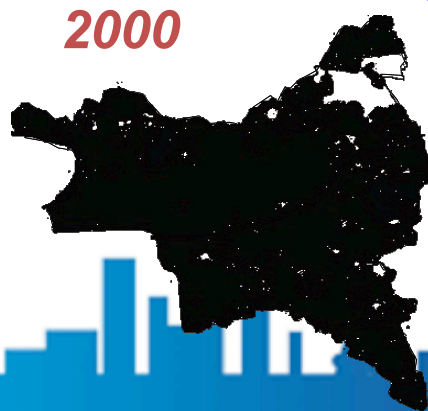
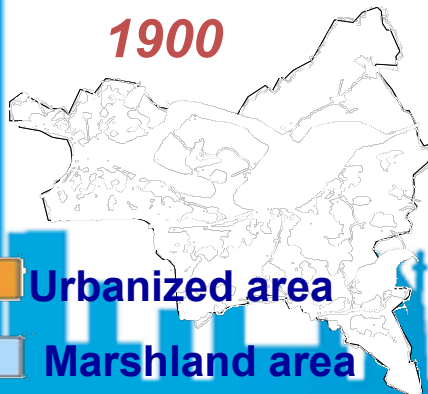
- 236 km<sup>2</sup>
- 40 municipalities
- 1,5 million inhabitants



## - Flate Topography



- 700 km sewer network
- Outlet Concentrated on outboard



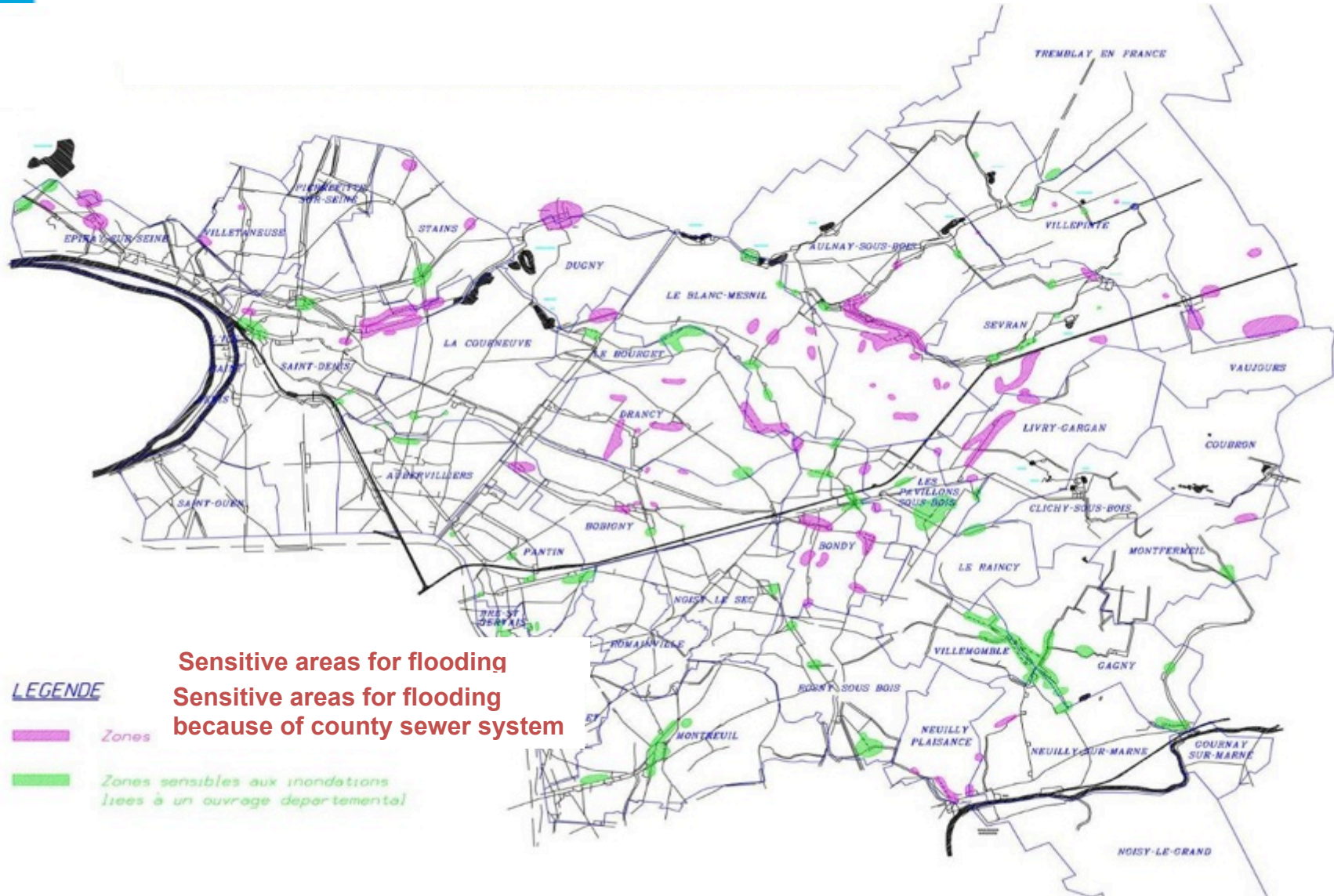
Urbanized area

Marshland area





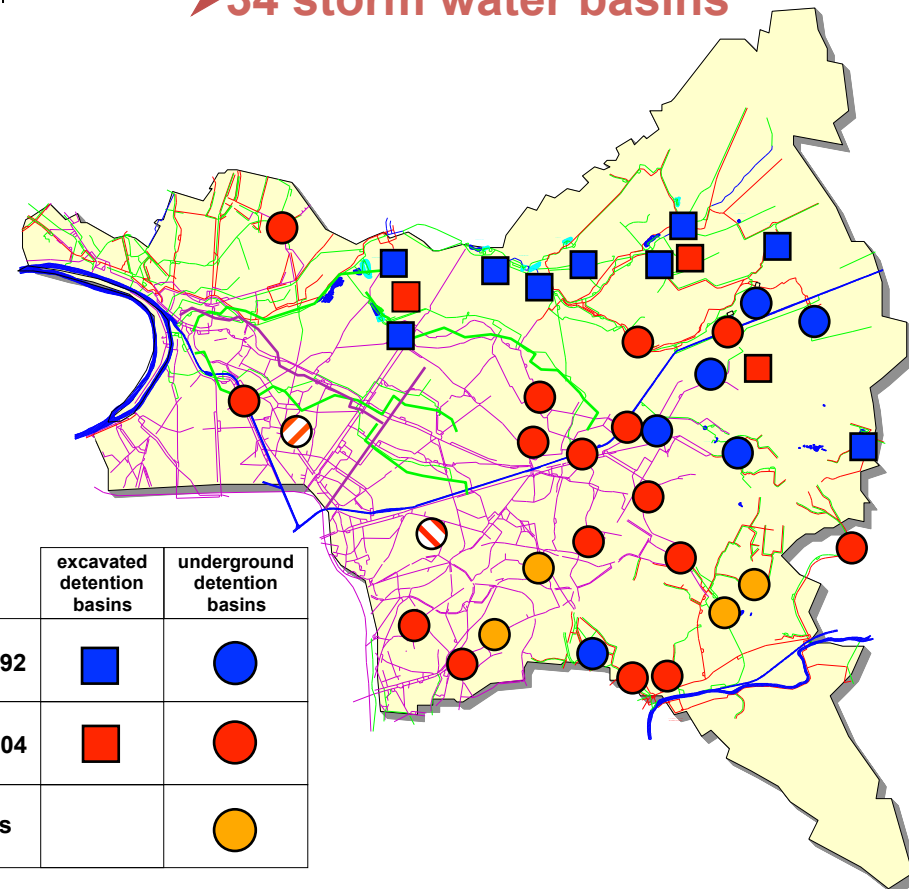
## Areas sensitive to flooding





For raining time :

➤ 34 storm water basins



- 12 pumping stations
- 27 rain gauges
- 26 measurements sites
- 8 siphons
- 7 regulating gates

	excavated detention basins	underground detention basins
Up to 1992		
1993 / 2004		
projects		

Synoptique | **planning pluie MVM** | \*Moree-Vieille Mer\* | Courbe intensive | Courbe cumul horaire | Courbe evenement | Journal zone

Imprimer

TABLEAU : planning pluie MVM à 12/04/2013 16:07:54

12/04/2013 16:07:54 ?

Selection de la pluie zone Moree-VMer

Duree_pluie_ecoulee		Pluie_observed_terrain		Pluie_prevue_Calamar		Pluie_proposee_IPSP	Pluie_choisie_Pilote	Heure_prevue_debut_pluie_IPSP		Validation_scenario_Pilote		Bulletin	
Nom	Valeur	Nom	Valeur	Nom	Valeur	Valeur	Valeur	Nom	Valeur	Nom	Etat	Nom	Etat
DUR_PLU_MOREE	26.00	CUM_EVT_MOREE	1.84	PREVISION_MVM	0.11	temps sec	temps sec	DEB_PLU_MVM	12/04/13 16:00	Validation scenario	OFF	Bulletin_ZV	OFF

12/04/2013 16:07:54 ?

Planning de conduite Zone Moree Vieille Mer

TC scenario	Activation TC	TC envoyee		TR scenario		Activation TR		TR envoyee				Decantation
		Date_Activation	Nom	Nom	Valeur	Nom	Valeur	Date_Activation	Nom	Consigne	Val Regul.	
ACT_INH_VIDB_AB	12/04/13 15:43	INH_VIDB1B2_AB		TR0-B_BM	7.00	ACT_TR0_B_BM	7.00	NORMAL	TR0_B_BM	7.00	0.00	DECANT_AB
ACT_CDF_V3_BT	12/04/13 15:50	CDF_V3_BT		TR0-VS_BT	1.00	ACT_TR0_VS_BT	1.00	NORMAL	TR0_VS_BT	1.00	0.00	
ACT_INH_VIDB1B2_BT	12/04/13 15:40	INH_VIDB1B2_BT										DECANT_BT
ACT_CDF_V_CI	12/04/13 15:50	CDF_V_CI										DECANT_CI
ACT_CDI_2V_CI	NORMAL	CDI_2V_CI										
CDE-DECB1_DU	ACT_CDE_DECB1_DU	NORMAL	CDE_DECB1_DU	TR0-B1B2_D2	0.00	ACT_TR0_B1B2_D2	0.00	NORMAL	TR0_B1B2_D2	0.00	0.00	DECANT_DU
	ACT_INH_VIDB_GP	12/04/13 15:40	INH_VIDB_GP									DECANT_GP
	ACT_CDF_V_LP	12/04/13 15:50	CDF_V_LP									DECANT_LP
CDF-V1_MP	ACT_CDF_V1_MP	NORMAL	CDF_V1_MP									
	ACT_INH_VIDB1B2_MP	12/04/13 15:40	INH_VIDB1B2_MP									
CDF-V1_PM	ACT_CDF_V1_PM	NORMAL	CDF_V1_PM									
	ACT_INH_VIDB1_PY	12/04/13 15:40	INH_VIDB1_PY	TR0-V1_P1								
	ACT_CDF_V_VG	12/04/13 15:40	CDF_V_VG									

12/04/2013 16:07:54 ?

Maximum mesure		Maximum mesure		Maximum mesure	
Nom	Valeur	Nom	Valeur	Nom	Valeur
m_YAM_B1_PM	62.34	m_YAM_D_BA	38.42	m_YAM_D_KK	58.78
m_YAM_S2_PY	36.89	m_YAM_V_CI	58.07	m_YAM_V_IP	49.63
m_YAM_V1_PD	32.55	m_YAM_V1_PM	62.09	m_YAM_V1_SA	48.04
m_YCO_EP_GE	28.24	m_YCO_MOREE_AB	38.25	m_YCO_MOREE_PY	36.79
m_YEP_VMER_M	25.09	m_YEP_VMER_PO	26.68	m_YUI_PLB_PO	25.05

**State of activation of the remote control after having validation of a scenario**

**Dark Green field:** automatic mode, local condition of passing the remote control are reached: the remote control is send by the control system to the local control site

**Purple field:** automatic mode, the remote control has been correctly established at the local control site

**Light green field:** automatic mode, we have reached the local condition to cancel the remote control the control system send a remote control to cancel it locally

**Dark blue field:** manual mode, the pilot is sending the remote control without the local condition

**Light blue field:** manual mode, the pilot cancel manually the remote control because the local condition have been reached to cancel it

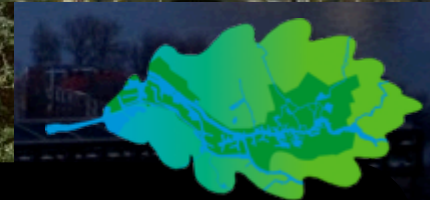
**Orange field:** NO authorisation to pass the remote control

**Yellow field:** the activation « line » has been forced to 0 or 1

**Dark pink field:** remote control disabled when it was sending to the local control site

**Light pink field:** remote control disabled when it get back in normal

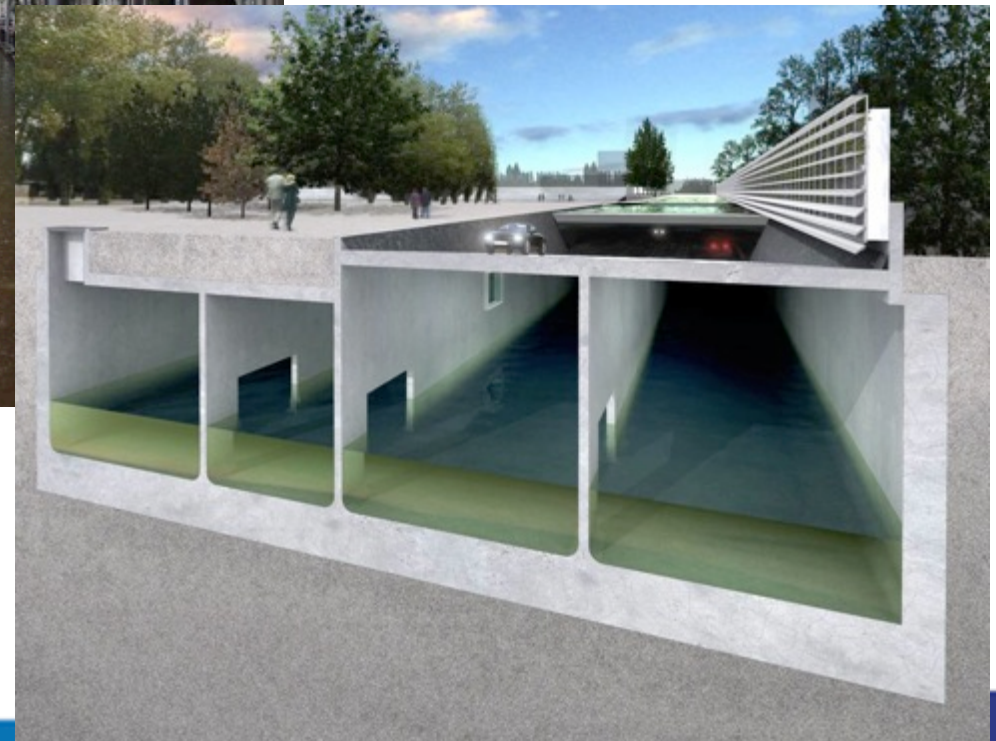




**Rotterdam: city in a delta ...**



# Flash flood control strategies: above and underground storage basins



# Flash flood control strategies: Water squares

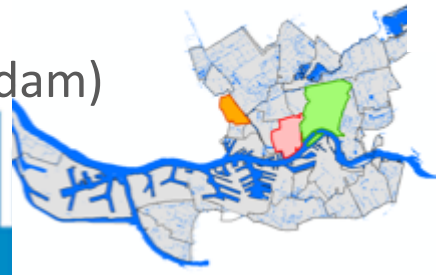
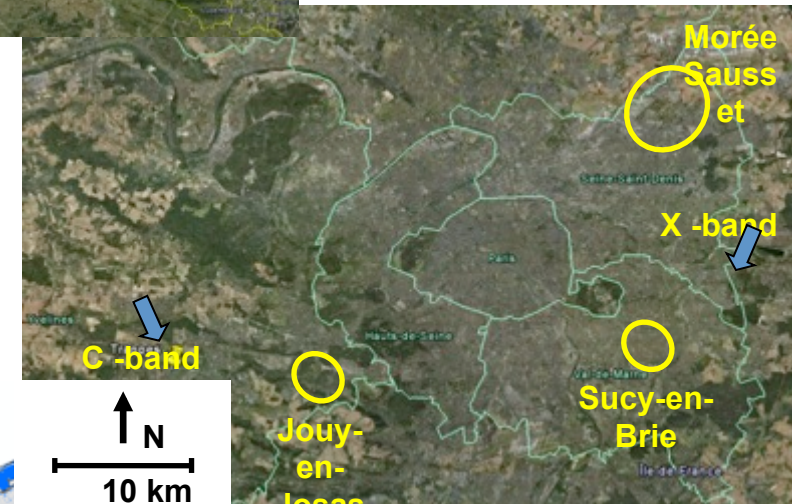




# RainGain: 4 cities, 10 pilot sites



- Cranbrook (London Borough of Redbridge)
- Purley (London Borough of Croydon)
- Torquay City Centre (Torbay, Devon)
- Leuven (Noord/gehele stad)
- Gent (PLURisk)
- Moree-Sausset (Paris Seine-St.-Denis)
- Jouy-en-Josas (Paris Seine-St.-Denis)
- Sucy-en-Brie (Paris Val-de-Marne)
- Kralingen-Crooswijk (Rotterdam)
- Centrum (Rotterdam)
- Spaanse Polder (Rotterdam)





# RainGain pilot sites

## More information: Factsheets



- Location, environmental setting
- Current pluvial flood problems
- Management objectives flood control



**Fine-scale rainfall measurement and prediction to enhance urban pluvial flood control**



**Pilot location: Purley Area, London Borough of Croydon (UK)**

### Monitoring

#### Rainfall

##### Rain gauges:

- 6 tipping bucket rain gauges with 0.2 mm resolution operated by the Environment Agency + 4 new tipping bucket rain gauges will soon be installed by Imperial College London as part of the RainGain project.

##### Radars:

- The area is within the coverage of two C-band radars at Office (see Figure 5):

Thames Radar	Thurnham Radar
C-band	C-band
horizontal*	Dual-polarisation
No*	Yes
ibolic 3.6 m diameter, 43 dB gain	
1*	
5.4 - 5.8 GHz	
m up to 50 km range/2 km up to 75 km range	
5 min scan repeat cycle**	
T.S, 2.5, 4.0,	0.5, 1.0, 1.5, 2.5, 4.0

\* dual-polarisation and Doppler  
\*\* at the potential benefits of reducing it will be tested

#### Water depth sensors

- 10 permanent flow sensors in sewers operated by Thames Water
- 2 new water depth sensors will be installed by ICL as part of the RainGain project (see Figure 6).

**Medium term flow survey data:** A medium term flow survey consisting of 79 flow monitors and 18 rain gauges (average of 1 gauge per 8.5 km<sup>2</sup>) was carried out by Thames Water between 28/01/11 and 13/07/11. These data will be used for calibration of the models of the Purley Area.

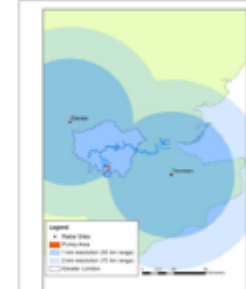


Figure 5: C-band radar coverage of the Purley Area

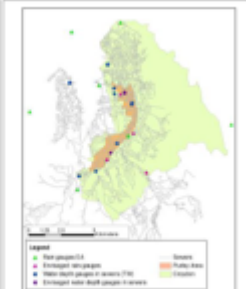


Figure 6: Monitoring and sewer system of the Purley Area



**Fine-scale rainfall measurement and prediction to enhance urban pluvial flood management**

**Pilot location: Morée Sausset Catchment, Paris area (France)**

### Location and Environmental Setting

The catchment named "Morée-Sausset" (from the names of two former rivers that used to drain it, which are now the two main sewers of the area) is located in the North-East of the Seine-Saint-Denis County. It is a predominantly urban area of 3,400 ha. It includes industrial areas (mainly in the North), residential zones and green areas. The area is rather flat (the average slope of the sewer pipes is 0.009 m/m) and has experienced a rapid urbanization over the last decades. The average coefficient of imperviousness is roughly 50%. The sewer system is a separate one in this area. There are neither weirs nor pumping stations in the sewer network on this area. Storm water is then routed to Seine River through the Garges-Epinay sewer. The Kodak catchment, which is a 144 ha mainly residential area located in the South-East of the greater area, is studied more in detail. It contains a green area currently under decontamination which corresponds to a former Kodak factory.

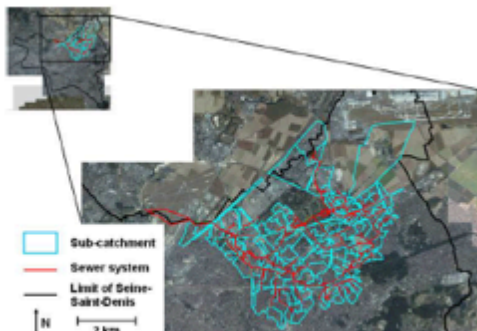


Figure 1: Picture of the Morée-Sausset catchment

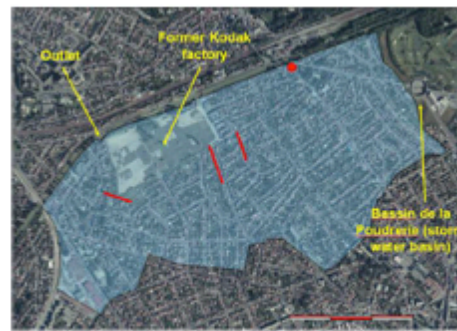
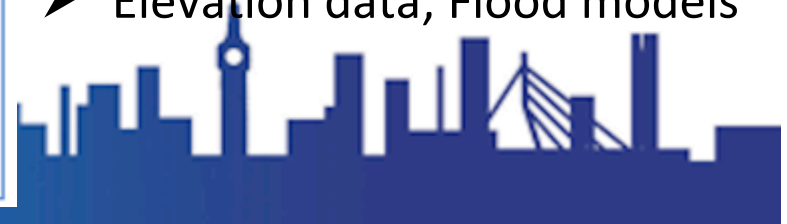


Figure 2: Picture of the Kodak catchment (weak spots in red)

- Monitoring: rainfall sensors, water levels sensors
- Elevation data; Flood models





# RainGain

## Extreme rainfall in cities:

- High resolution rainfall data collection
- High resolution modelling
- Contributing to urban flood resilience

*Interested? Want to get involved?*

*Visit: [www.raingain.eu](http://www.raingain.eu)*