Paris Pilot Site

RainGain meeting

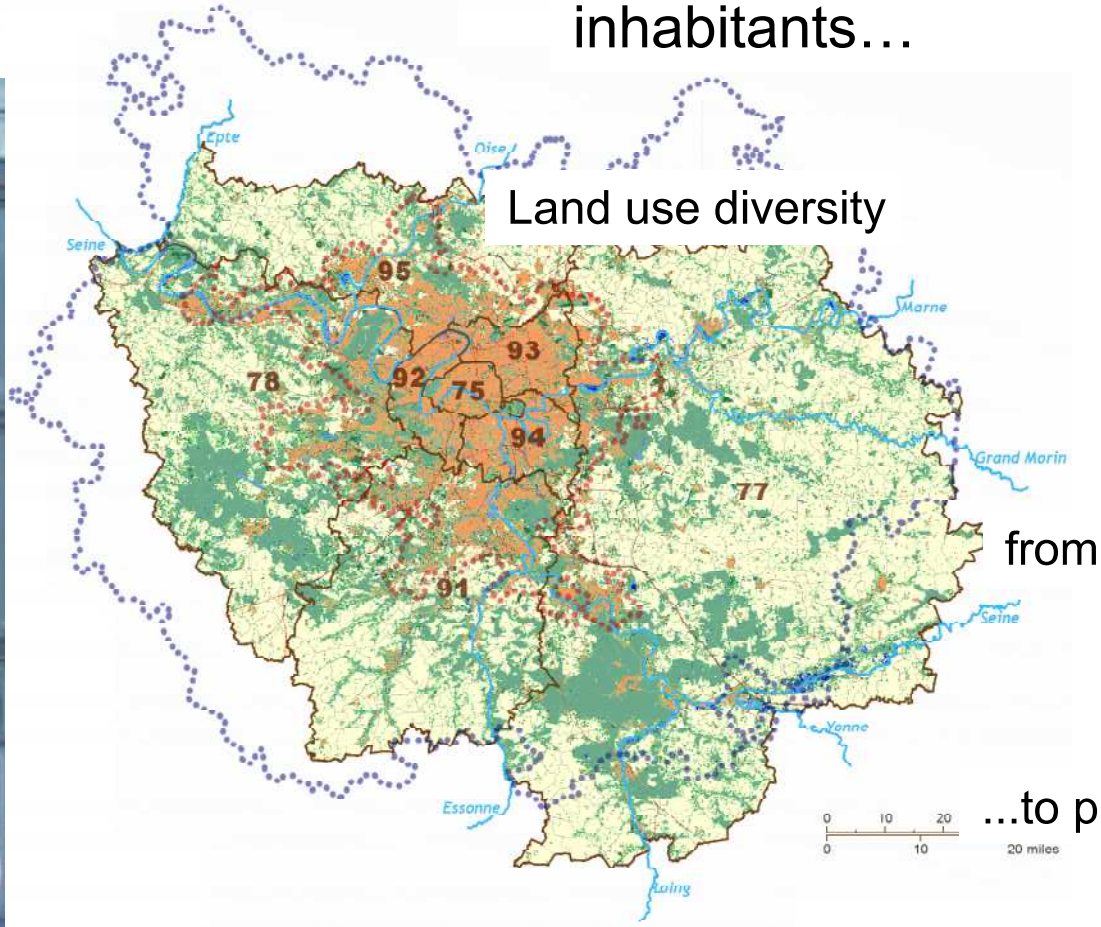
UKL 17/04/12

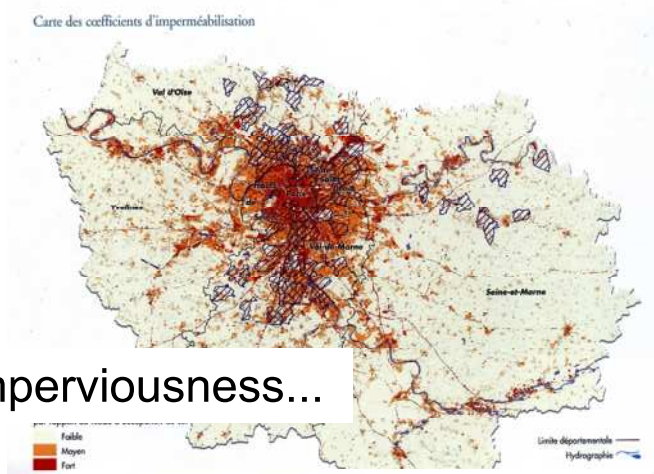
Île de France (Greater Paris) to test X-band radar technology

École des Ponts ParisTech

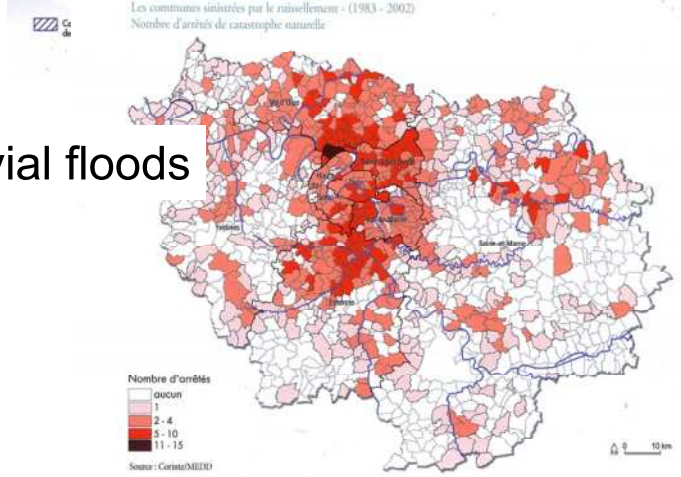
Almost 12 millions inhabitants…

Land use diversity





from imperviousness...



...to pluvial floods

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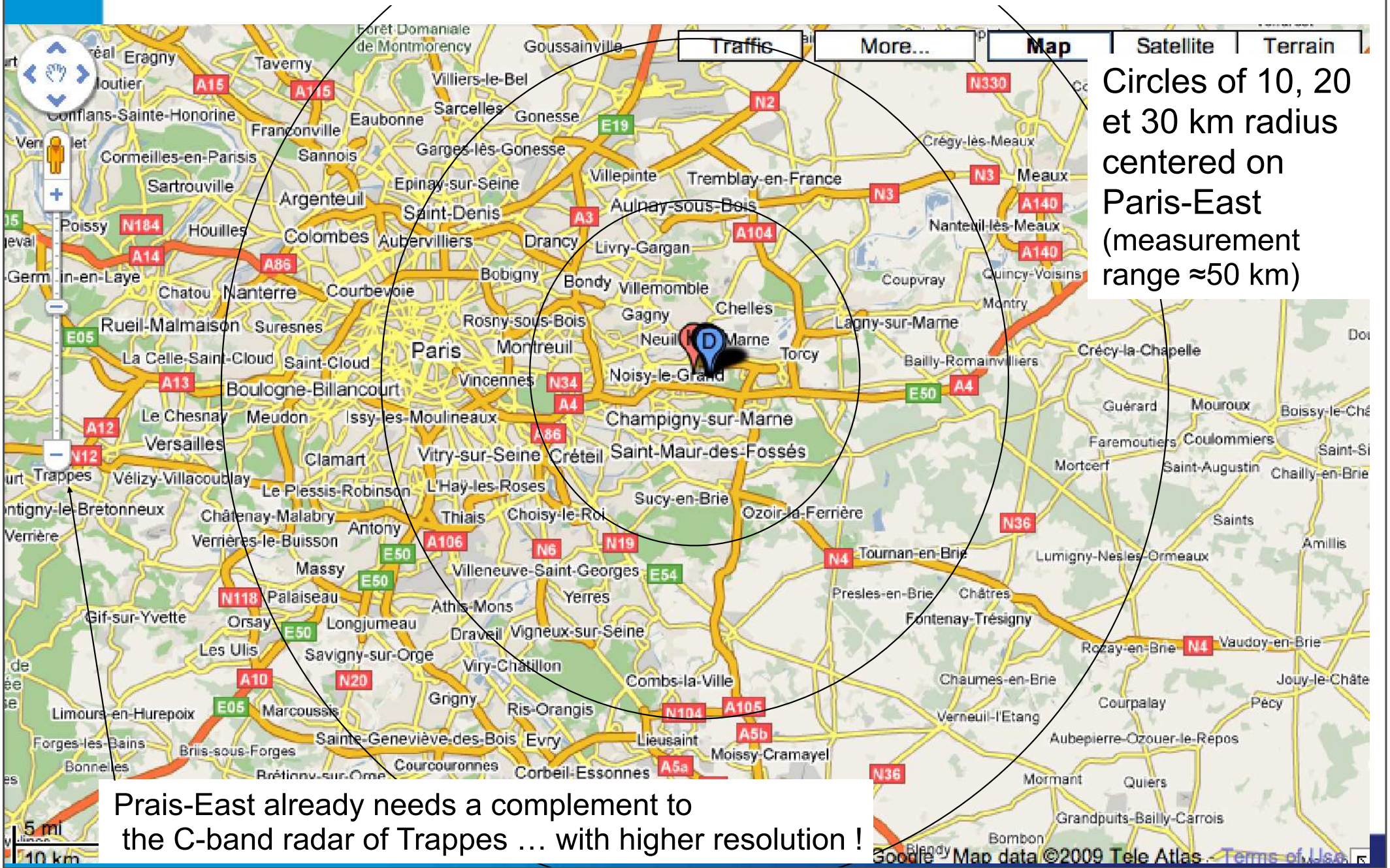
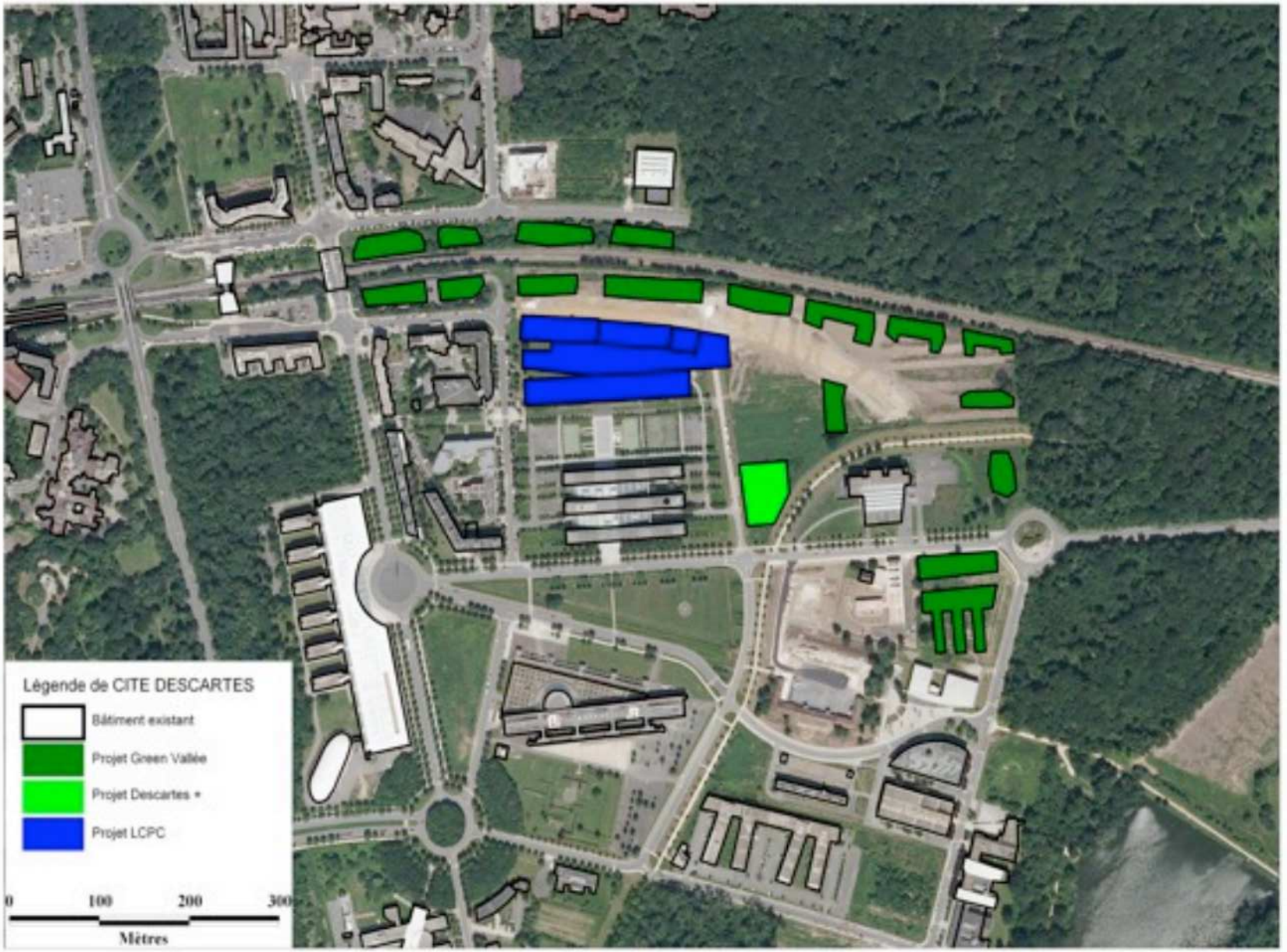
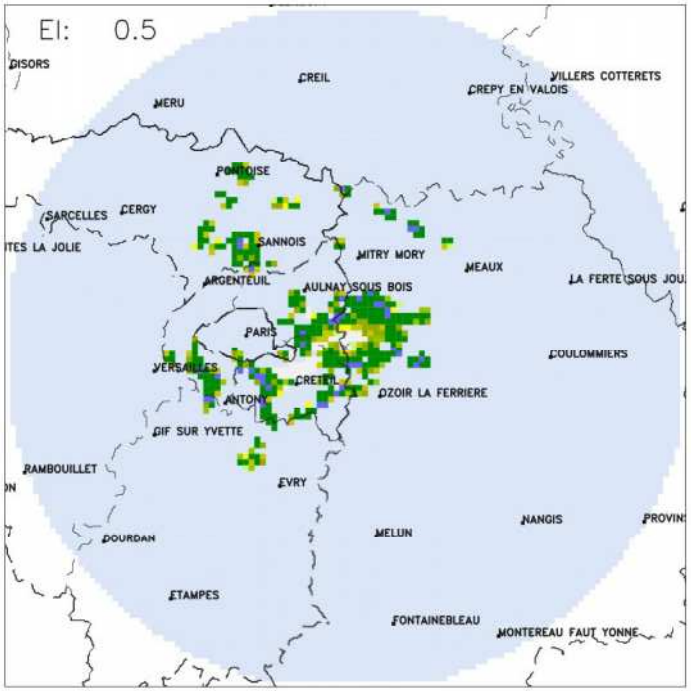
X-band radar

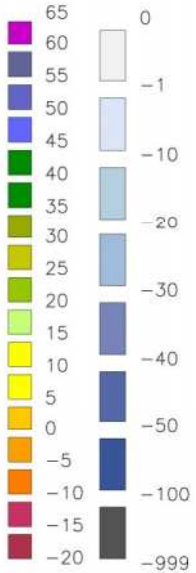

Traffic
More...
Map
Satellite
Terrain
Circles of 10, 20 et 30 km radius centered on Paris-East (measurement range ≈50 km)
Paris
Montreuil
Saint-Denis
Argenteuil
Boulogne-Billancourt
Nanterre
Versailles
Champigny-sur-Marne
Saint-Maur-des-Fossés
Créteil
Vitry-sur-Seine
Noisy-le-Grand
Meaux
Trappes
Prais-East already needs a complement to the C-band radar of Trappes … with higher resolution !
5 mi
10 km
Google
Map data ©2009 Tele Atlas - Terms of Use

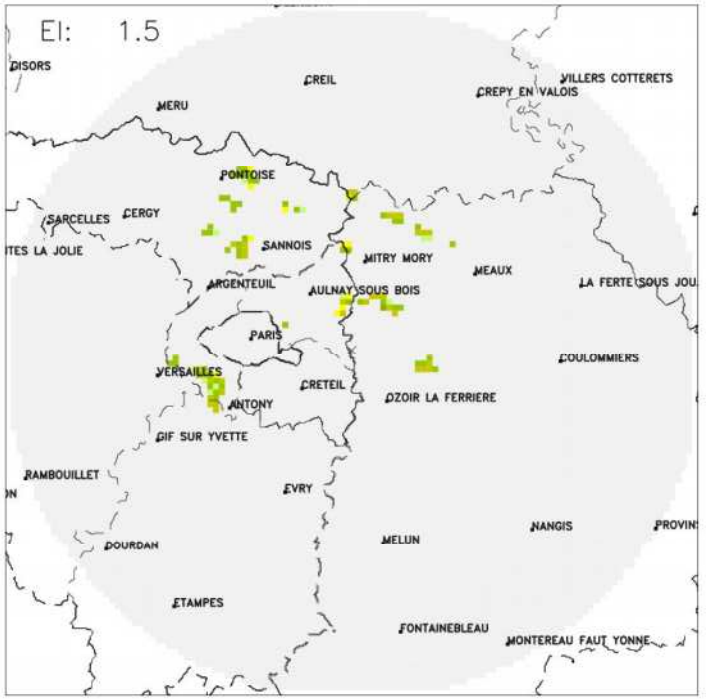
Implementation on ENPC

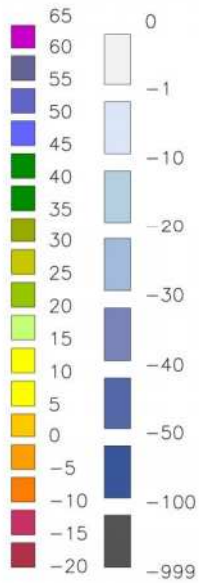


Orographic masks and ground clutter (R= 60 km)







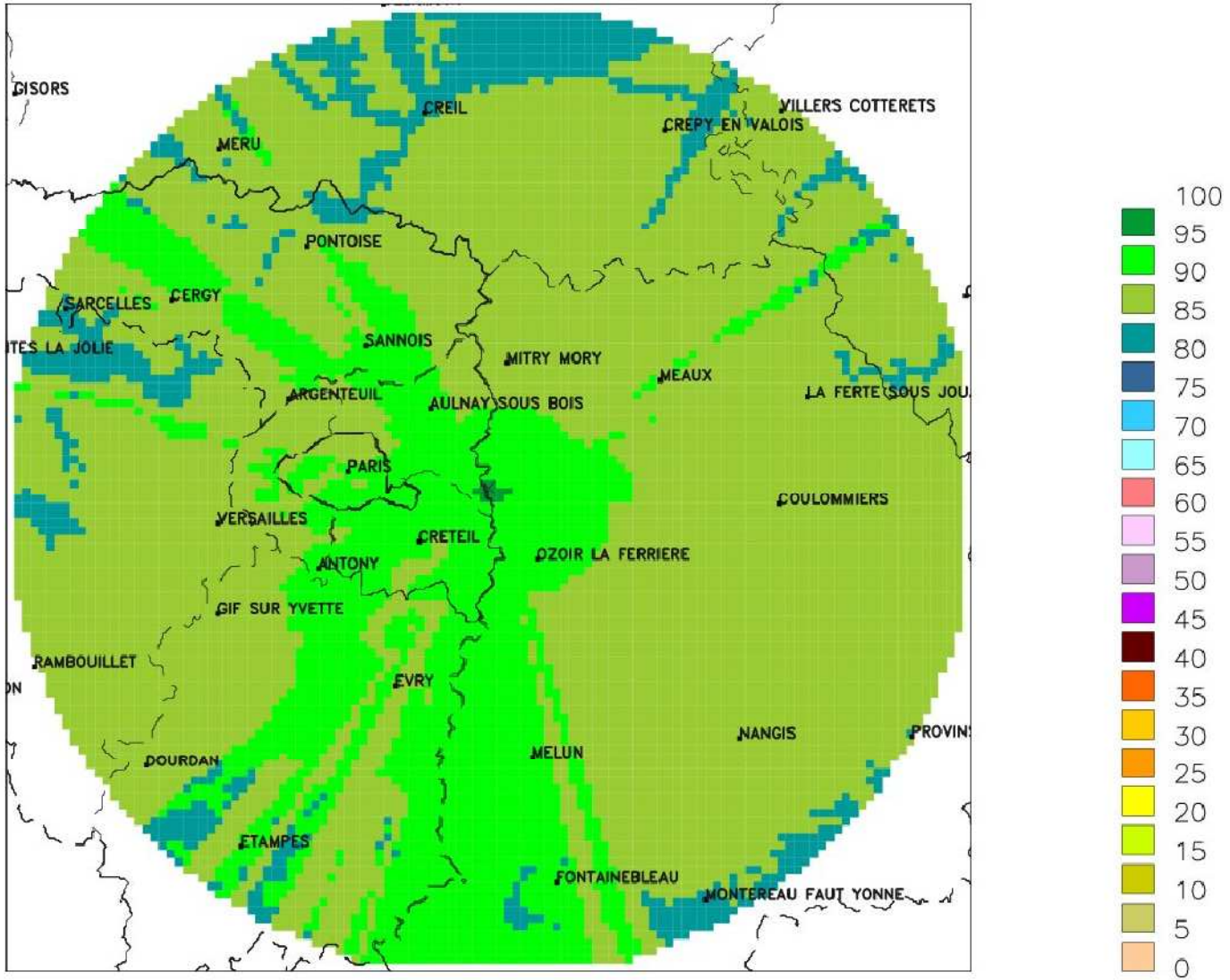


Orographic mask (%) and groun clutter (dBZ) for elevations 0.5° et 1.5 ° °

- Few orographic mask (<10%) aux élévations ≥ 0.5°
- gournd clutter at short distance (<10km) jusqu'à 1.5 °

(Novimet, 2010)

Radar visibility (R= 60 km)



Quality index> 80 (err < 20%) over the full area

3D GIS data base for a systematic study of potential IDF sites

(developed by J. Richard)

Visite des sites pour implantation radar

Bâtiment NOISY-LE-GRAND

Château eau TORCY

Bâtiment Habit
FONTENAY SOU

ENPC

Château d'eau NOISIEL

Tour RODIN CHAMPIGNY SUR MARNE

Bâtiments Habitations VILLEJUIF et LE KREMLIN BICETRE

Tour TDF CHENNEVIERES SUR MARNE

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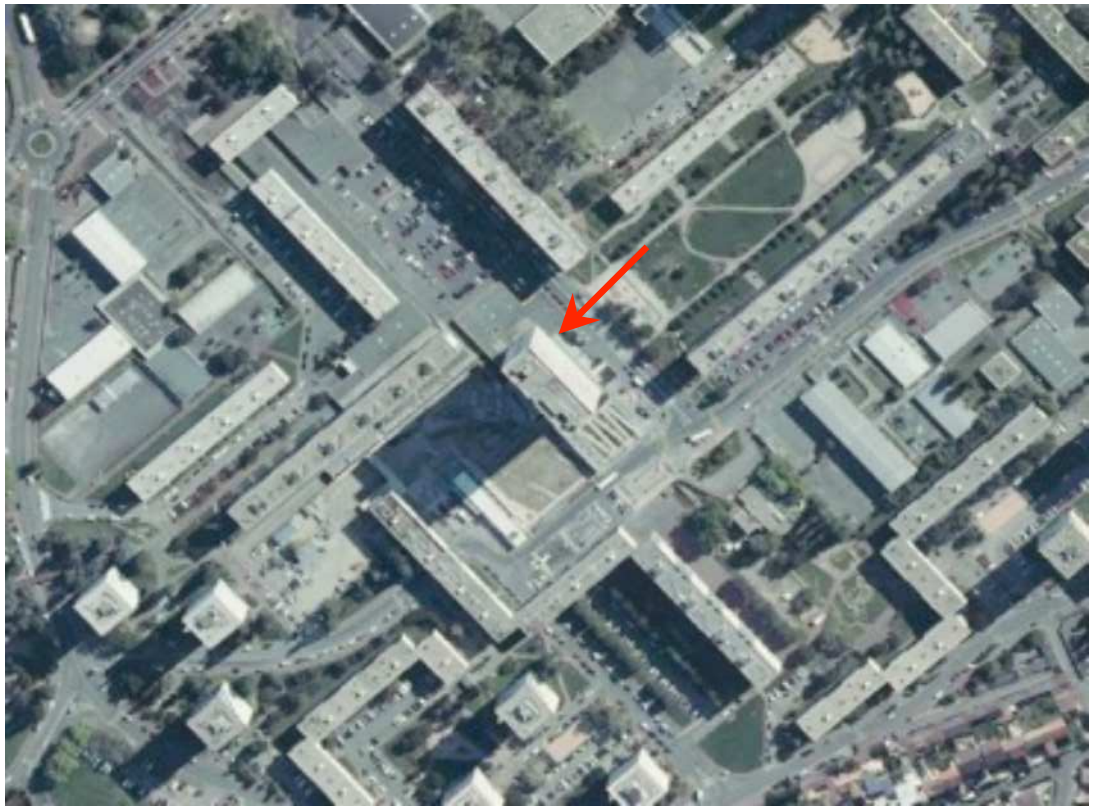
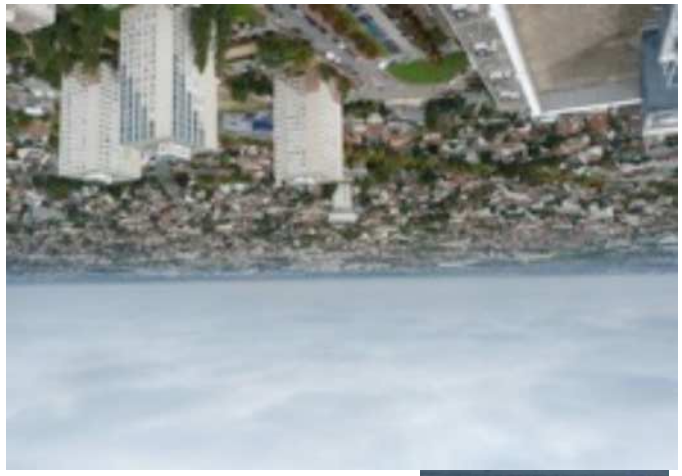
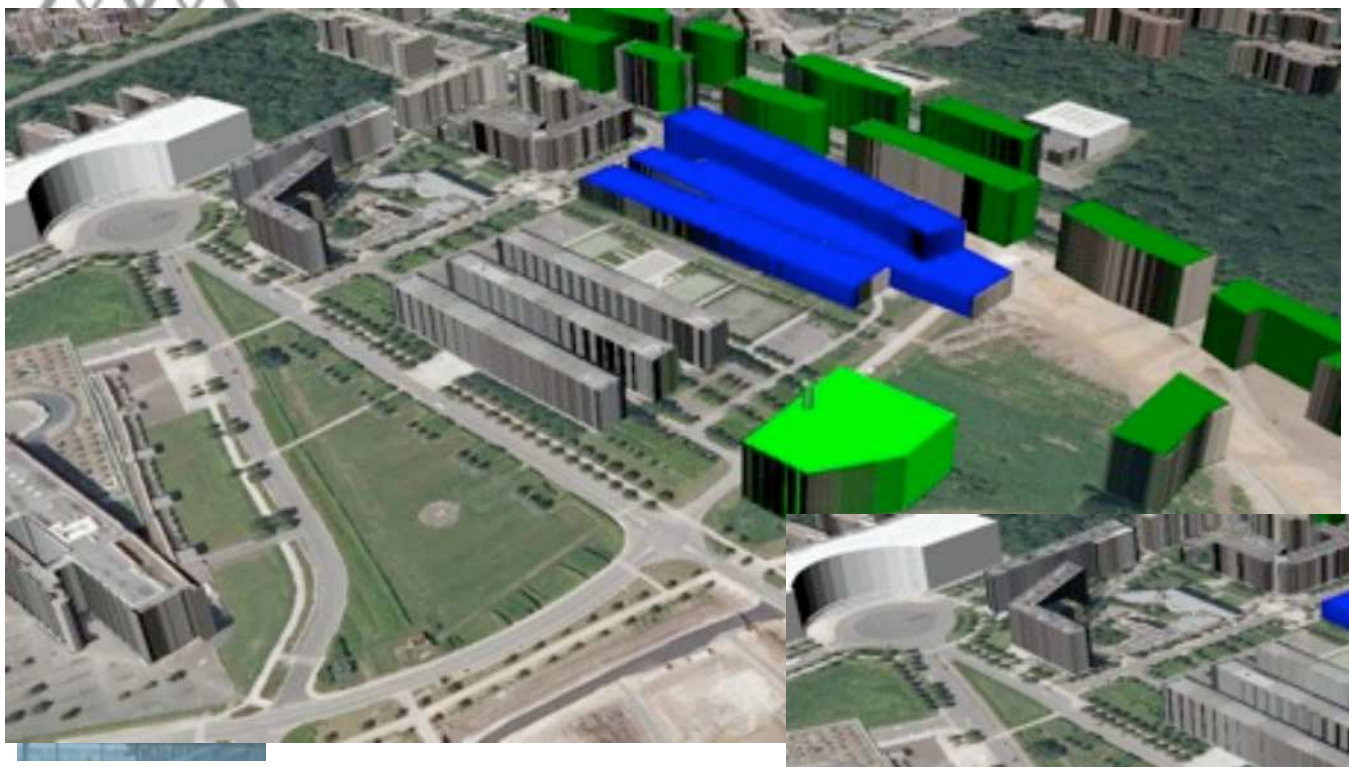




Implementation



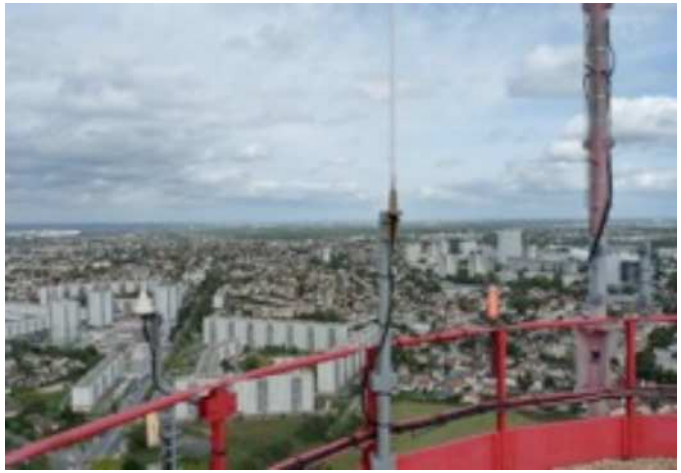
OVer Descartes+ (24,37 + 10 m)

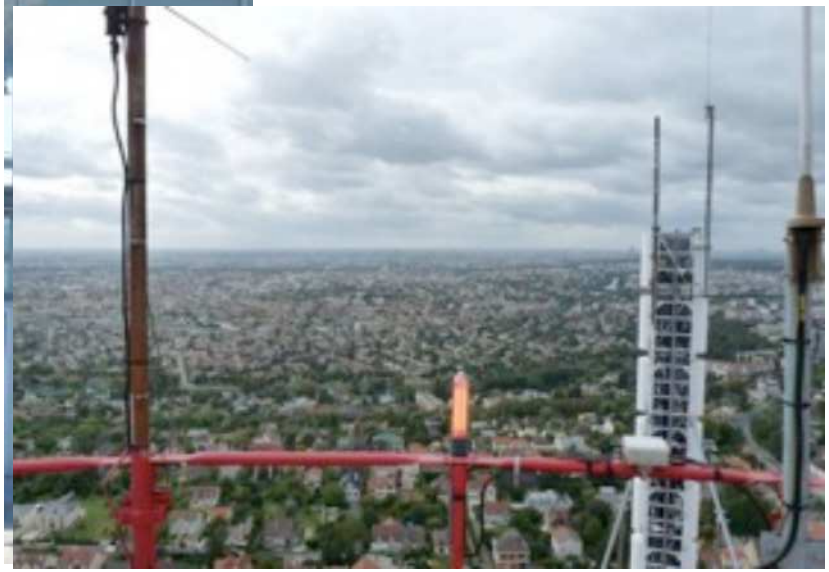
Over ENPC
(19 + 10 m)

Areas of 60 m and 1 km (ENPC)

École des Ponts

PARIS·EST





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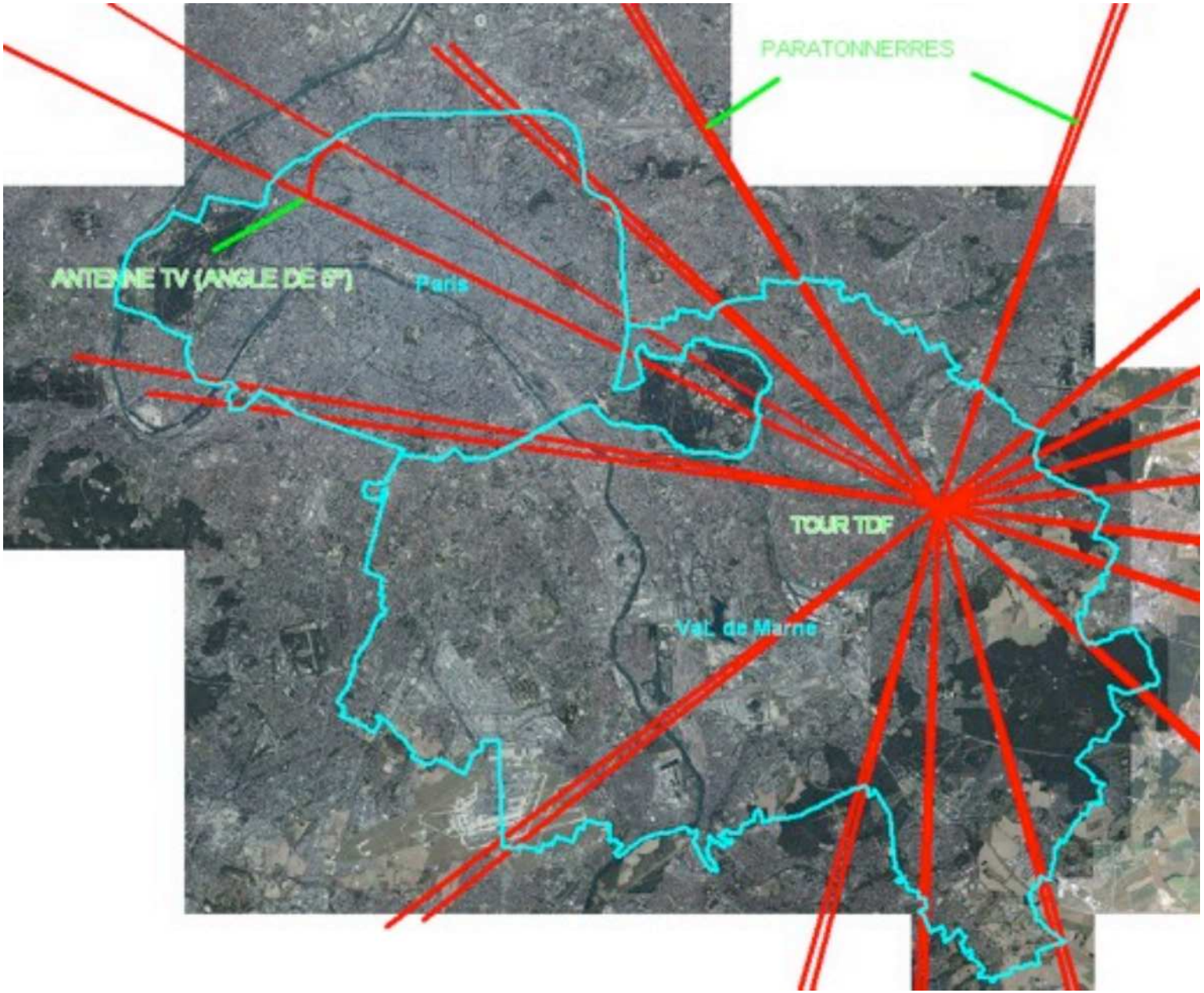
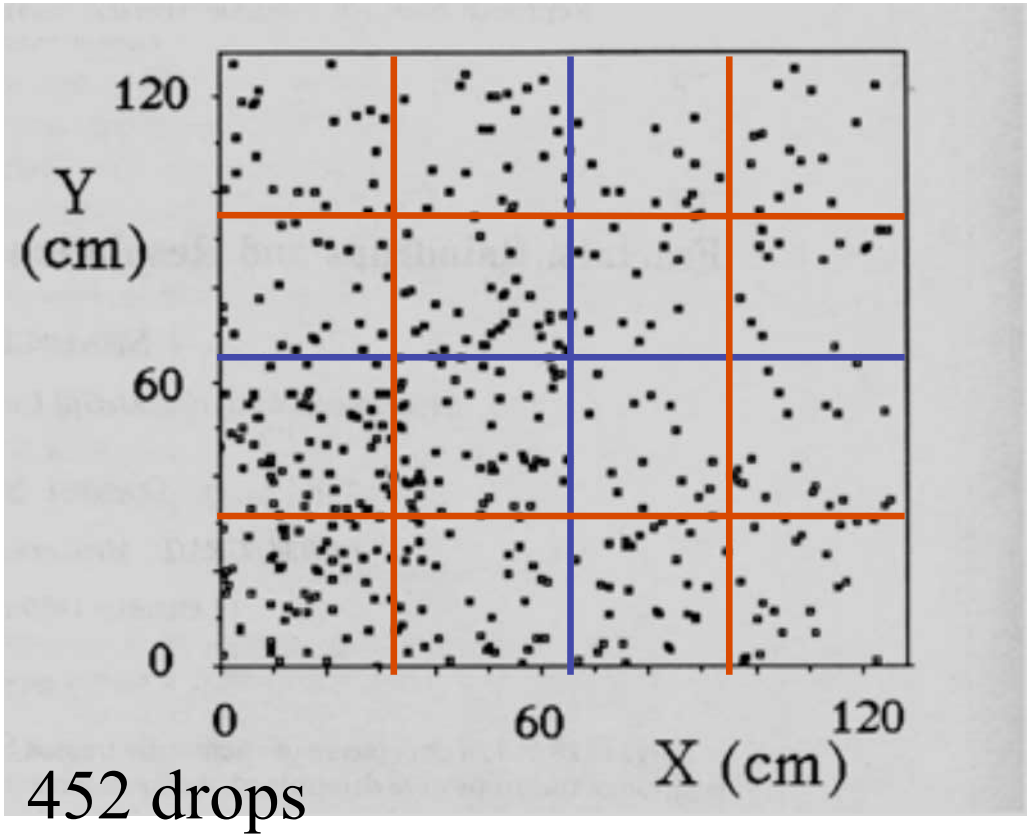
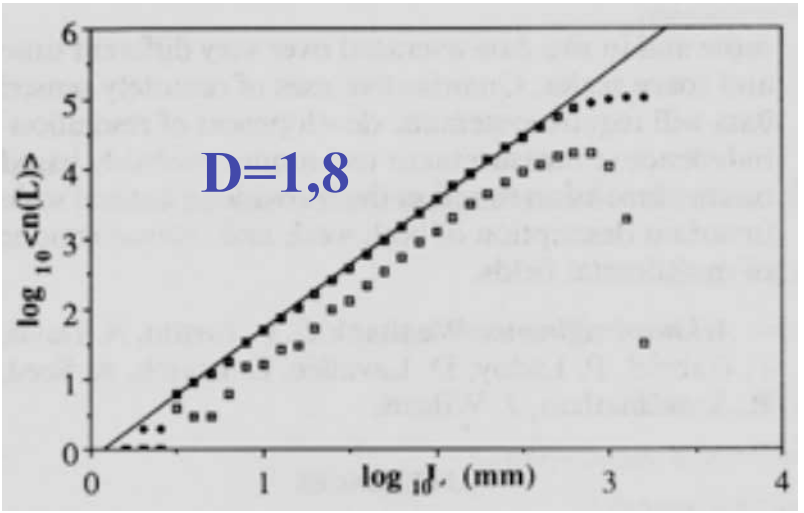
PARIS-EST



Heterogeneity of rain horizontal cuts
(blotting paper)



452 drops

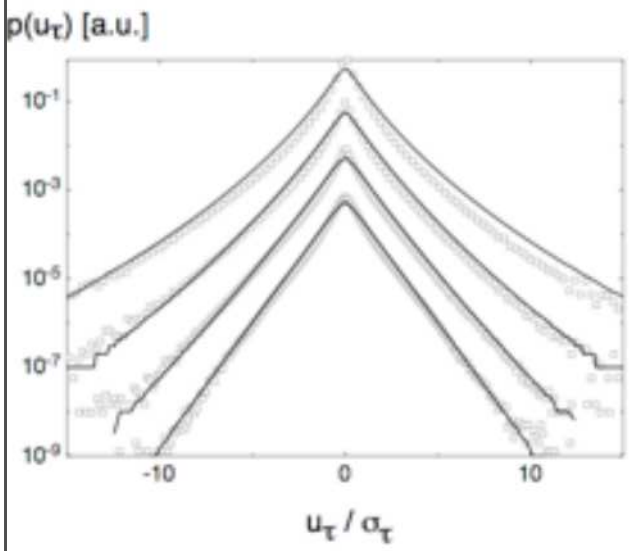


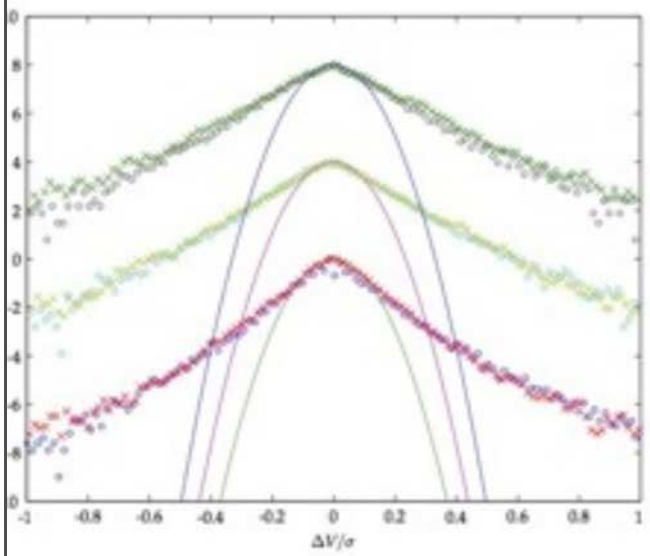
$N(L)=L^{-D}$

Lovejoy and Schertzer, JAM 1990

… already questions the Marshall-Palmer relationship $Z = aR^b$

Turbulence and precipitation

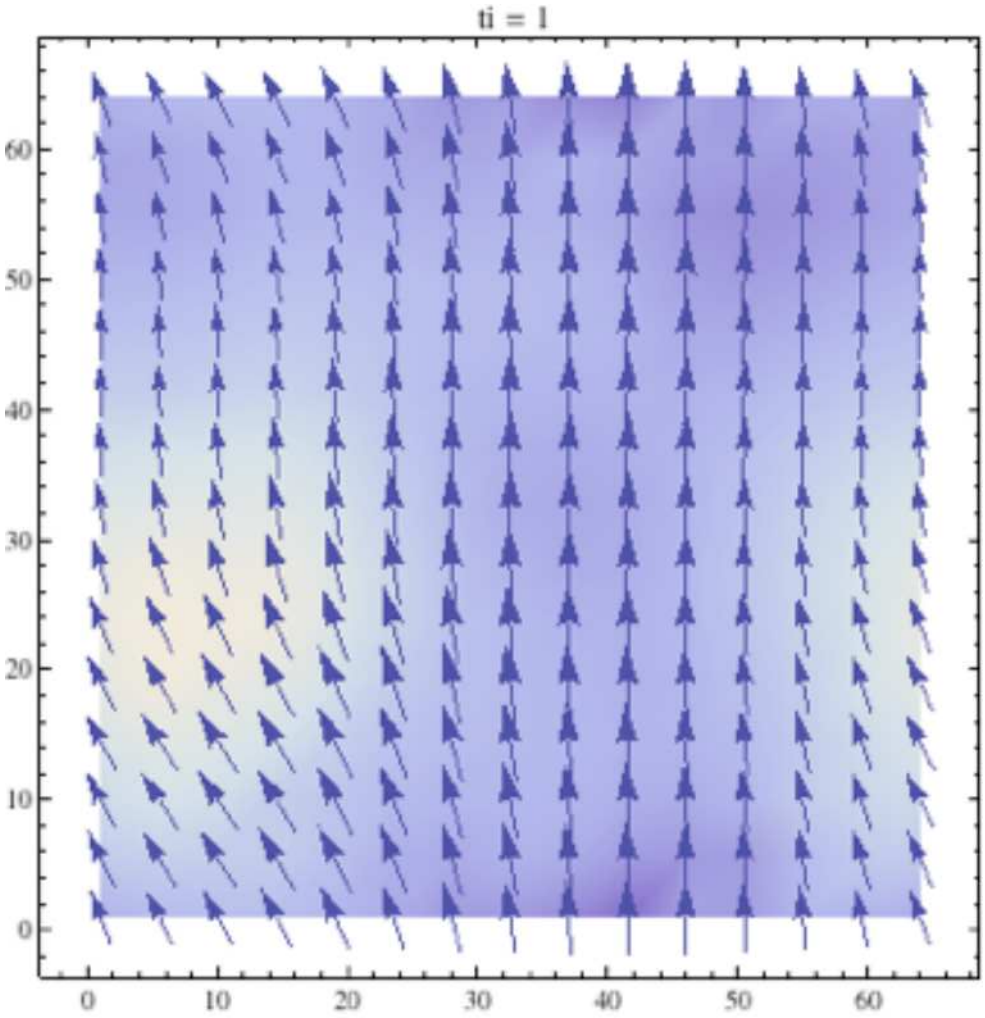




Fitton et al, J. Phys. 20111

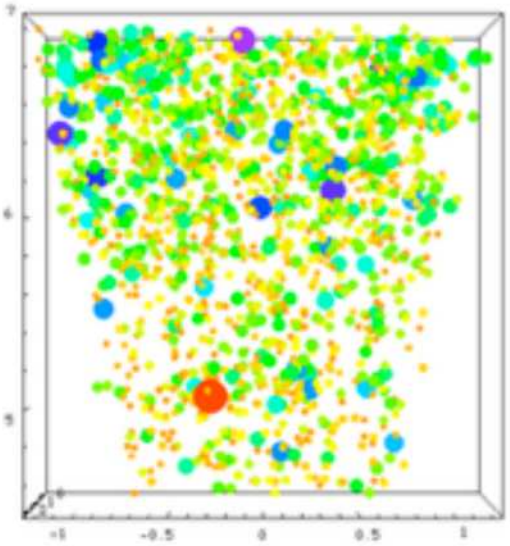
> 10 rms !!
STRONGLY
NON
GAUSSIAN !

(relevance of
geostatistics?)



Multifractal simulation of a 2D+1 cut of wind (arrows) and vorticity (temperature-like color palette)

Rainfall heterogeneity and radar reflectivity



Effective reflectivity $Z_{e,\lambda}$ of a pulse volume B_λ of scatters with $\sigma(\boldsymbol{x})$ volumes

k_r = radar wave number

$$Z_{e,\lambda} = \left| \int_{B_\lambda} \sigma_\Lambda(\boldsymbol{x}) e^{i\boldsymbol{k}_r \cdot \boldsymbol{x}} d\boldsymbol{x} \right|^2$$

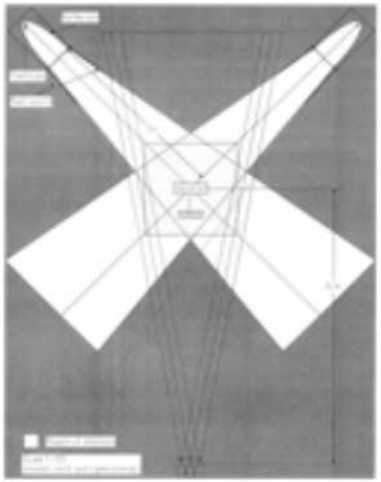
(Rayleigh scattering)

$$Z_\lambda = \int_{B_\lambda} \sigma_\Lambda(\boldsymbol{x})^2 d\boldsymbol{x}$$

Radar reflectivity

Homogeneous scatter distribution:

$$Z_{e,\lambda} \approx Z_\lambda$$



(Desaulniers-Soucy et al.2001, Lovejoy et al. 2003, Lilley et al; 2004)

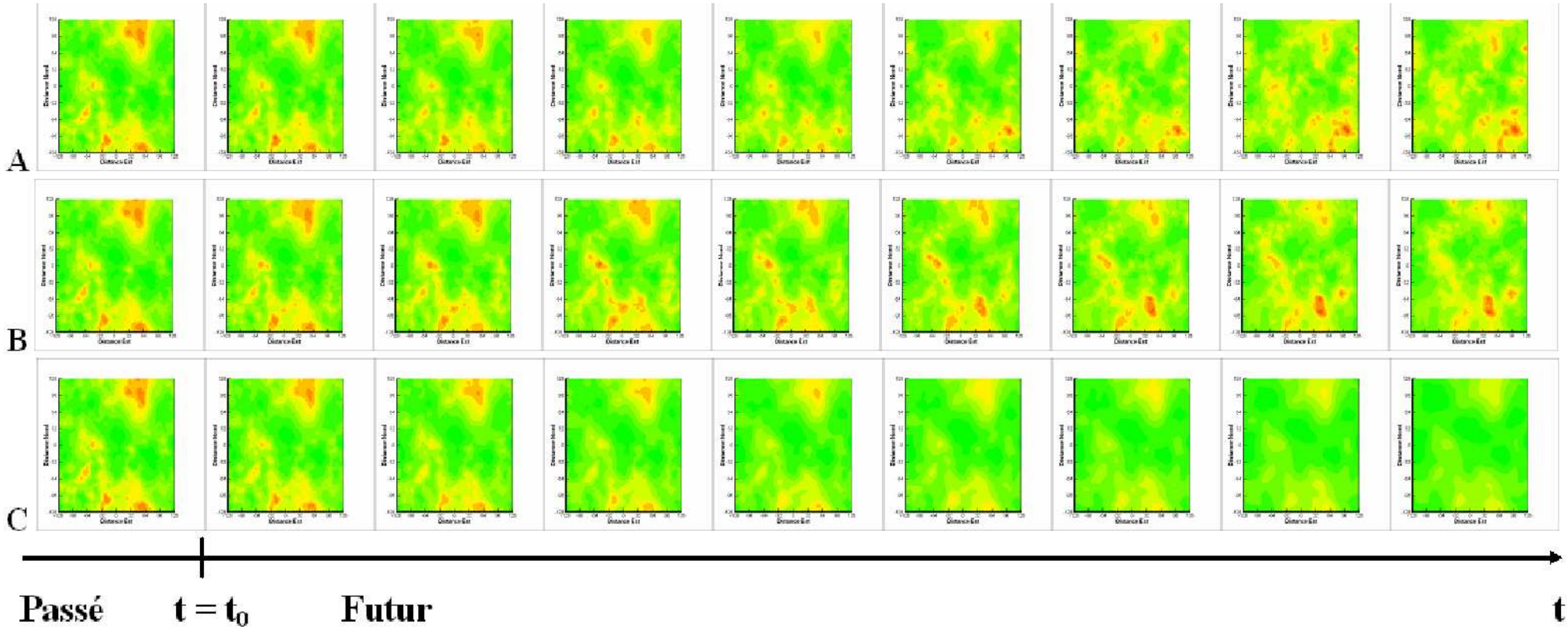
Otherwise, "**speckle**"/"**drop rearrangement**" **bias** of the corresponding statistical moment of order *q*:

$$sb_\lambda^{(q)} \equiv < Z_{e,\lambda}{}^q > / < Z_\lambda{}^q > -1$$

(<.> denotes the ensemble average)

=> 3D+1 video disdrometer (pending)

Examples of nowcasting simulations



Realisations A,B,C (252^2) have common past (t=0, t_0=32) for t= t_0,-48 :

A =reference simulation, B is an other outcome ('stochastic forecast'), whereas the small scales of C are deterministically defined to preserve the conservation of the flux (forecast with deterministic sub-grid modelling)

S+L 2004, Macor et al

The Multi-Hydro numerical platform

Overall description:

- Multi-hydro developed at LEESU (v1, El Tabach et al, 2008, v2, A. Giangola-Murzyn et al., 2012)

- currently in a validation and demonstration phase (Heywood site, Manchester; Villecresnes site, Val-de-Marne).

- a core that makes interact different modules, each representing a portion of the water cycle in urban hydrology.

Main goals:

- taking into account small scales → fully distributed model

- physically based model (no calibration)

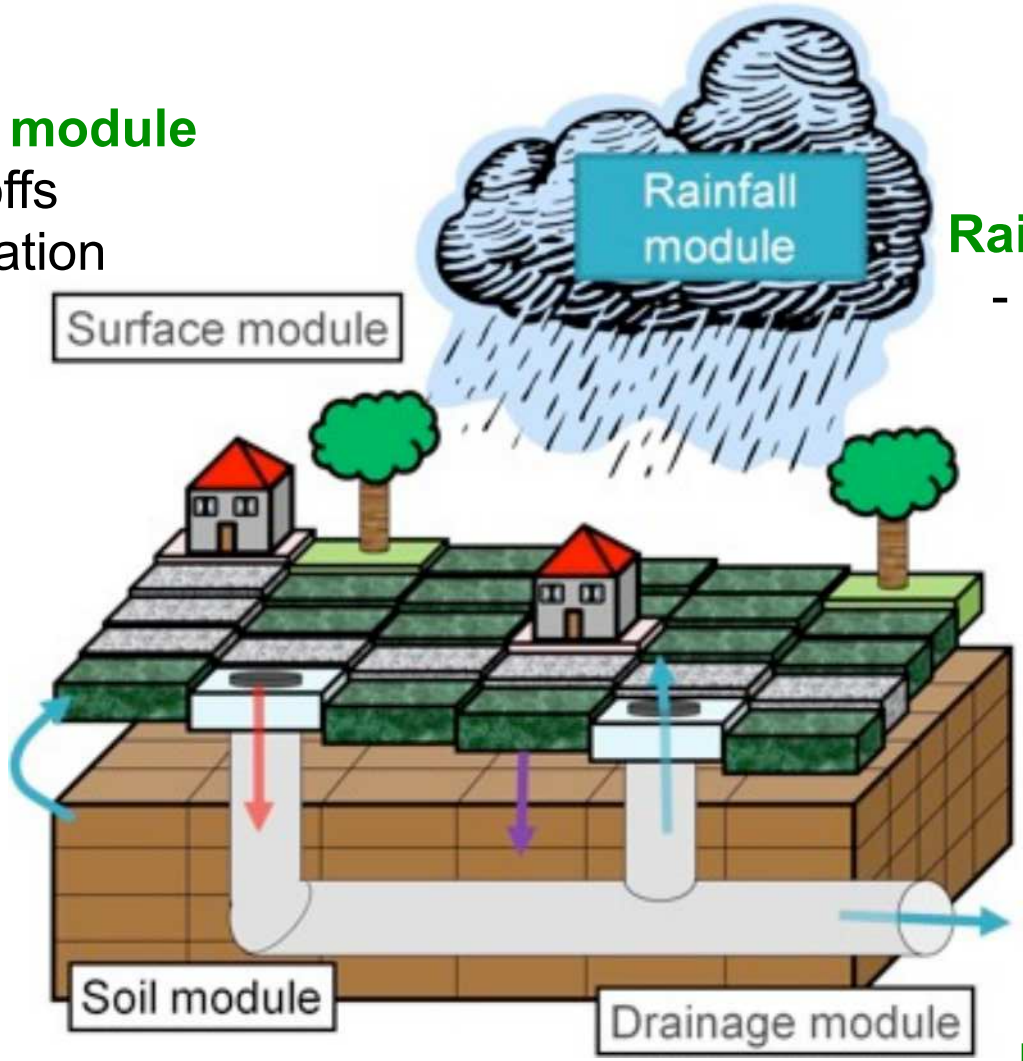
- easily transportable → a conversion module to generate inputs from available GIS data

- open access software packages to benefit from the feedback of a large community and frequent update.

The Multi-Hydro numerical platform

Urban area physical processes modeled in Multi-Hydro

Surface module
- Runoffs
- Infiltration

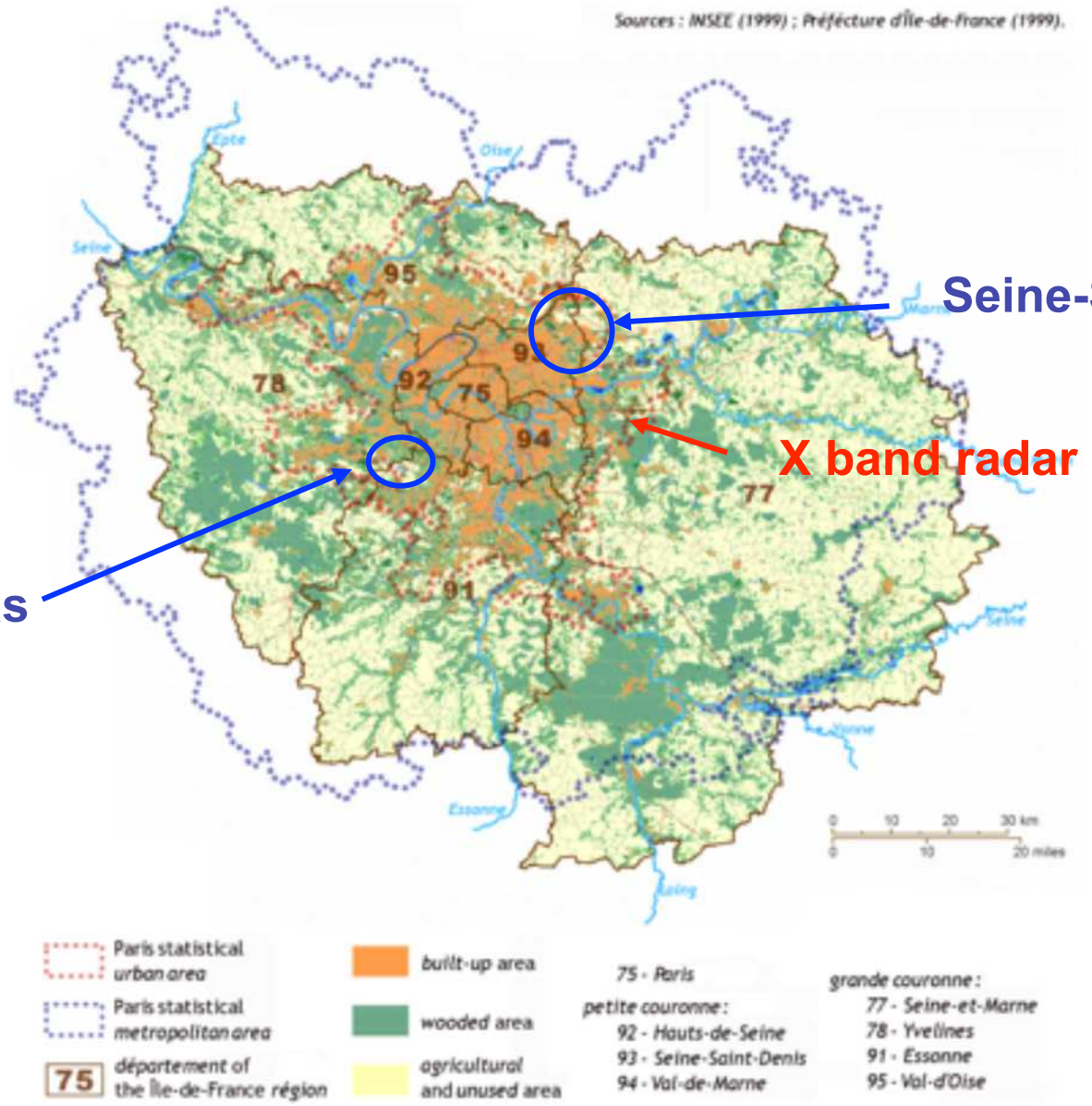


Rainfall module
- Spatio-temporal rainfall

Soil module
- Vertical flow in the non-saturated area
- Saturation during a rainfall event

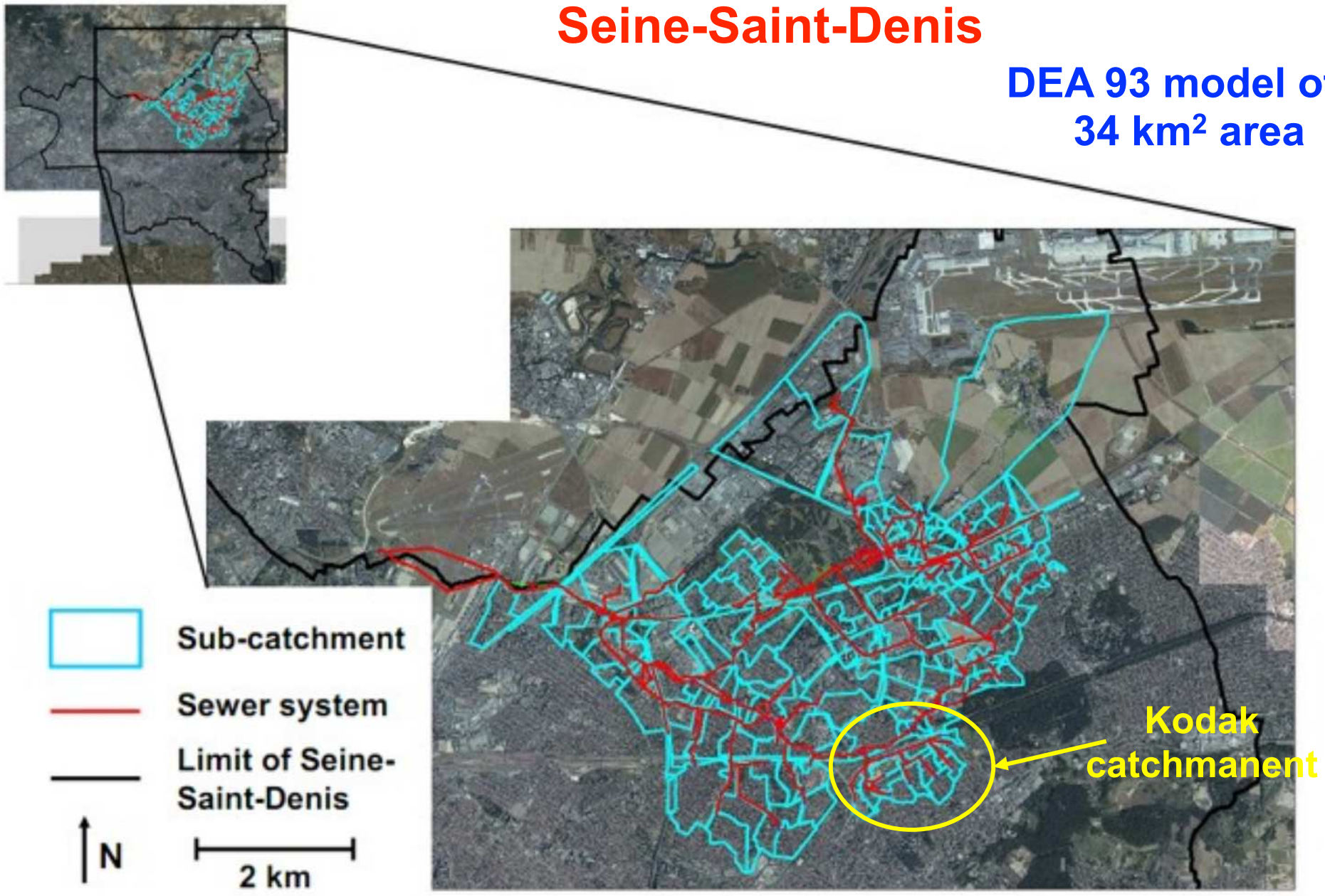
Drainage module
- Sewer flow
  (free surface, and loaded)
- Overflow

Case studies in the RainGain project



Seine-Saint-Denis

DEA 93 model of a 34 km² area



- Modelled with semi-distributed 1D model Canoe (lumped model for each sub-catchment and Saint-Venant equations in the links)

- 34 Km² with 198 sub-catchments (avg 17 ha)
- 69 Km of links (avg slope 0.009 m/m)
- Rather flat area (mean link slope 0.009 m/m)

Seine-Saint-Denis

Kodak catchment

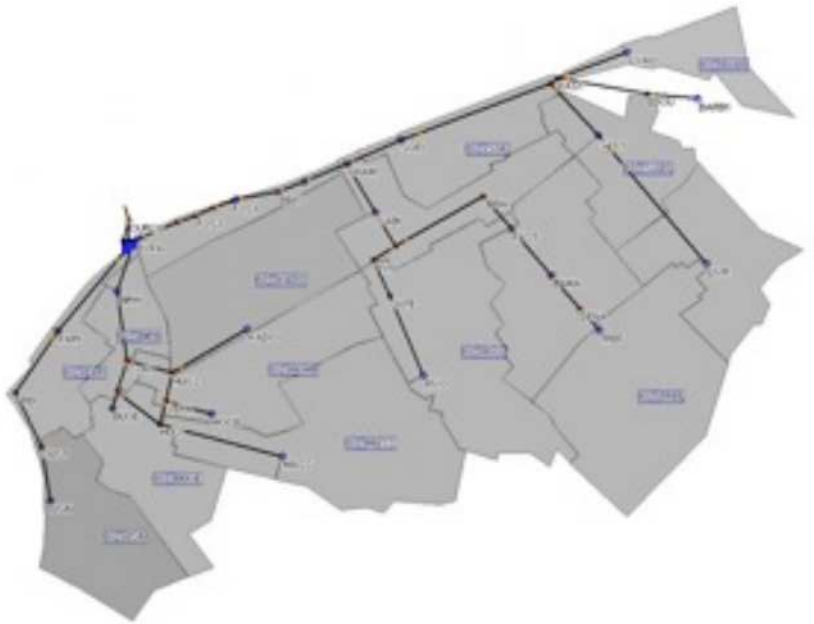
- 1.47 km^2
- Known for regular overflow
- Project to build a storm water storage basin

Seine-Saint-Denis

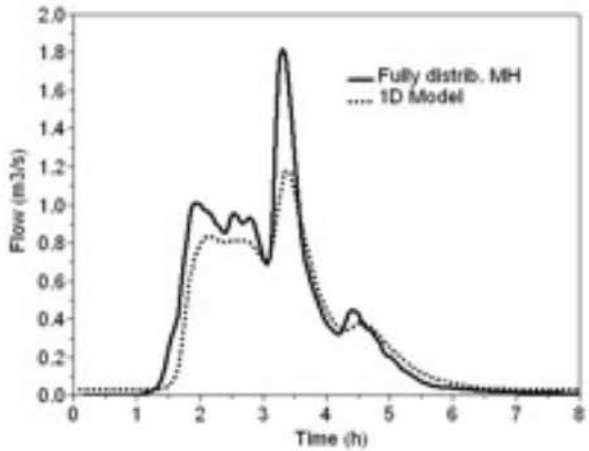
Multi-Hydro : 10 m resolution

Kodak catchment

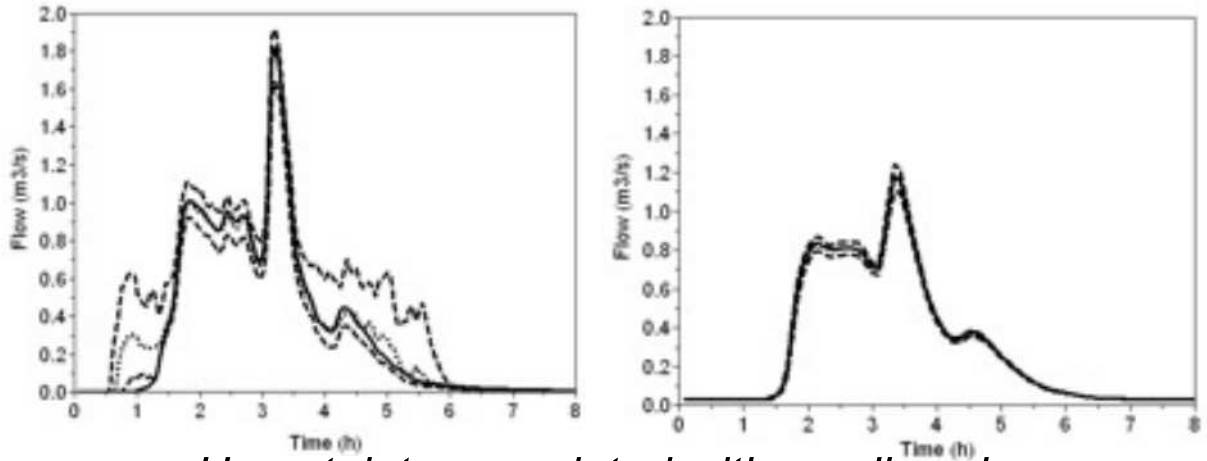
Semi-distributed 1D model



First implementation: a 15 mm rainfall event (C band radar data, 1km x 5min)



Raw radar data



Uncertainty associated with small scale unmeasured rainfall variability

Jouy-en-Josas

Sharp slope

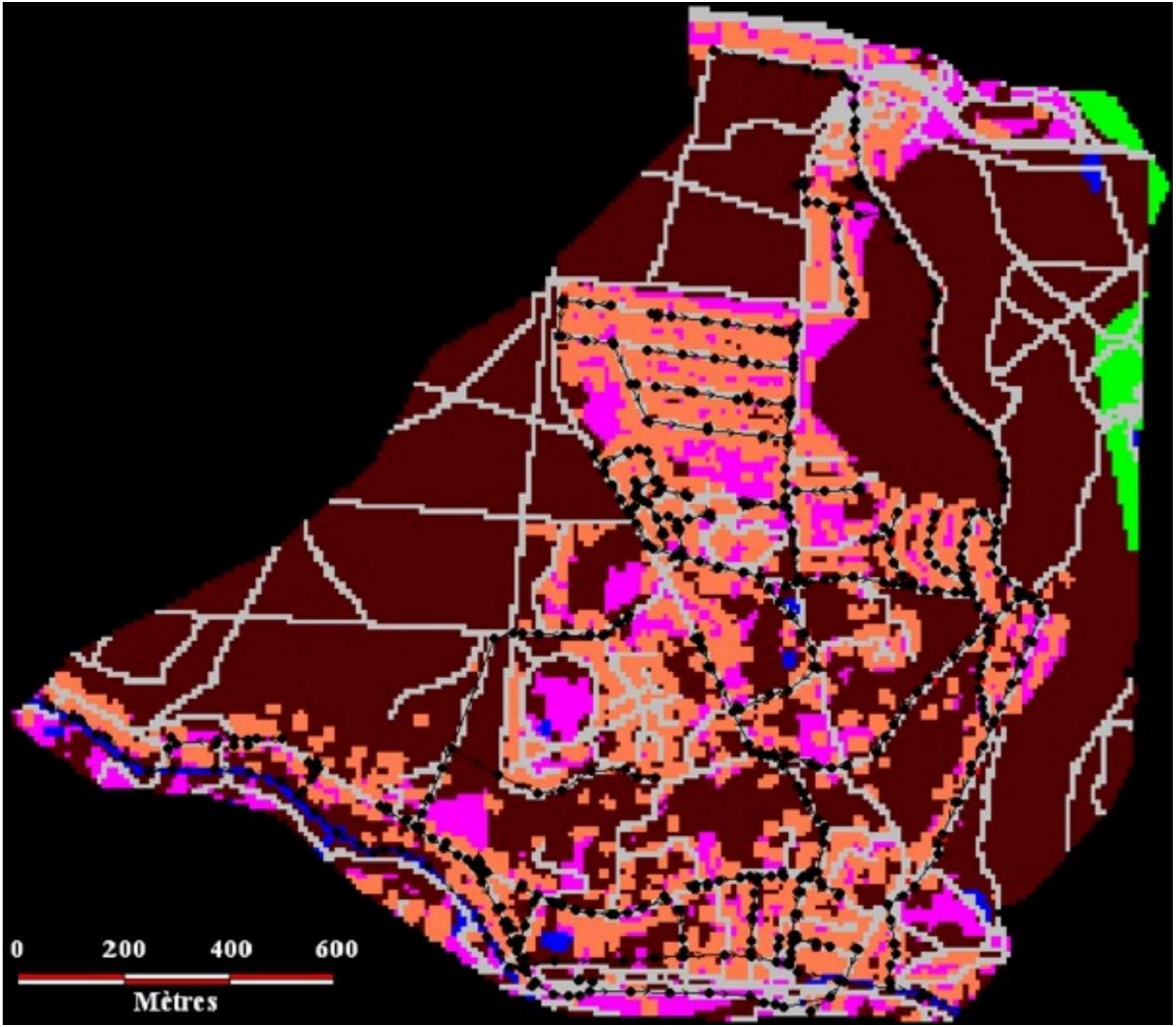
Bièvre river

RER C Station

Kinder garden

Hillside from the valley

- 2.5 km² area / Great slopes (~100m of elevation difference) / various land use
- 1982 : severe flooding mainly associated to runoff


0
200
400
600
Mètres

Paris Pilot Site Status

- WP1
  - radar siting
    - a systematic study of potential sites
    - 2 top sites:
      - ENPC/Bienvenuë building: architect agreement?
      - TDF tower: TDF to become a RainGain partner?
  - tender
    - revision of the call to be issued next month
  - IdF meteo-hydrological data base
- WP2
  - speckle effect (measurement bias): 3D+1 video disdrometer (pending)
  - stochastic nowcasting (inc. 1 RainGain PhD thesis)
  - stochastic downscaling and ensemble rainfall realisations
- WP3
  - IdF hydrological data base (CG93, CG94...)
  - numerical platform Multi-Hydro
    - studies of various IdF sites
    - impacts of small scale variablity
- WP4
  - reservoir management (inc. 1 RainGain PhD thesis (CG94))
  - RTC improvement (CG93)
- FR NOG: 20/04/12: programme *now* available on the RainGain site