

# What happens to rainfall in urban areas? Dual monitoring and modelling approach in a small urban catchment in Nantes, France

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## Traditional Urban hydrology

Runoff on impervious areas  
during wet weather

Flow in buried sewer systems

Major rain events/floods

OK for Design of sewers

*gray  
hydrology*



## Revisiting urban hydrology → Hydrology!

NBS / favor infiltration & evapotranspiration

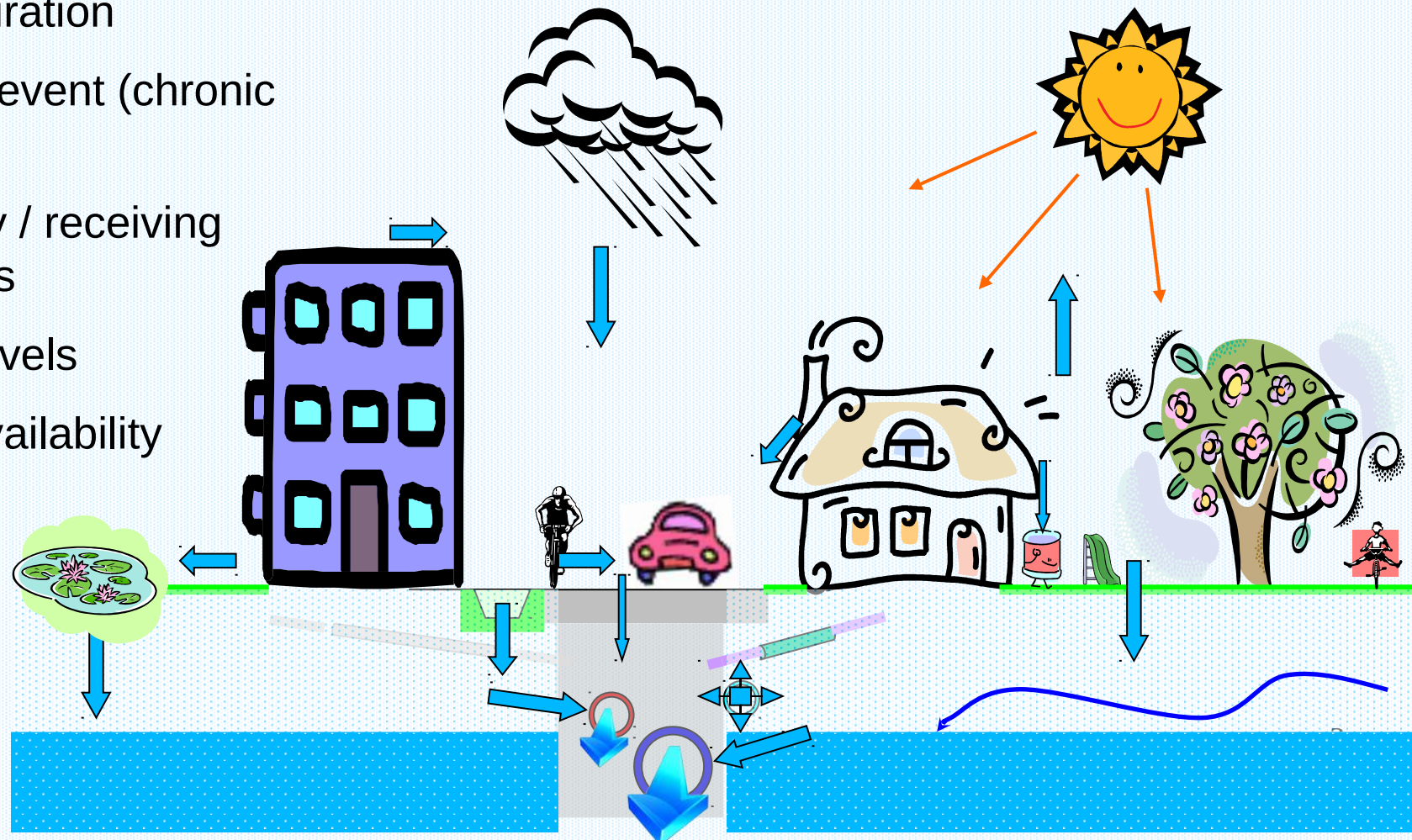
Current rain event (chronic pollution)

Water quality / receiving environments

Low water levels

Soil water availability

*green hydrology?*



New urban planning strategies

Source control rainwater management

Greening cities

## Objectives

### A better representation of the water budget in urban environments

Urban critical zone monitoring / more integrative knowledge

Distributed and more physical-based hydrological modelling

### Plan

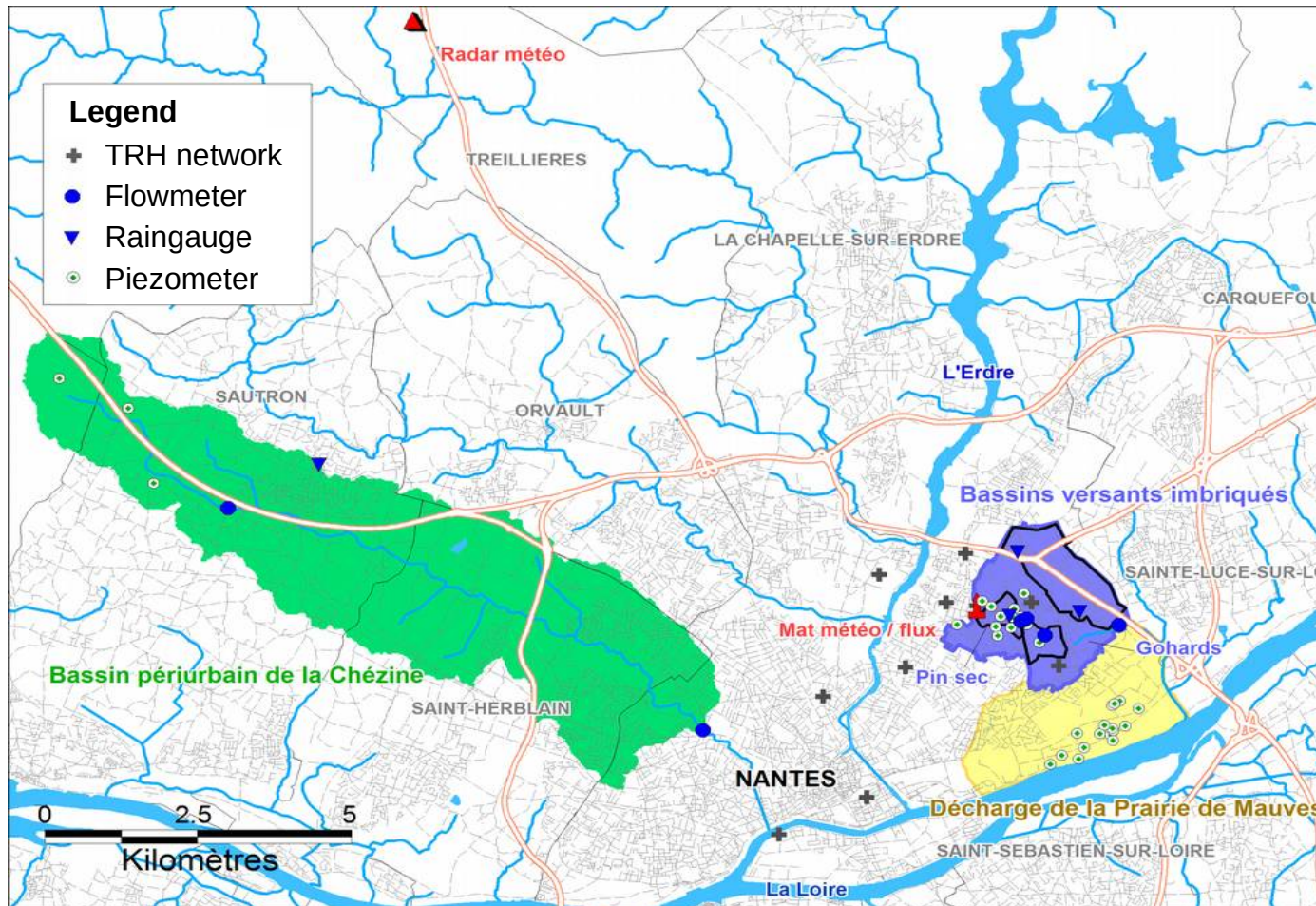
- Monitoring
- Water budget of a small catchment
- Modelling





# ONEVU : a research observatory

Objectives : monitoring of water, pollutant and energy balances of several urban and peri-urban watersheds/neighbourhoods on the long-term



Observations from 2006

Within IRSTV / OSUNA\*

SNO Observil (National network of 11 french cities focusing on environmental monitoring)

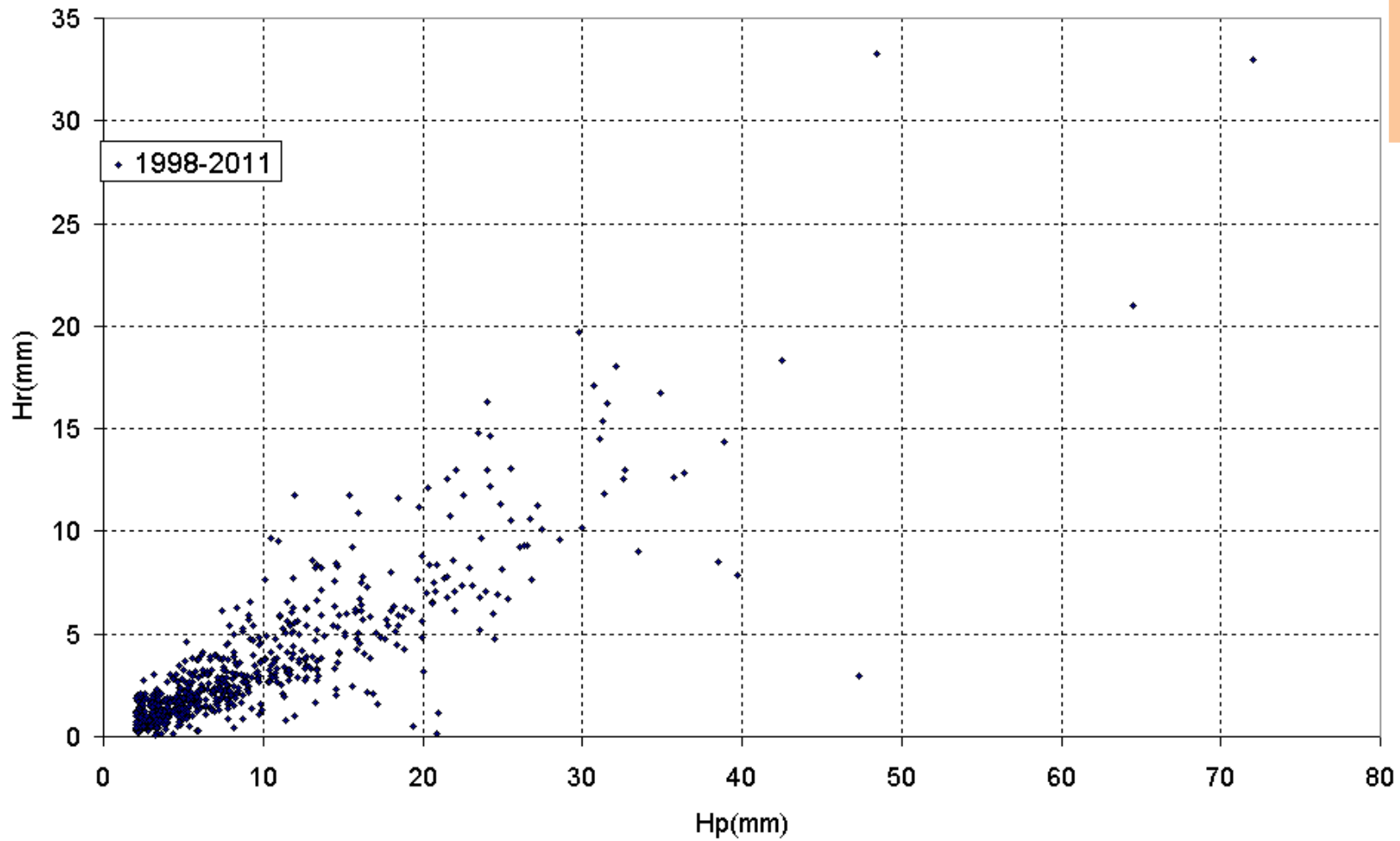


within RI OZCAR



\*  
IRSTV - Research Institute of urban sciences and techniques  
OSUNA - Observatoire des Sciences de l'Univers Nantes Atlantique

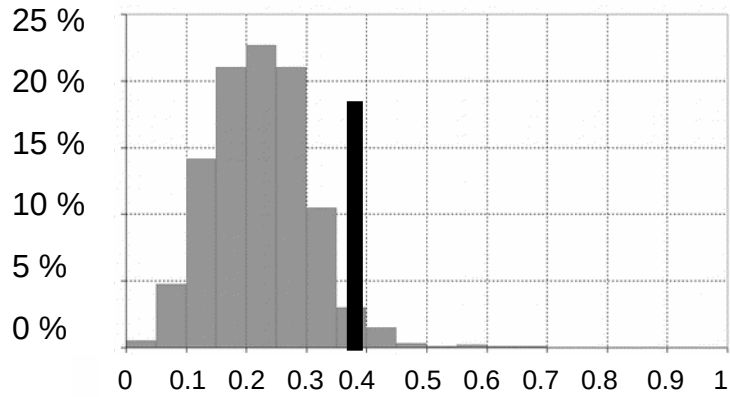
## Rainfall/Flowrate data



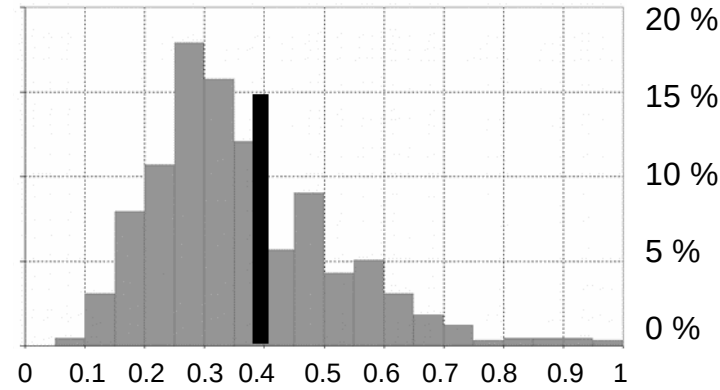
Runoff depth  $H_r$  vs Rainfall depth  $H_p$  / Gohards-réseau (180 ha)

~800 rain events

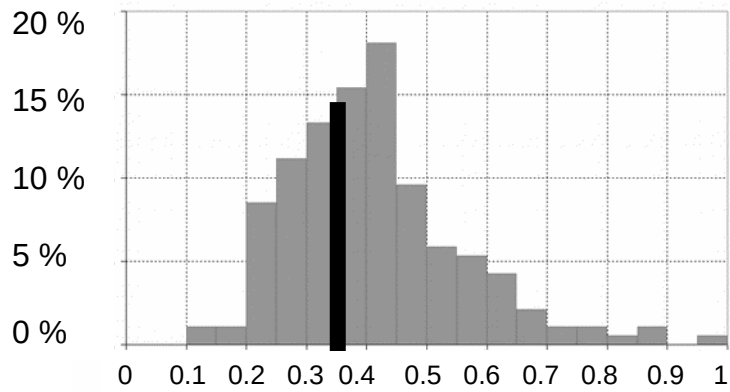
## Rainfall/Flowrate data : Flow coefficient distribution



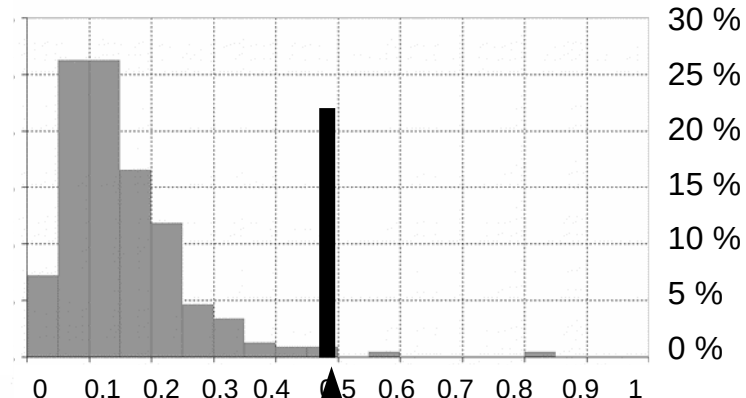
a) Rezé (1991-2001)



b) Gohards-réseau (1998-2011)



c) Gohards ruisseau (2008-2011)



d) Pin sec (2009-2012)

Impervious  
fraction value

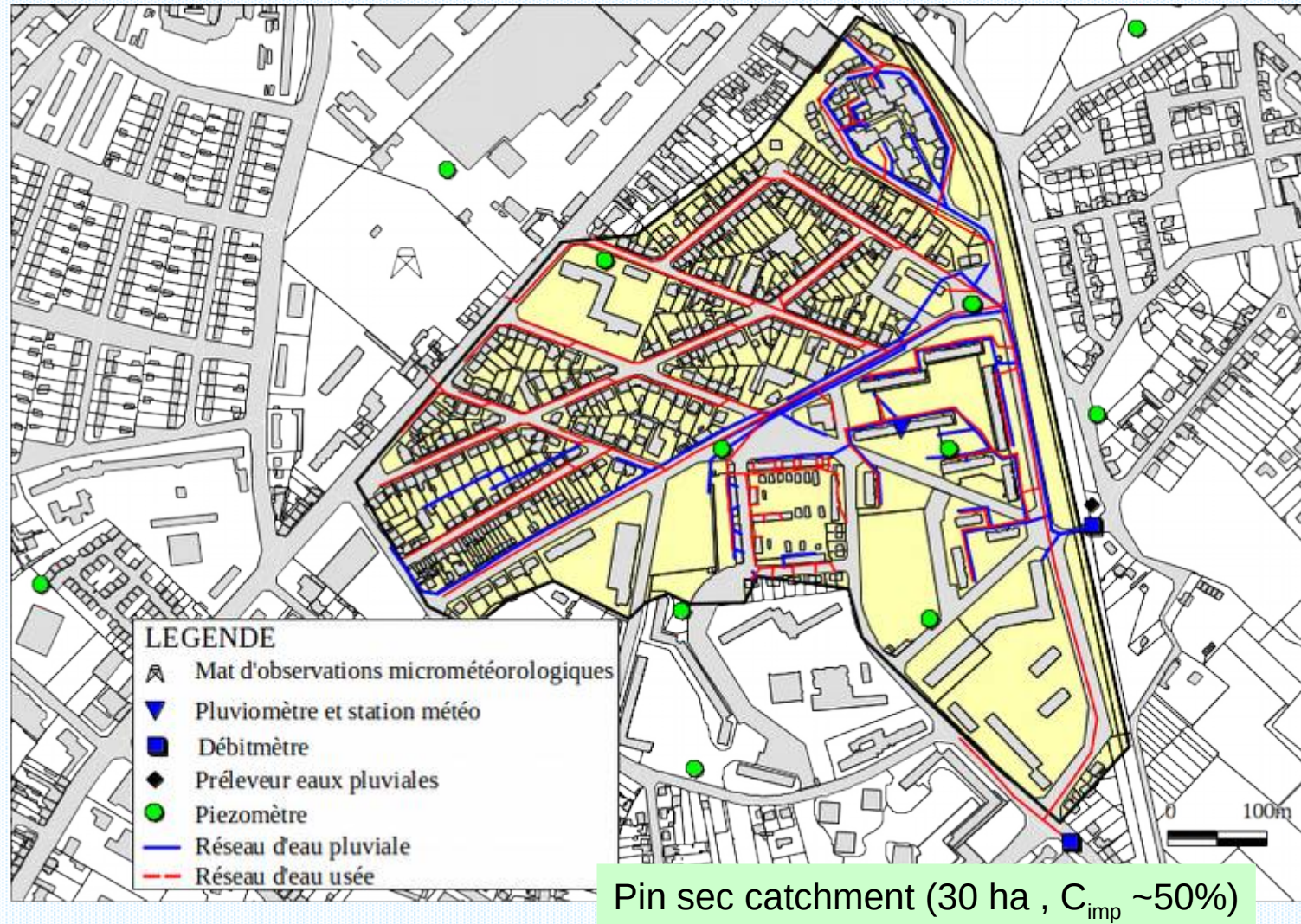
Flow coefficient =  $\text{Runoff depth} / \text{Rainfall depth} = \text{Runoff volume} / \text{Rainfall volume}$



## Focus on a small urban catchment

Monitoring of rainfall, flowrate (wastewater and stormwater sewers)

Groundwater level, Soil moisture, Heat fluxes





## Focus on a small urban catchment

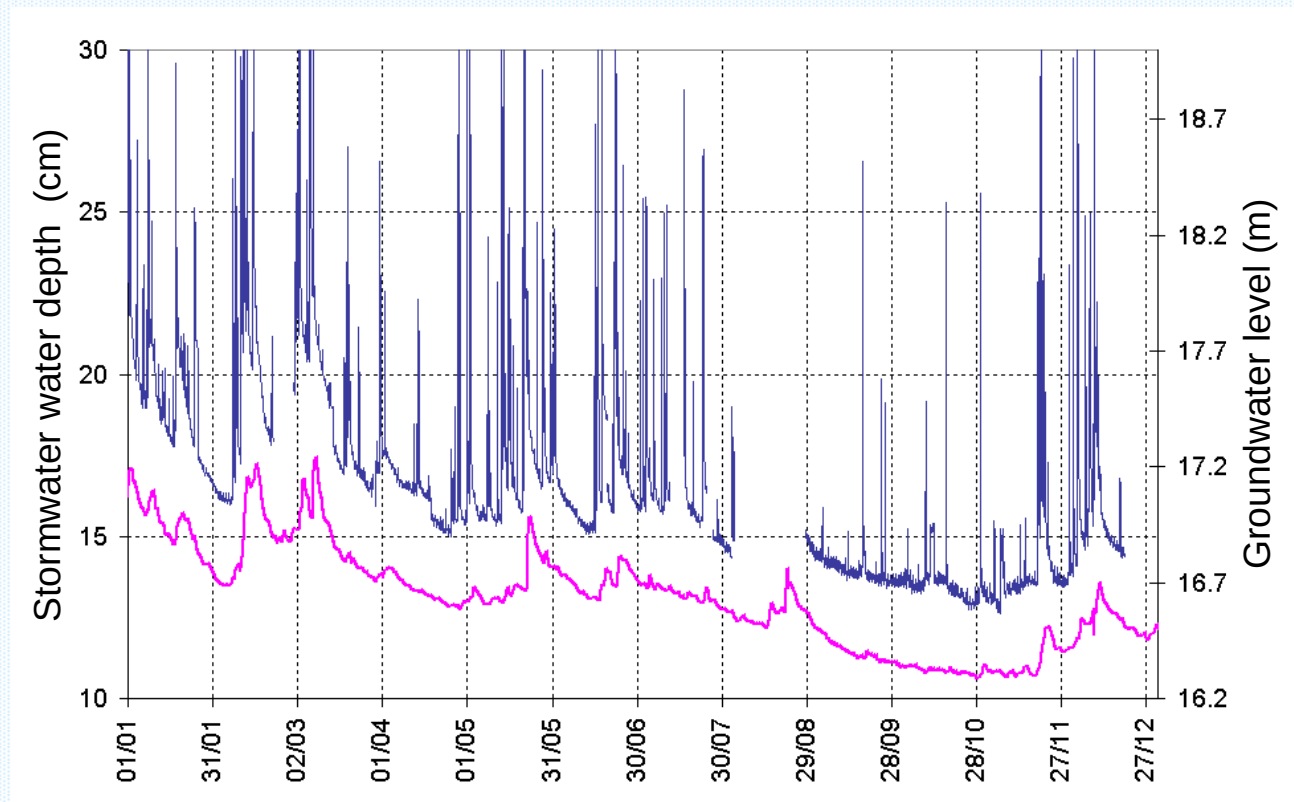
Baseflow evolution in buried sewer vs groundwater level

Year 2007

Cofluctuation  
flowrate / groundwater  
level

parasitic infiltration in  
sewers / groundwater  
drainage

Role of soil



*phd Le Delliou (2009)*  
*Rodriguez et al. (2020)*  
[doi.org/10.3390/w12030689](https://doi.org/10.3390/w12030689)

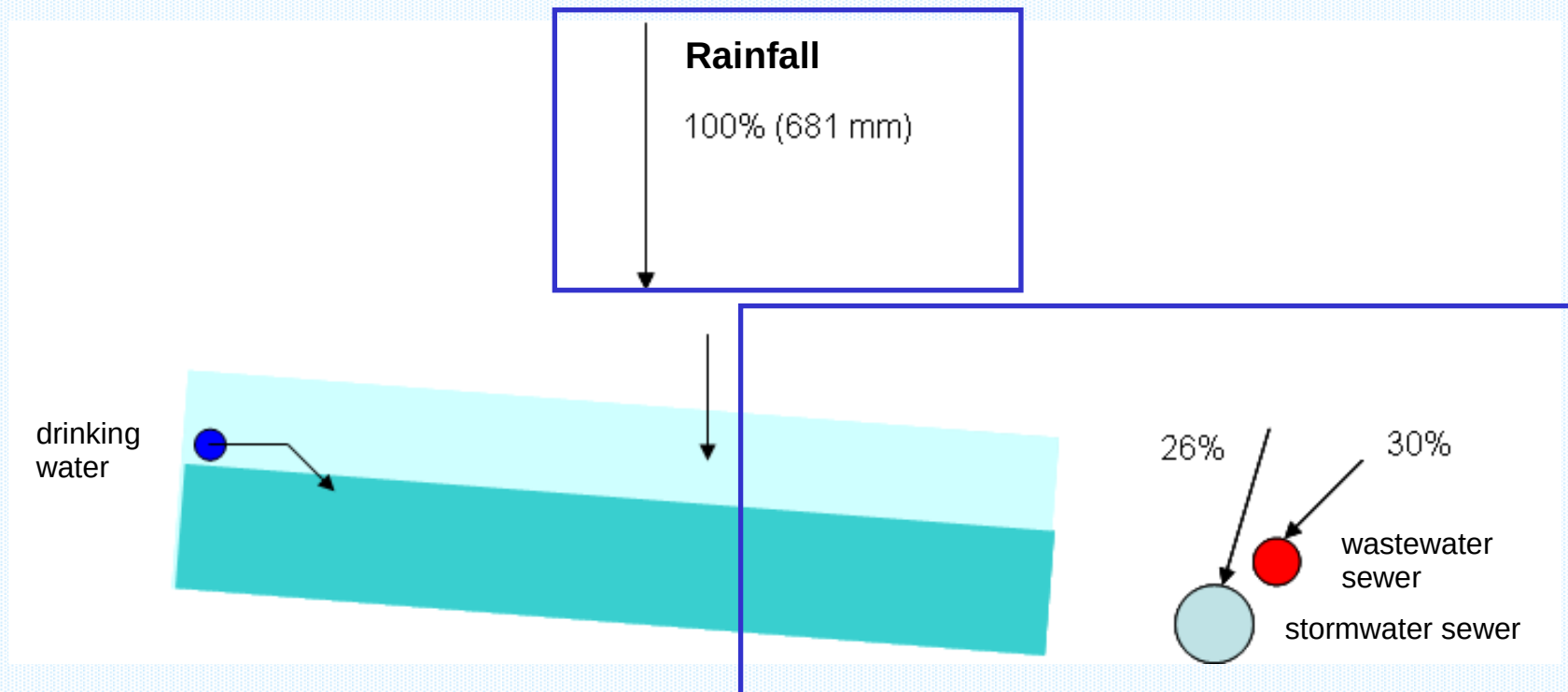
Pin sec catchment (30 ha ,  $C_{imp} \sim 50\%$ )

## Water budget : well known components

Monitoring ???

Yealy balance (2011) on Pin sec catchment

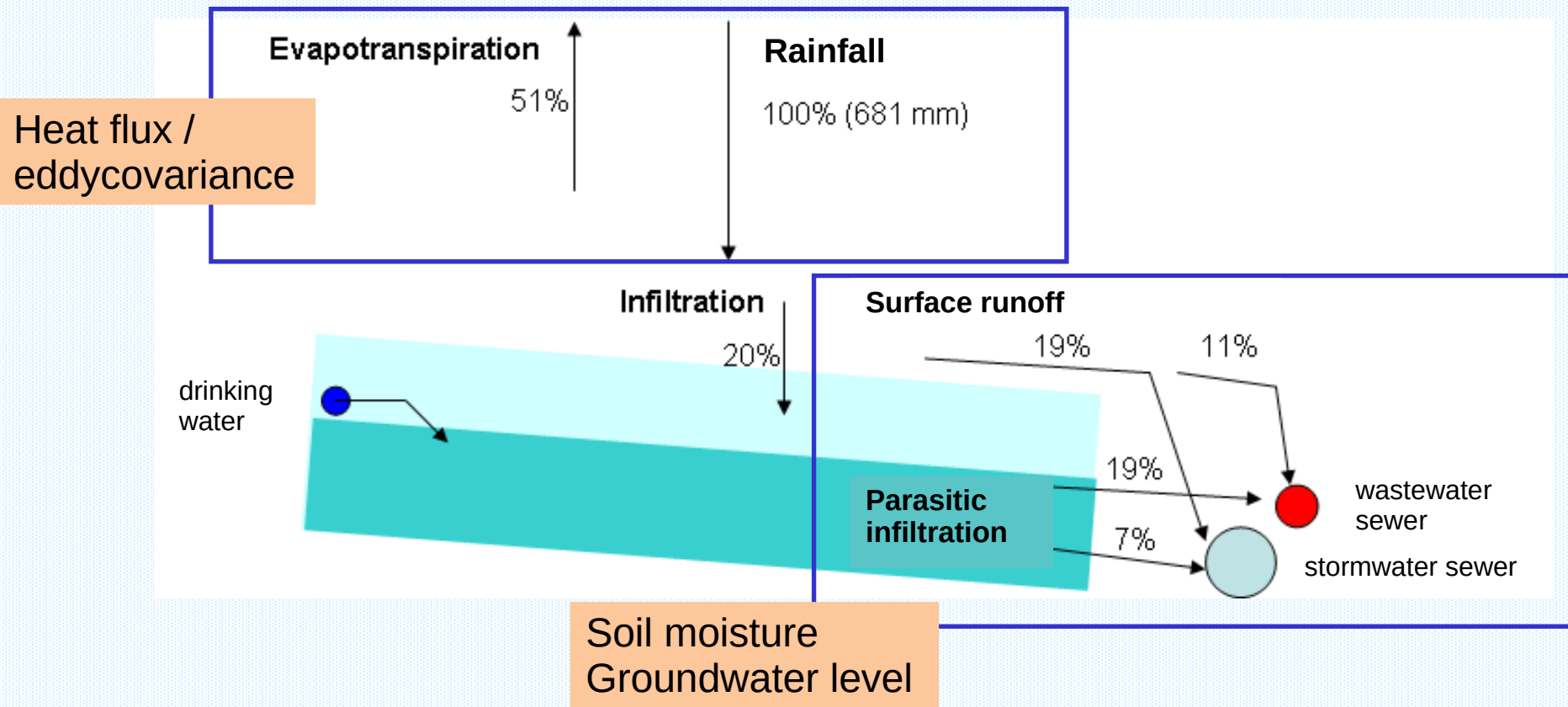
Raingauge



Flowmeter

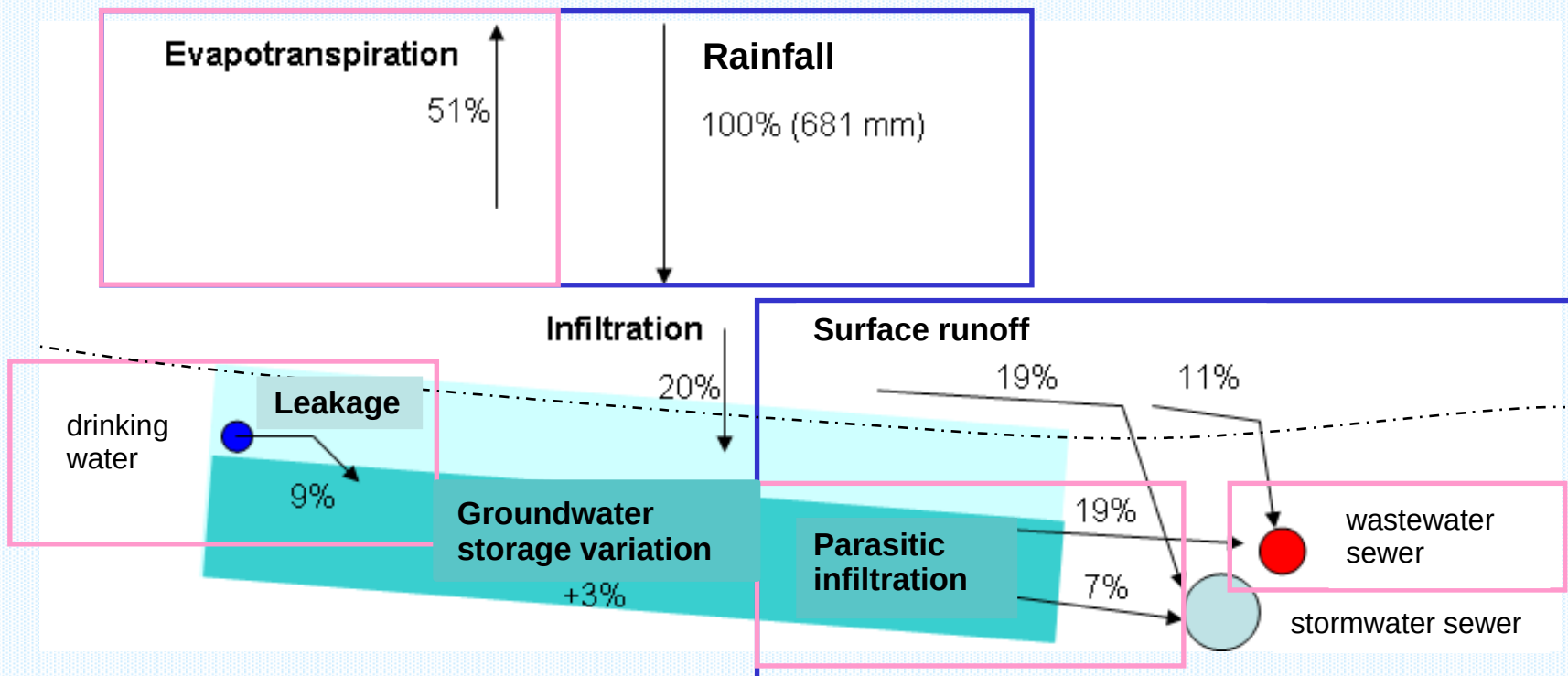
## Water budget : well known components

Yealy balance (2011) on Pin sec catchment



## Water budget : well known components and other to be refined

Yealy balance (2011) on Pin sec catchment





## Processes representation : a more integrated ambition

Hydrological modelling of urban catchments

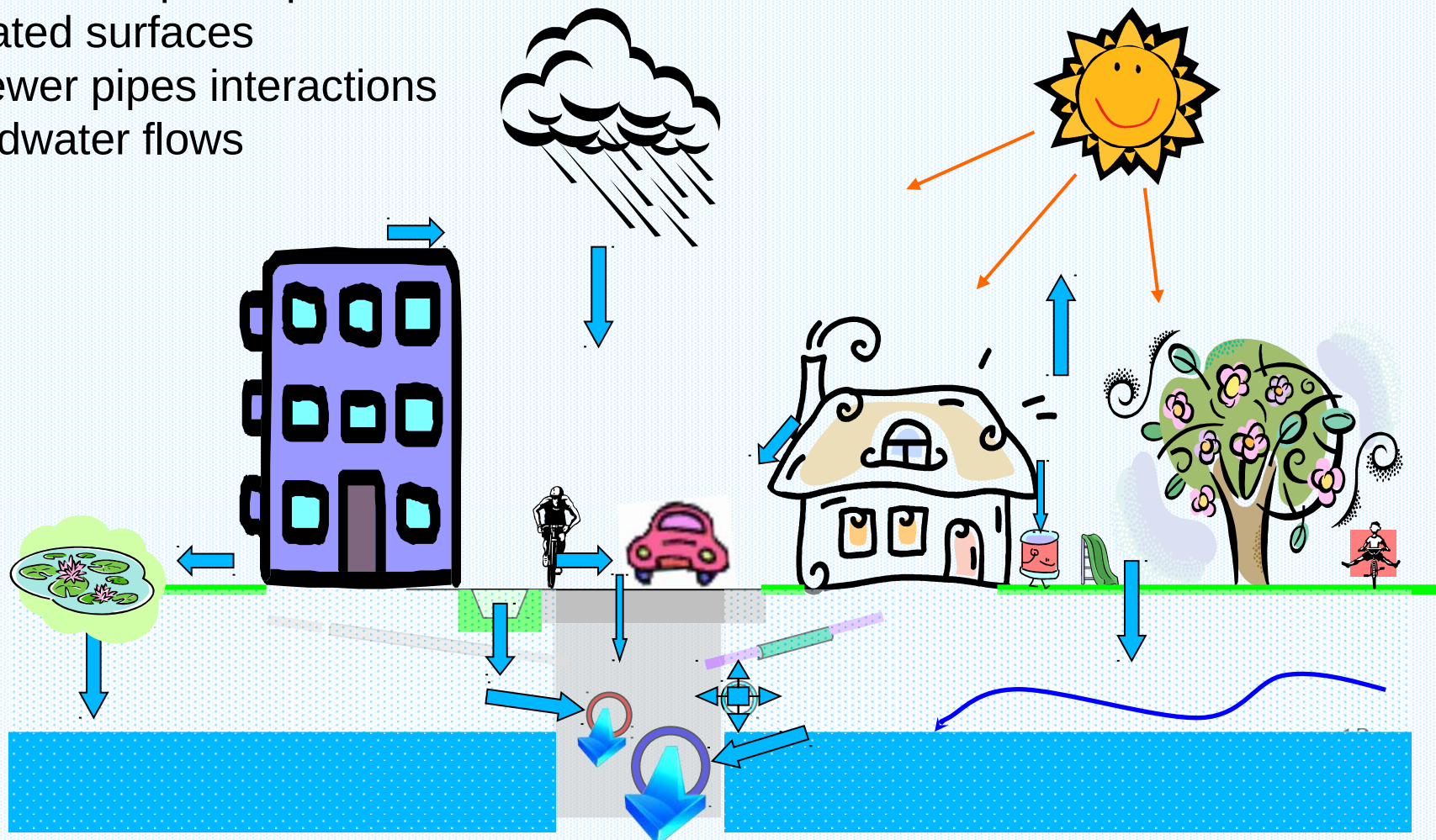
Physical processes

Surface/atmosphere processes

Vegetated surfaces

Soil/sewer pipes interactions

Groundwater flows



## Processes representation : a more integrated ambition

Hydrological modelling of urban catchments

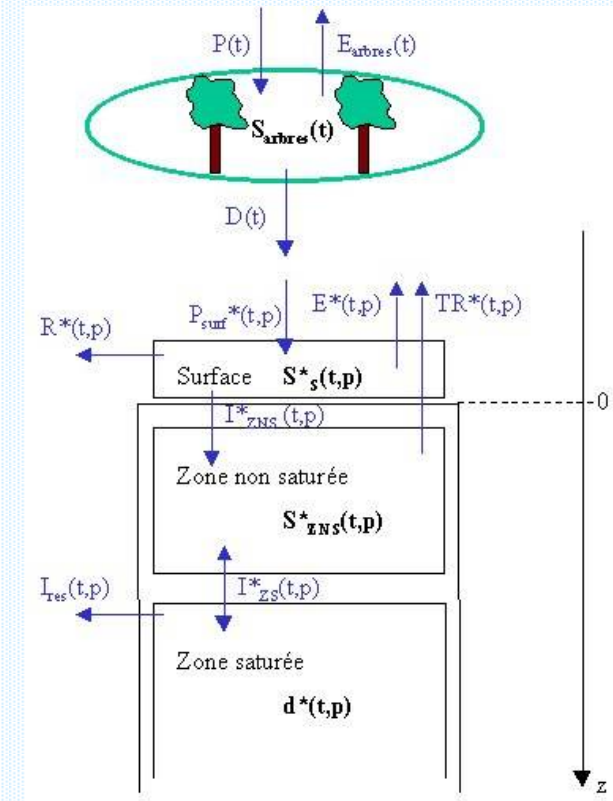
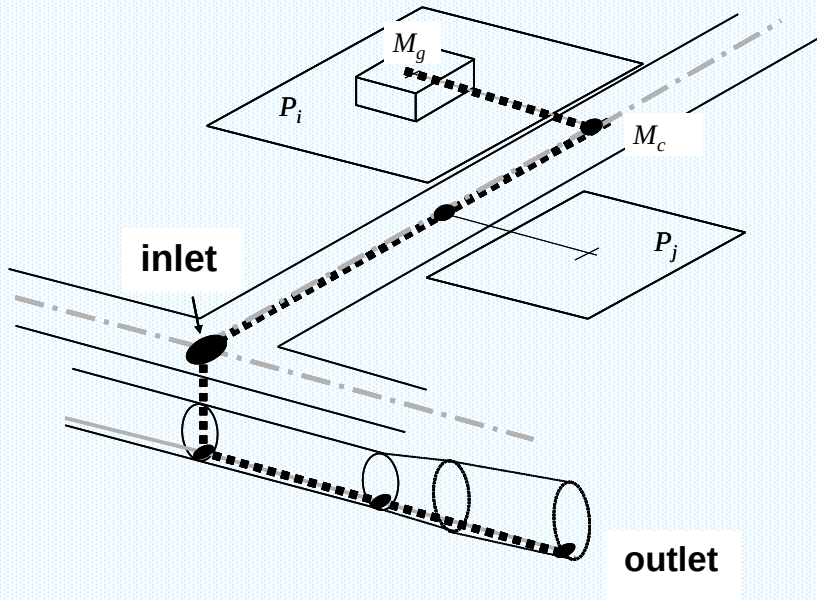
URBS-MO model

modelling unit UHE (Roof, Street, non impervious areas)

1D vertical parametrisation scheme for one UHE

Horizontal fluxes / Soil drainage by sewers (UHE)

Routing / Runoff connexion to the hydrographic network  
(Muskingum method)

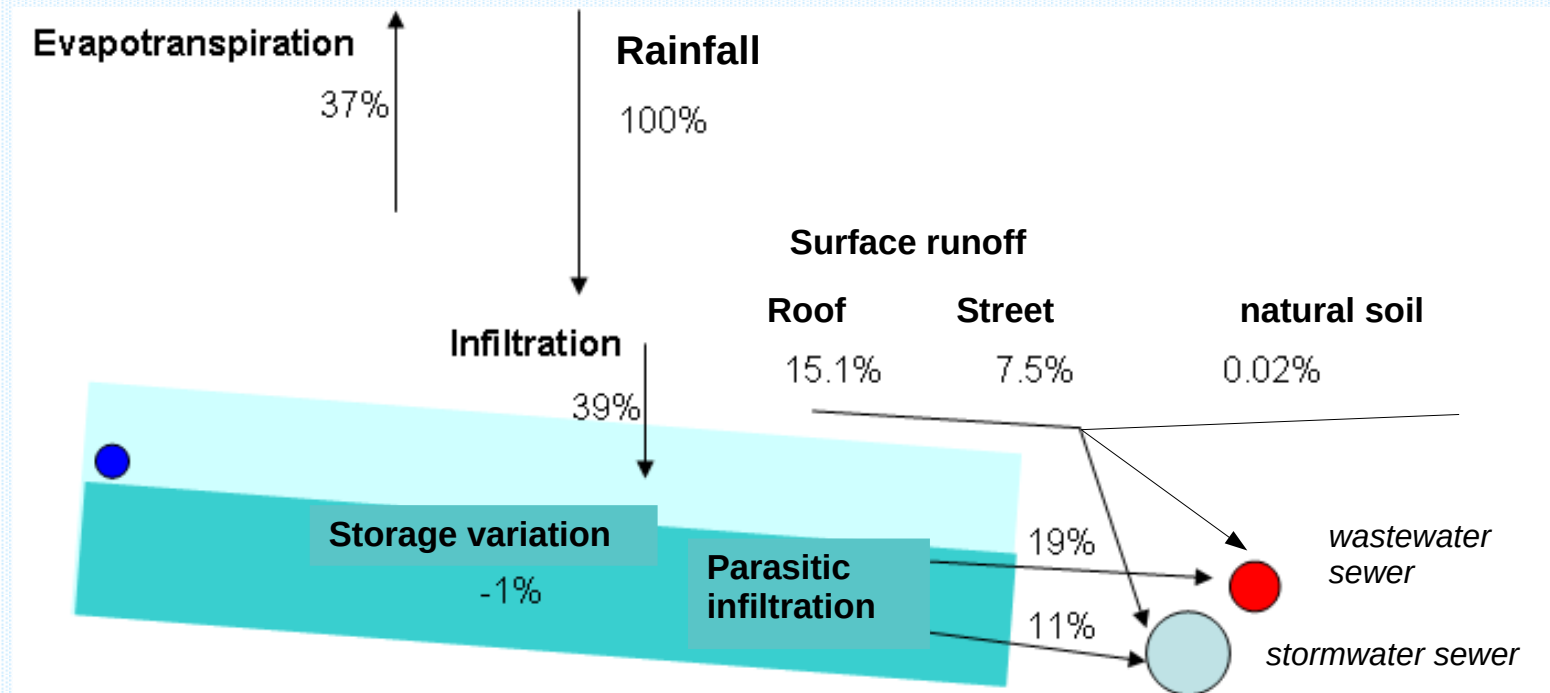


Rodriguez F., Andrieu H., Morena F., 2008. doi.org/  
10.1016/j.jhydrol.2007.12.007

## Représentation des processus : quelques résultats

Pin sec catchment

Water budget simulation on one average hydrological year



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Surface runoff... but not only !

Importance of the hydrological behaviour of soil

Role of evapotranspiration

Relevance of a more integrated approach of urban hydrology

NBS solutions, City greening & global change