

11<sup>e</sup> Conférence internationale

LYON 2023

— L'eau dans la ville | Urban water

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L'eau dans la ville | Urban water

**Potentiel des *arbres de pluie* dans la gestion du ruissellement urbain : bilan global d'un dispositif expérimental au sein de la mini ville SenseCity**

**Potential of *stormwater trees* for sustainable urban runoff management: overall assessment of an experimental device within SenseCity**

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leesu

laboratoire eau environnement systemes urbains

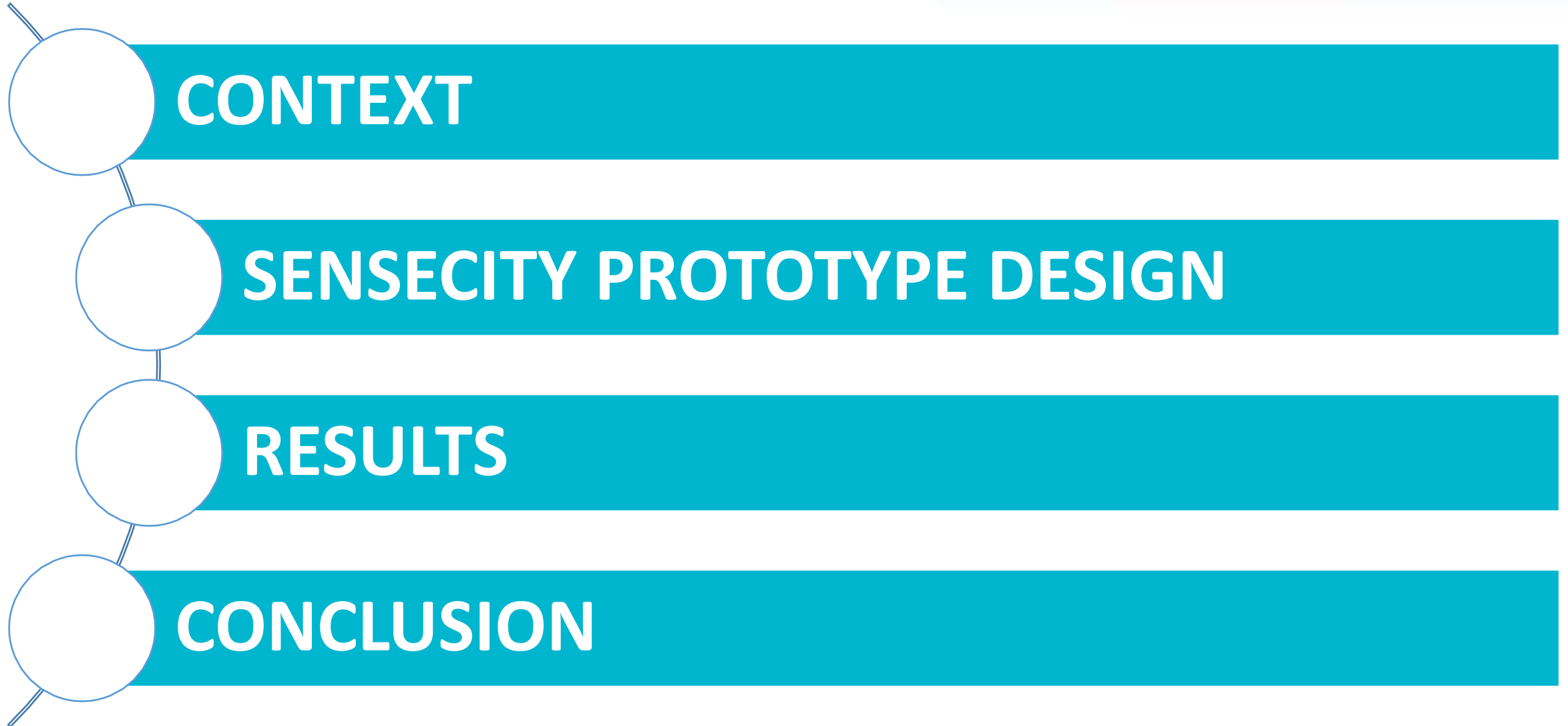
sense CITY

OPUR

Hydrasol

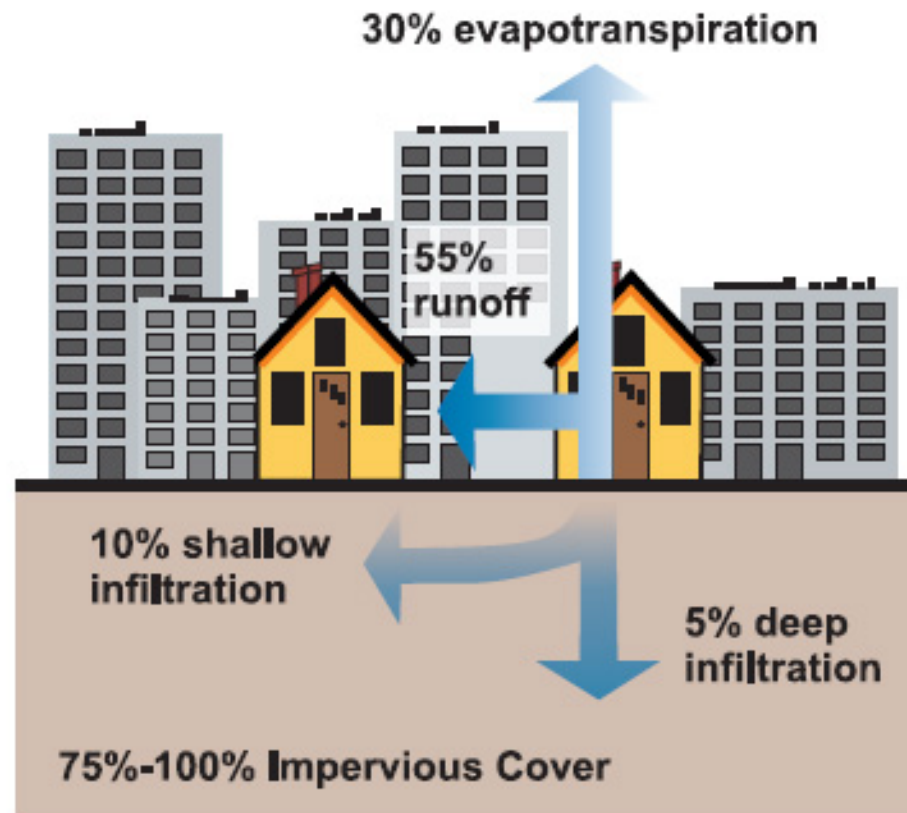
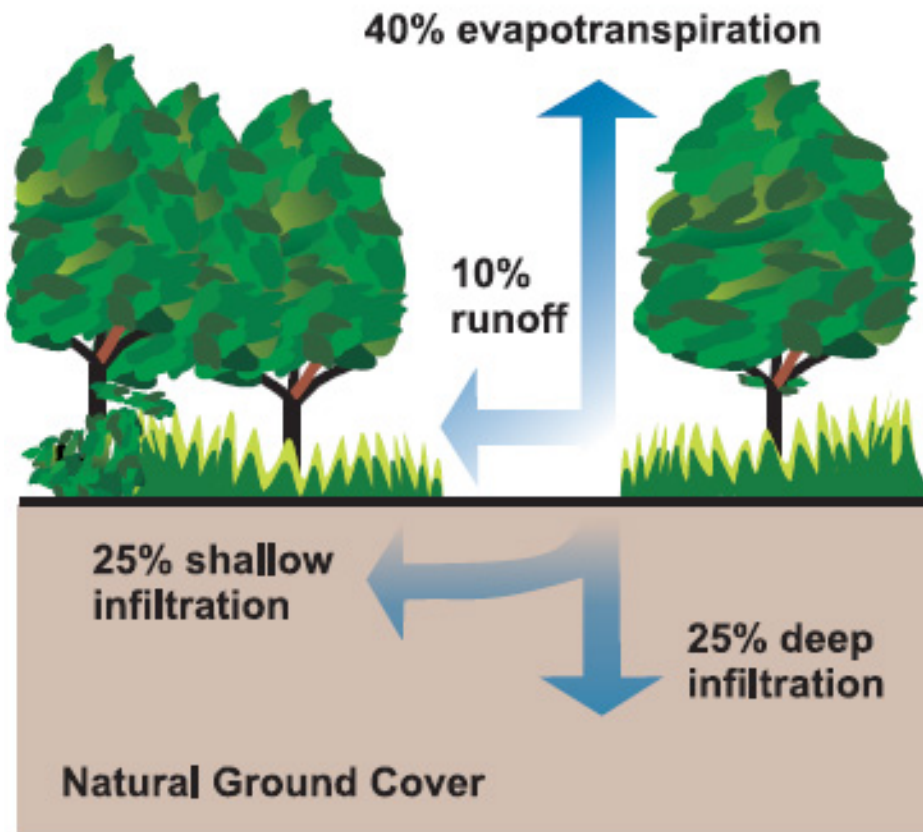
Cerema

# PLAN



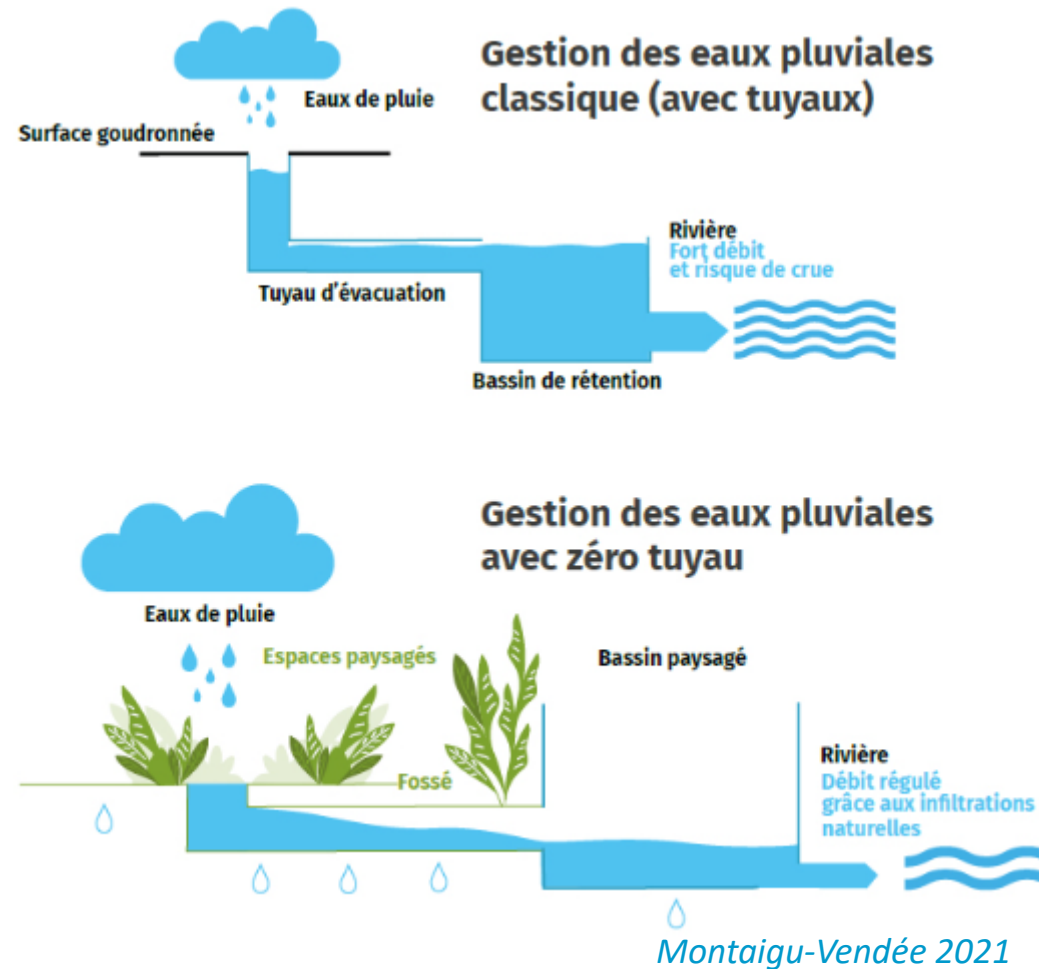
# CONTEXT

# Effect of urbanization on hydrological functioning



EPA 2003

# Management at the source of stormwater



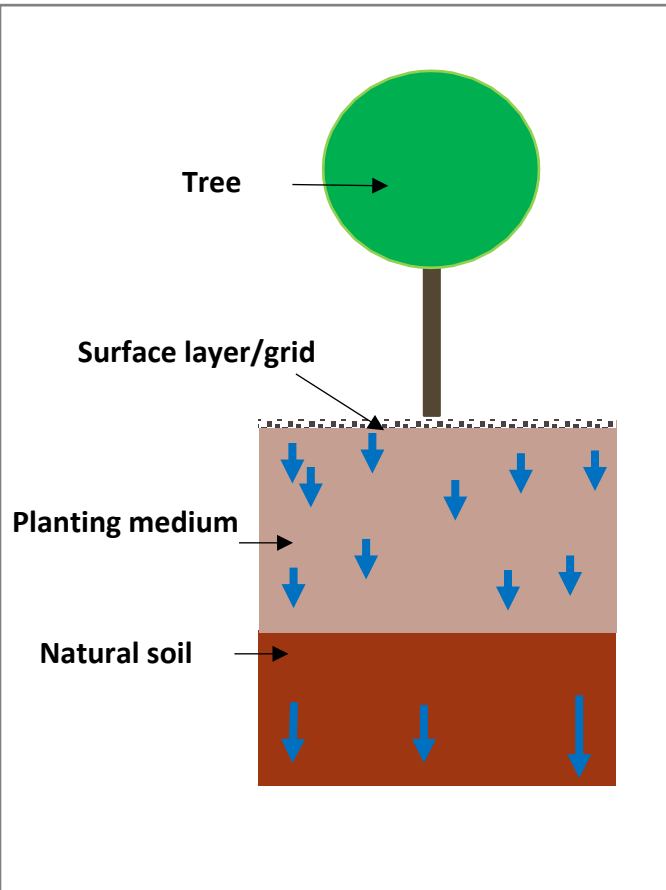
SIARE 2018

- Limit runoff volume and network overflows
- Limit the pollution discharged during rainy periods

# Street tree to stormwater tree

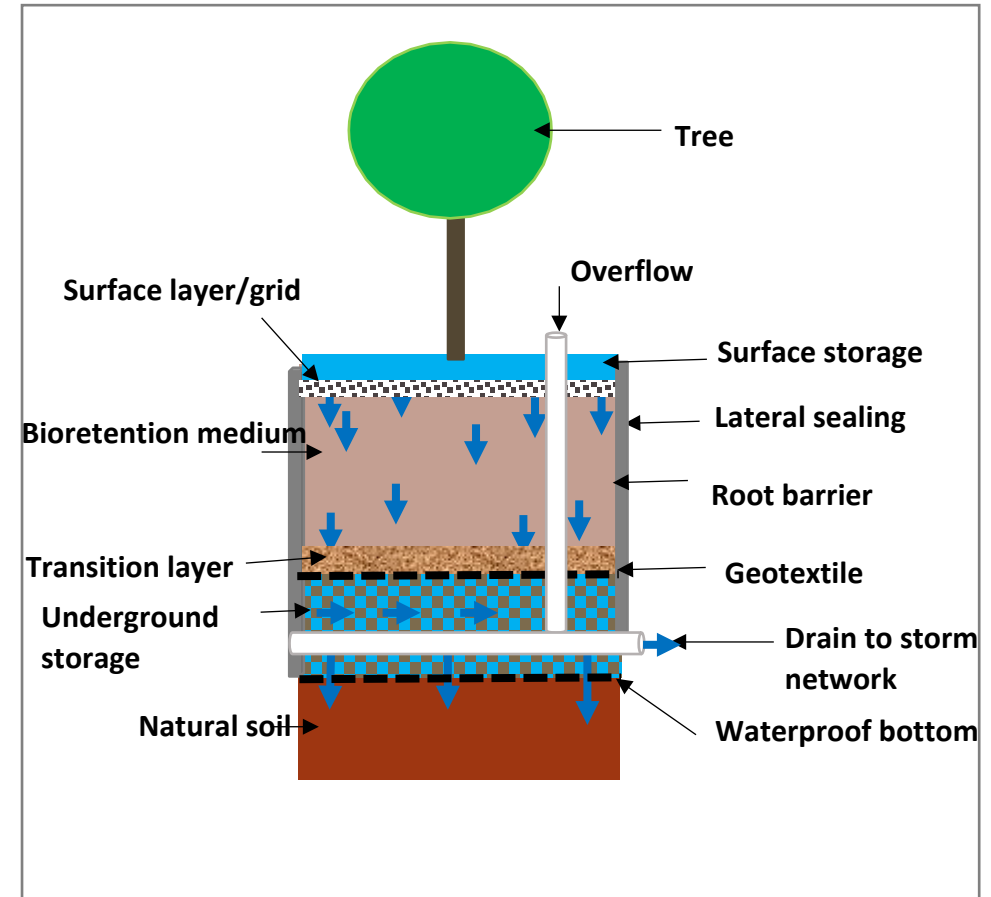
## Main differences

- ✓ A system to direct runoff to trees
- ✓ Specially designed soil and root development
- ✓ A design for the storage
- ✓ A drainage system to evacuate excess volume
- ✓ ...



Street tree

06/07/2023



Stormwater tree

# Stormwater tree



## Rainwater Collection

Reduction of discharges in the recovery network

## Reduction of runoff path

Reduction of pollution

## Storage

Water reserve for trees, especially in dry and hot periods

## Exfiltration

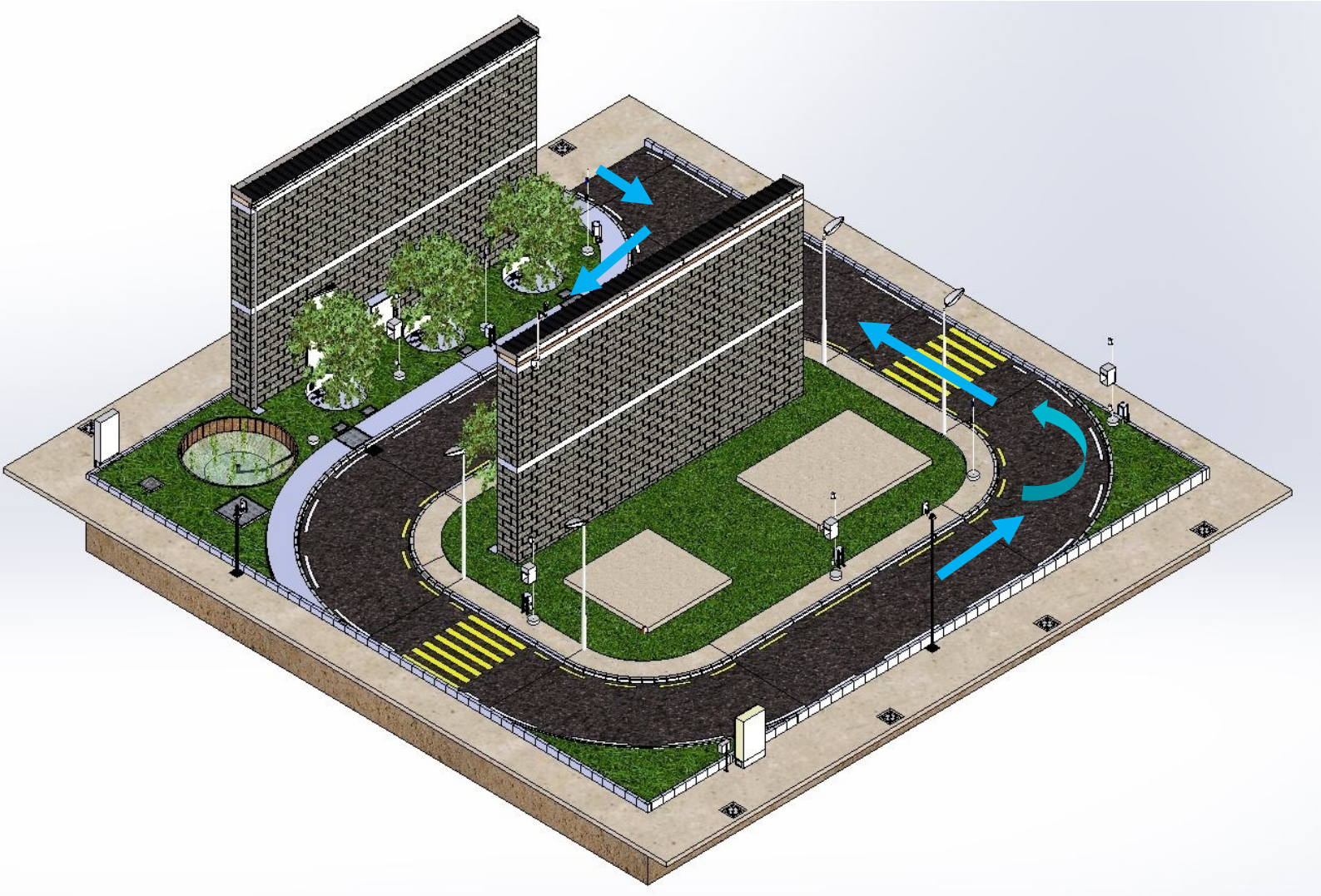
Drainage to the basement or to an outlet

*Describe, understand and analyze the hydrological functioning of a stormwater tree (SenseCity) for urban runoff management*

# SENSECITY PROTOTYPE DESIGN



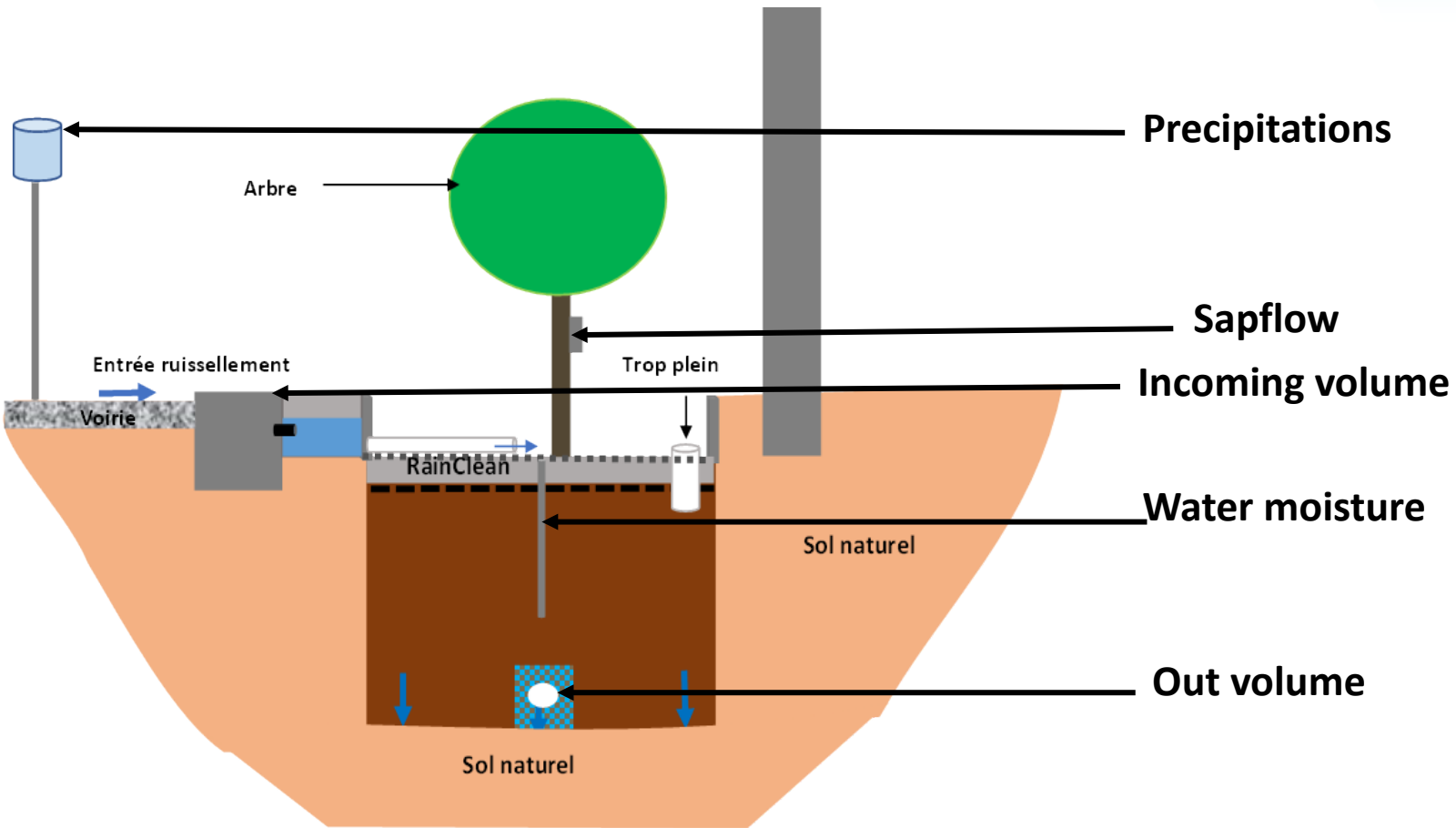
# SenseCity prototype design



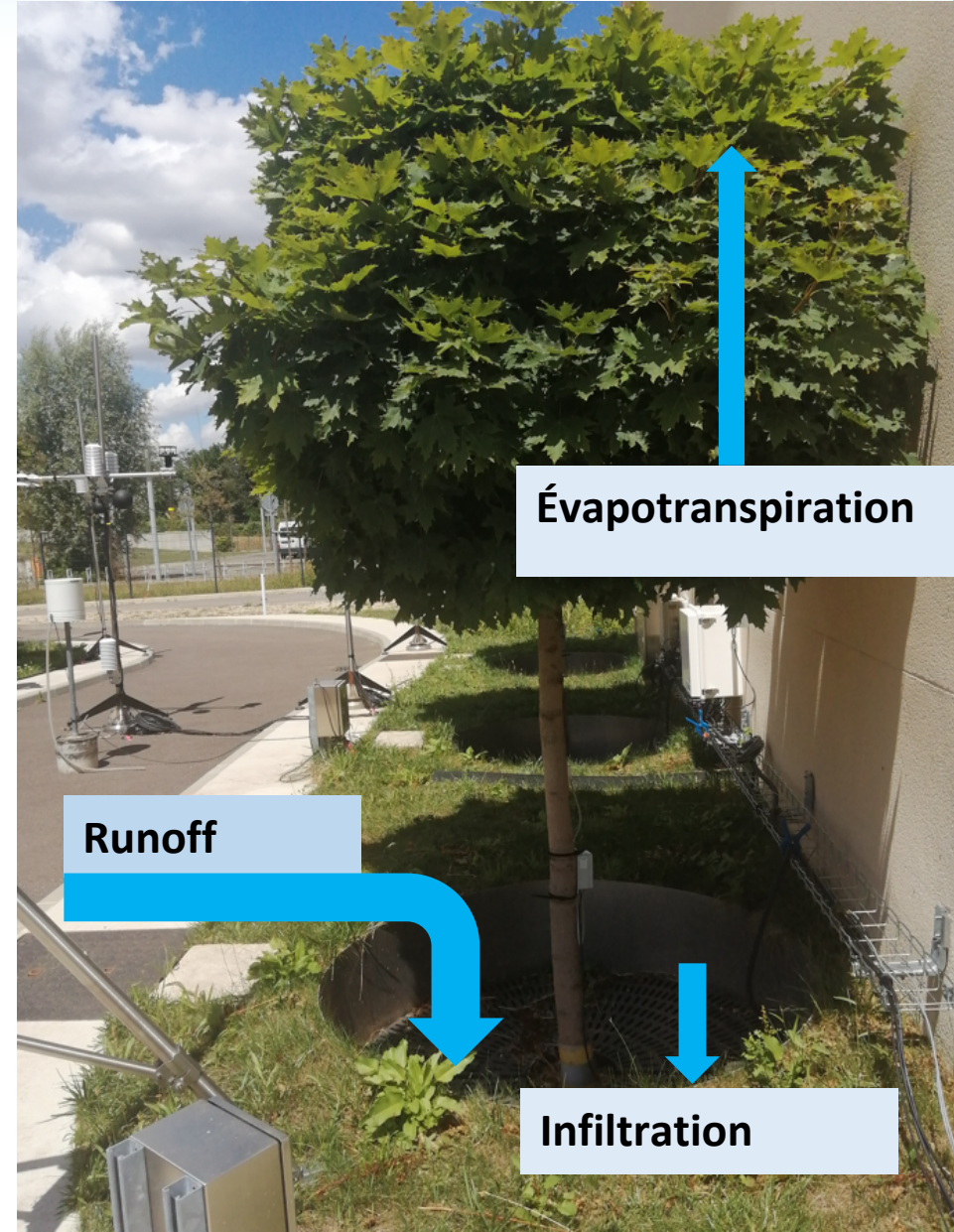
## 3 Stormwater trees fed by pavement runoff

- ❑ Surface area : 88m<sup>2</sup>
- ❑ Species: Acer platanoide globosum
- ❑ Hight:3.5m
- ❑ Diameter: 8cm

# SenseCity prototype design



*Inflow = 2 rain gauges, electromagnetic flowmeters*  
*Outflow = Sap flow sensor (heat dissipation); tilting trough,*  
*Storage = Water content sensor*



# Hydrological indicators

## Reduction in annual volume

$$Ev_{BV + OGA, an} = \frac{V_{out} BV, an}{H_{rain_{ev}} * (Surface BV + Ouvrage)}$$

## Drainage time

$$HTv = H_{end\ drainage} - H_{end\ rain}$$

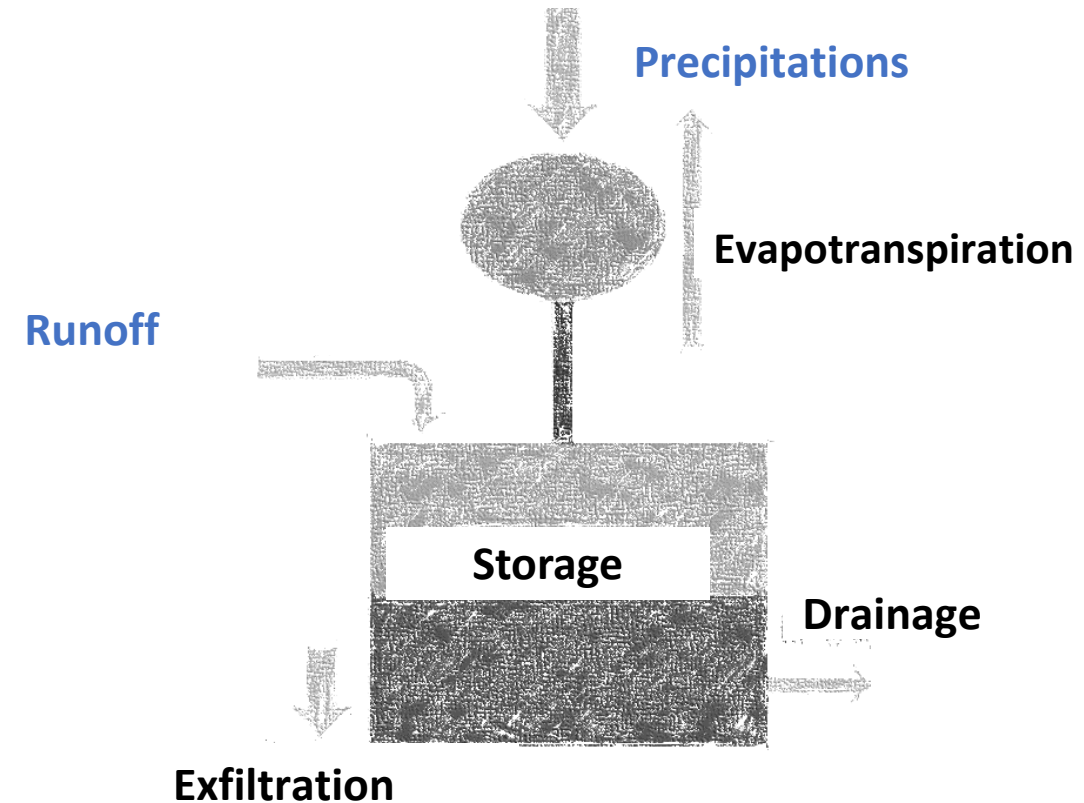
## Reaction time

$$HTr = H_{start\ drainage} - H_{start\ runoff}$$

## Water balance

$$Inflows - Outflows = Stock\ variation$$

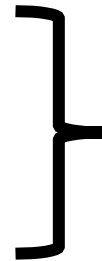
$$Initial\ Stock + Inflow = final\ stock + sapflow + outflow + Exfiltration$$



# RESULTS

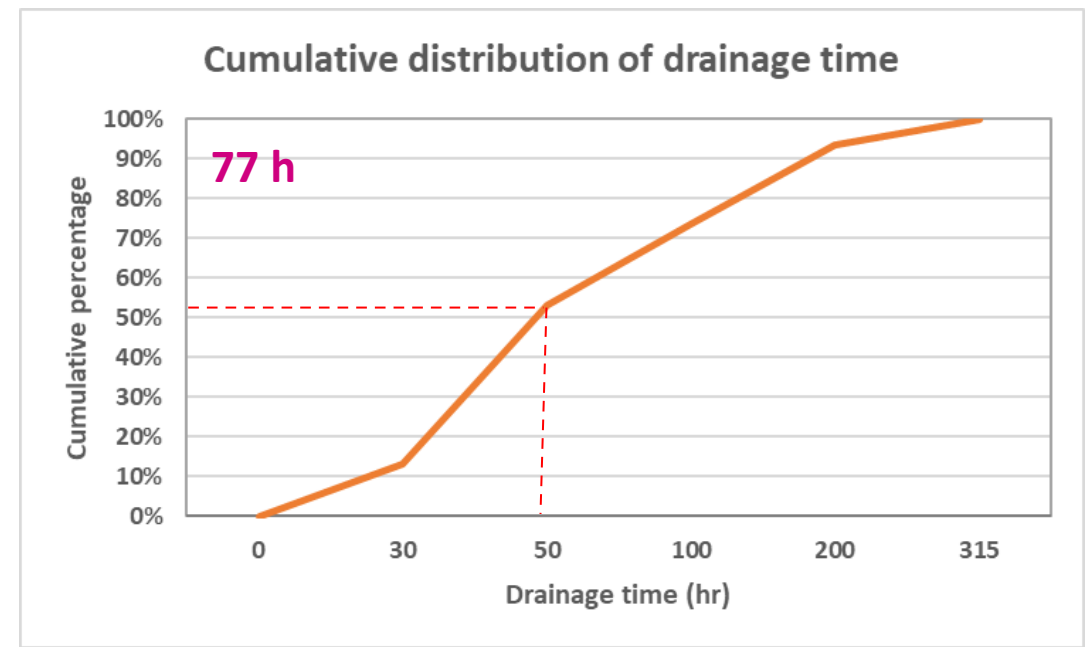
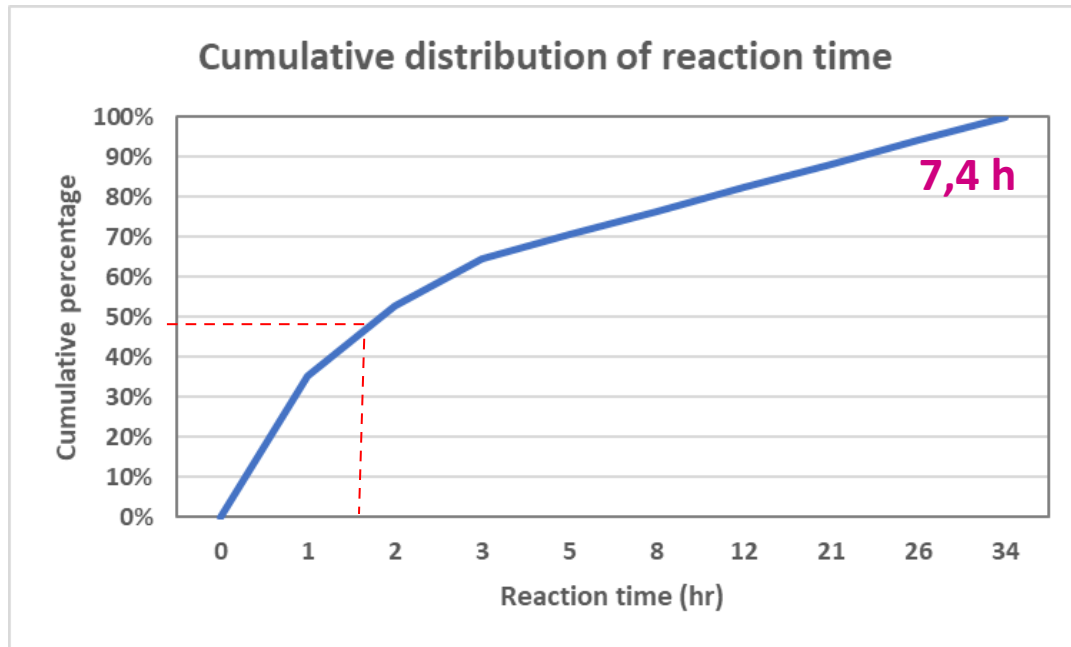
# Hydrological performance

- ❑ Follow up period (March-December 2022)
- ❑ 206mm runoff inflow
- ❑ 39mm drainage outflow
- ❑ No system overflow



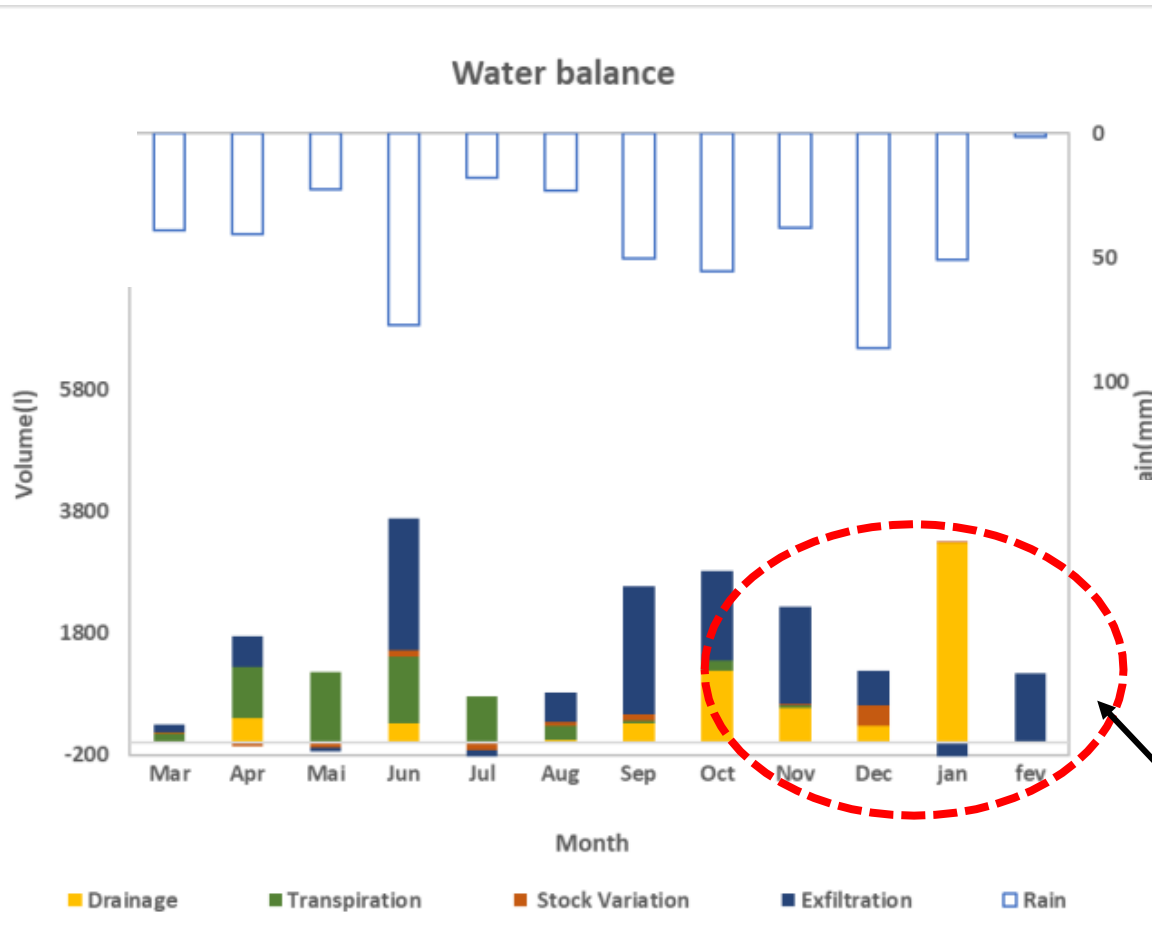
Annual reduction volume **80%**

✓ Annual reduction volume 44% for vegetated filter (Kanso 2021)



- The initial condition of the soil moisture
- Substrate properties

# Water balance



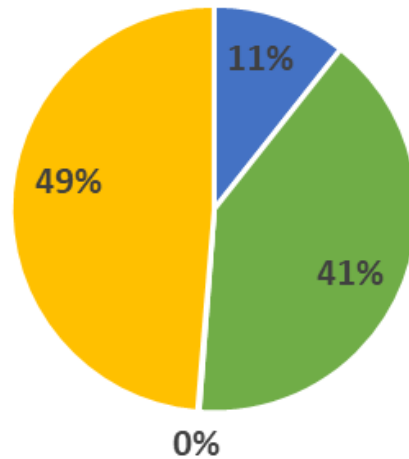
- Higher exfiltration rate of 53%, transpiration of 27% and drainage of 19%;
- Weak transpiration in the autumn and winter period, characterized by the loss of leaves;
- Transpiration is higher in summer,

No leaves

- Refreshment of the local environment in summer
- Refill groundwater

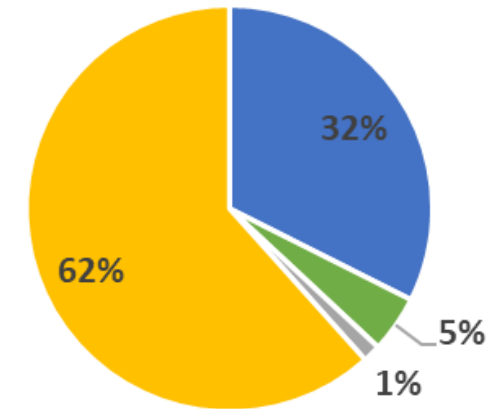
# Water balance

## Vegetative period



■ Drainage ■ Transpiration ■ Stock Variation ■ Exfiltration

## Dormancy period



■ Drainage ■ Transpiration ■ Stock Variation ■ Exfiltration

- Vegetative period (April-September): More Transpiration and low Drainage
- Dormancy period (October-March) :Low Transpiration and more Drainage

# CONCLUSION



# Conclusion and perspectives

- ✓ **Stormwater tree is a promising management technique for urban runoff reduction;**
- ✓ **Annual reduction volume 80%.**
- ✓ **Annual water balance: preponderant exfiltration 53%, transpiration 27%;**
- ✓ **Best performance in vegetative period;**
- ✓ **Satisfy the plant water requirements by adequate ratio or complementary stock?**



**THANK FOR YOUR ATTENTION**