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## Introducing economy into potentiality mapping of mar scheme

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# INTRODUCING ECONOMY INTO POTENTIALITY MAPPING OF MAR SCHEME

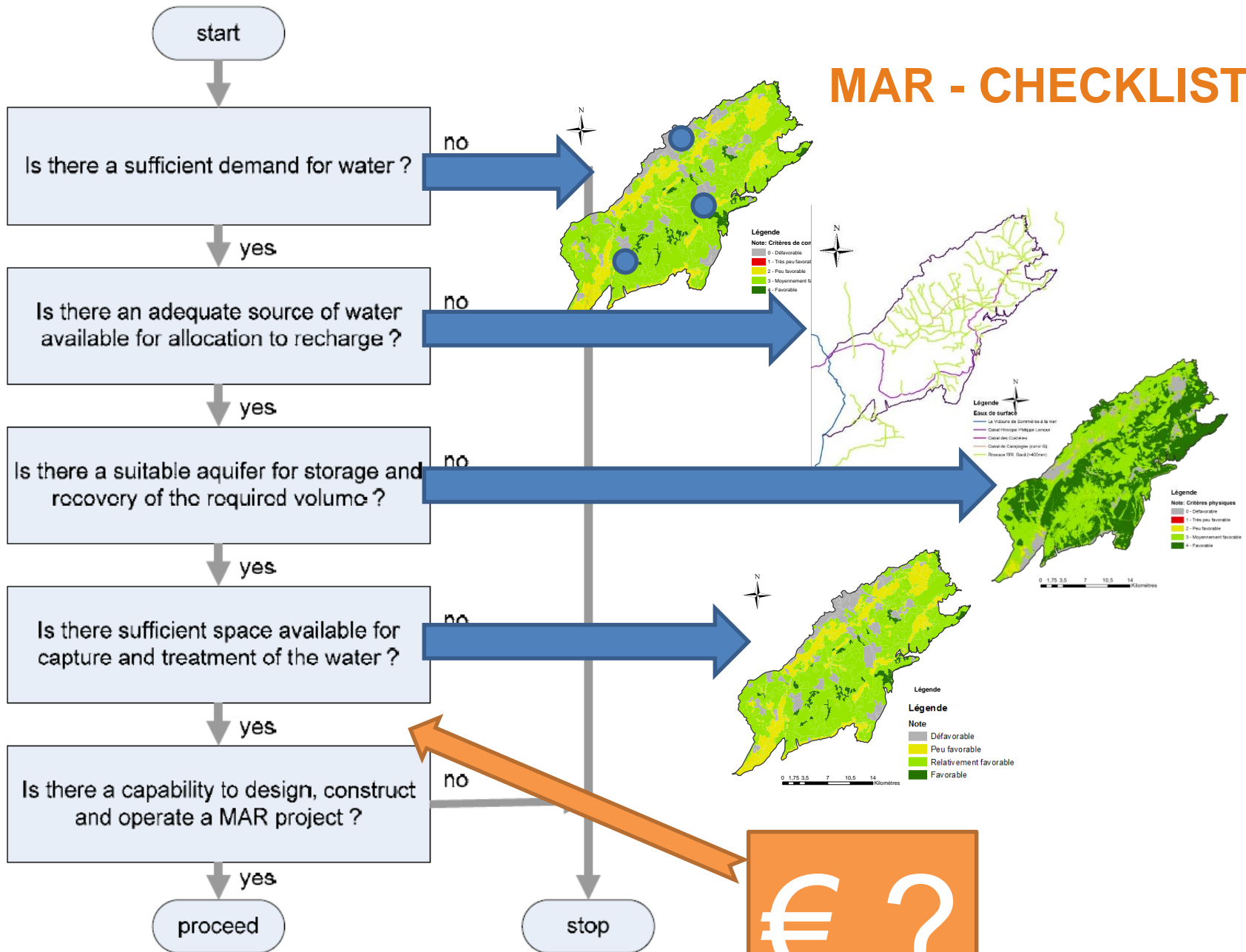
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CABALLEO Y. AND DESPRATS JF.*



Géosciences pour une Terre durable

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# MAR - CHECKLIST

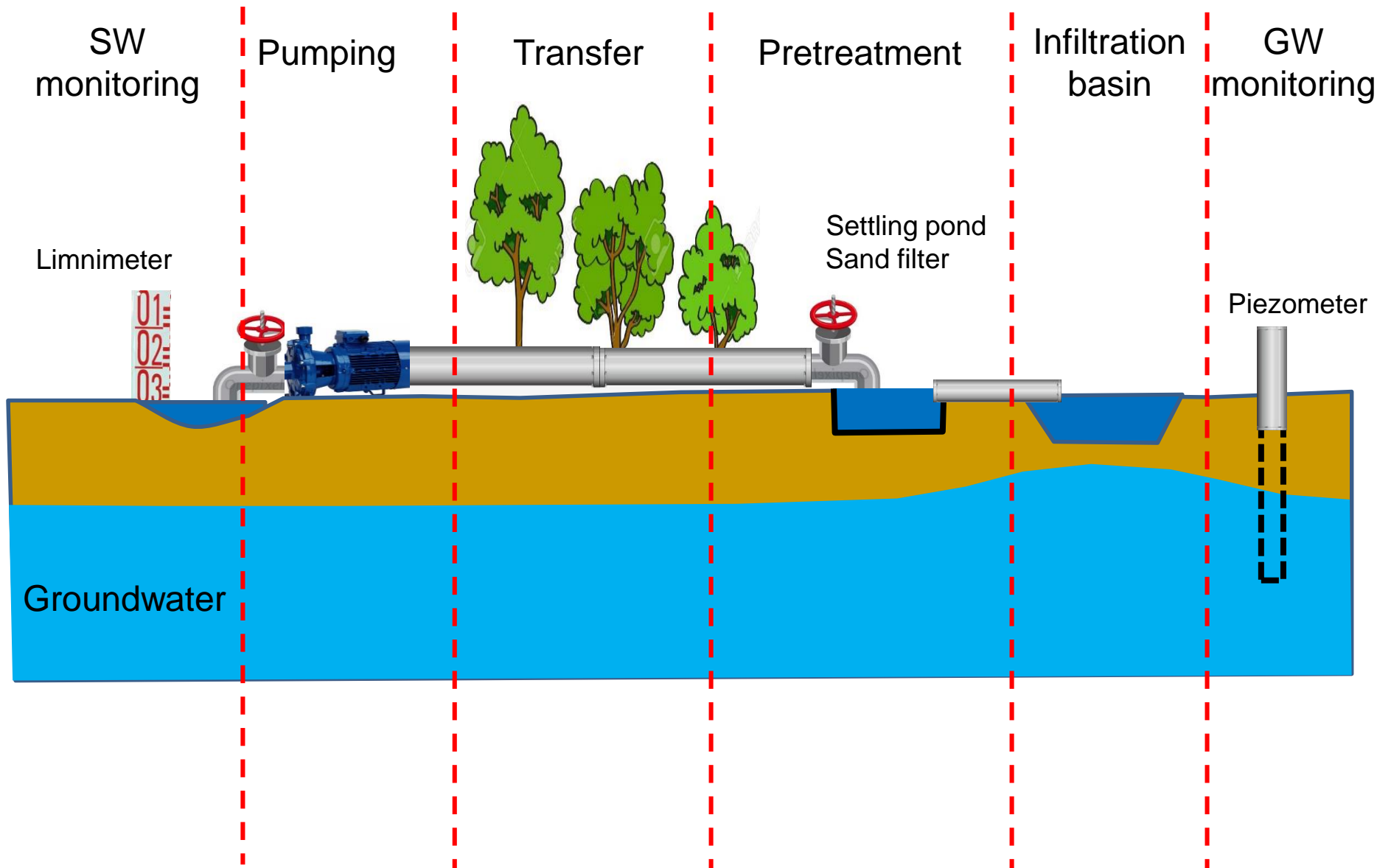


# OBJECTIVE: COSTS MAPPING

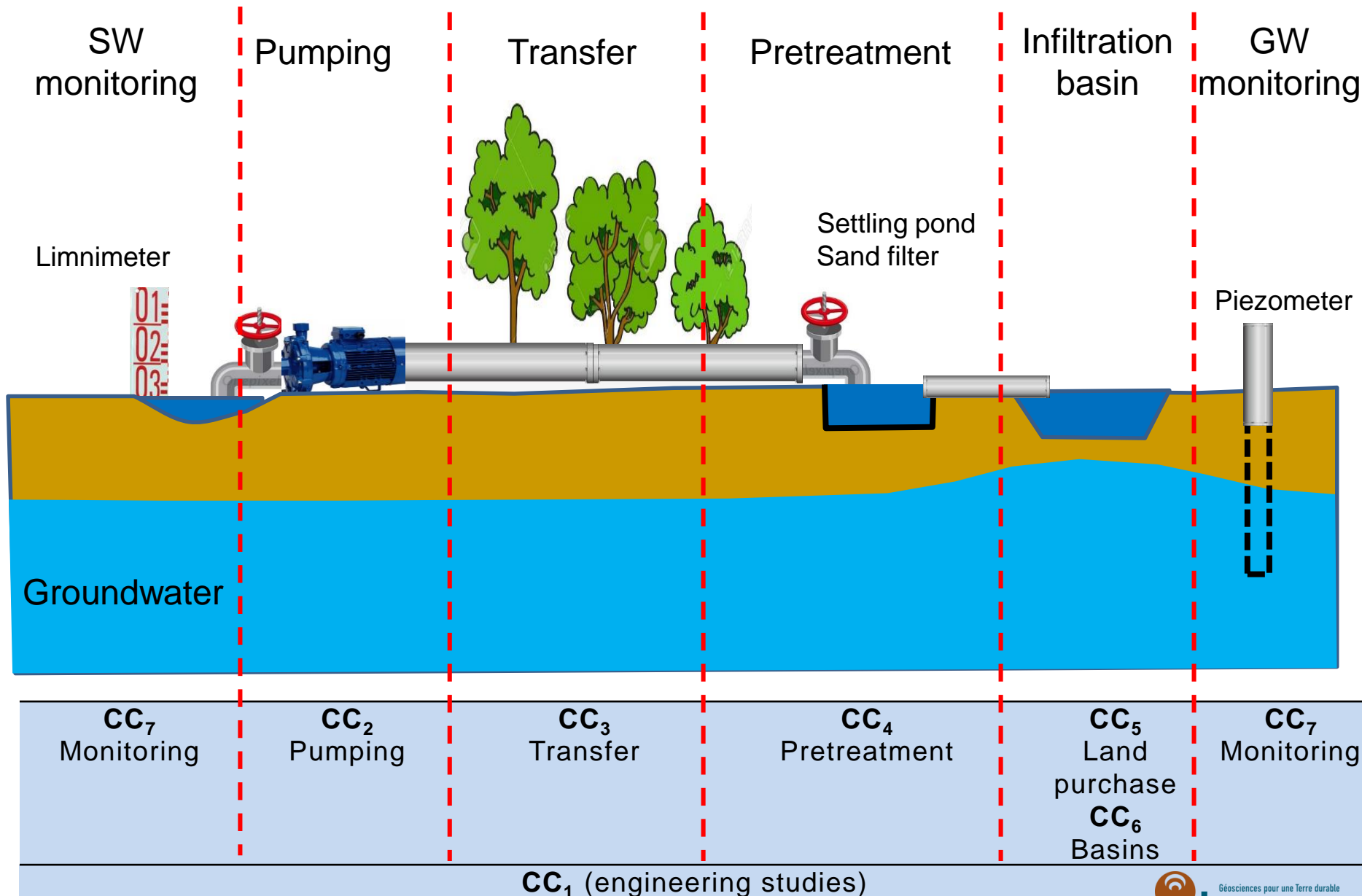
## Outline:

- Identify the engineering components of a MAR scheme (indirect recharge)
- Identify the associated capital and operational costs functions
- Evaluate the costs function
- Calculate a levelised cost map (€/m<sup>3</sup>) according to life duration of MAR
- Application to a real case study
- Analyse the sensitivity of levelised costs
- Conclusion

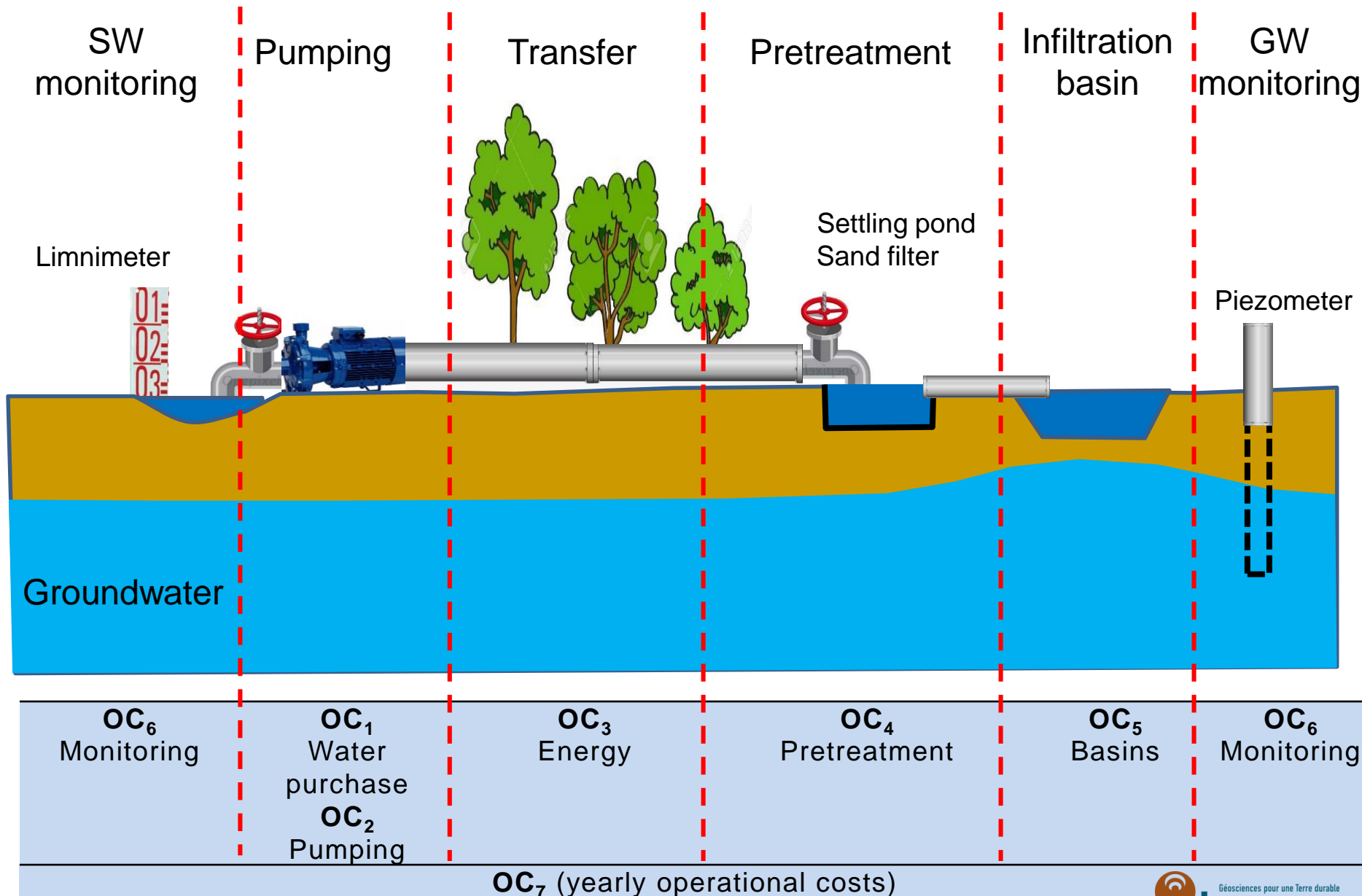
# ENGINEERING COMPONENTS OF AN INFILTRATION BASIN SCHEME



# CAPITAL COSTS OF AN INFILTRATION BASIN SCHEME




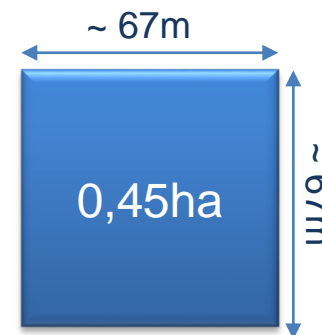
# OPERATIONAL COSTS OF AN INFILTRATION BASIN SCHEME



# SIZE OF AN INFILTRATION BASIN: REFERENCE EXAMPLE

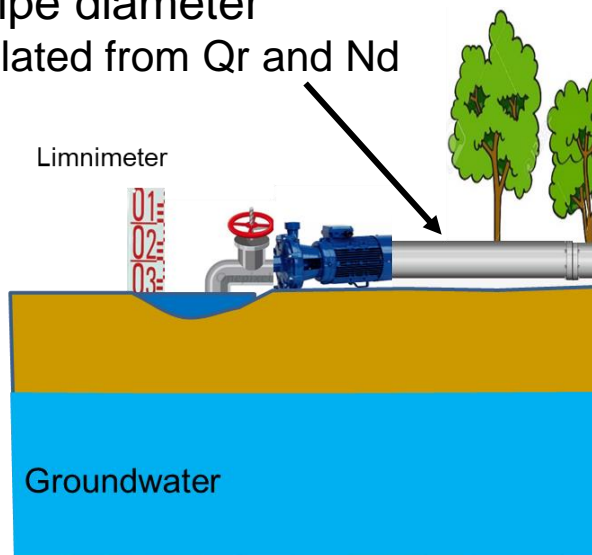
- ✓  $Q_r = 1 \text{ Mm}^3/\text{yr}$
- ✓  $N_d = 243 \text{ days}$
- ✓  $i = 1 \text{ m/d}$



**S<sub>b</sub>** infiltration basin surface area

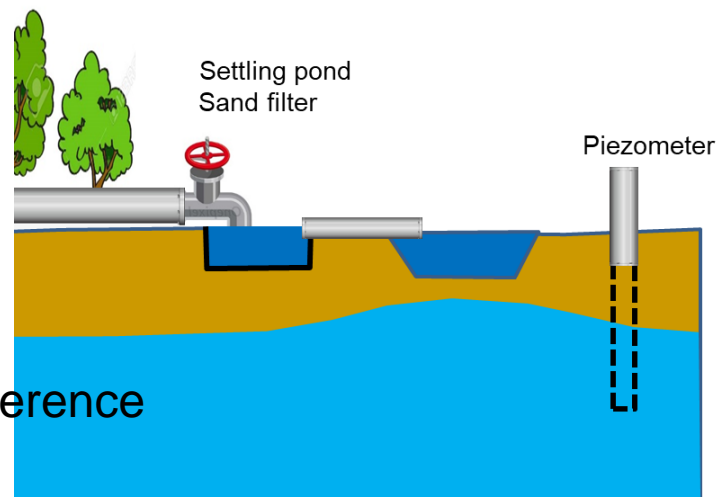



**D:** Distance surface water - basin

**d<sub>i</sub>:** pipe diameter  
 calculated from  $Q_r$  and  $N_d$



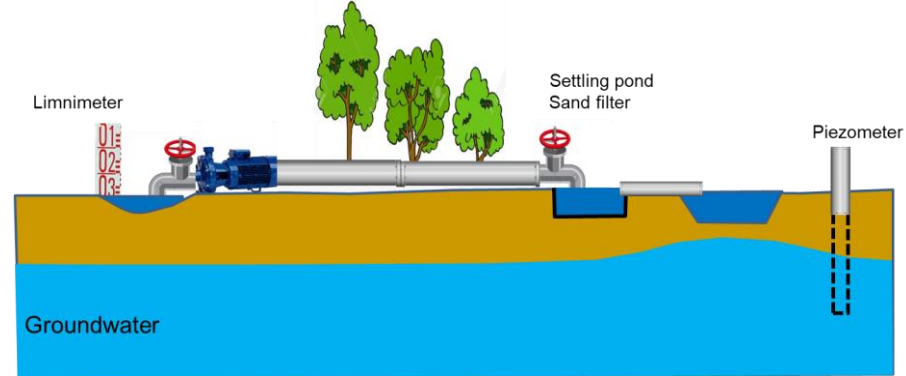

**H:** Head difference





# COSTS FUNCTION

## CAPITAL COSTS (CC) - €



CC1 – Engineering studies

x 10%

CC2 – Pumping system

Water Agency Cost Observatory =  $f(Qr)$

CC3 – Water transfer

Water Agency Cost Observatory =  $f(D, di)$

CC4 – Pretreatment

According to water quality =  $f(Qr)$

CC5 – Land purchase

Land value LV =  $f(Sb)$

CC6 – Basin building

Water Agency Cost Observatory =  $f(Sb)$

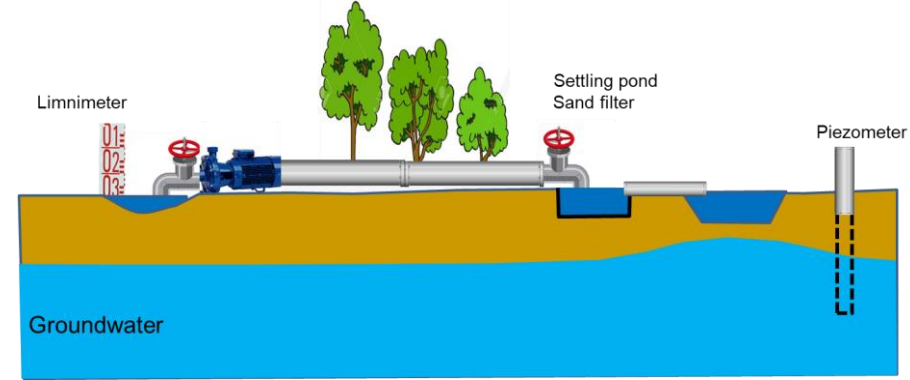
CC7 – Monitoring

Estimate (piézometers, protection, water sampling and analysis...)

Total Capital Costs

# COSTS FUNCTION

## OPERATIONAL COSTS (OC) - €/YEAR



OC1 – Water purchase Water companies prices =  $f(Q_r)$  **not always**

OC2 – Pumping maintenance Part of CC2

OC3 – Energy Electricity rates =  $f(Q_r, Nd, H)$

OC4 – Pretreatment According to water quality, =  $f(Q_r)$

OC5 – Basin maintenance (scraping...) Guide BBP, NORPAC et IDDR (entretien bassin de rétention), =  $f(S_b)$

OC6 – Monitoring Estimation (2 to 4 monitoring campaigns/yr)

x 10%

OC7 – Yearly operational costs

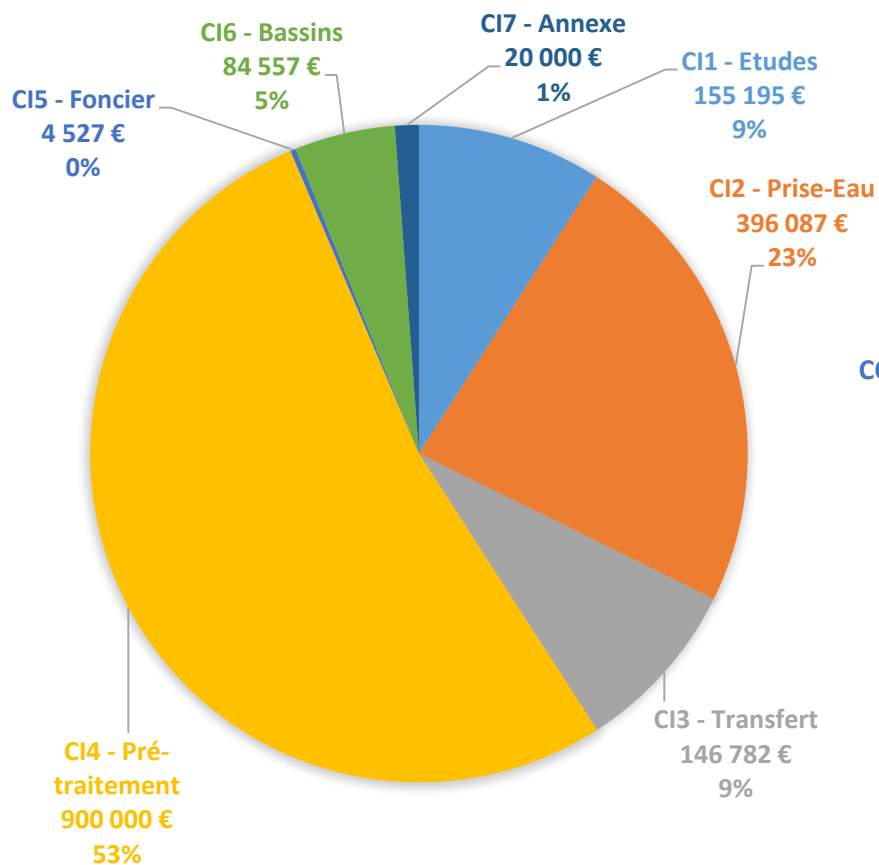
Total Operational Cost

# COSTS ANALYSIS AND LEVELISED COST

## REFERENCE EXAMPLE

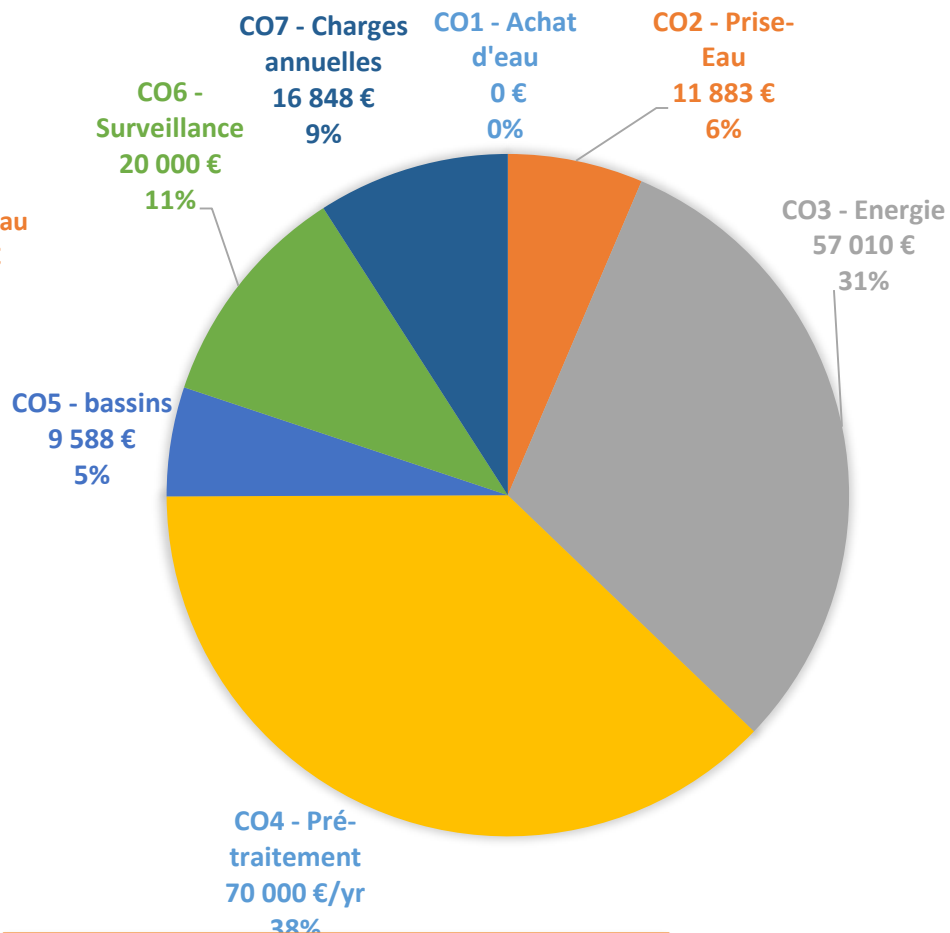
### Capital Costs (CC)

= 1 700 000 €



### Operational Costs (OC)

= 180 000 €/yr



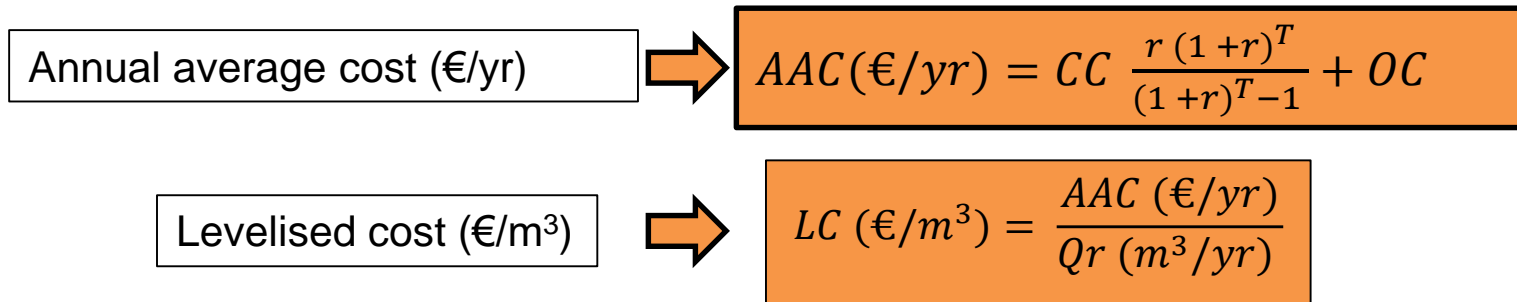
Qr = 1 Mm<sup>3</sup>/yr  
Nd = 243 days  
i = 1 m/d

H = 100 m  
D=1000 m

Pre-treatment: 0.1 €/m<sup>3</sup>

# LEVELISED COST

## REFERENCE EXAMPLE



= Capital costs + Operating costs per m<sup>3</sup> of water recharged

$$= 0.10 + 0.18 = 0.28 \text{ €/m}^3$$

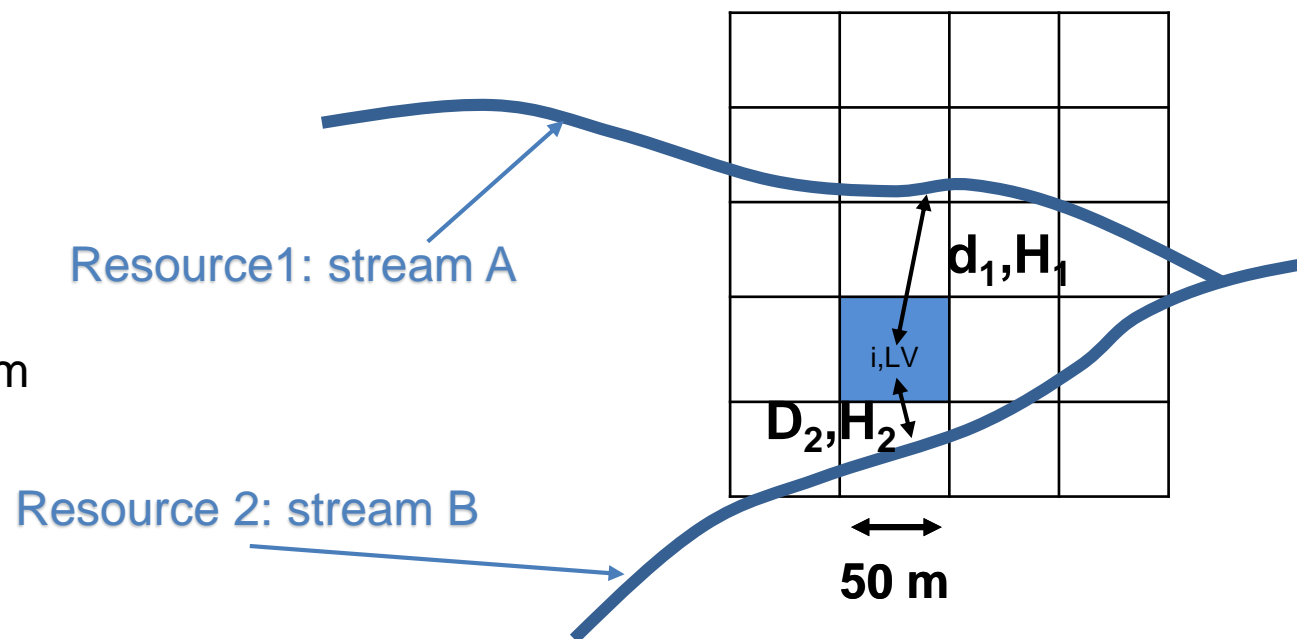
$Qr = 1 \text{ Mm}^3/\text{yr}$   
 $Nd = 243 \text{ days}$   
 $i = 1 \text{ m/d}$

$H = 100 \text{ m}$   
 $D = 1000 \text{ m}$

$T$ : useful life duration = 30 years  
 $r$ : discount rate = 4 %  
Pre-treatment: 0.1 €/m<sup>3</sup>

## COSTS MAPPING

Cell gridding: 50 m X 50 m



Extraction of following distributed data for each cell:

- Distance  $D$  between cell – nearest surface water point;
- Head change  $H$  between cell – nearest surface water point (using DEM);
- Infiltration rate  $i$  on the cell (value obtained from permeability maps)
- Land value (distributed according to «Small Agricultural regions» data).

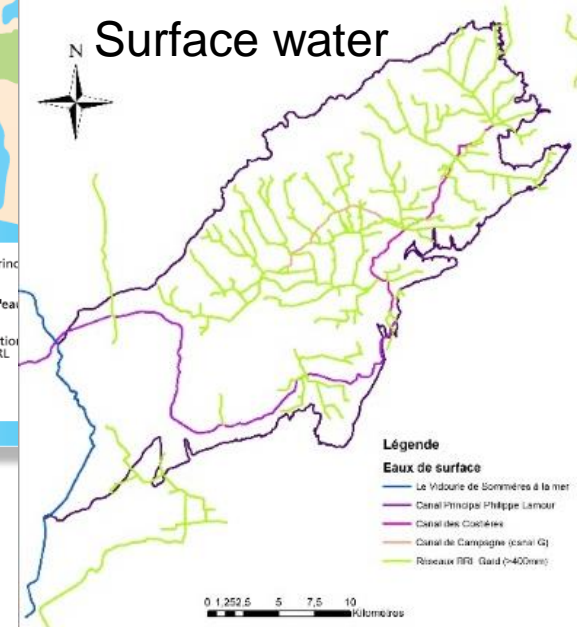
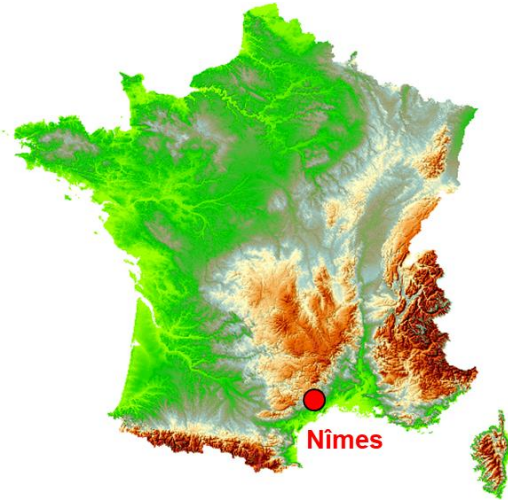
Other parameters are not distributed and are then fixed.

In each cell, LC is computed for each surface water resource:

**the lowest LC is kept**

# APPLICATION TO A CASE STUDY

## VISTRENQUE ET COSTIÈRES AQUIFER (SOUTH OF FRANCE)



| Qr                    | Nd       | Surface water resource         |
|-----------------------|----------|--------------------------------|
|                       |          | Le Vidourle river              |
|                       |          | Canal Philippe Lamour (BRL)*   |
|                       |          | Canal des Costières (BRL)*     |
|                       |          | Canal de Campagne (BRL)*       |
|                       |          | Untreated water network (BRL)* |
| 1 Mm <sup>3</sup> /yr | 243 days |                                |

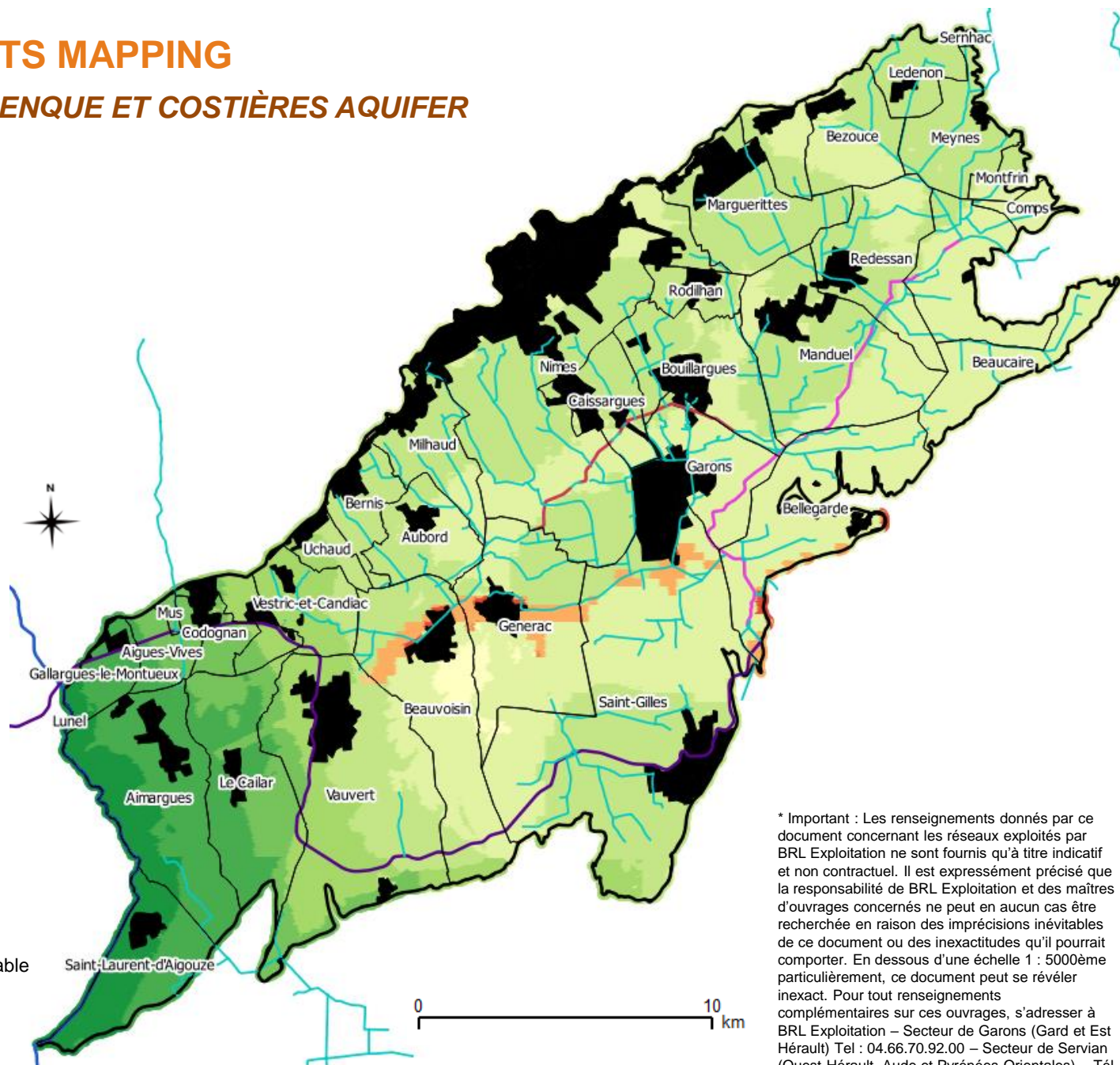
# LEVELISED COSTS MAPPING

## APPLICATION: VISTRENQUE ET COSTIÈRES AQUIFER

### LC (€/m<sup>3</sup>)

- 0.1353 - 0.1500
- 0.1500 - 0.2000
- 0.2000 - 0.2500
- 0.2500 - 0.3000
- 0.3000 - 0.3500
- 0.3500 - 0.4000
- 0.4000 - 0.4500
- 0.4500 - 0.5000
- 0.5000 - 0.5500
- 0.5500 - 0.6000
- 0.6000 - 0.6500
- 0.6500 - 0.7000
- 0.7000 - 0.7059

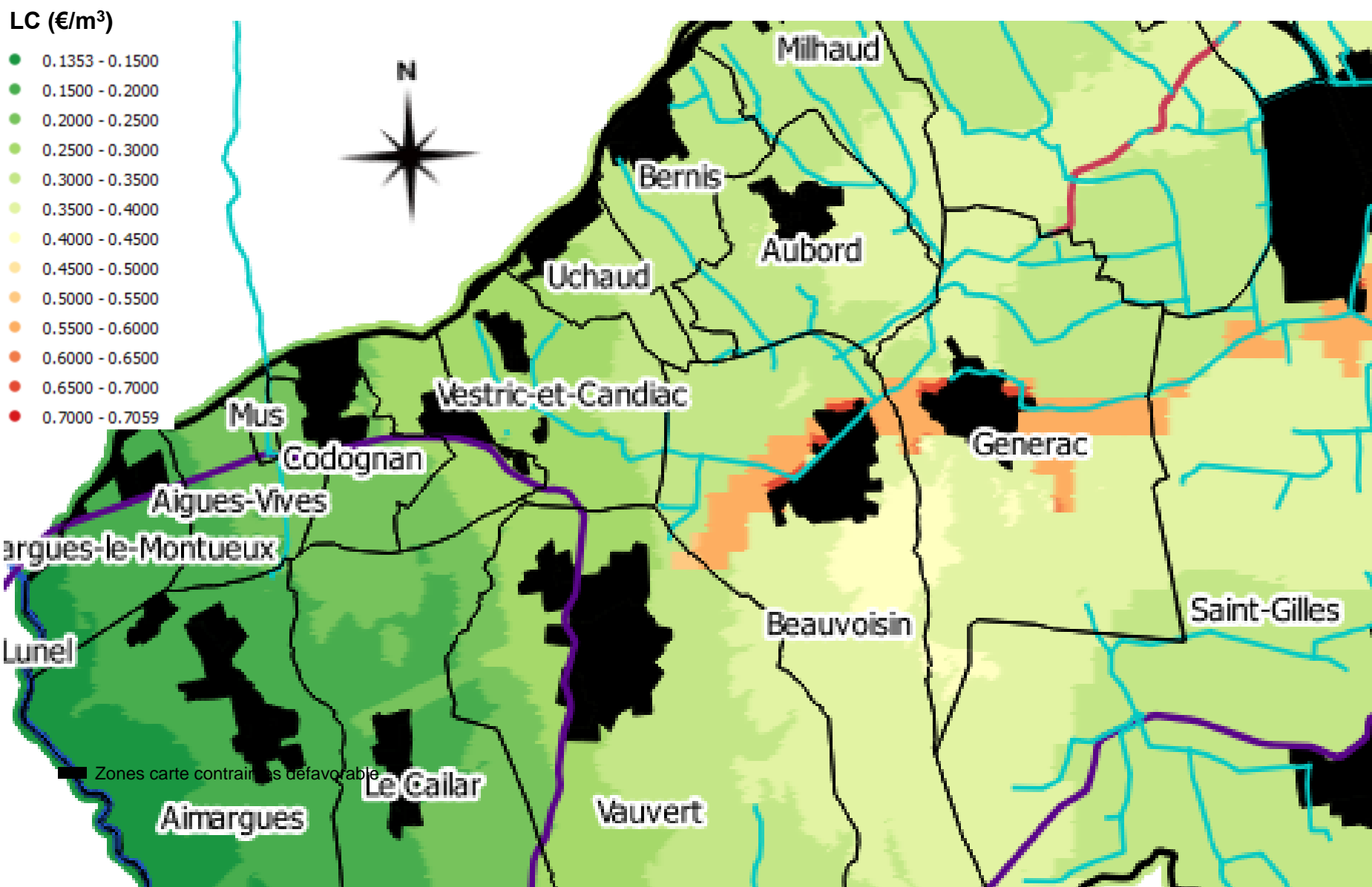
■ Zones carte contraintes défavorable



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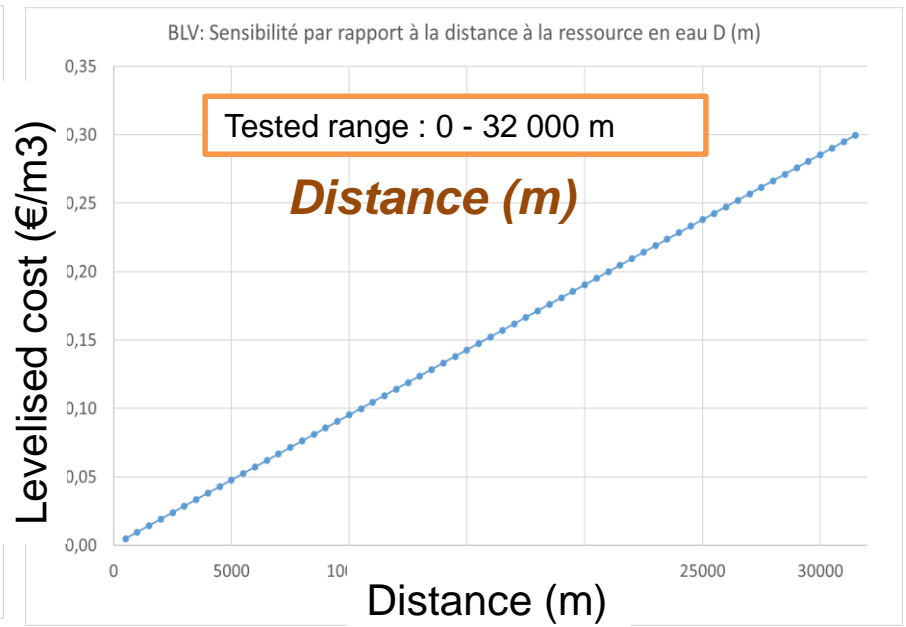
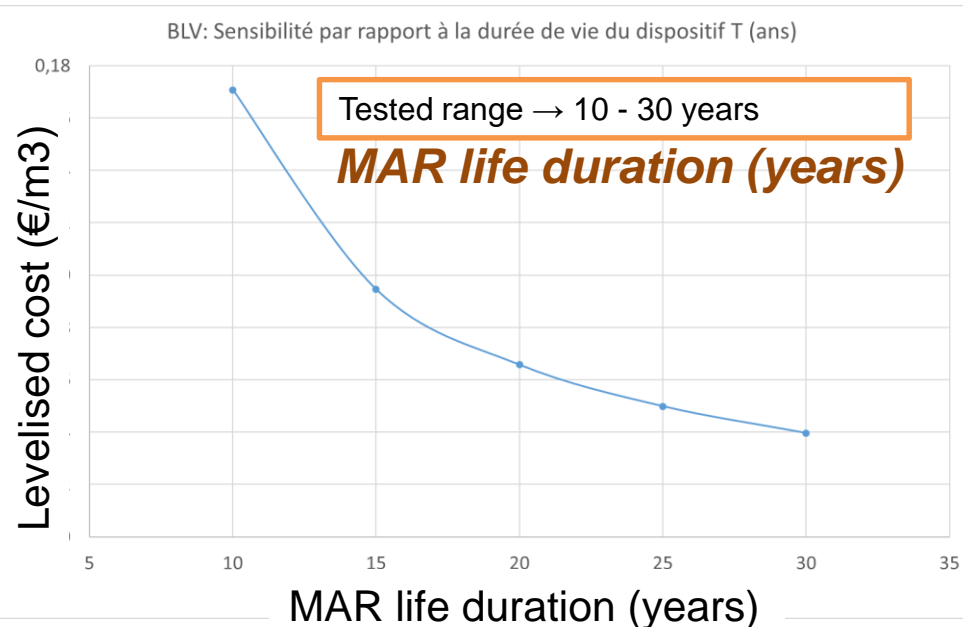
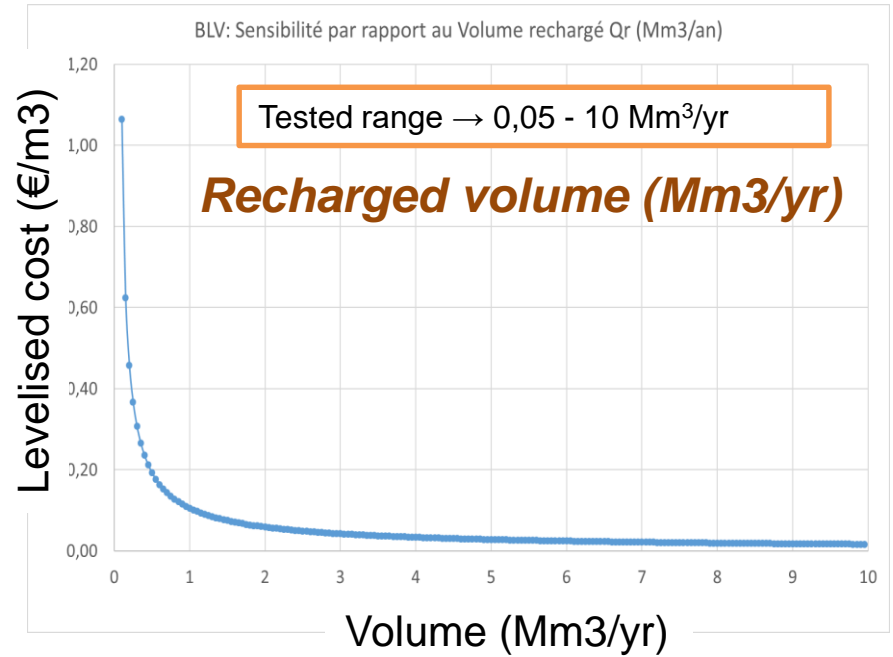
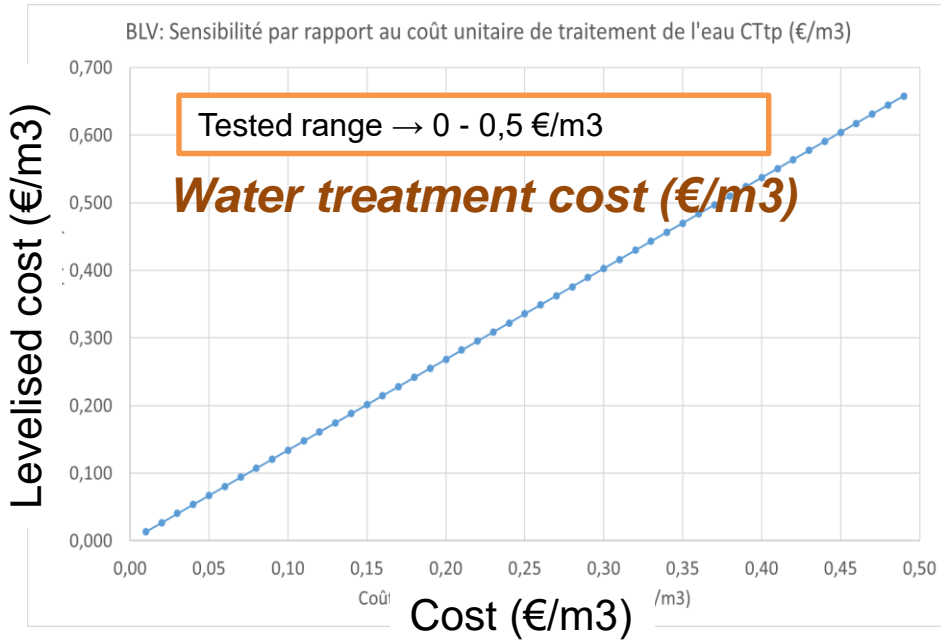
# COSTS MAPPING (ZOOM)

APPLICATION: VISTRENQUE ET COSTIÈRES AQUIFER





# LEVELISED COSTS SENSITIVITY ANALYSIS



# LEVELISED COSTS SENSITIVITY ANALYSIS

## SUMMARY TABLE

Impact of various parameters on levelised costs:

|                 |   |            |  |
|-----------------|---|------------|--|
| <b>Qr</b>       | Annual water recharged volume (Mm <sup>3</sup> /year)     | <b>VVT</b> | Land value (€/ha)                                      |
| <b>Nd</b>       | Annual recharge duration (days)                           | <b>p</b>   | Infiltration basin depth (m)                           |
| <b>D</b>        | Distance ressource – basin (m)                            | <b>CO1</b> | Water price (€/m <sup>3</sup> )                        |
| <b>H</b>        | Head difference ressource – basin (m)                     | <b>N</b>   | Duration between 2 basin maintenance servicing (years) |
| <b>i</b>        | Soil infiltration rate (m/day)                            | <b>Hc</b>  | Clay thickness to scrab (m)                            |
| <b>Para_CI1</b> | Part of engineering studies in the total capital cost (%) | <b>r</b>   | Discount rate (%)                                      |
| <b>CTtp</b>     | Water treatment cost (€/m <sup>3</sup> )                  | <b>T</b>   | MAR scheme life duration (years)                       |

|  |  |
|--|--|
|  | High impact on LC (> 0.10 €/m <sup>3</sup> )     |
|  | Moderate impact on LC (> 0.05 €/m <sup>3</sup> ) |
|  | Low impact on LC (< 0.05 €/m <sup>3</sup> )      |

# CONCLUSION

A cost function is fully distributed in order to map the levelised costs of recharged water in a given study area

The cost function can be used in order to illustrate the various parameters impacting the total costs.

The costs map can be mixed with other types of suitability maps in order to identify the most suitable location for a MAR scheme

Perspective:

- Applying such a method to other type of recharge schemes
- Computing the levelised cost of recovered water