



Use of modeling to protect, plan and manage water resources in catchment areas

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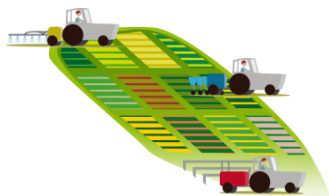
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Agricultural Production and the Environment
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Developers of solutions for agriculture



1st editor of decision support tools (DST) in agriculture in France (2,6 M ha)
40 cooperatives currently using these devices



Agricultural practices panel
10 000 farms / year
DST: 2 millions ha in databases / year

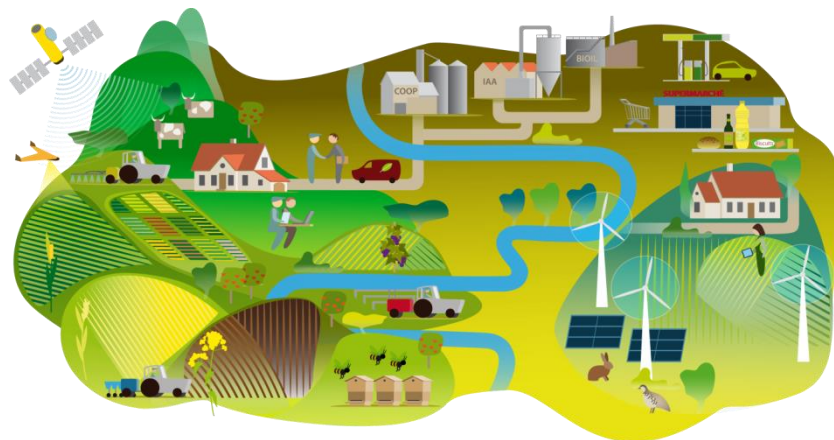


Acquisition of agricultural references
Biggest database of plots testing in France (+1200 plots tests/year)



Nutrition and alternative control for crops

Agriculture, Economy, Environment



Channels Management (Life Cycle Analysis ...)
Land Management (Water and Biodiversity)

73 drinking water wells (450 000 ha of catchment areas under management)

Context and problematic

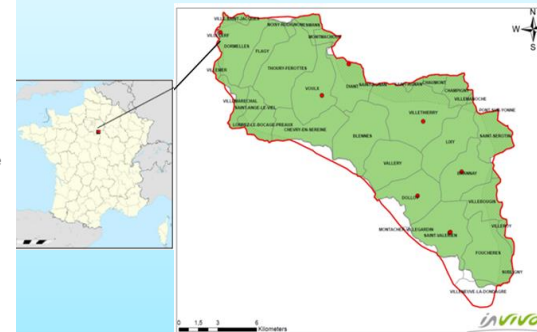
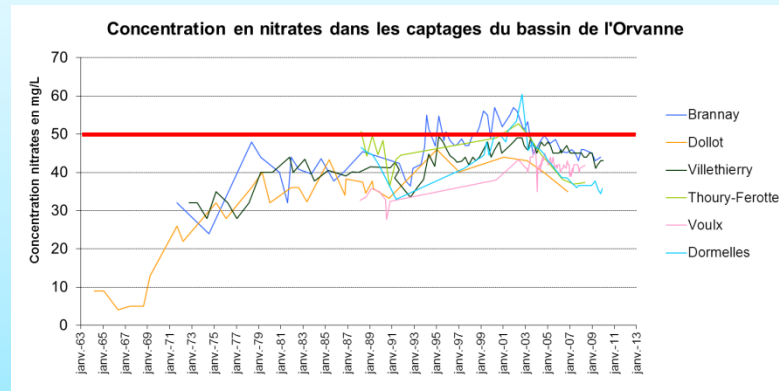
Catchment Area (CA) of Dormelles (France) - 24 000 ha

Goal :

To provide a good raw water quality (nitrates and pesticides)

Dormelles case

- Well of 19m in the chalk aquifer under the Orvanne alluvium
- Agricultural nitrate pollution 37 mg/l growing ($\Delta^{15}\text{N}$)
- CA of 24 000 ha**
- 250 farmers involved**

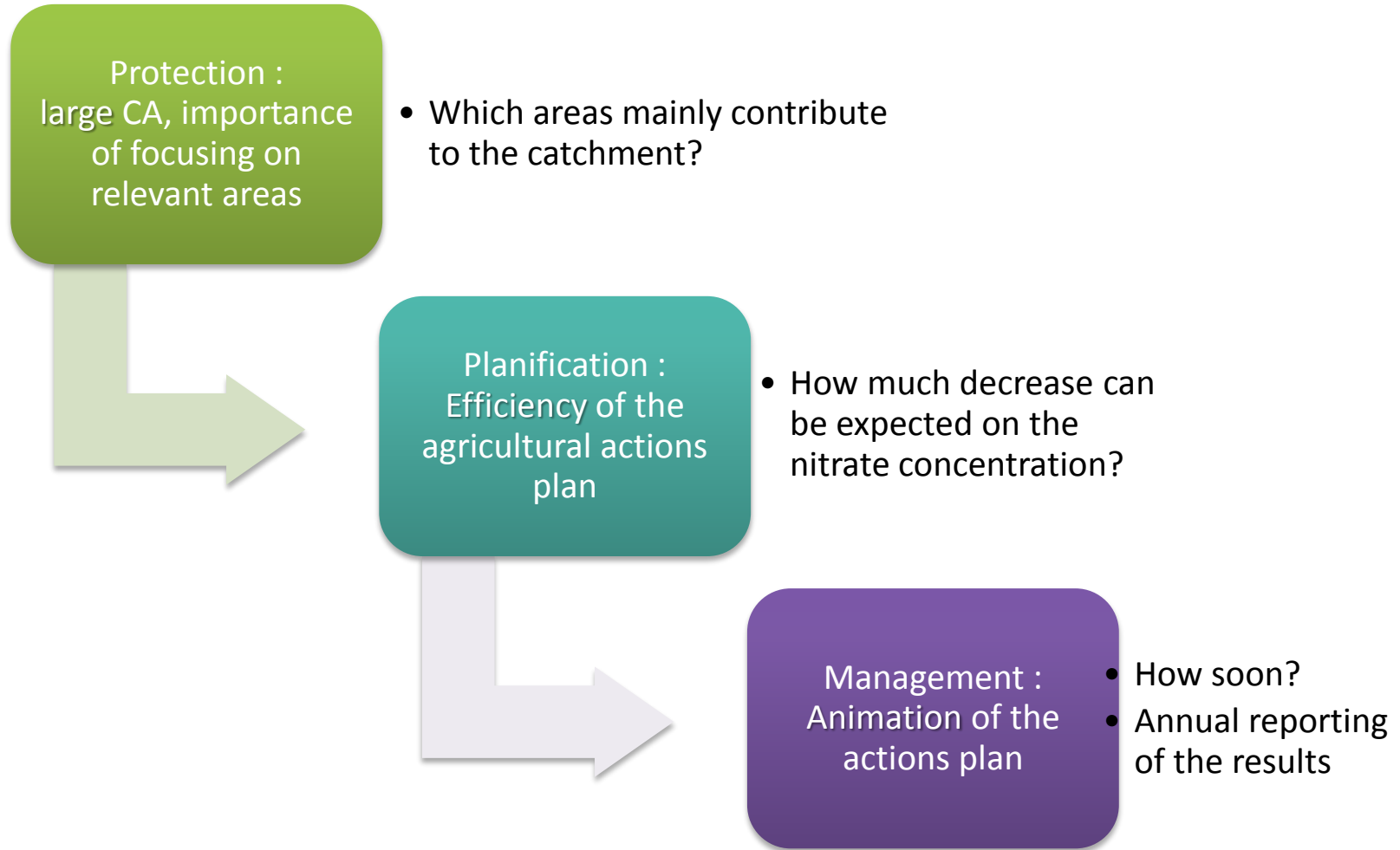


How to achieve the goal efficiently with limited means (time and money) ?

Problematic

Catchment Area of Dormelles (France) - 24 000 ha

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Watermodel

Integrated modeling tool of groundwater resources and surface water quantity and quality

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Chronology

Developped by Yves
Emsellem since
1967

Processus invented
in the 60's at IFP
institute and at the
CIG (Fontainebleau)

Controlled and
validated since
1992 by the Danish
Institute and the
COWI

Used in France and
abroad (56 models
in France, 19
around the world)

Specifications

Integrated
surface/groun-
d-water

GIS and
chrono-
geographical
databases

Quadtree
mesh builder

Transfers of
various
pollutants
including
nitrates and
pesticides

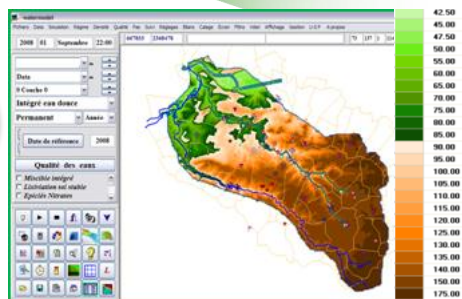
Brine

Modeling
steady state,
transient and
long
transient

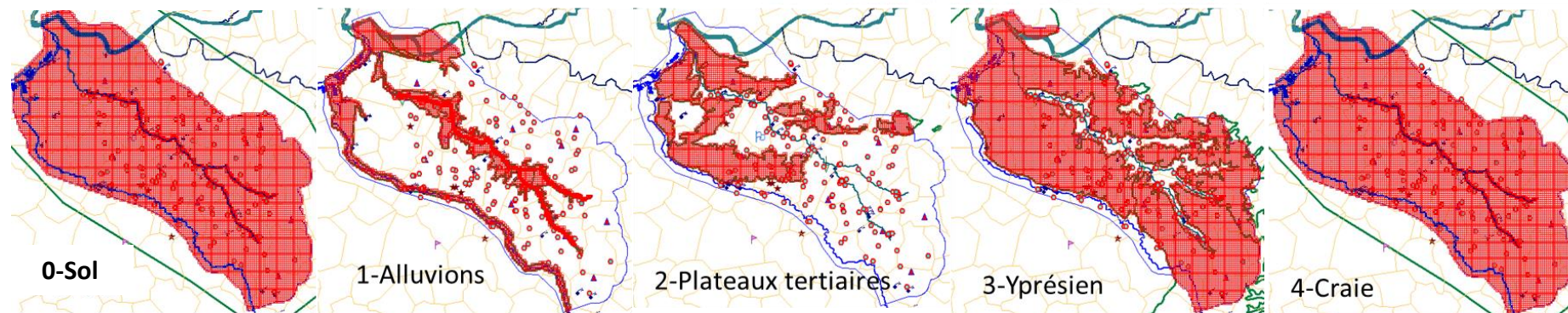
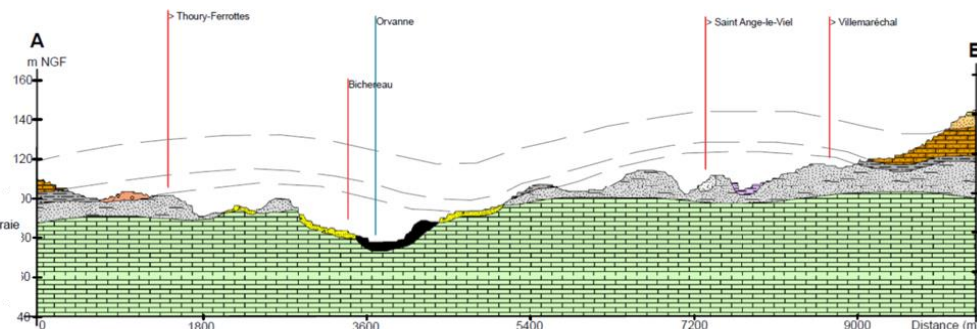
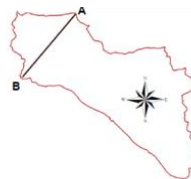


Model construction in space

Quadtree mesh – layers settings



Légende



Model geometry

The vertical and horizontal extensions
Topography: MNT (in no 50m)
Thickness, roof and wall layers

Settings

Soil

Soil roughness
available water capacity

Hydrogeology

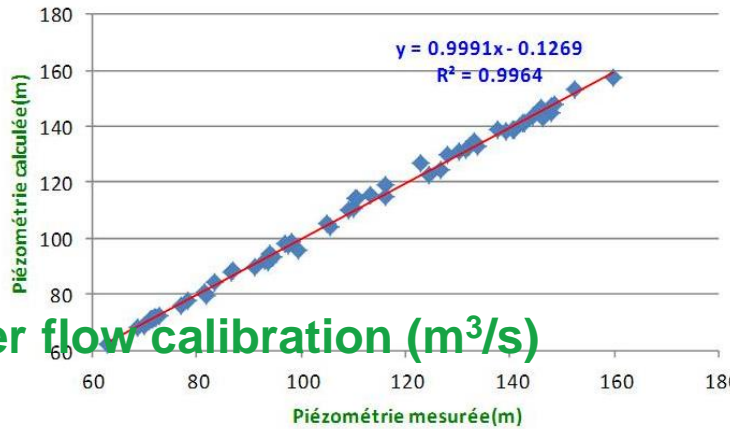
crack porosity
matrix porosity
vertical permeability
horizontal permeability
transmissivity
storage

Model calibration

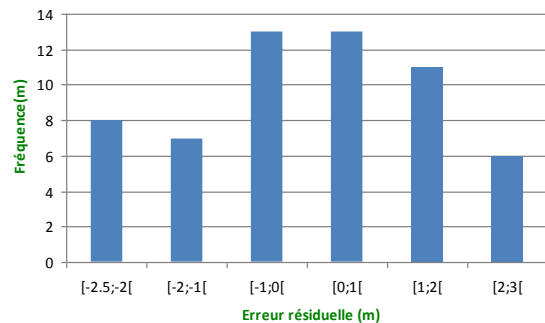
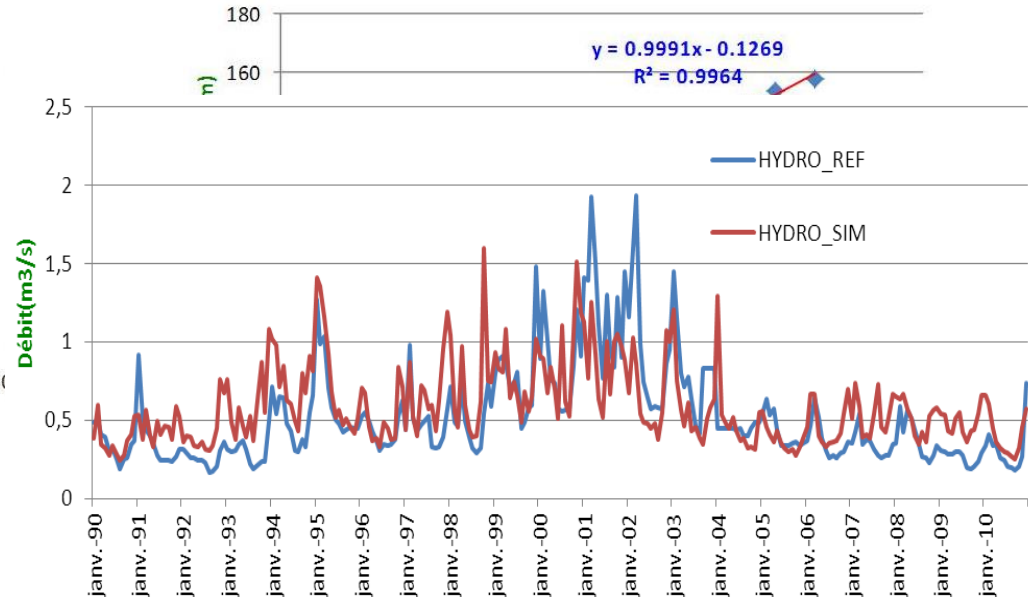
Piezometry - transient regime 1989- 2010

58 fieldpoints measured

High water (april 2010)



Low water (september 2010)



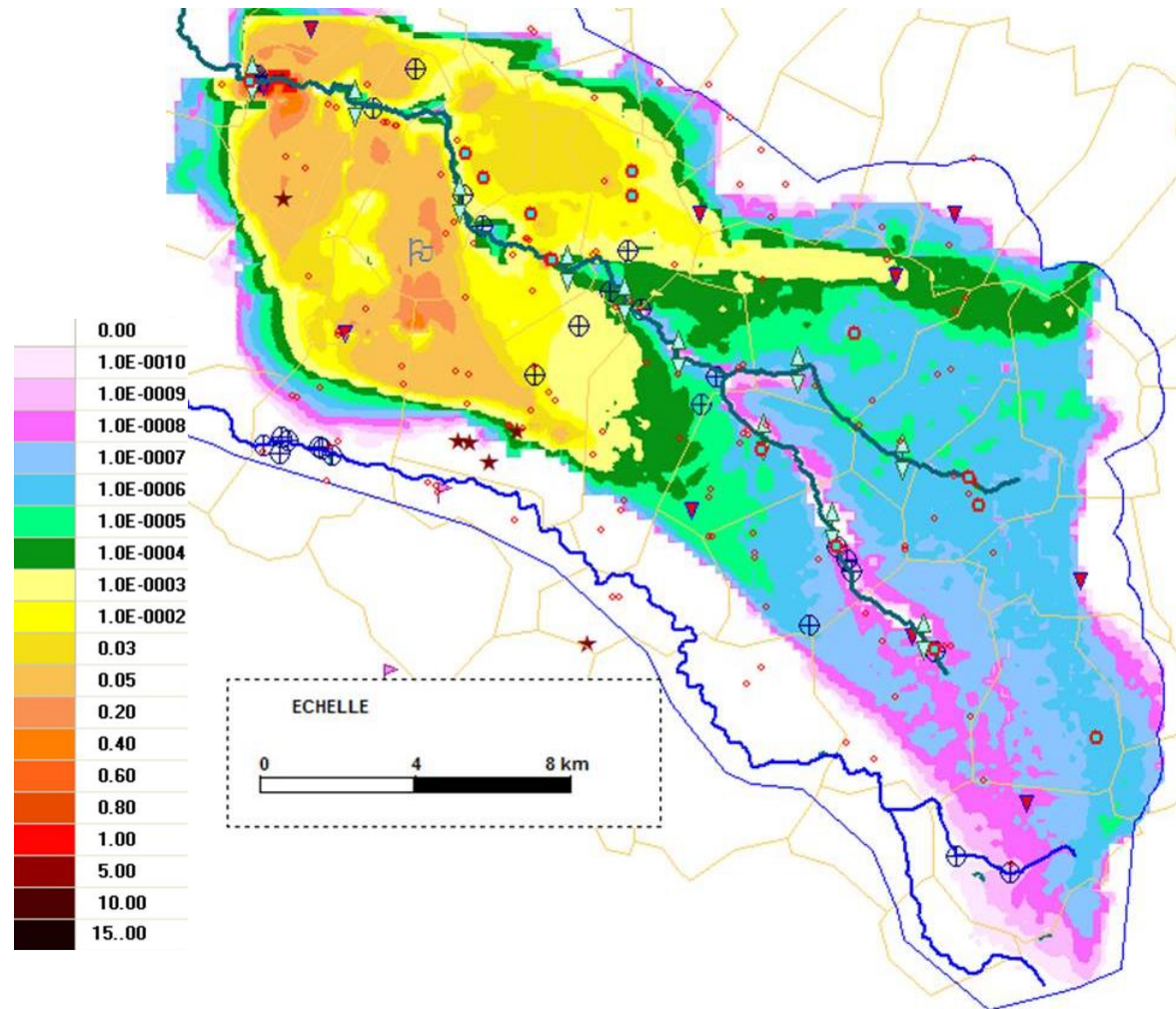
Model exploitation - results

Hydraulic Contributing Areas (HCA) - definition

Hydraulic Contributing Areas

→ The idea is to determine the contribution to the sensed flow (m^3/h) at any point on the surface of catchment area

Contribution to the catchment of Dormelles (m^3/h) in layer 0 (soil) for a rated flow of $200 \text{ m}^3/\text{h}$.



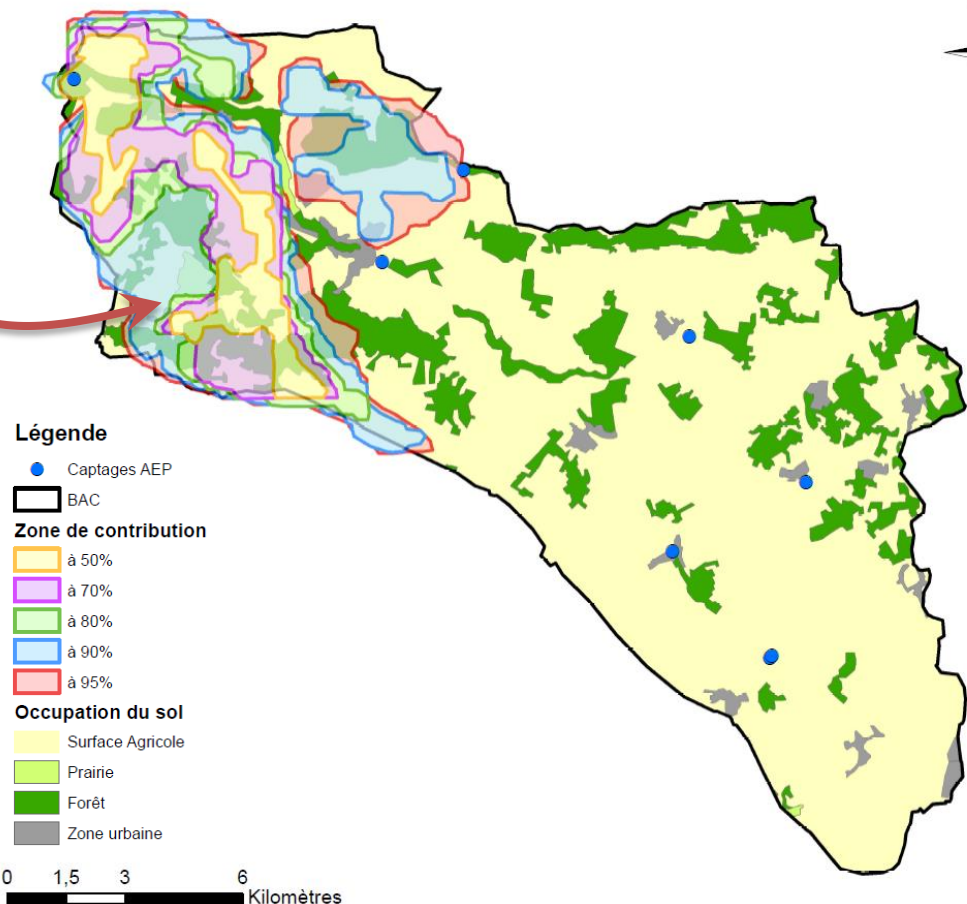
Model exploitation - results

Hydraulic Contributing Areas (HCA) - determination

HCA Dormelles well pumping at 200 m³/h:

- **95% of the caught flow comes from 26% of the total CA**

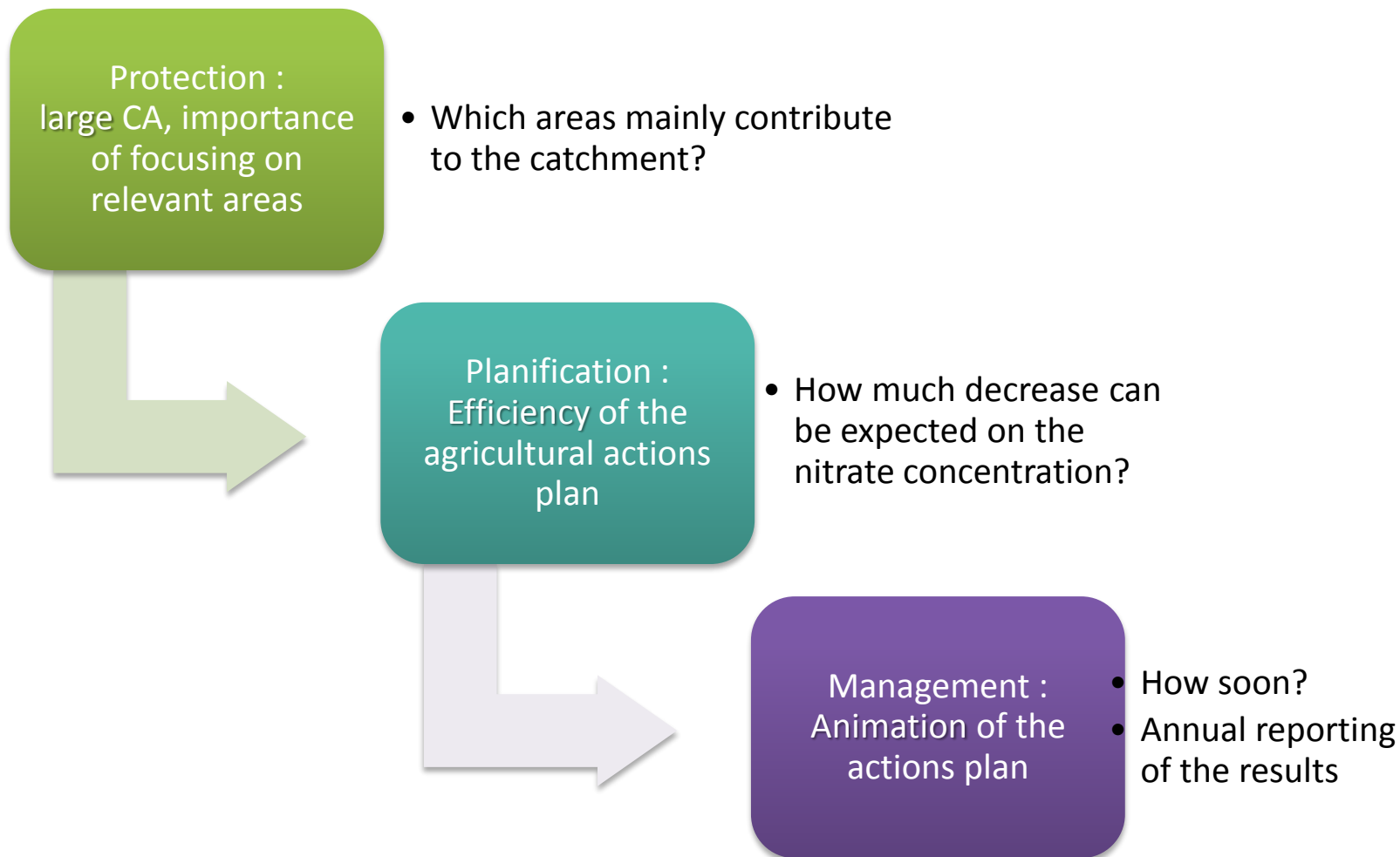
| HCA | % CA | Number of farmers | Agricultural area |
|------|------|-------------------|-------------------|
| 50% | 5% | 39 | 802 ha |
| 70% | 10% | 57 | 1 749 ha |
| 80% | 13% | 60 | 2 310 ha |
| 90% | 22% | 84 | 3 802 ha |
| 95% | 26% | 93 | 4 408 ha |
| 100% | 100% | 250 | 17 629 ha |



Problematic

Catchment Area of Dormelles (France) - 24 000 ha

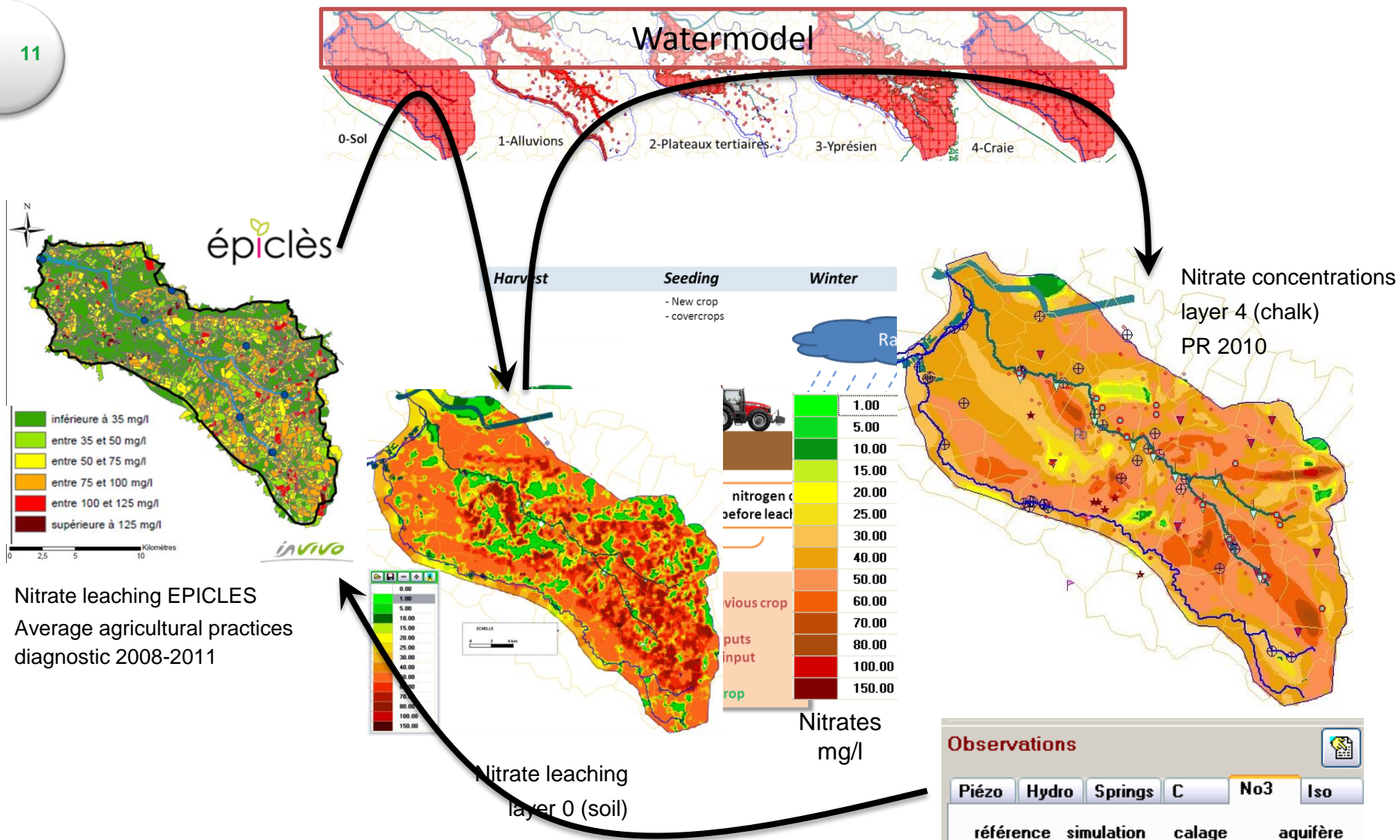
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Nitrate flow modeling

Coupling *Epiclès* and Watermodel

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Nitrate flow modeling

Actions plan modeling

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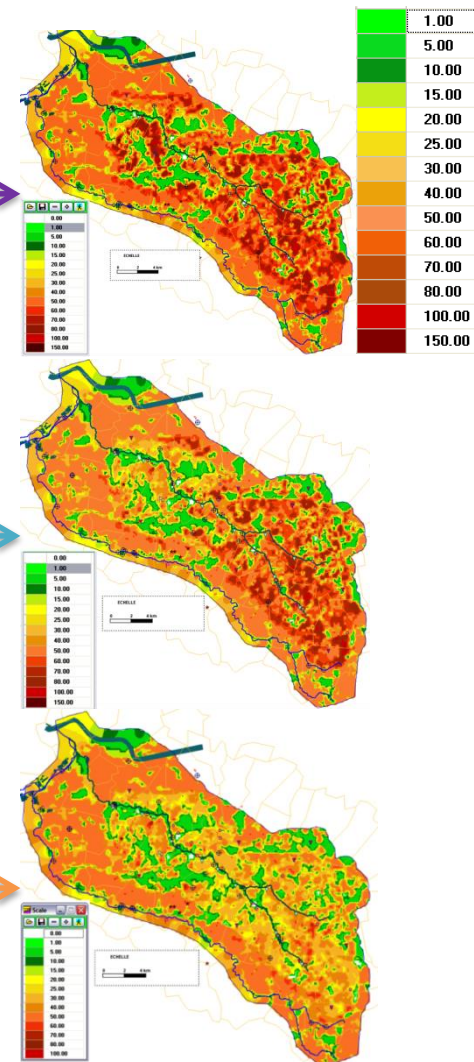
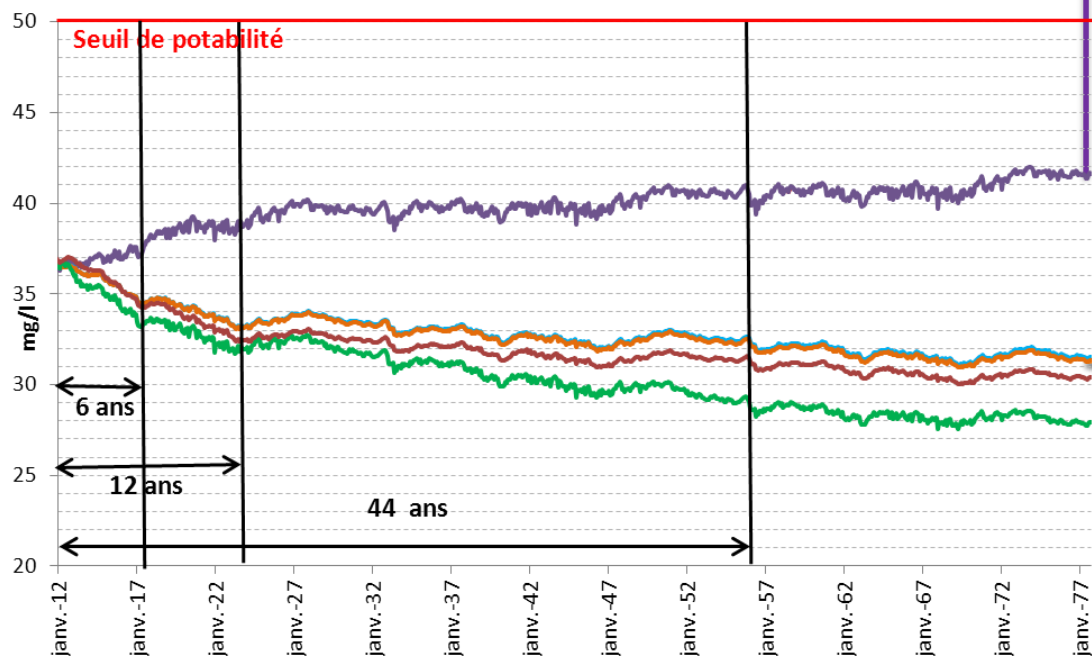
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— Actions plan on HCA

— Actions plan on CA

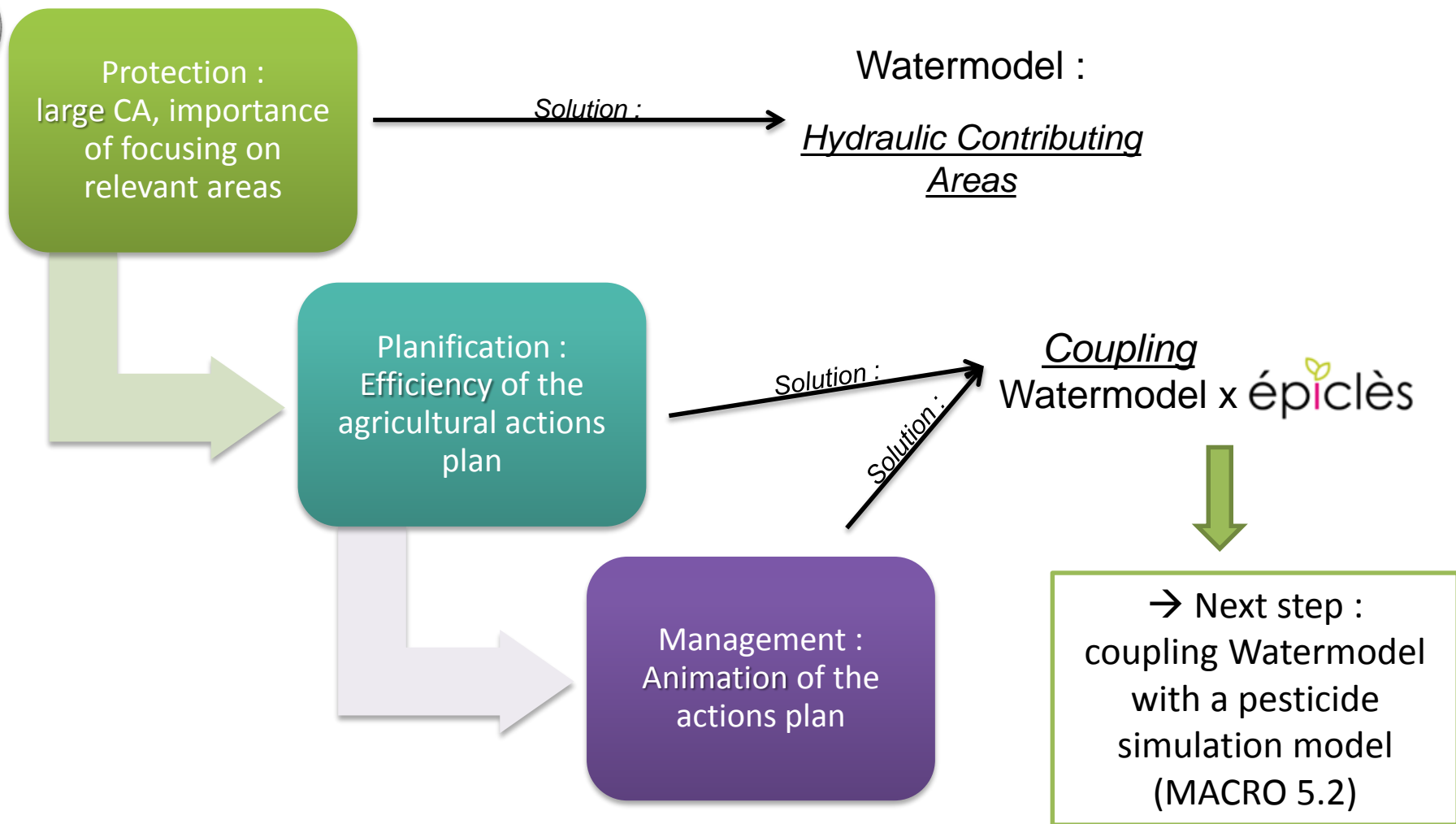
— Actions plan on HCA + 140 ha back to grass

— Actions plan on HCA + 42 ha back to grass



Conclusion and perspectives

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Thank you !

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