

Modelling of drainage and hay production over the Crau aquifer for analysing impact of global change on aquifer recharge

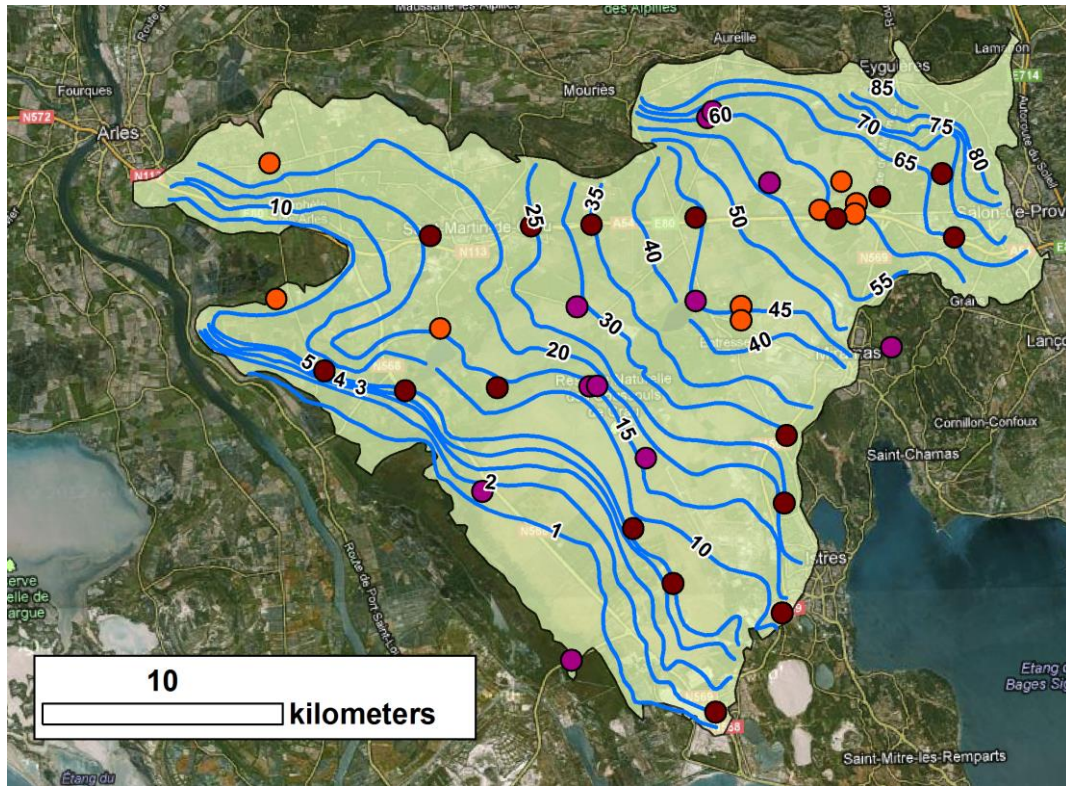
Antoine Baillieux

Albert Olioso, Rémi Lecerf, André Chanzy, Françoise Ruget, Olivier Banton, Patrice Lecharpentier, Mohamed Alkassem Alosman, Stephane Ruy, Belen Gallego Elvira

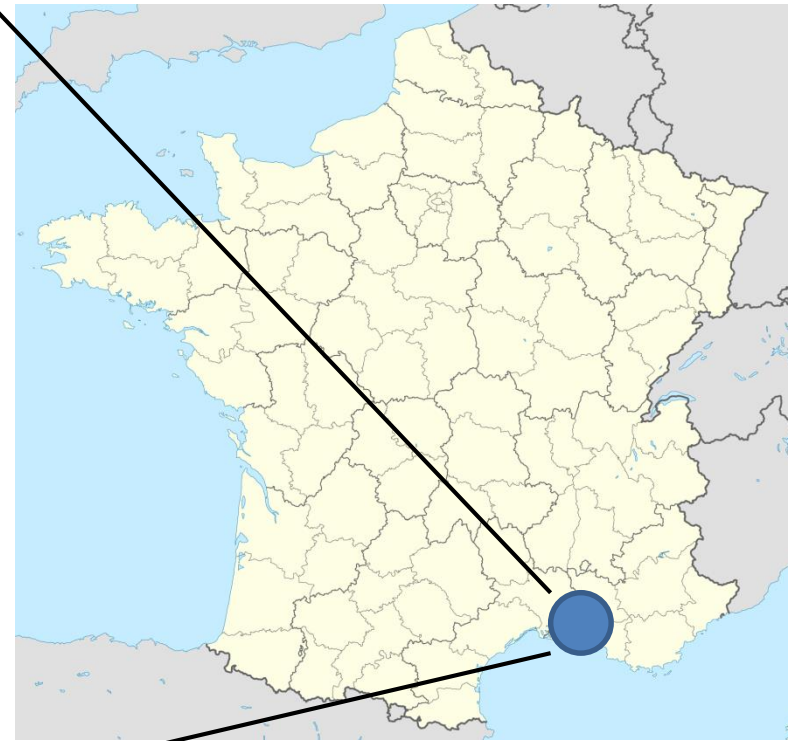
CONTEXT

- **In Mediterranean region**, agricultural production is strongly related to irrigation water, which depends on climate and the competition with other water uses
- Importance of acquiring knowledge and tools for:
 - **predicting impacts** of possible changes in climate and water uses
 - **defining adaptations** of agricultural systems to these changes
- **SIRRIMED** project addresses issues related to sustainable uses of water in Mediterranean irrigated agricultural systems, with the overall aim of optimizing irrigation water use

THE AQUIFER OF THE CRAU PLAIN

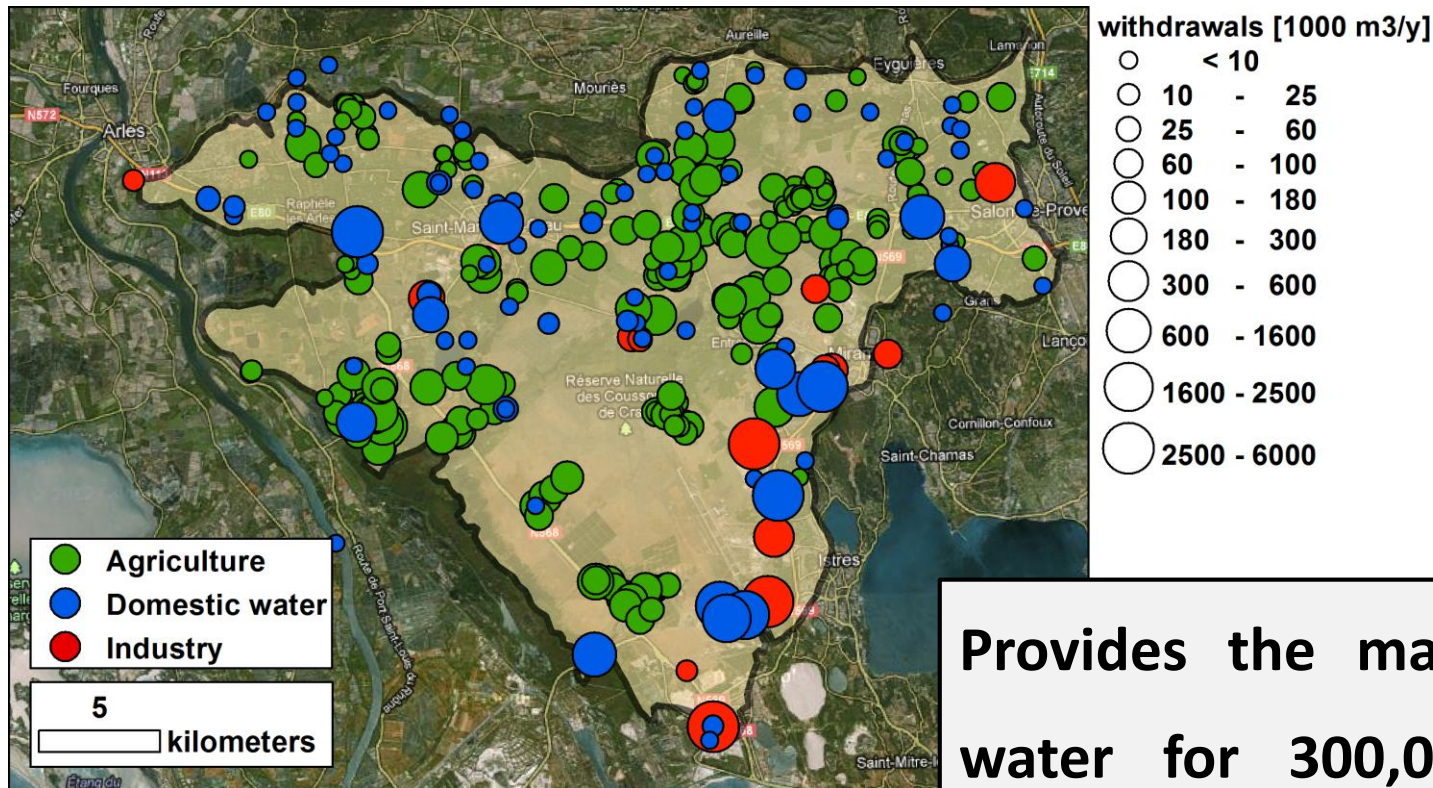


**Isopiestic lines and
observations points**



Location of the study area

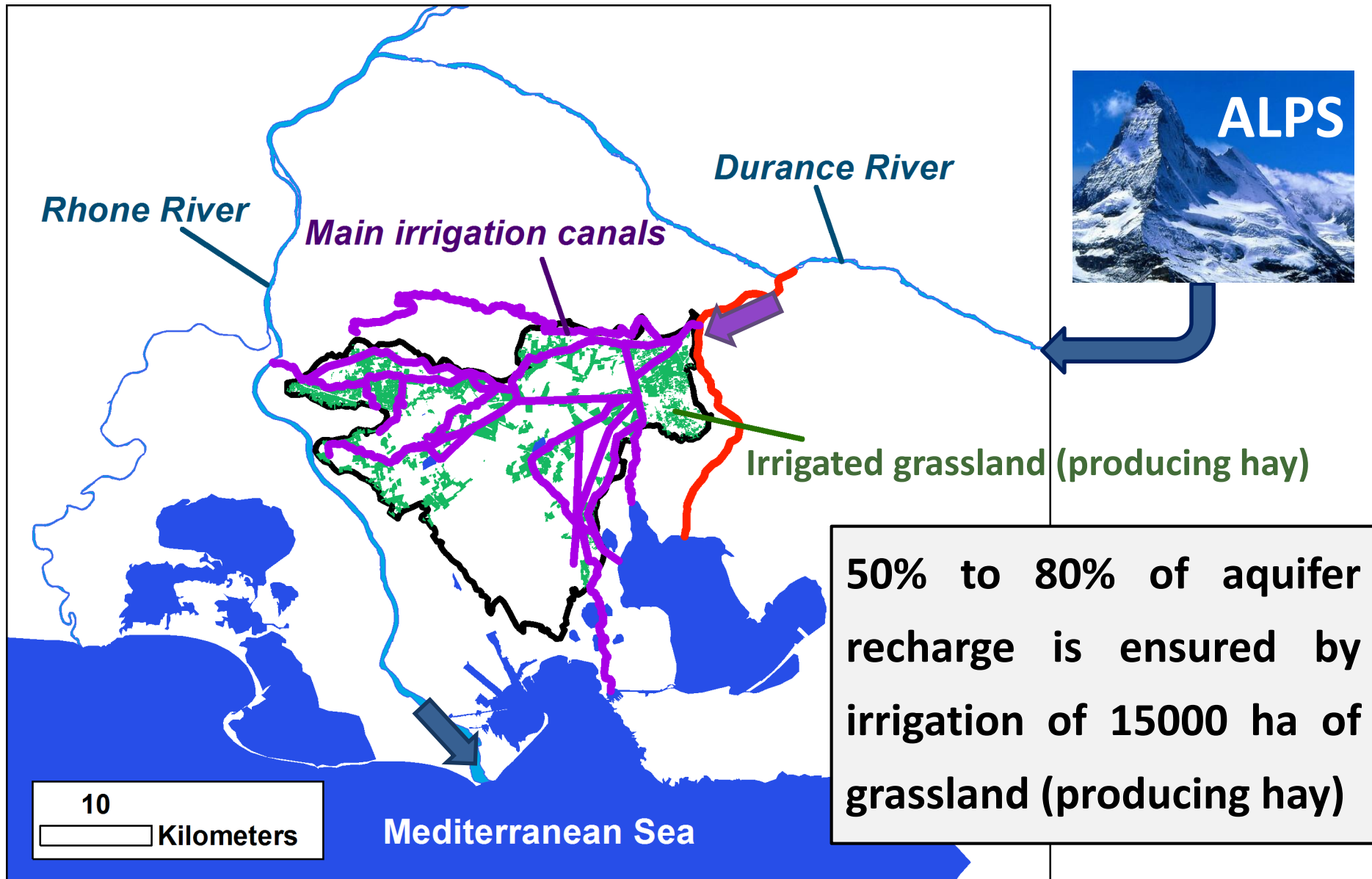
THE AQUIFER OF THE CRAU PLAIN



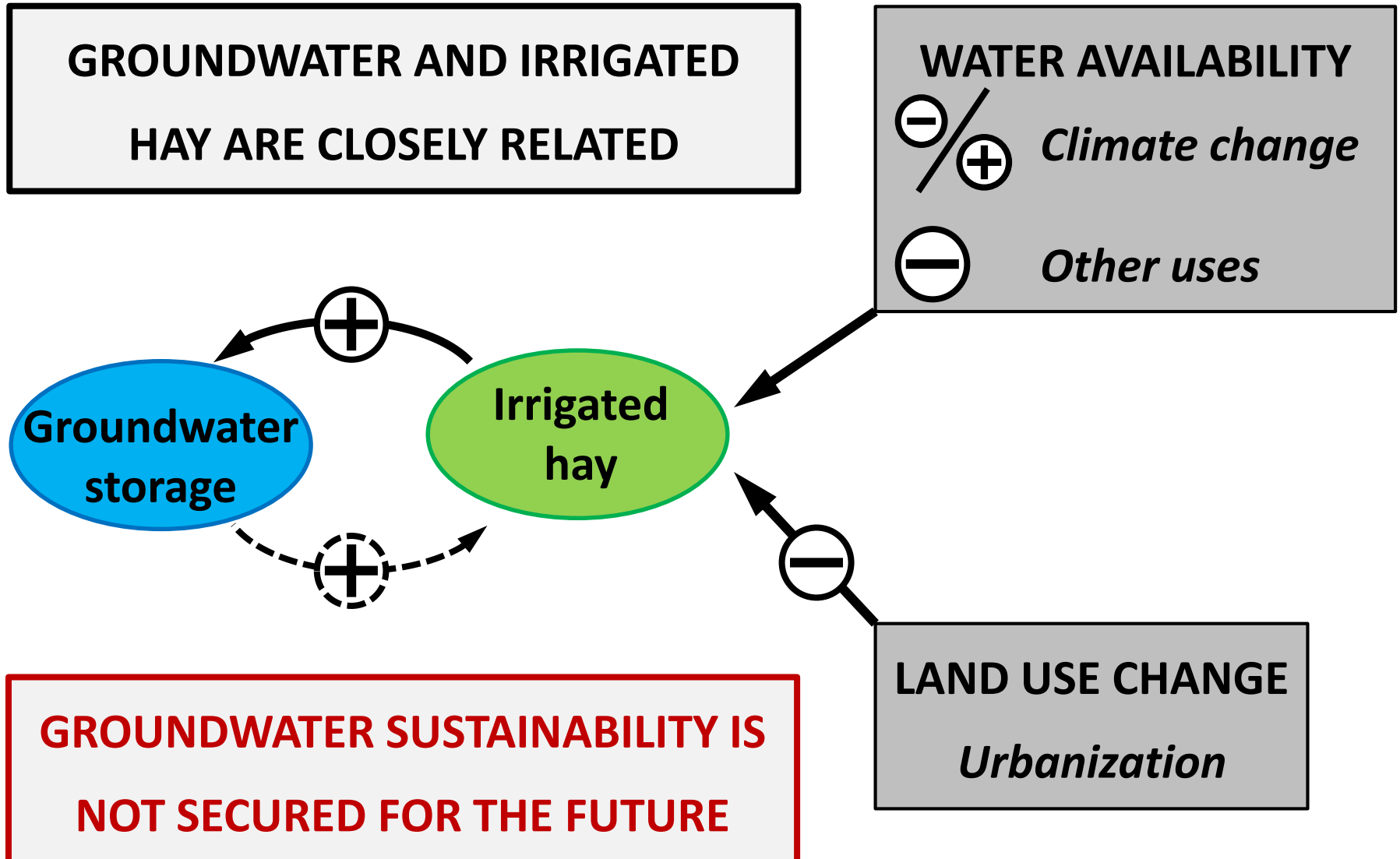
Groundwater withdrawals

Provides the main resource in water for 300,000 inhabitants and for industrial and agricultural needs

THE AQUIFER OF THE CRAU PLAIN



THE AQUIFER OF THE CRAU PLAIN



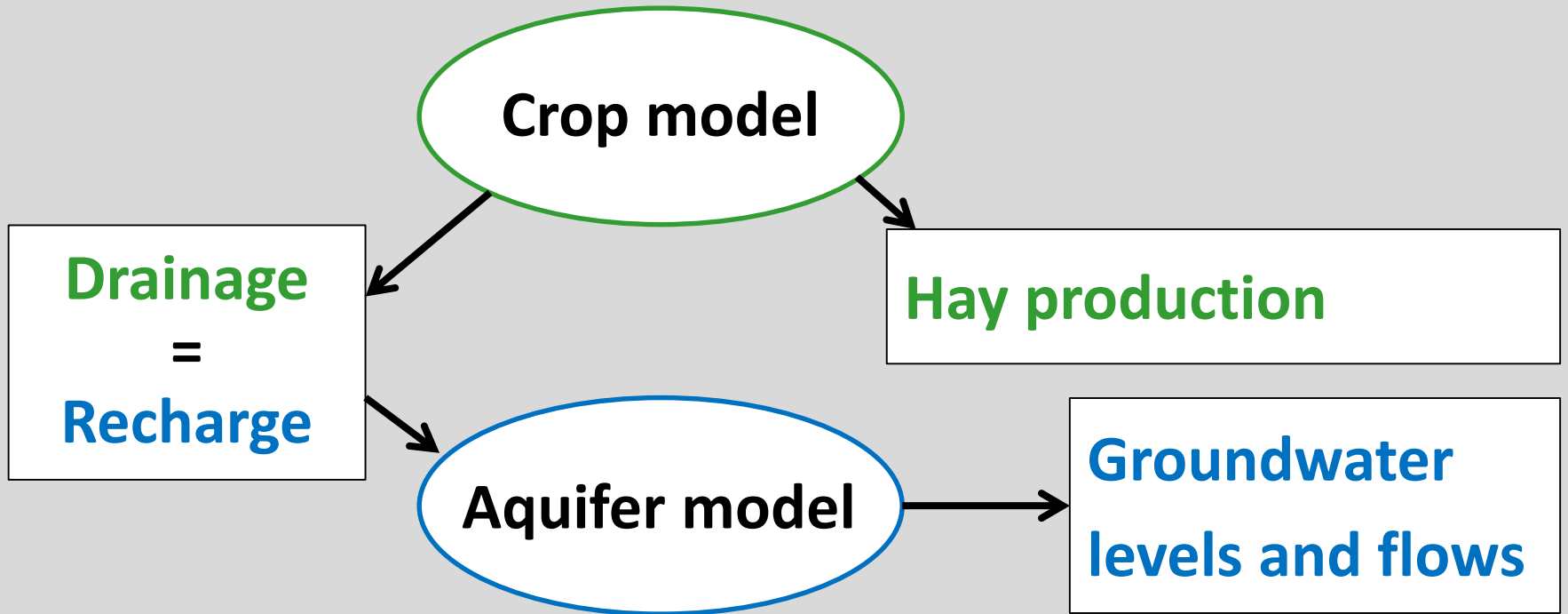
OBJECTIVES

For improving irrigation water management in the context of climate and land-use changes, how to :

- 1) quantify the actual contribution of the irrigation to the total recharge?**
- 2) investigate possible evolution of hay production, water drainage and water table level?**

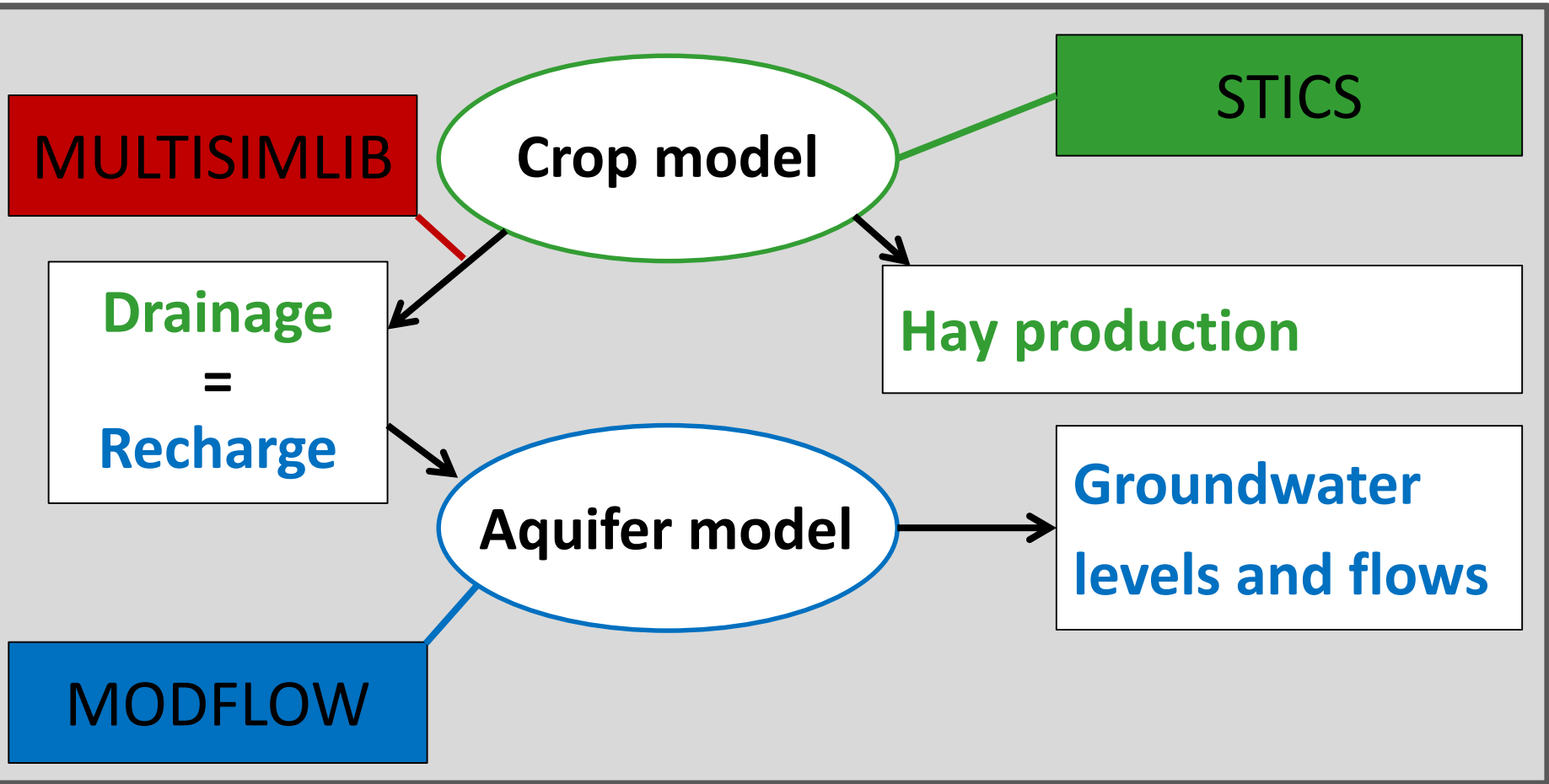
METHODS

INTEGRATED WATERSHED APPROACH



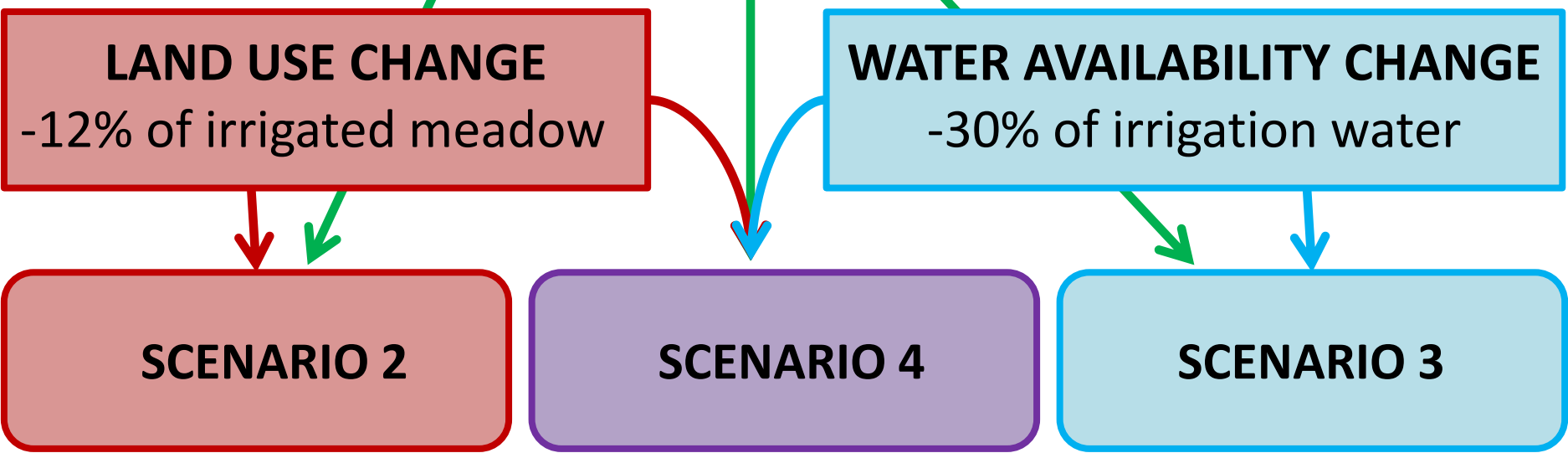
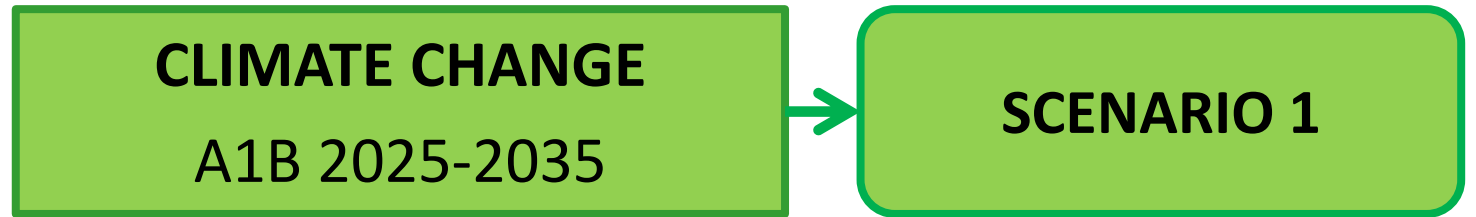
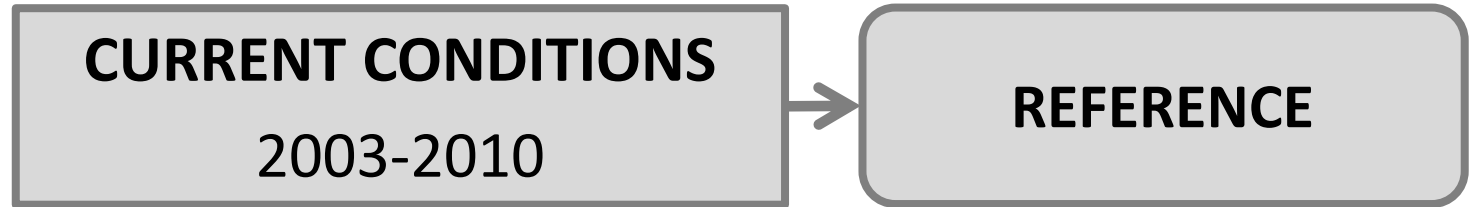
METHODS

INTEGRATED WATERSHED APPROACH

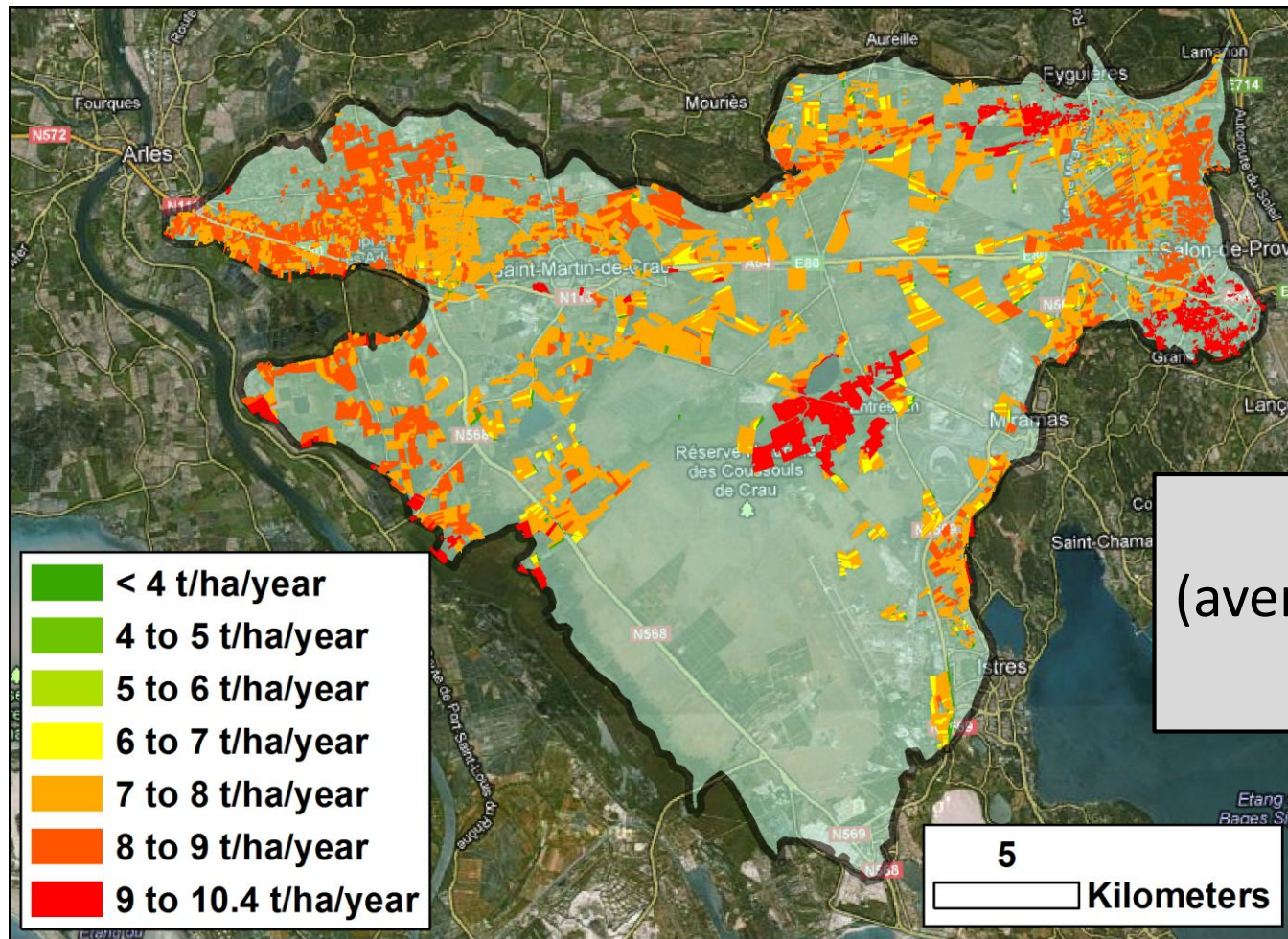


METHODS

Simulation of current conditions and of 4 scenarios



SIMULATION OF CURRENT CONDITIONS

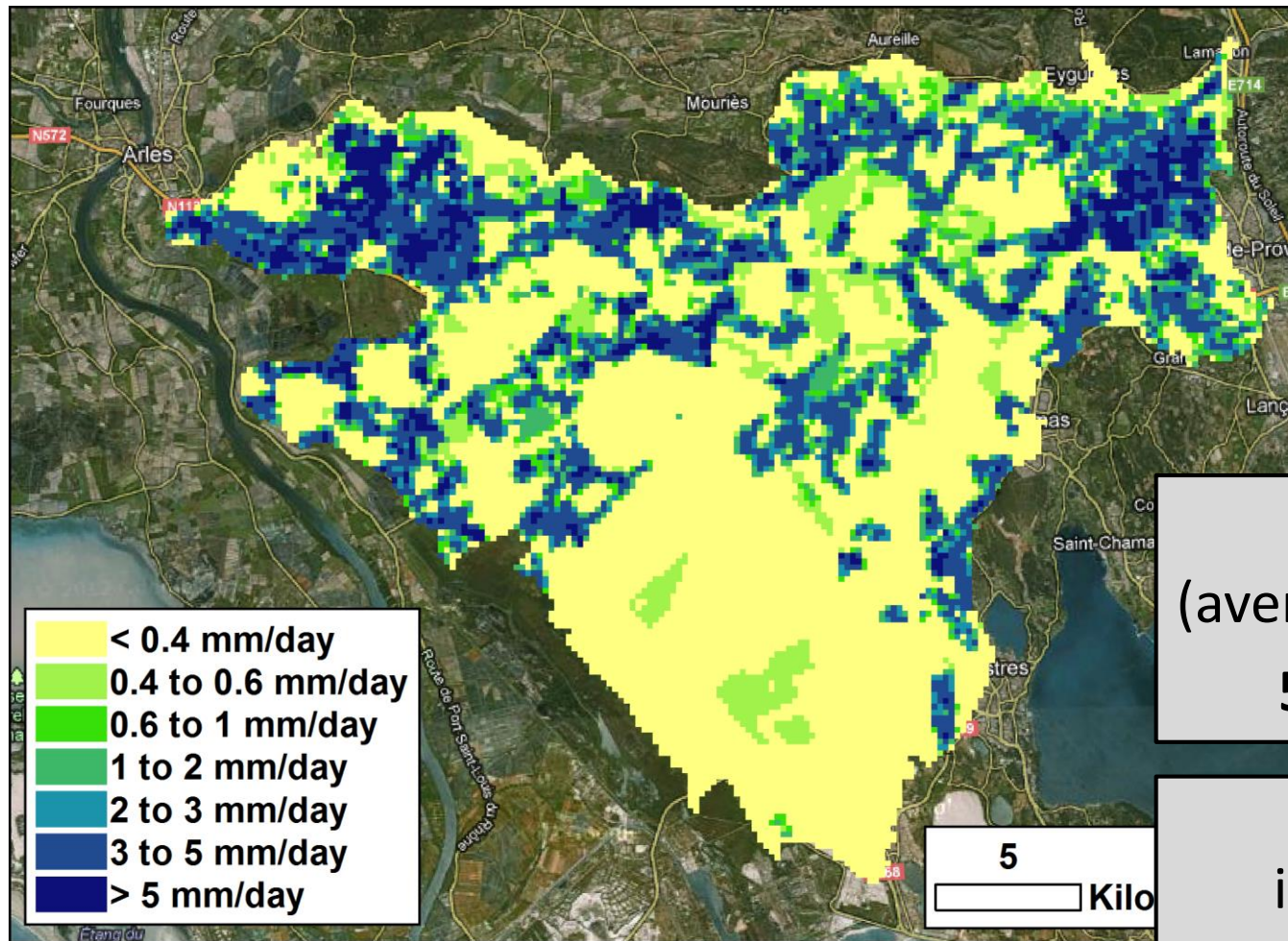


Hay yield
(average 2003 – 2010):
8 t ha⁻¹ year⁻¹

HAY YIELD 2003 – 2010

STICS – MULTISIMLIB SIMULATION

SIMULATION OF CURRENT CONDITIONS



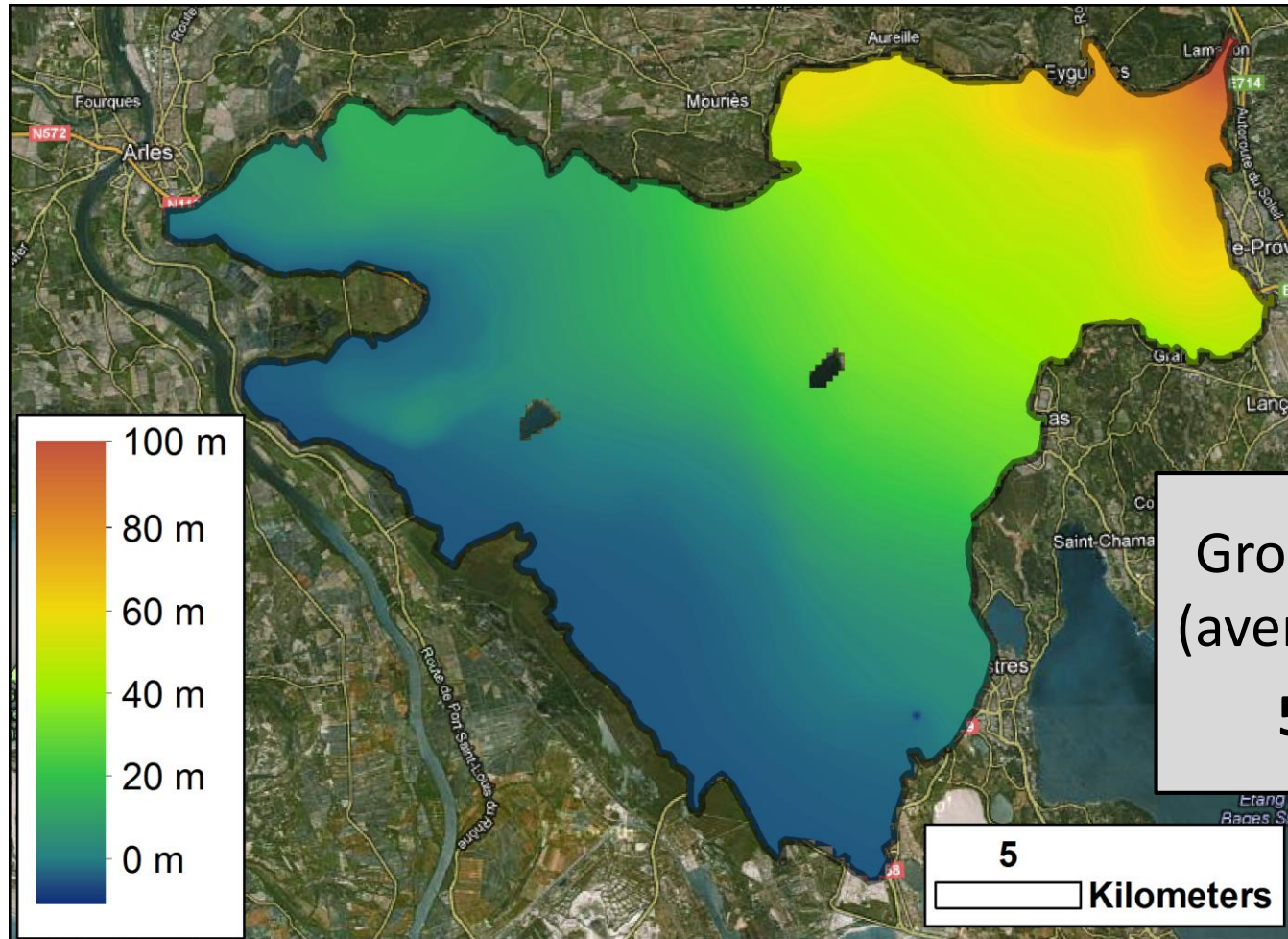
Drainage rate
(average 2003 – 2010):
550 mm year⁻¹

Drainage in
irrigated areas:
77% of total recharge

DRAINAGE 2003 – 2010

STICS – MULTISIMLIB SIMULATION

SIMULATION OF CURRENT CONDITIONS



Groundwater volume
(average 2003 – 2010):
550 million m³

WATER HEAD 2003 – 2010

MODFLOW SIMULATION

SIMULATION OF 4 SCENARIOS

CURRENT CONDITIONS
2003-2010

Hay yield: $8 \text{ t ha}^{-1} \text{ year}^{-1}$
Average drainage: 550 mm year^{-1}
Groundwater volume: $550 \cdot 10^6 \text{ m}^3$

CLIMATE CHANGE
A1B 2025-2035

SCENARIO 1

LAND USE CHANGE
-12% of irrigated meadow

WATER AVAILABILITY CHANGE
-30% of irrigation water

SCENARIO 2

SCENARIO 4

SCENARIO 3

SIMULATION OF 4 SCENARIOS

CURRENT CONDITIONS
2003-2010

Hay yield: **8 t ha⁻¹ year⁻¹**
Average drainage: **550 mm year⁻¹**
Groundwater volume: **550 10⁶ m³**

CLIMATE CHANGE
A1B 2025-2035

Hay yield: **+11 %**
Drainage: **-1%**
Groundwater: **-0.2%**

LAND USE CHANGE
-12% of irrigated meadow

WATER AVAILABILITY CHANGE
-30% of irrigation water

SCENARIO 2

SCENARIO 4

SCENARIO 3

SIMULATION OF 4 SCENARIOS

CURRENT CONDITIONS

2003-2010

Hay yield: $8 \text{ t ha}^{-1} \text{ year}^{-1}$

Average drainage: 550 mm year^{-1}

Groundwater volume: $550 \cdot 10^6 \text{ m}^3$

CLIMATE CHANGE

A1B 2025-2035

Hay yield: **+11 %**

Drainage: **-1%**

Groundwater: **-0.2%**

LAND USE CHANGE

-12% of irrigated meadow

Hay yield: **+11 %**

Drainage: **-13%**

Groundwater: **-6%**

WATER AVAILABILITY CHANGE

-30% of irrigation water

SCENARIO 4

SCENARIO 3

SIMULATION OF 4 SCENARIOS

CURRENT CONDITIONS

2003-2010

Hay yield: $8 \text{ t ha}^{-1} \text{ year}^{-1}$

Average drainage: 550 mm year^{-1}

Groundwater volume: $550 \cdot 10^6 \text{ m}^3$

CLIMATE CHANGE

A1B 2025-2035

Hay yield: **+11 %**

Drainage: **-1%**

Groundwater: **-0.2%**

LAND USE CHANGE

-12% of irrigated meadow

Hay yield: **+11 %**

Drainage: **-13%**

Groundwater: **-6%**

WATER AVAILABILITY CHANGE

-30% of irrigation water

Hay yield: **+3 %**

Drainage: **-31%**

Groundwater: **-20%**

SCENARIO 4

SIMULATION OF 4 SCENARIOS

CURRENT CONDITIONS
2003-2010

Hay yield: **8 t ha⁻¹ year⁻¹**
Average drainage: **550 mm year⁻¹**
Groundwater volume: **550 10⁶ m³**

CLIMATE CHANGE
A1B 2025-2035

Hay yield: **+11 %**
Drainage: **-1%**
Groundwater: **-0.2%**

LAND USE CHANGE
-12% of irrigated meadow

Hay yield: **+11 %**
Drainage: **-13%**
Groundwater: **-6%**

WATER AVAILABILITY CHANGE
-30% of irrigation water

Hay yield: **+6 %**
Drainage: **-31%**
Groundwater: **-19%**

Hay yield: **+3 %**
Drainage: **-31%**
Groundwater: **-20%**

SUMMARY

- irrigated grasslands play a major role in the Crau aquifer recharge and, more generally, in the water cycle over the area
- future increases in temperature and an adequate management of irrigation may lead to an increase in hay production
- decrease in drainage, due to global changes, may lead to a significant decrease of the aquifer storage, threatening the sustainability of the groundwater resource

SIRRIMED

SUSTAINABLE USE OF IRRIGATION WATER IN THE MEDITERRANEAN REGION