Bringing INnovation to onGOing water management (Horizon 2020 project, 2015-2019)

PRECIPITATION PATTERN CHANGES IMPACT IN THE GROUNDWATER QUALITY AT ALUVIÕES DO TEJO AQUIFER, PORTUGAL

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BINGO AIM: assess the impacts of climate change in the integrated water cycle
THIS STUDY AIM: to evaluate the potential impact of CC in groundwater quality…

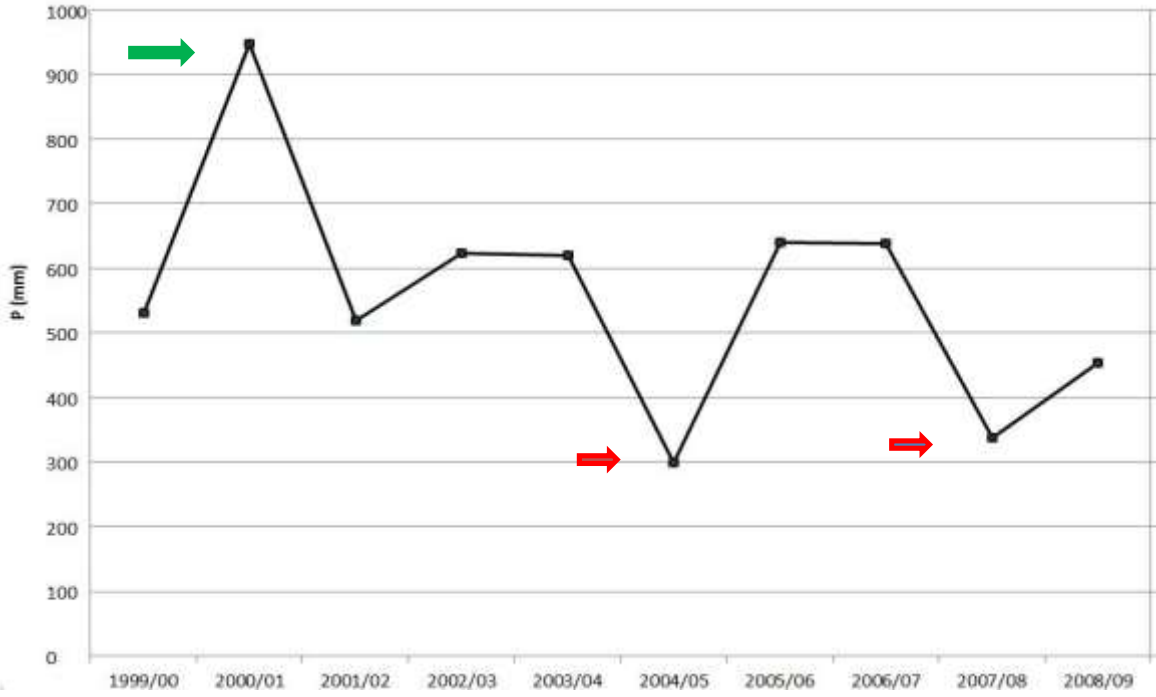
… by evaluating how has the climate variability in the decade 2000-2009 affected the groundwater quality in the alluvial aquifer Aluviões do Tejo

METHODS:

1) In a CC scenario the main variables subject to change are: P, ETP & T

In 2000-2009 decade there were :

- 2 hydrological years of drought: 2004/05 e 2007/08
- 1 wet year: 2000/01



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METHODS:

2) Considering that the studied area is an agricultural area, the changes in the precipitation pattern and therefore in the natural aquifer recharge, should be noticed as changes in the nutrient leaching to groundwater. So, we have used:

- NO_3^-: to evaluate the changes in nutrient leaching
- EC: to analyse a more global change in the water mineralogy
- Cl^-: as a conservative element

3) What we would expect, a priori, from this analysis in an agricultural area (not considering changes in the land cover nor in fertilization practices):

- P < => R < So, with the same application of fertilizers: > NO_3^- in the natural recharge
- P < => More irrigation: > NO_3^- than natural recharge (… and the opposite if P >)
- However (1) these effects might have a delayed effect in the groundwater quality (maybe in the following year) and
- (2) in dry years NO_3^- can be lower if R is too low compared to the groundwater flow (e.g. when recharge takes place far away from the study area)

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STUDY AREA:

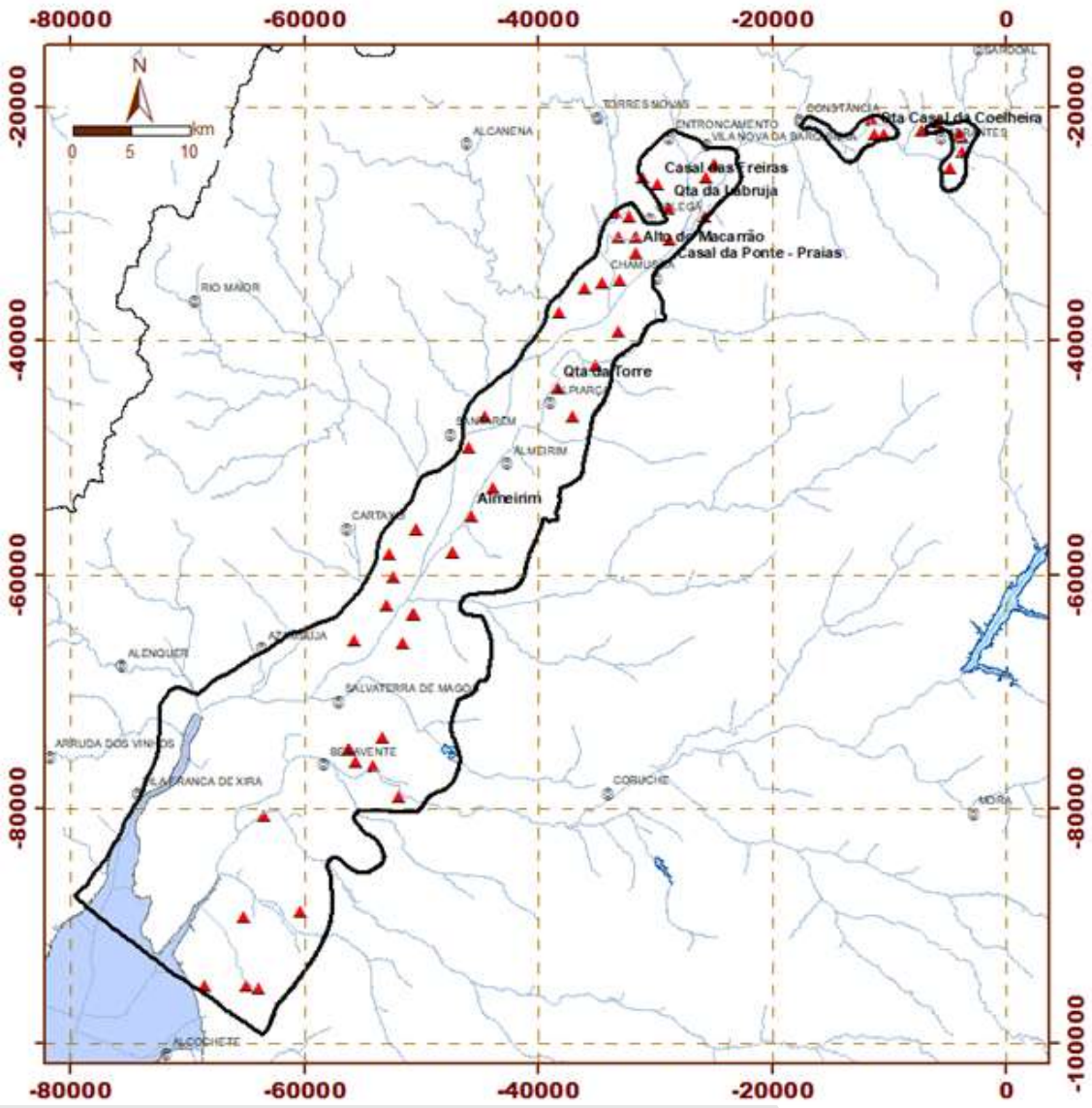
- Area: 1 052 km^2
- Phreatic aquifer; intergranular and multilayer
- Alluvial and fluvial deposits
- Sand, silt and gravel

Portuguese Env. Agency:

- 56 wells

Annual water balance (Lobo-Ferreira *et al*., 2011):

- R: 218 hm^3 (1/3 of the average P of 654 hm^3)
- Consumption: 90 hm^3: agriculture (76%) human consumption (19%); industry (5%)



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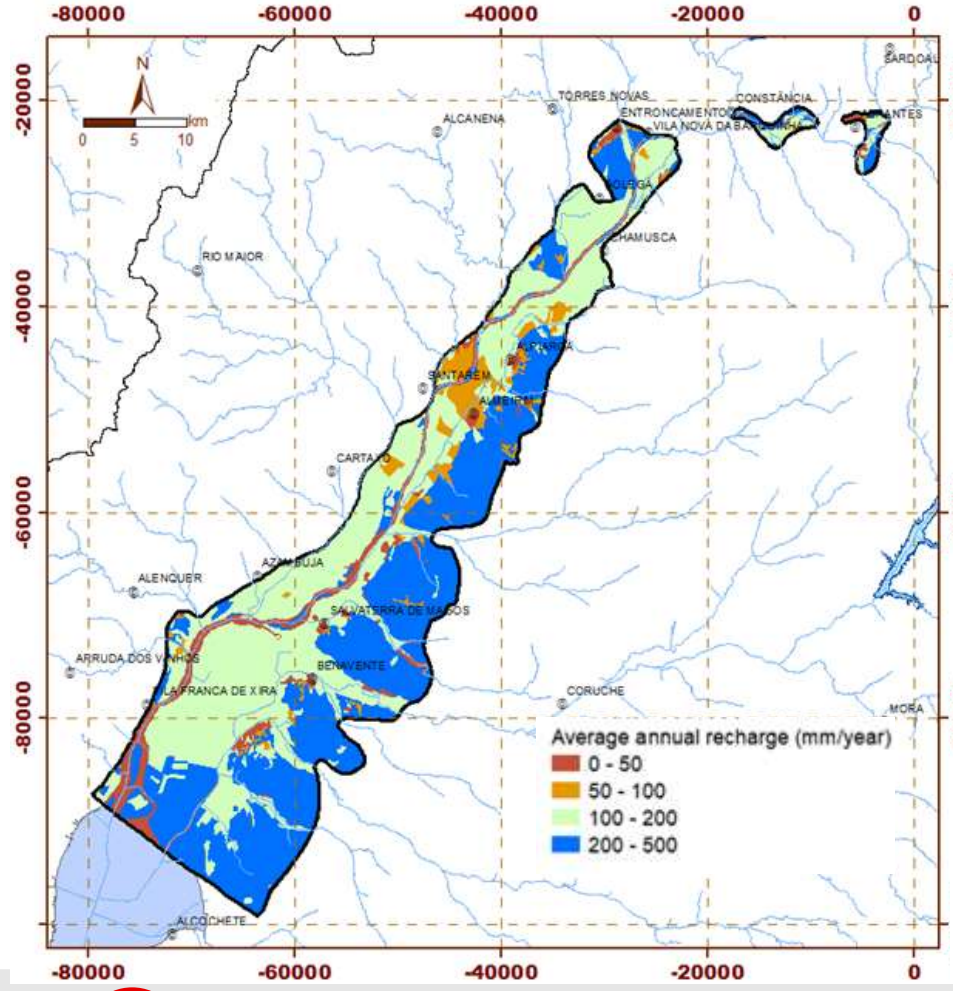
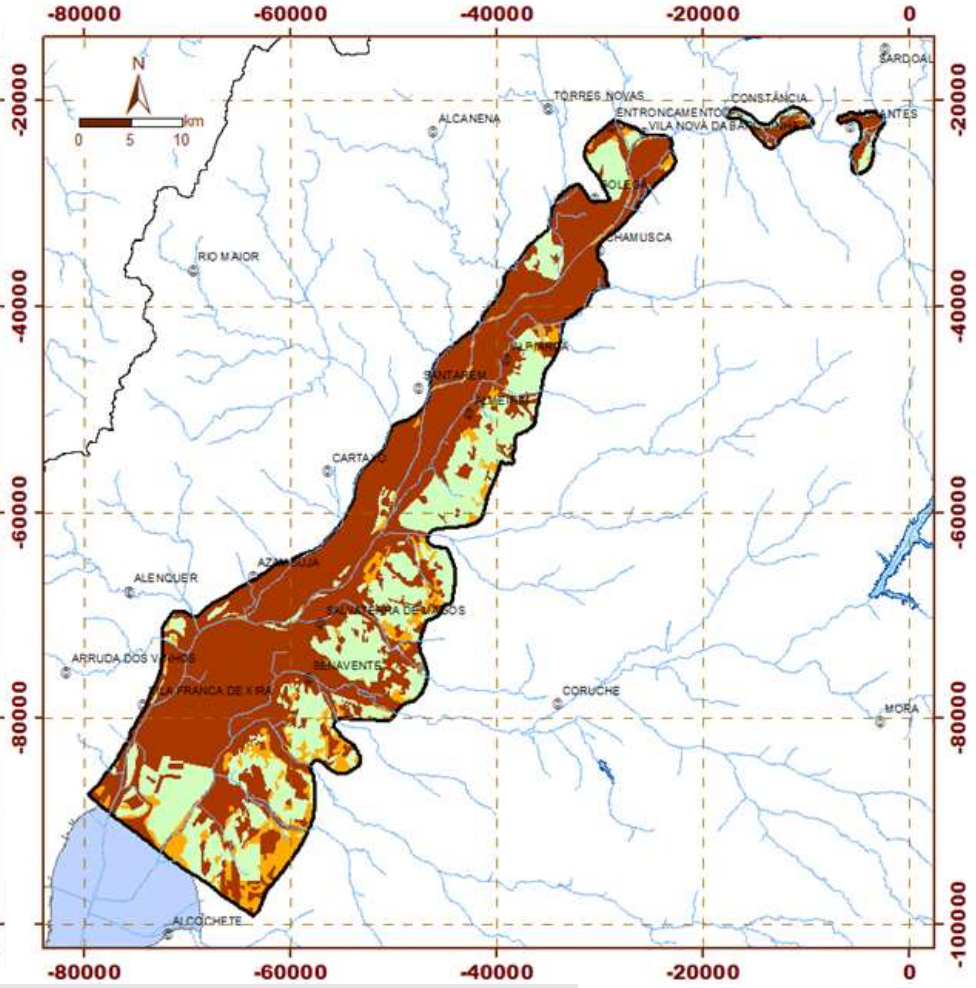
STUDY AREA: Average recharge 2000/09 & 2004/05





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Lobo-Ferreira *et al.*, 2011

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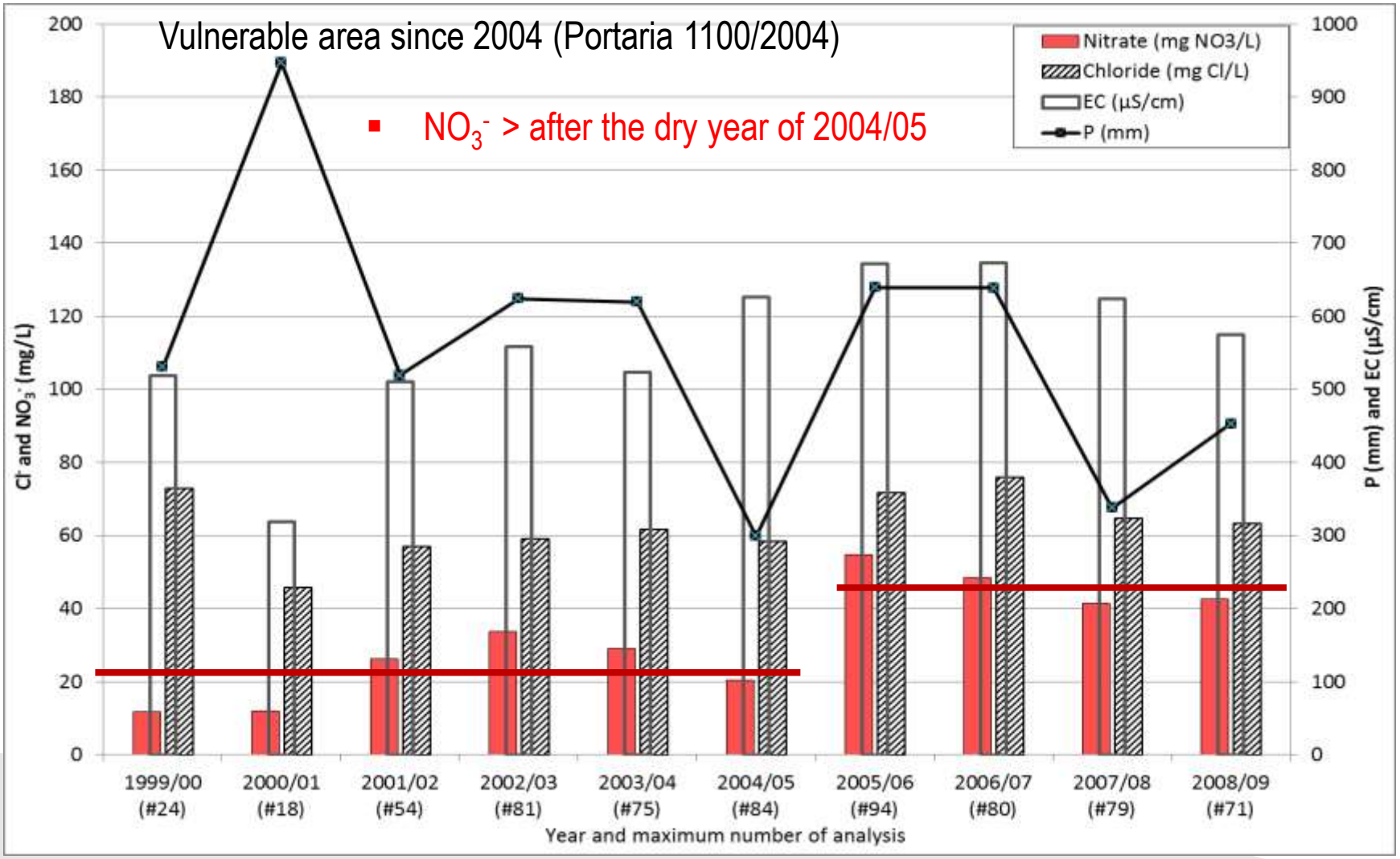
RESULTS: Data from 2000/09: 56 wells // Semi-annual analysis: March & September (with some variations) // Several incomplete series



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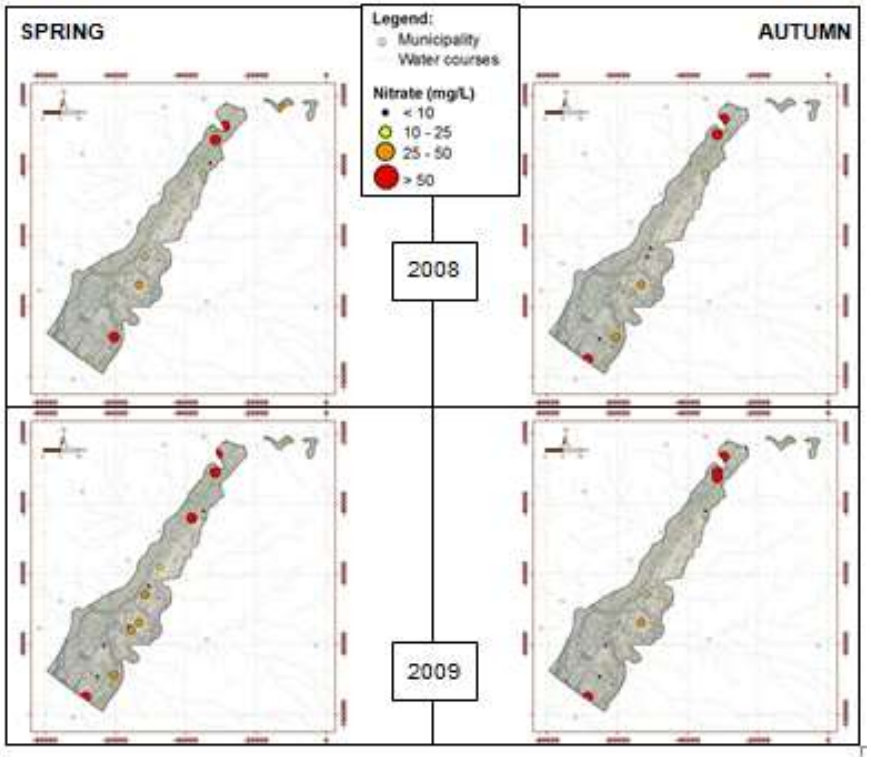
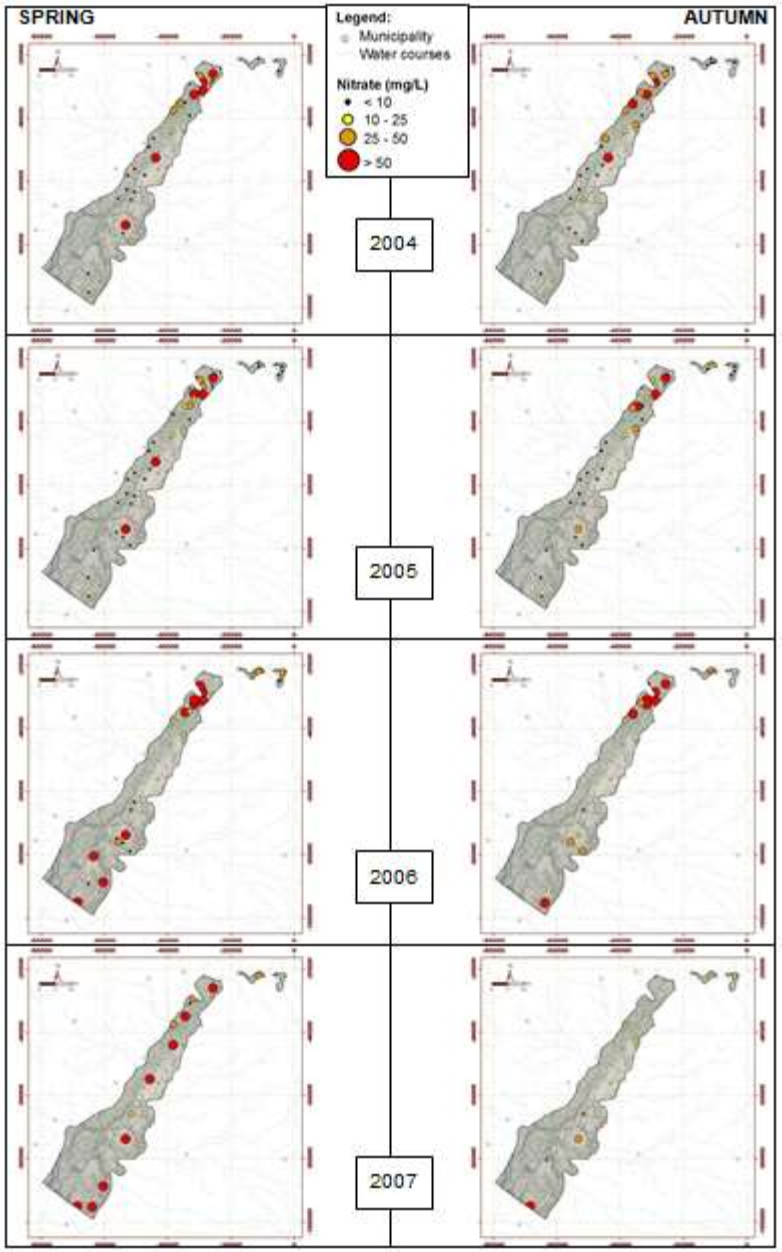
RESULTS:

- NO_3^- > in Spring





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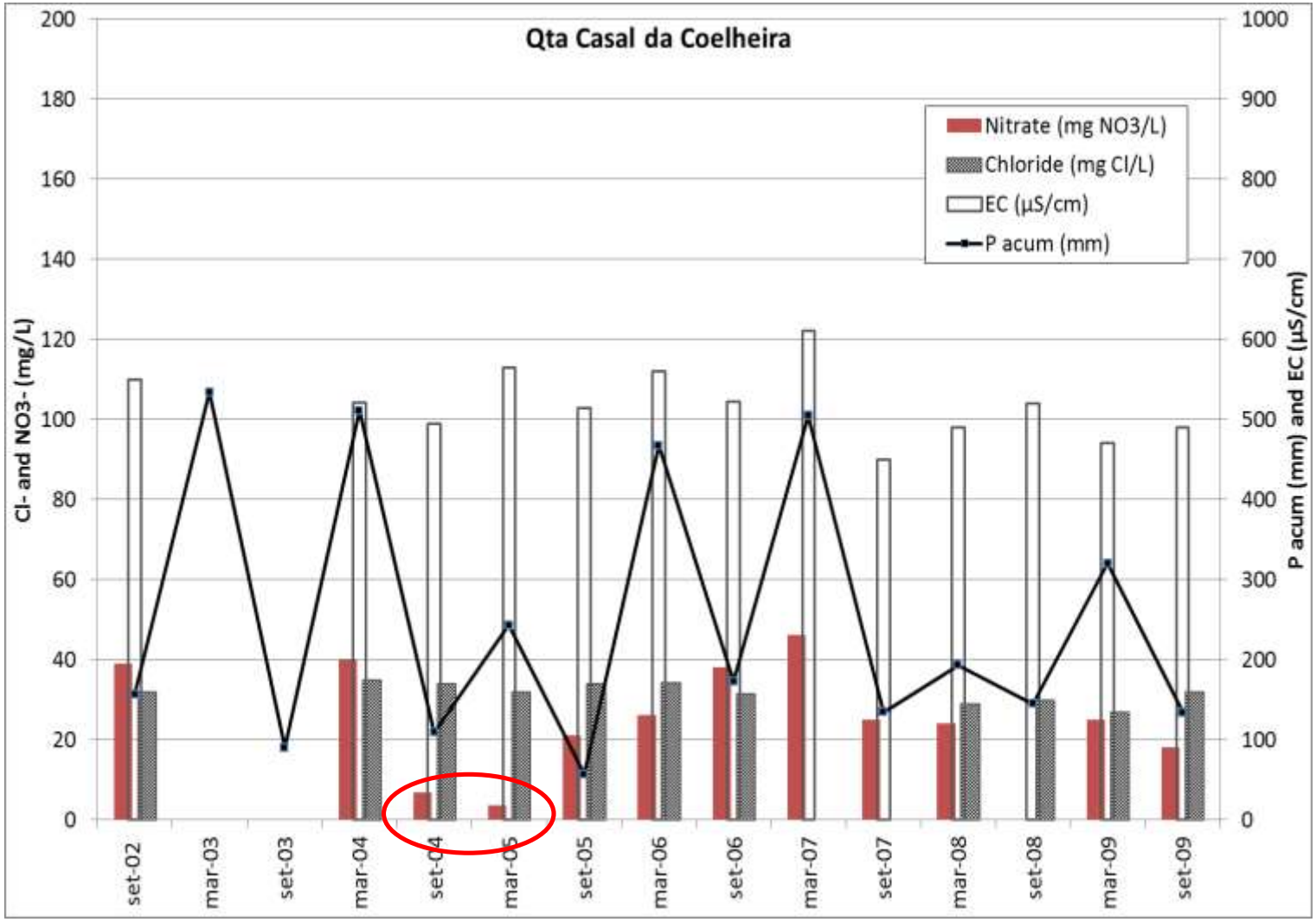
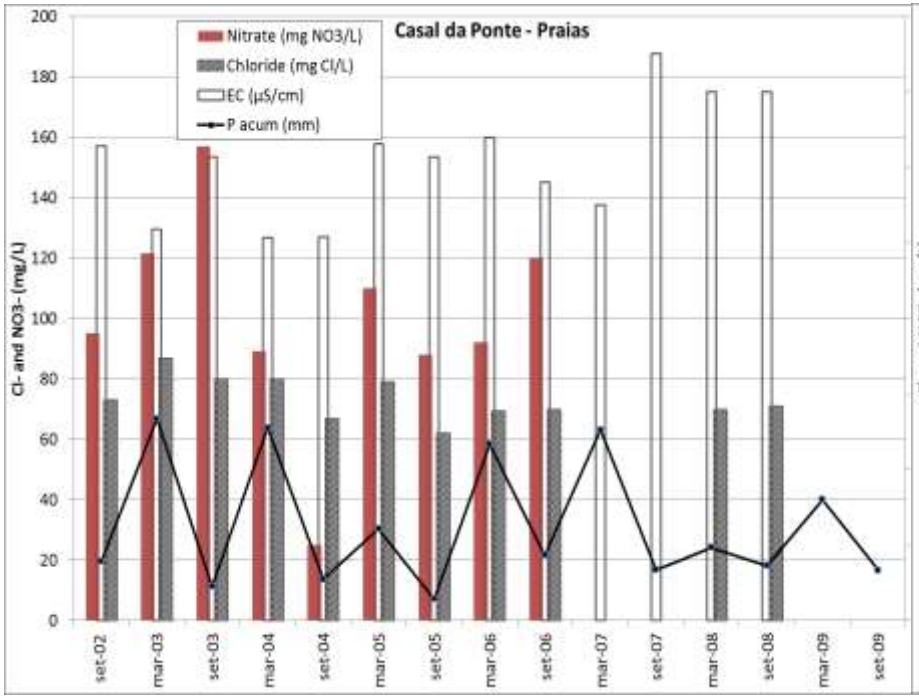
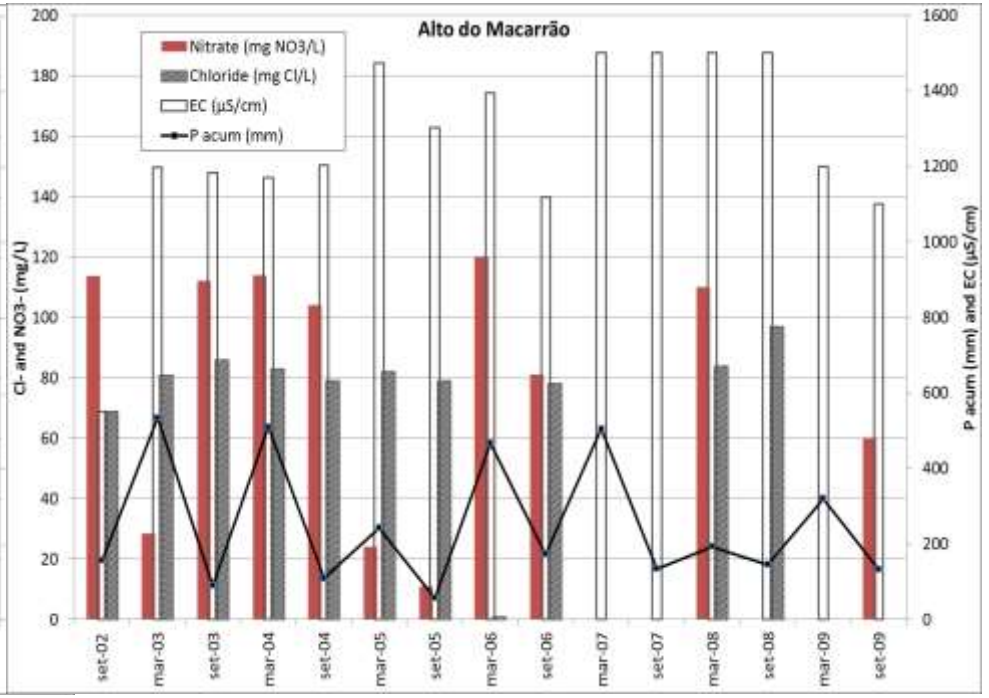
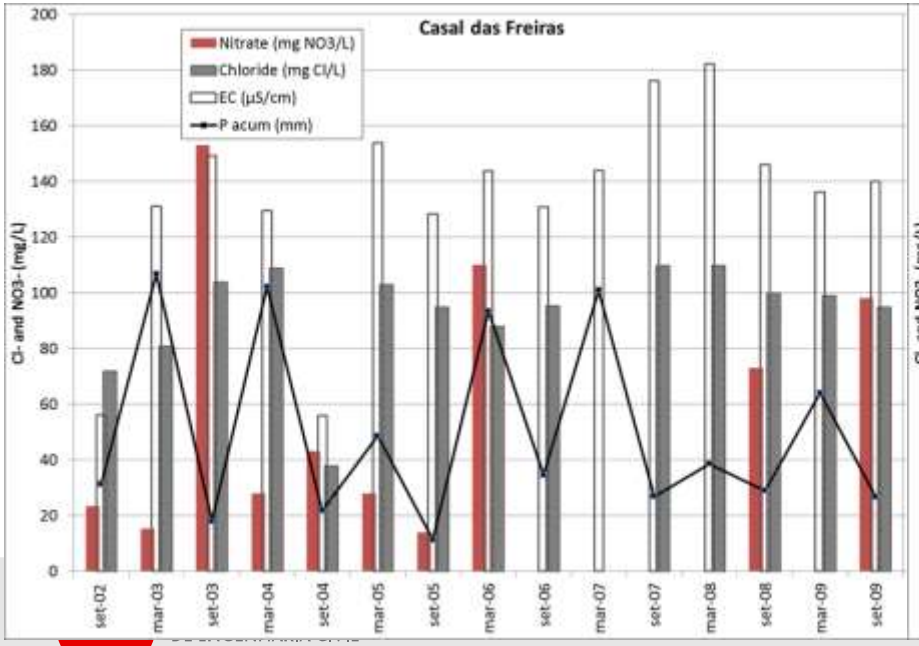
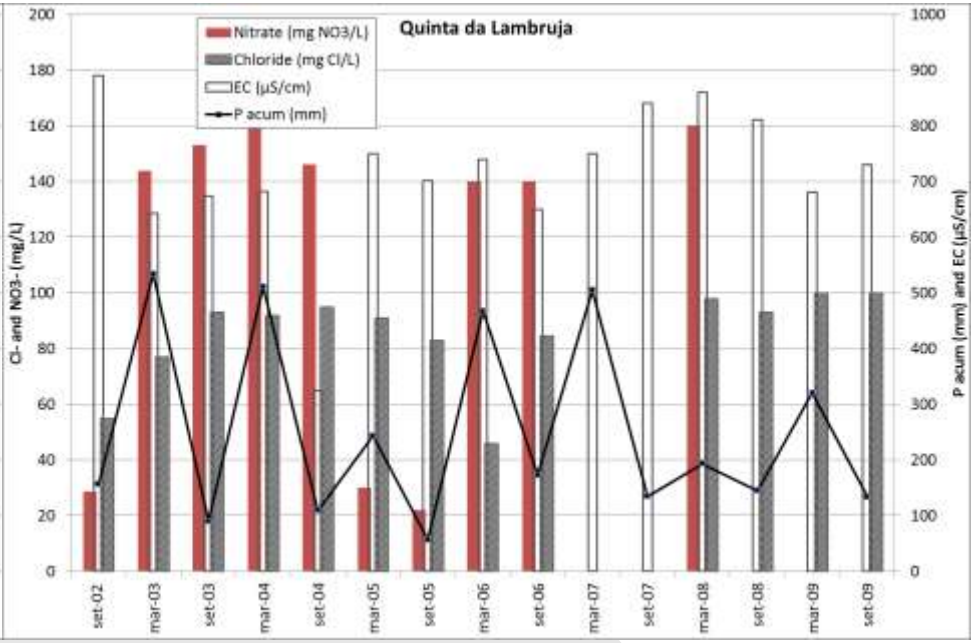
RESULTS:




Casal da Ponte - Praias
Nitrate (mg NO3/L)
Chloride (mg Cl/L)
EC (µS/cm)
P acum (mm)
Cl- and NO3- (mg/L)
0
20
40
60
80
100
120
140
160
180
200
set-02
mar-03
set-03
mar-04
set-04
mar-05
set-05
mar-06
set-06
mar-07
set-07
mar-08
set-08
mar-09
set-09


Alto do Macarrão
Nitrate (mg NO3/L)
Chloride (mg Cl/L)
EC (µS/cm)
P acum (mm)
Cl- and NO3- (mg/L)
P acum (mm) and EC (µS/cm)
0
20
40
60
80
100
120
140
160
180
200
0
200
400
600
800
1000
1200
1400
1600
set-02
mar-03
set-03
mar-04
set-04
mar-05
set-05
mar-06
set-06
mar-07
set-07
mar-08
set-08
mar-09
set-09


Casal das Freiras
Nitrate (mg NO3/L)
Chloride (mg Cl/L)
EC (µS/cm)
P acum (mm)
Cl- and NO3- (mg/L)
0
20
40
60
80
100
120
140
160
180
200
set-02
mar-03
set-03
mar-04
set-04
mar-05
set-05
mar-06
set-06
mar-07
set-07
mar-08
set-08
mar-09
set-09


Quinta da Lambruja
Nitrate (mg NO3/L)
Chloride (mg Cl/L)
EC (µS/cm)
P acum (mm)
Cl- and NO3- (mg/L)
P acum (mm) and EC (µS/cm)
0
20
40
60
80
100
120
140
160
180
200
0
100
200
300
400
500
600
700
800
900
1000
set-02
mar-03
set-03
mar-04
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set-05
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set-06
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set-07
mar-08
set-08
mar-09
set-09

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CONCLUSIONS:

- A clear pattern in water quality cannot be seen. However, in several wells, there seems to be a decrease in NO_3^- in the years 2004-05 (R is too low compared to the groundwater flow?).
- During the period analyzed (2000-2009) there were new rules established by the code of good practice for agriculture that imposed restrictions on the values and fertilization periods.
- However, what is observed after 2004 is an increase in the concentration of nitrates that cannot be justified with the possible new practices, since these would contribute to decrease the application of nitrates and, consequently, the concentration in groundwater.
- The changes observed in water quality can result from several factors other than weather conditions.
- Changes in land use were not considered relevant due to the limited areas. However, changes in specific types of crops within the same land cover class may have played a role (not investigated).
- The quality can also be affected by the existing pressures, such as septic tanks, cattle, among others. However, there are no records of important changes during these years that could interfere with the relative comparison made in this study.

Thank you for your attention

CONCLUSIONS :

- The main conclusion that can be drawn from this brief analysis is that during periods of drought, contaminants introduced into the soil, originating from agricultural or other practices, are temporarily retained in the soil horizon until the next wet period leaches them to the saturated zone.
- The time lag between the introduction of contaminants and the increase in groundwater concentrations depends on the depth at the piezometric level and the permeability of the geological formations (among several other aspects included in a classic assessment of the vulnerability of groundwater to contamination).
- What is the potential impact that climate changes might have in the future groundwater chemistry? For equivalent pressures, same contamination levels reaching groundwater at different times? Will > retention time in soils (in droughts) allow decreasing biodegradable compounds? Will particle retention, adsorption of contaminants increase? Will aerobic/anaerobic conditions changes play a role? Will plants retain more fertilizers?