Impacts of climate change on water availability in Alentejo (Portugal)

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GestAqua .AdaPT ADAPTATION WATER RESOURCES CLIMATE CHANGE

- Mediterranean water resources (already vulnerable at present) - high potential to be affected by climate change

→ decreases in runoff and streamflow
increases in evapotranspiration and CO^2 atmospheric concentrations
shifts in crop growth cycles
changes in land-cover / land-use

GestAqua .AdaPT | ADAPTATION WATER RESOURCES CLIMATE CHANGE

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- What are the impacts of **climate change** in Alentejo
  - water availability (**quality/quantity**)
  - reservoirs response
  - irrigation water requirements
  - reservoir phosphorus inflows

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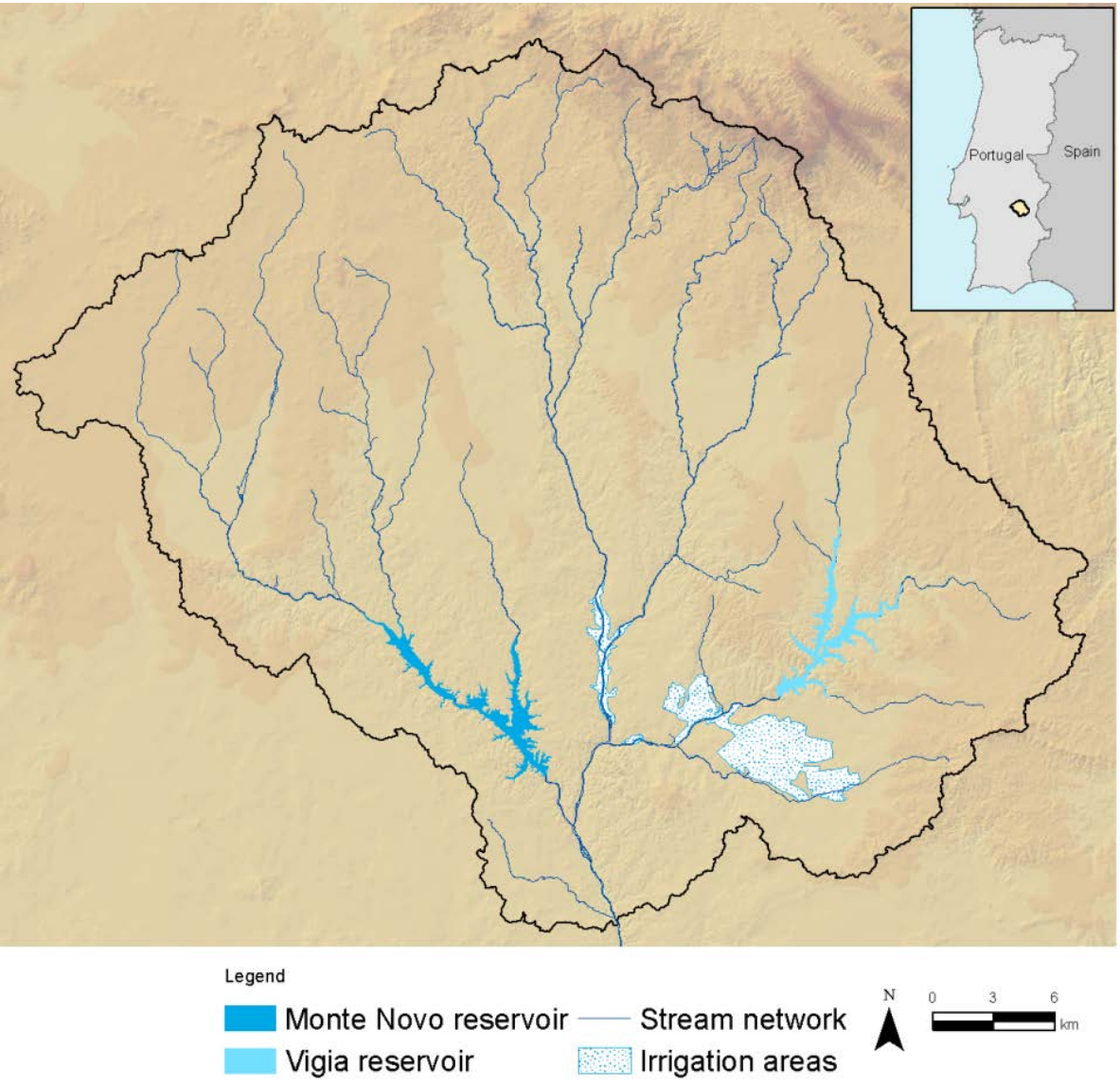
- Development and implementation of adaptation strategies to future climate



The area is under dry Mediterranean climate (less 500mm/yr)

The Monte Novo and Vigia catchment (814.7km^2) is a multipurpose reservoir system used for water supply (district of Évora) and irrigation. Drains in to the Alqueva reservoir (largest artificial lake in the Iberian Peninsula - 4150hm^3)

Rainfed crops - 44% (oats 60%; winter pasture 40%)

Agroforestry - 30% (evergreen oaks interspersed with winter cereals or pasture) - “montado”

Broad-leaved forest - 13% (cork oak)

Permanent crops - 7% (olive groves, vineyards)

Irrigated crops - 4% (corn, sunflower, olive groves, vineyards)

SWAT Soil & Water Assessment Tool

SWAT2012

→ 1973 – 2012

(daily meteorological data from 3 measuring stations)

4 years warm up

→ manual calibration + CUP Sufi2

↓

Climate change scenarios

climate models (euro cordex)

RCA4

RACMO22E

projections

RCP 4.5

RCP 8.5 "worst" scenario

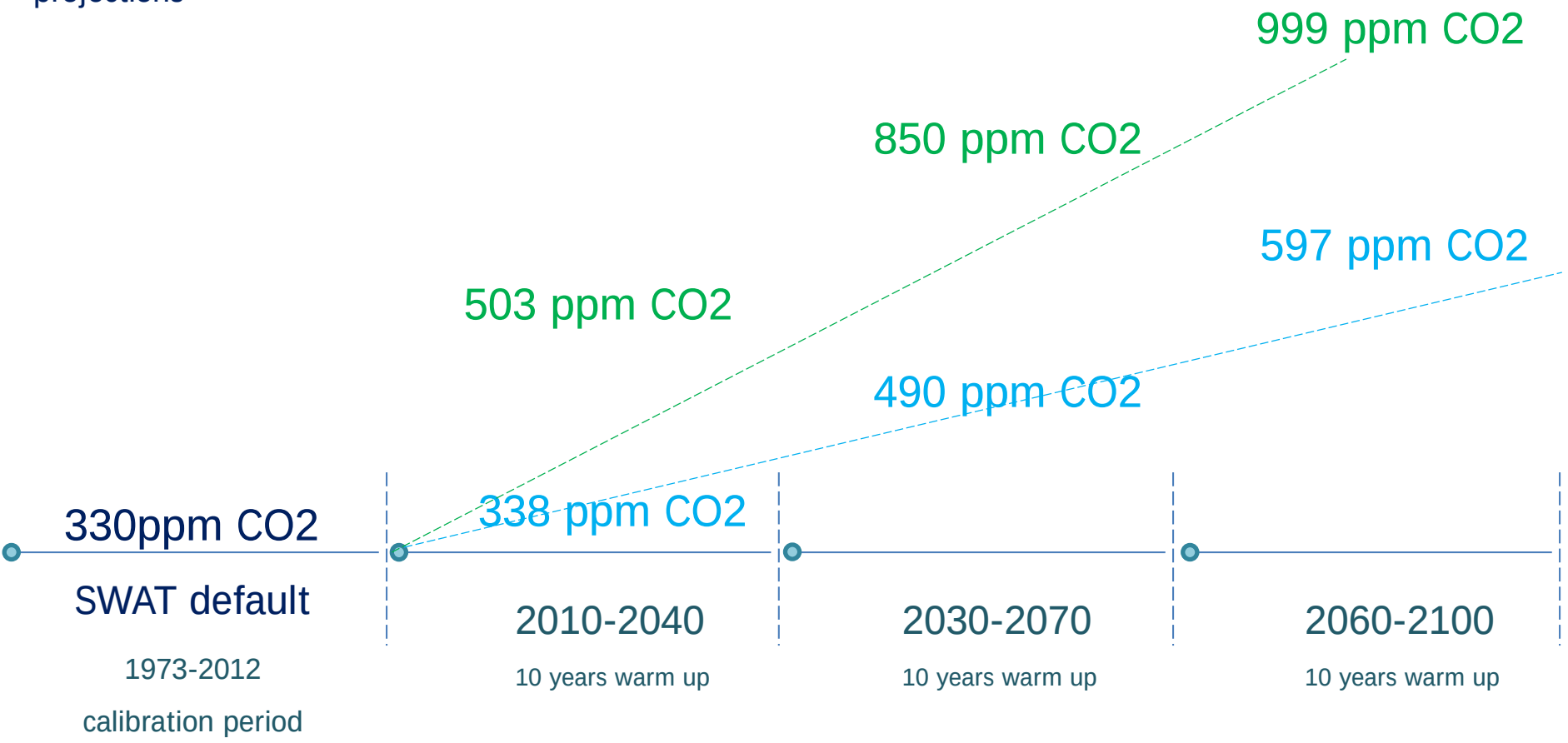
2010-2040	2030-2070	2060-2100
10 years warm up	10 years warm up	10 years warm up

Compare with each climate model control period (1971-2000)

1197 ppm CO2

SWAT model conflict

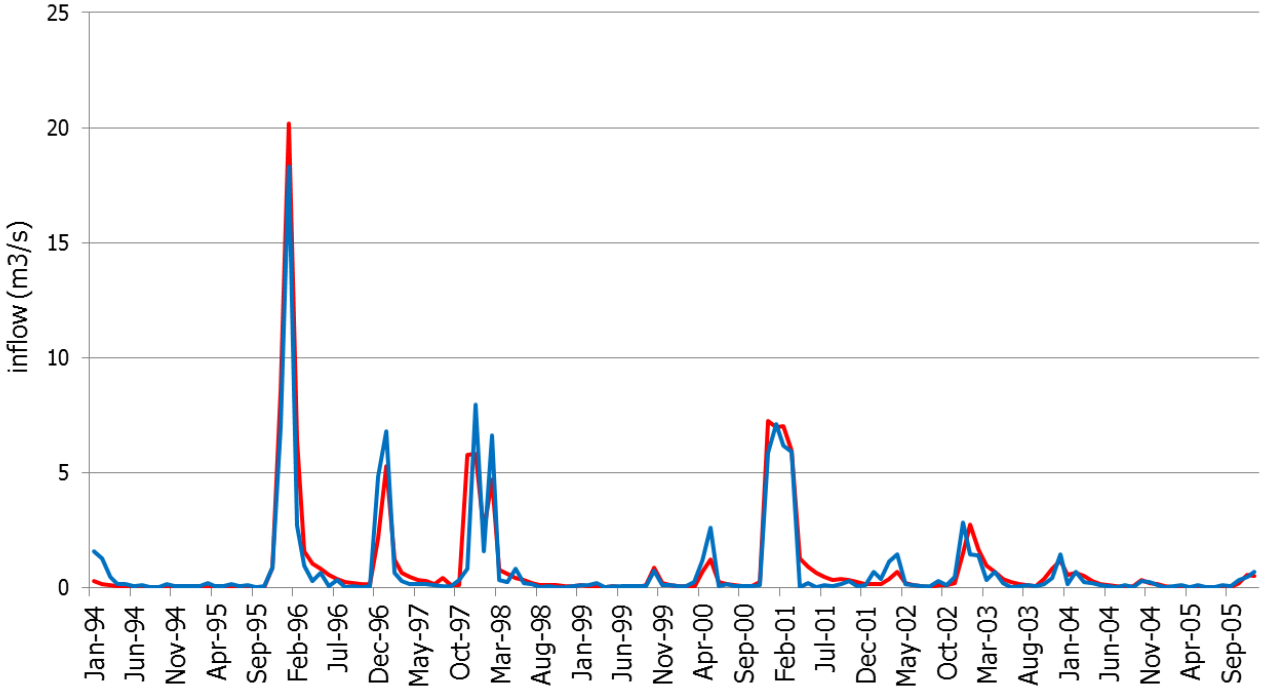
RCP 4.5 and RCP 8.5 (“worst” scenario) projections



Monte Novo reservoir inflow (jan 1994 to dec 2005)

NSE	bR²	Pbias
0.89	0.89	7.94

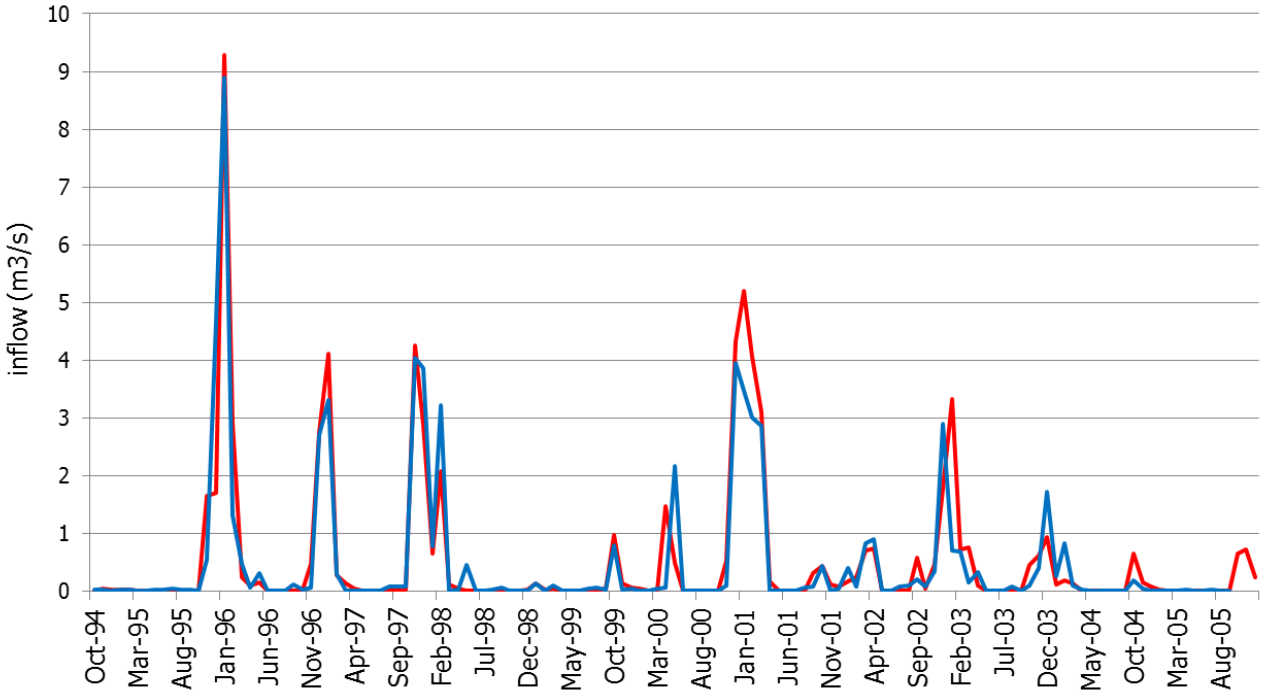
very good performance rating
(Moriasi et al. 2007)



Vigia reservoir inflow (oct 1994 to dec 2005)

NSE	bR²	Pbias
0.83	0.84	6.21

very good performance rating
(Moriasi et al. 2007)



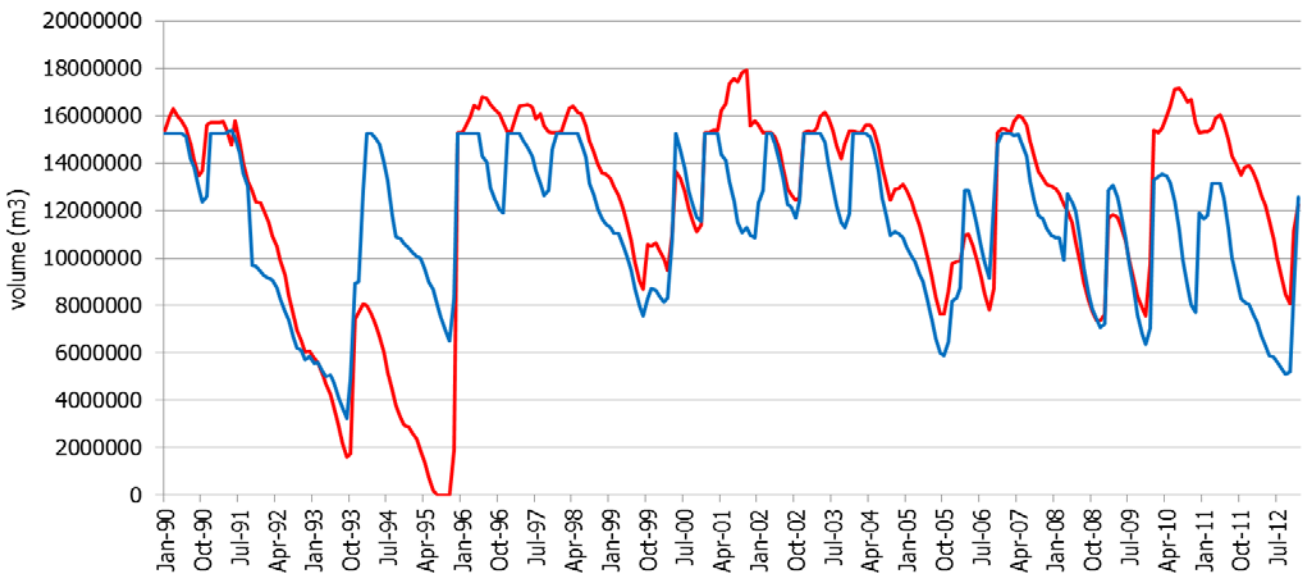
SWAT

Observed

Monte Novo reservoir volume (jan 1990 to dec 2012)

NSE	bR²	Pbias
0.51	0.52	3.31

satisfactory performance rating
(Moriasi et al. 2007)

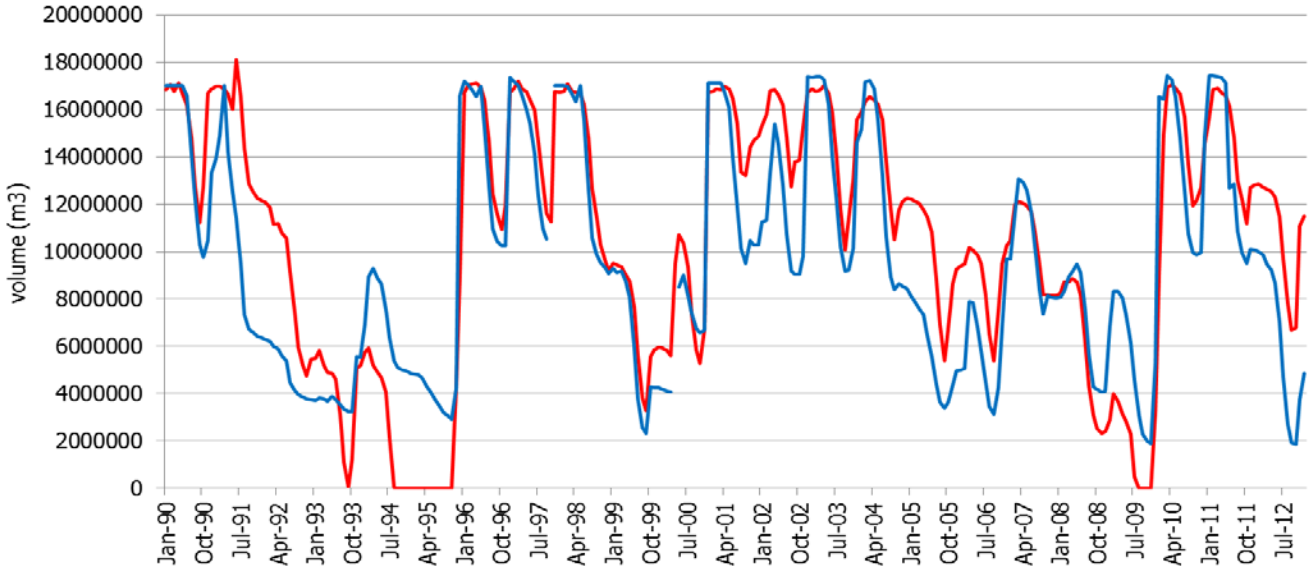


- SWAT limits a “realistic” simulation of inter-annual variations - reservoir water consumption depends on irrigation requirements and storage volume
- Monthly “average input” constrains the simulation of drought situations/water conservation measures/changes to irrigated area or crops

Vigia reservoir volume (jan 1990 to dec 2012)

NSE	bR²	Pbias
0.72	0.74	8.37

good performance rating
(Moriasi et al. 2007)



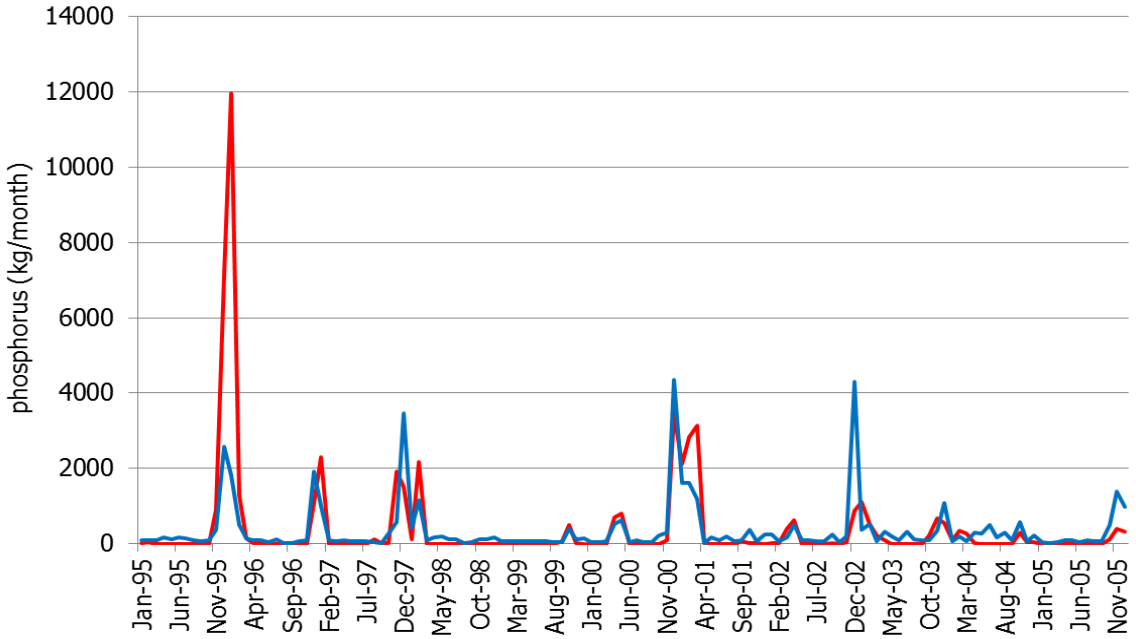
SWAT

Observed

Monte Novo reservoir phosphorus (jan 1995 to dec 2005)

NSE	bR²	Pbias
0.33	0.33	9.11

satisfactory performance rating
(Moriasi et al. 2007)

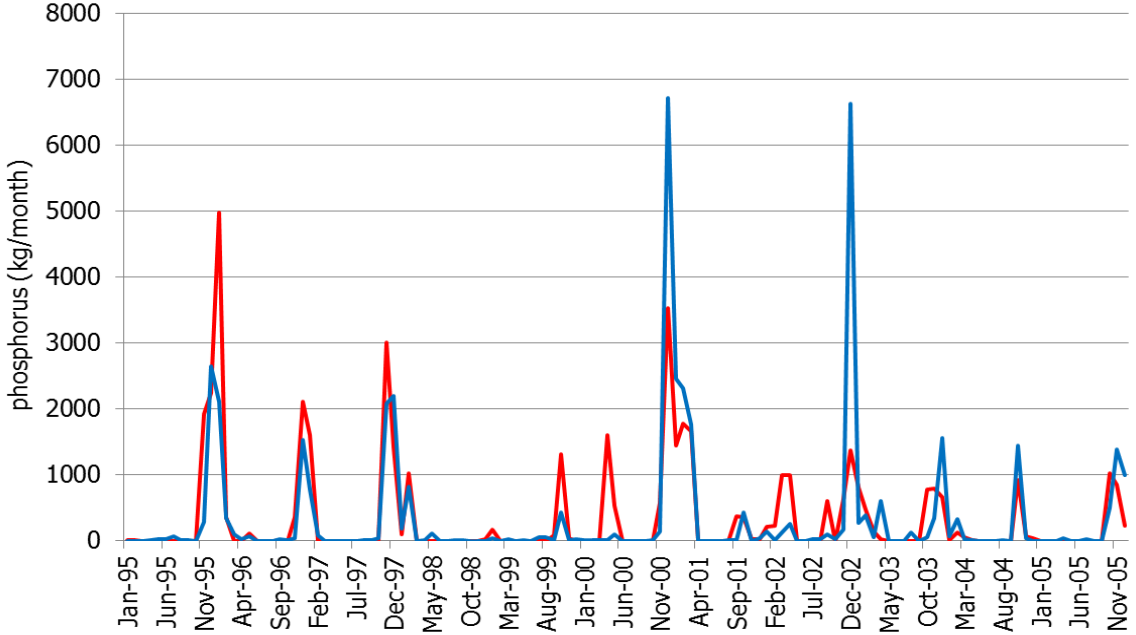


- Phosphorus data is given by one daily record per month (records are not continuous)
- Phosphorus high peaks linked with low reservoir water volume

Vigia reservoir phosphorus (jan 1995 to dec 2005)

NSE	bR²	Pbias
0.15	0.49	1.74

satisfactory performance rating
(Moriasi et al. 2007)

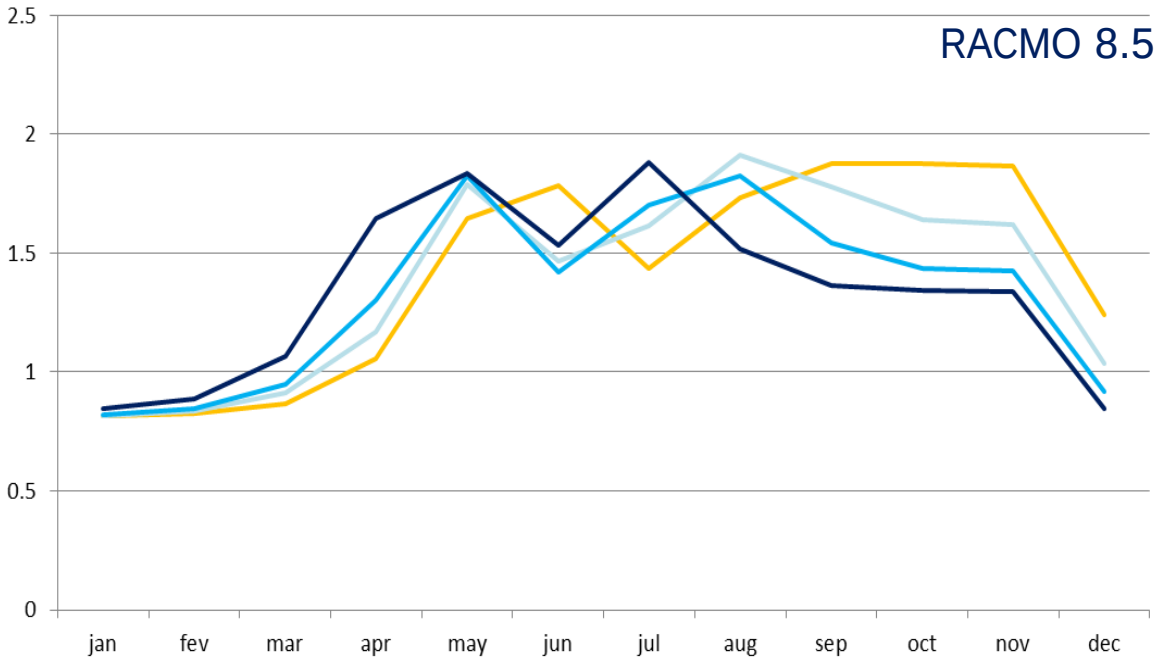


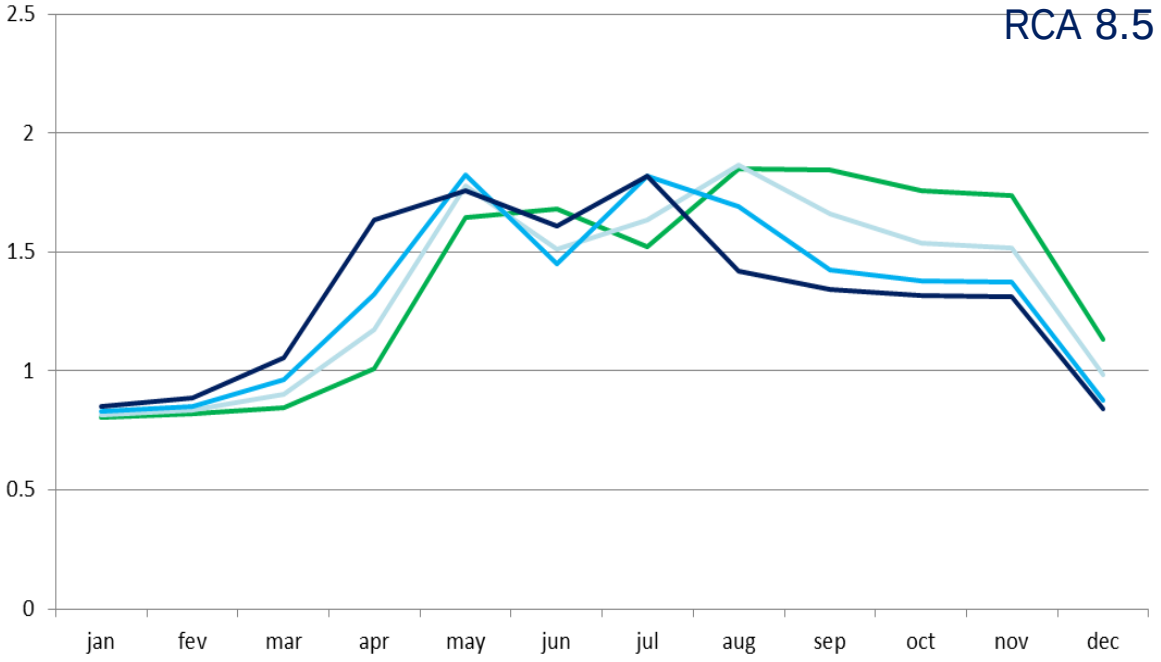
SWAT

Observed

LAI (leaf area index)
average for all crops

- Gradual anticipation of the start of vegetation development in spring and lower vegetation cover in summer and autumn
- Higher frequency of water stress conditions, due to the higher climatic aridity (i.e. a combination of lower rainfall and higher potential evapotranspiration)

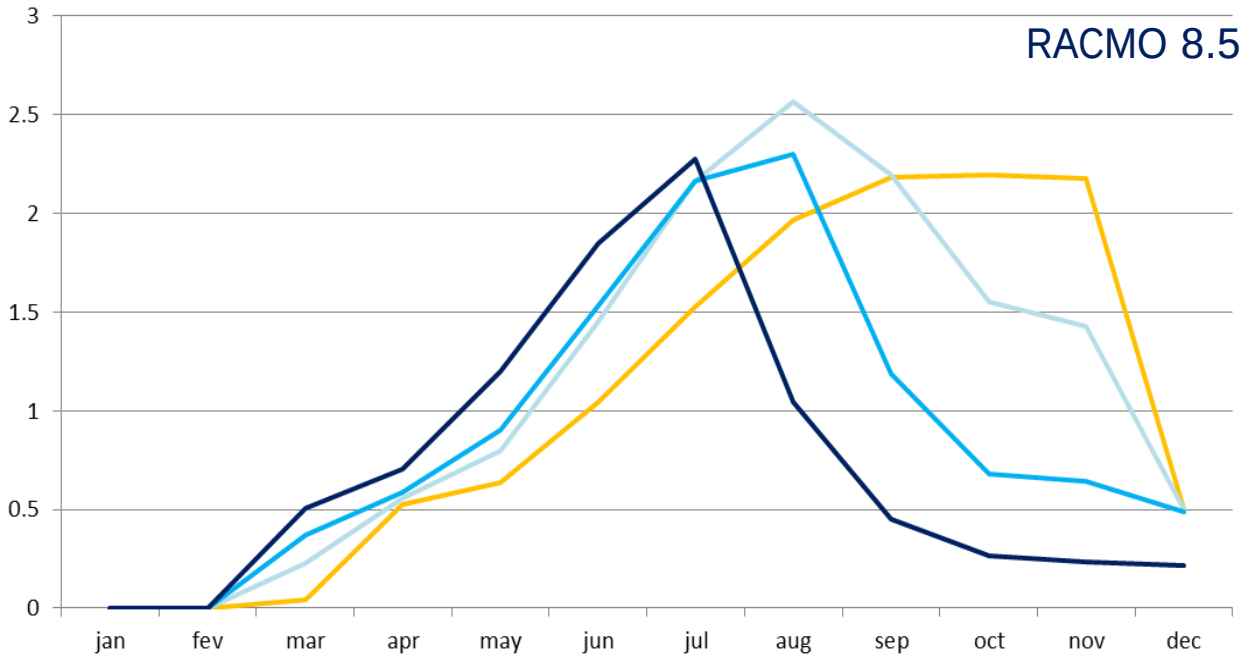


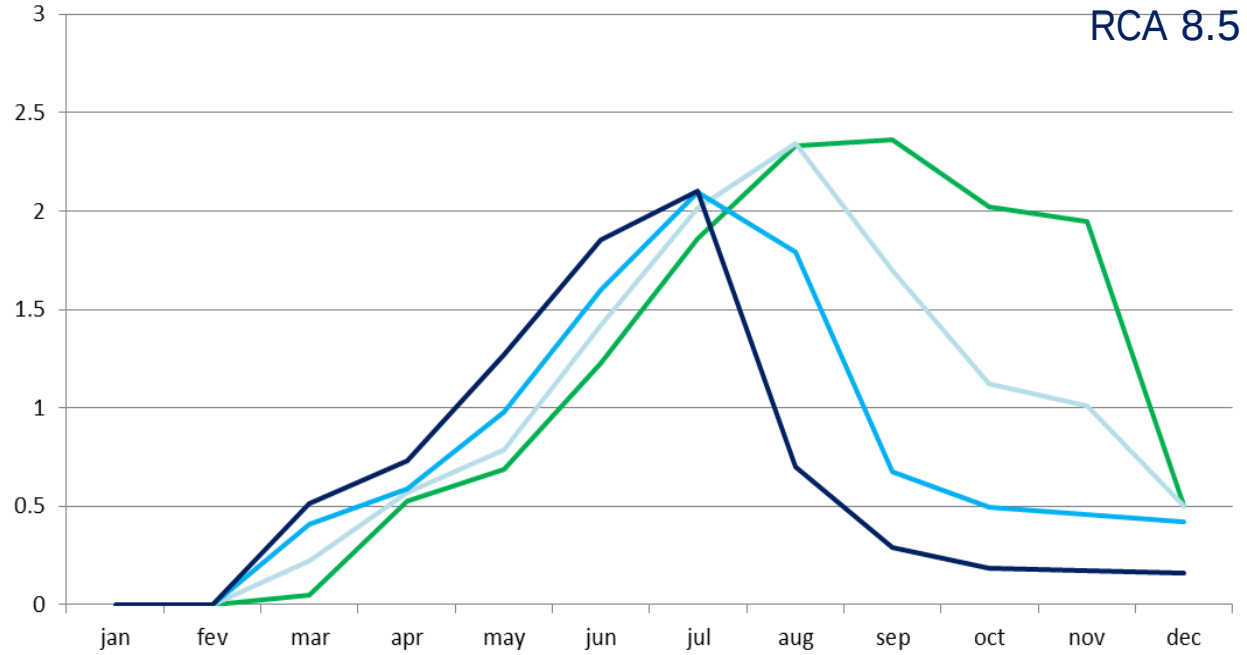


RACMO control
RCA control
2010-2040
2030-2070
2060-2100

LAI (leaf area index) Vine

- Earlier begging of growing season (up to 2 month) due to a favorable winter - warmer but still humid





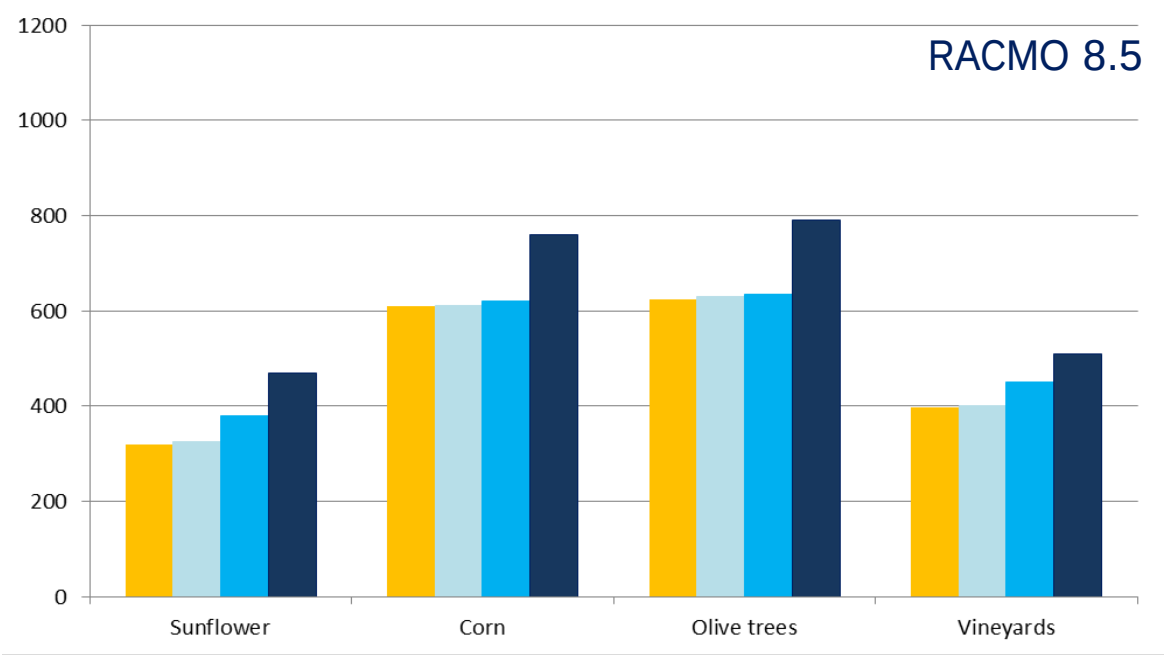
RACMO control
RCA control
2010-2040
2030-2070
2060-2100

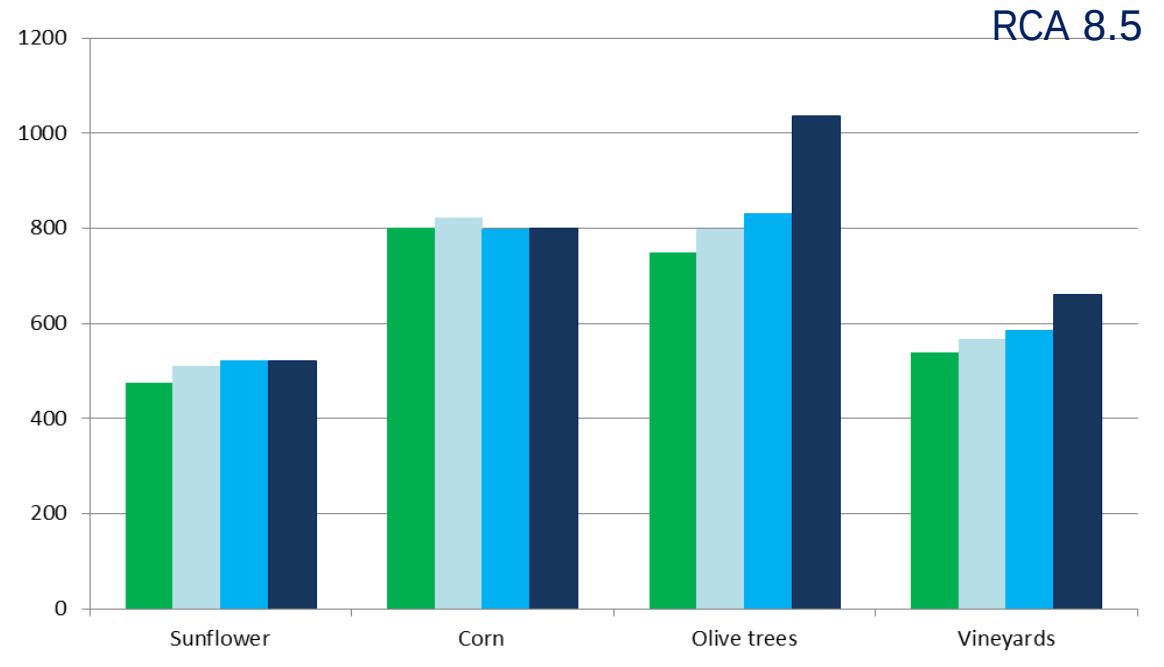
Irrigation water requirements
(mm/year)

- Moderate increase of water requirements (in line with the decrease in annual rainfall, coupled with an increase in temperature and potential evapotranspiration)

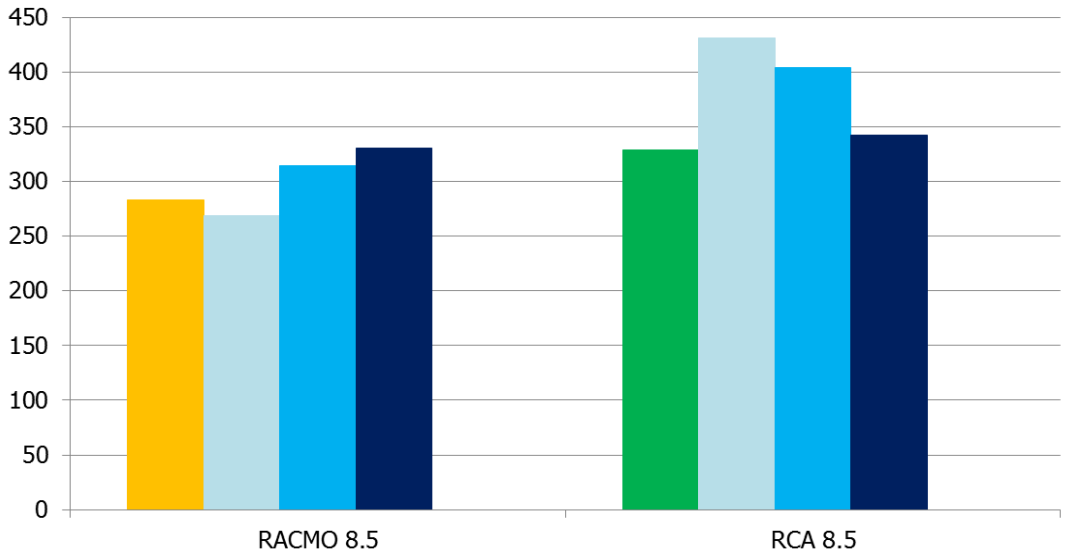
- Annual crops (sunflower and corn) are less sensitive to climate changes due to seasonal changes, namely a decrease in autumn rainfall

RACMO control
RCA control
2010-2040
2030-2070
2060-2100



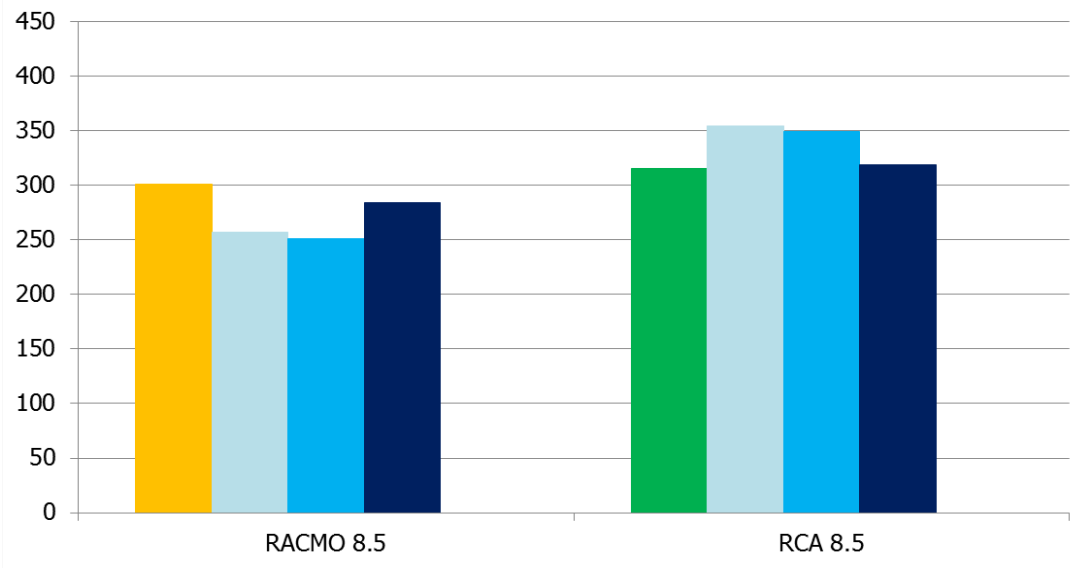


Monte Novo reservoir phosphorus (kg/month)



- Increase in phosphate exports from agricultural fields, due to rainfall and runoff in the wet season, with higher impacts on soil losses
- Changes to phosphate transport until the reservoirs, which closely follow the inflow variation trends
- The Monto Novo reservoir vulnerable - watershed has a larger occupation of intensive croplands (annual cultures), with a consequential higher use of fertilizers and soil mobilization

Vigia reservoir phosphorus (kg/month)



RACMO control
RCA control
2010-2040
2030-2070
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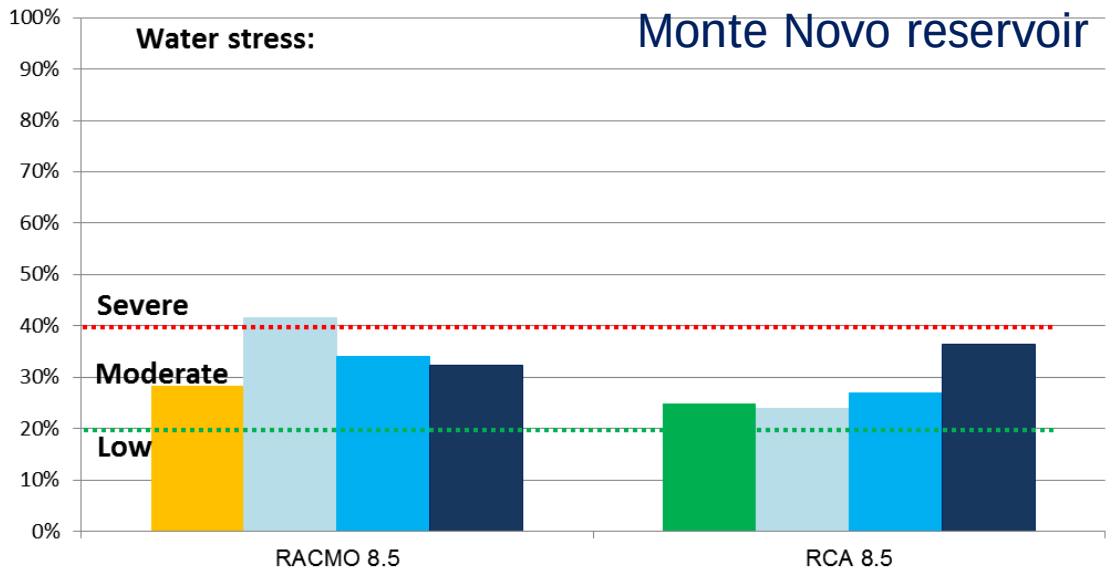
- Water exploitation index (WEI)

$$\text{WEI} = \frac{\text{Water use (urban + irrigation)}}{\text{water available}}$$

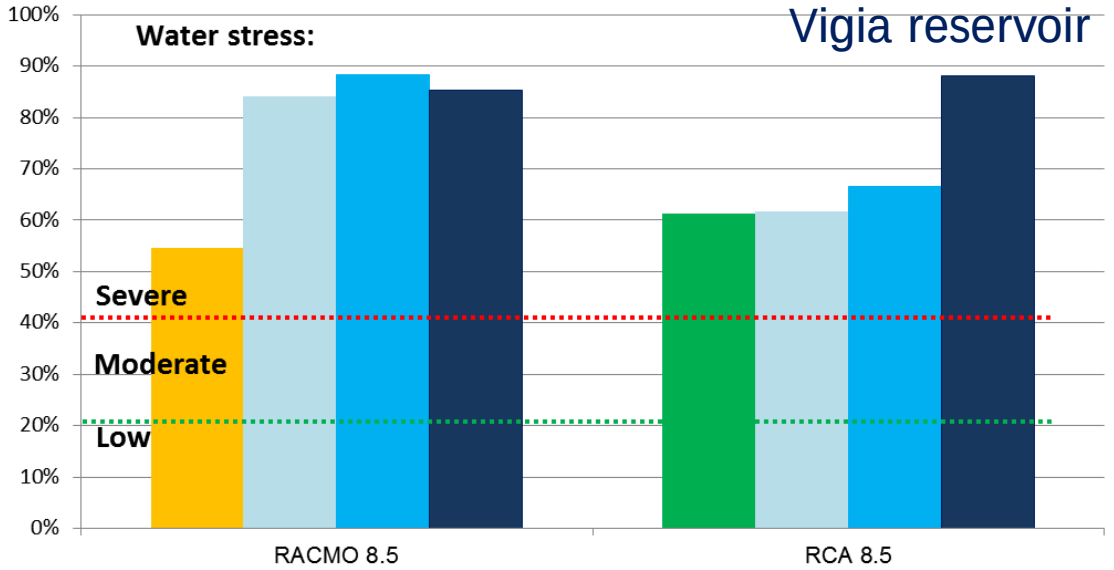
(based on irrigation requirements and inflows to each reservoir)



- Monte Novo reservoir will continue to be, in moderate water stress

- Moderate increase of the irrigated area (from 3.9 % up to 7.1% - 2041)

- Vigia reservoir will continue to be in severe water stress.



RACMO control
RCA control
2010-2040
2030-2070
2060-2100

- Low capacity to support climate change adaptation measures involving an increase in irrigated area
- Water efficiency measures, both for irrigated systems and for crop selection, could limit foreseen water stress conditions
- Climate change adaptation measures might already lead to short-term improvements in water resources
- Changes in the management operations – anticipating planting operation 1 or 2 months
- Adaptation strategies to future climate change:
  - increase of the irrigated area (from 3.9 % up to 7.1% - 2041) – unsuitable system response due severe to water stress
  - changes on crops – plants with lower water dependency
  - more efficient irrigation systems for olive groves and vineyards

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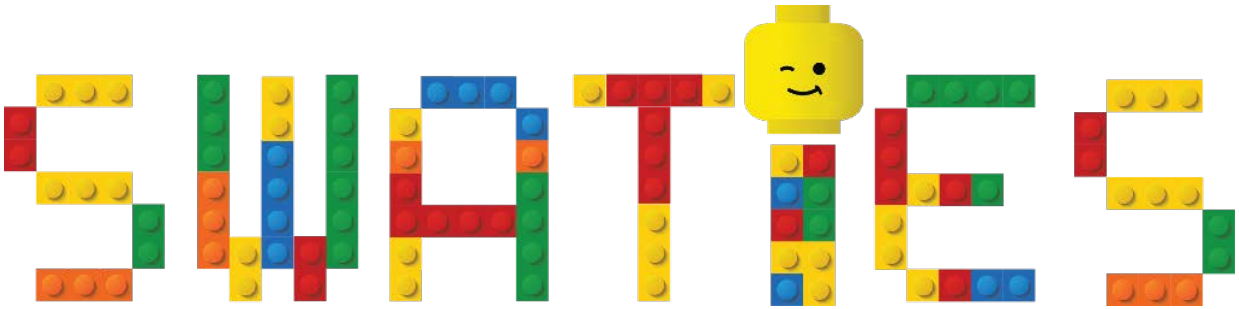
Thank you



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