The ClimAware project

- climate change impacts on the management of water resources -

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Center for Environmental Systems Research

The main objectives of ClimAware:

- Analyse the impacts of climate change on freshwater resources
- Investigate uncertainties in climate model – scenario combinations
- Identify efficient adaptation strategies
- Contribute to the implementation of the WFD

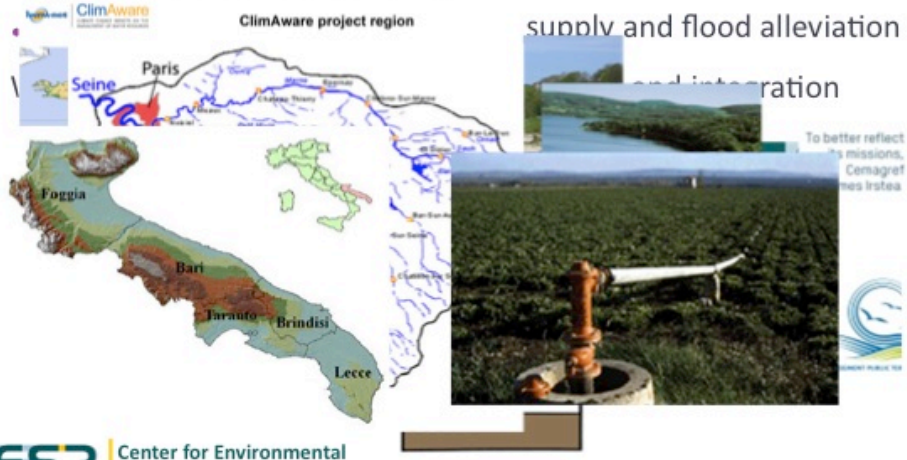
How does the project wants to achieve its objectives?

WP 1: European modelling

WP 2: Case studies

- CS1: Eder River, Germany
- CS2: Seine River basin, France

- to set the framework for the whole project
- to select appropriate scenarios and climate change input
- to perform European modelling
- Influence of climate change on hydromorphological characteristics
- supply and flood alleviation under CC
- and integration



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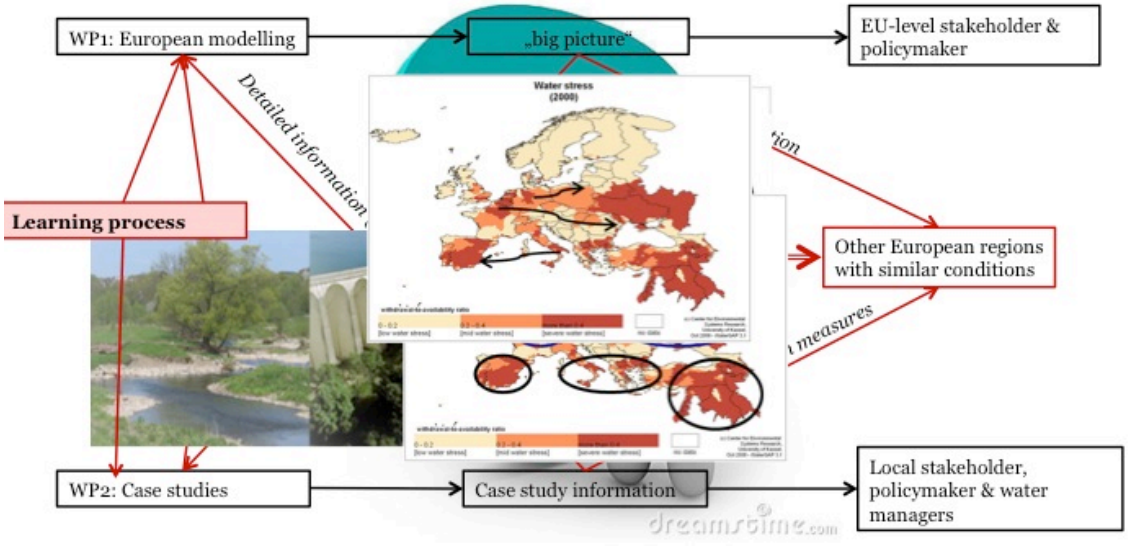
Cross-scale and cross-case analysis



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Climate change projections and scenarios

Time slices:

- Baseline: 1971-2000
- Scenarios: 2050s (2041-2070)

Global circulation models:

- CNCM3 (Centre National de Recherches Meteorologiques, France)
- ECHAM5 (Max-Planck Institute for Meteorology, Germany)
- IPSL –CM4 (Institute Pierre Simone Laplace, France)

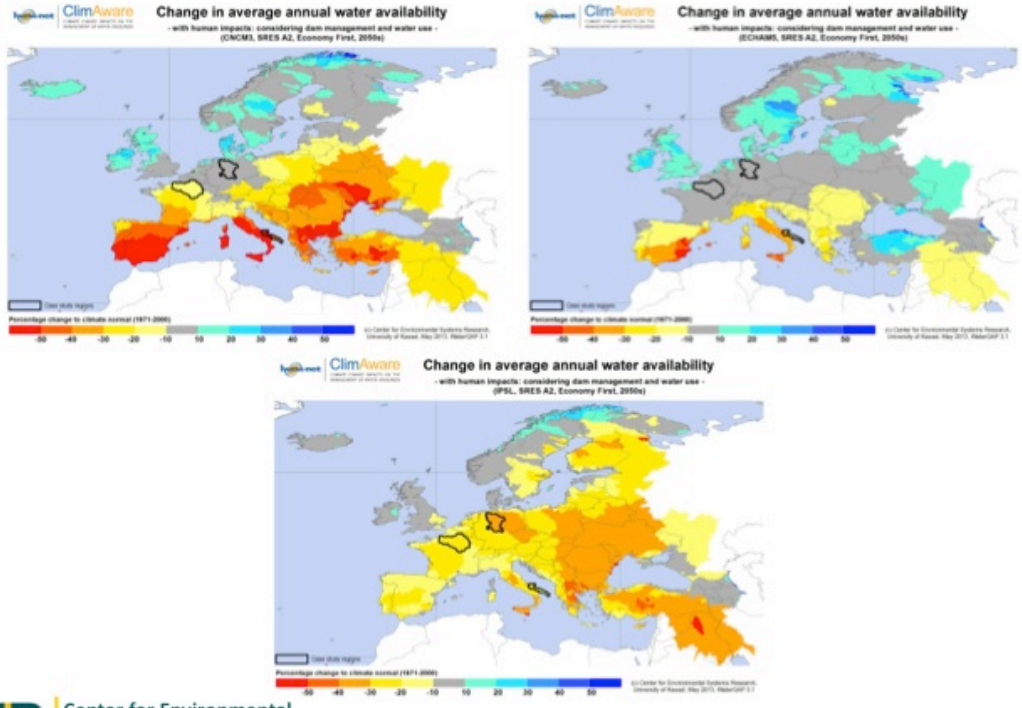
Emission scenarios:

- SRES A2
- SRES B1

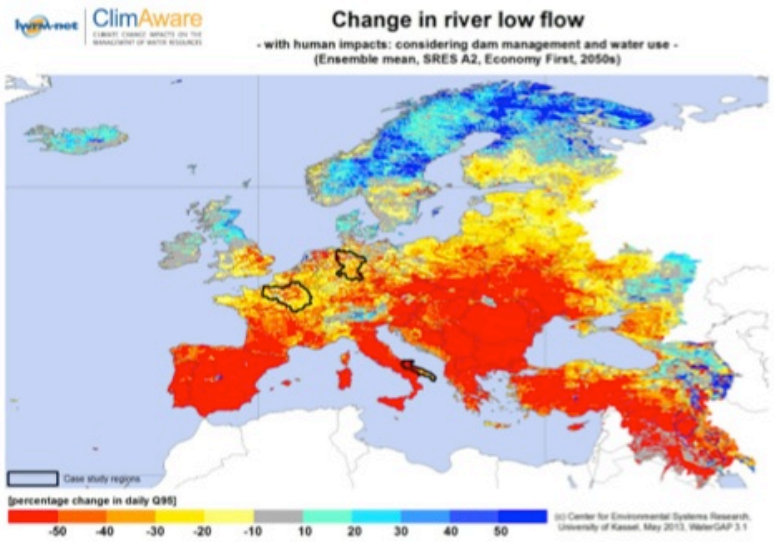
Socio-economic scenarios:

- Economy First
- Sustainability Eventually

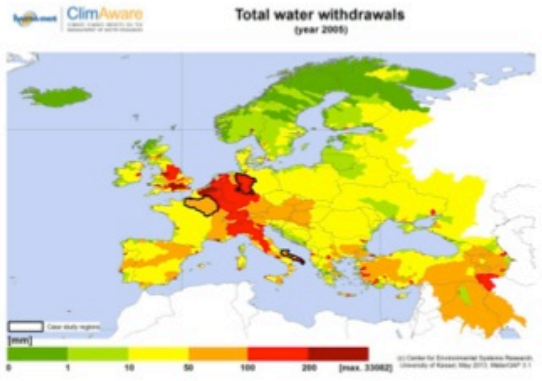
European modelling: annual water availability

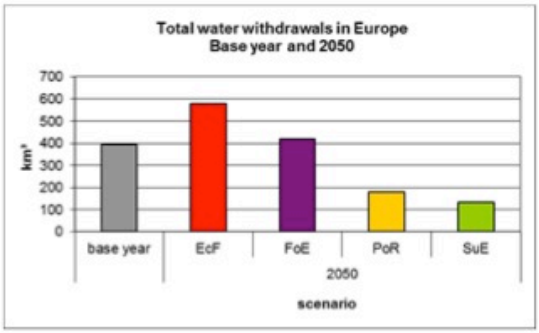


European modelling: change in low flows



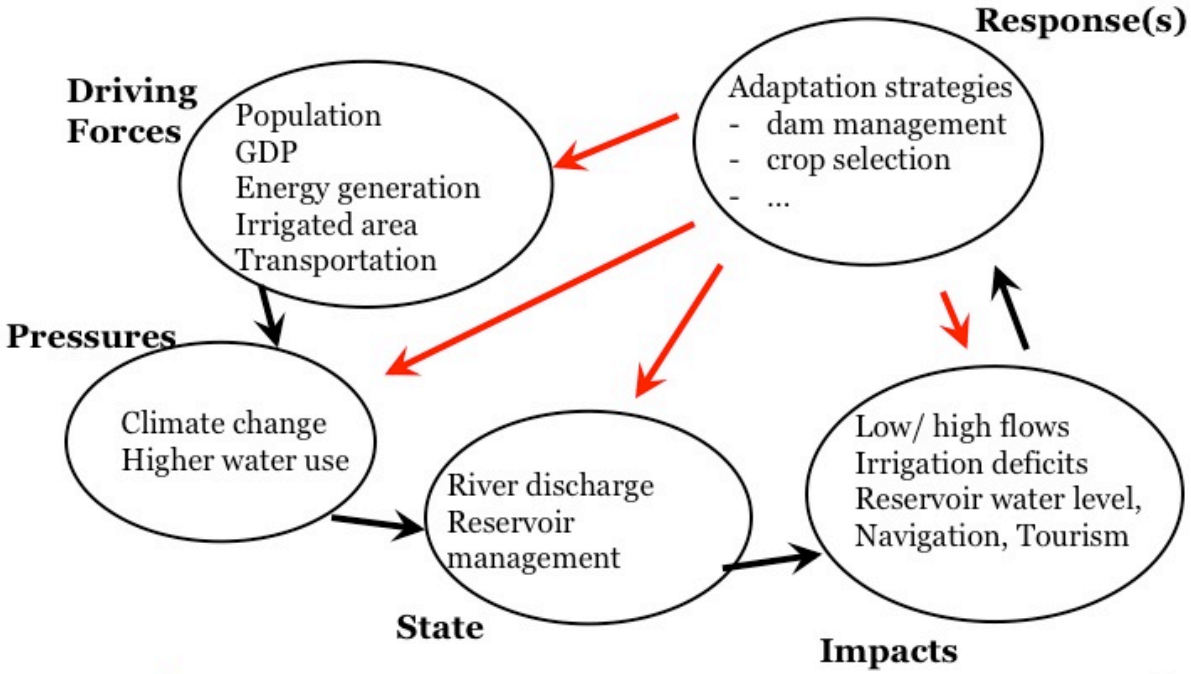
European modelling: change in total water withdrawals





http://www.cesr.de/SCENES_WebService/

DPSIR-framework



Changes in climatic driving forces

Eder	2000s	ensemble mean	uncertainty GCM
Precipitation (A2)	901mm	+2.4%	(-9.2 to 9.9%)
Precipitation (B1)	901mm	-3.4%	(-9.4 to +3.0%)
Temperature (A2)	8.0°C	+2.2°C	(+1.6 to +2.5°C)
Temperature (B1)	8.0°C	+1.7°C	(+1.3 to +2.2°C)

Seine	2000s	ensemble mean	uncertainty GCM
Precipitation (A2)	839mm	-7.3%	(-12.0 to -3.5%)
Precipitation (B1)	839mm	-11.3%	(-13.0 to -9.6%)
Temperature (A2)	10.6°C	+2.1°C	(+1.7 to +2.3°C)
Temperature (B1)	10.6°C	+1.6°C	(+1.3 to +1.9°C)

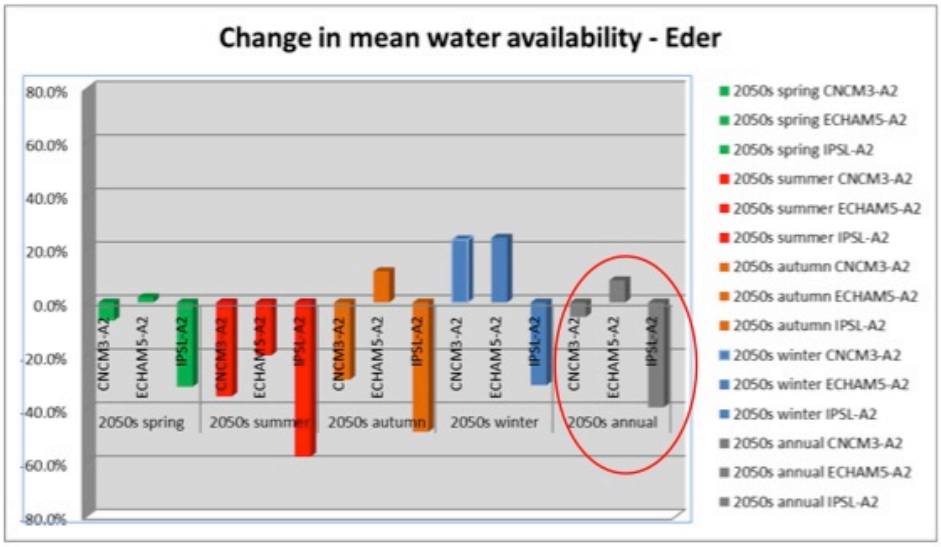
Apulia	2000s	ensemble mean	uncertainty GCM
Precipitation (A2)	594mm	-20.6%	(-25.2 to -17.1%)
Precipitation (B1)	594mm	-14.4%	(-16.8 to -12.8%)
Temperature (A2)	15.4°C	+2.3°C	(+2.0 to +2.4°C)
Temperature (B1)	15.4°C	+1.8°C	(+1.5 to +2.1°C)

Analysis (Eder River)

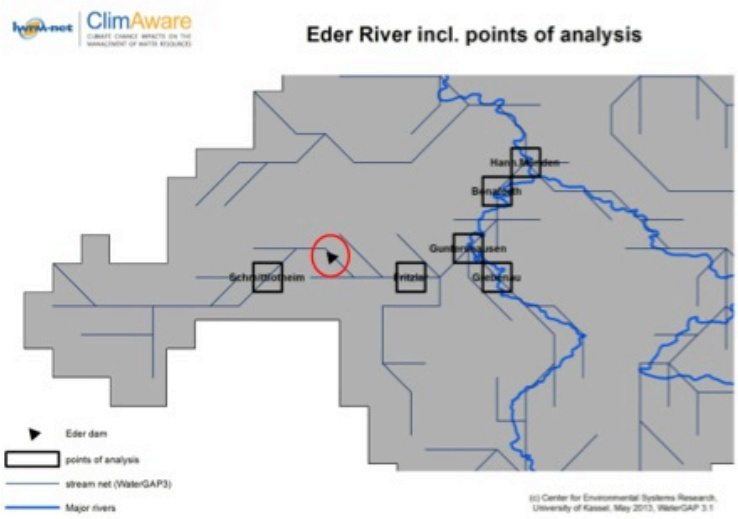
Indicators to identify
- Impact of climate change on low flows?
- Impact of climate change on high flows?

Adaptation strategies with respect to the following questions:
- Is current reservoir management sufficient for future challenges?
  - Is navigation still possible in the future?
  - Impacts on tourism during summer
  - Does flood protection need to be improved?
- What is the impact on nature (WFD)?

Change in state variables (Eder River)



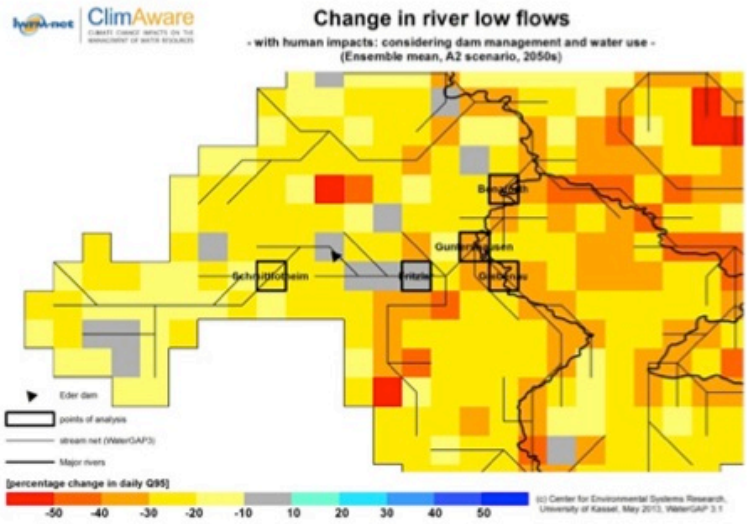
Impacts on low flows (Eder River)



Elevation of Q95 low flow due to dam management

River	Station	2000s	2050s (Ens.mean)
Eder	Schmittlotheim	0%	-23%
Eder	Fritzlar	20%	9%
Fulda	Grebenau	0%	-34%
Fulda	Guntershausen	17%	-20%
Fulda	Bonaforth	17%	-23%
Weser	Hann.Münden	12%	-26%

Impacts on low flows (Eder River)



Fluss	Station	Perc. Change 2050s
Eder	Schmittlotheim	-22%
Eder	Fritzlar	-8%
Fulda	Grebenau	-36%
Fulda	Guntershausen	-31%
Fulda	Bonaforth	-35%
Weser	Hann. Münden	-38%

Analysis (Seine River basin)

Indicators to identify
- Impact of climate change on low flows?
- Impact of climate change on high flows?

Adaptation strategies with respect to the following questions:
- What is the impact of climate change on seasonal flows?
- What is the impact of future water demands?
- Does current reservoir management need to be adapted to future conditions?

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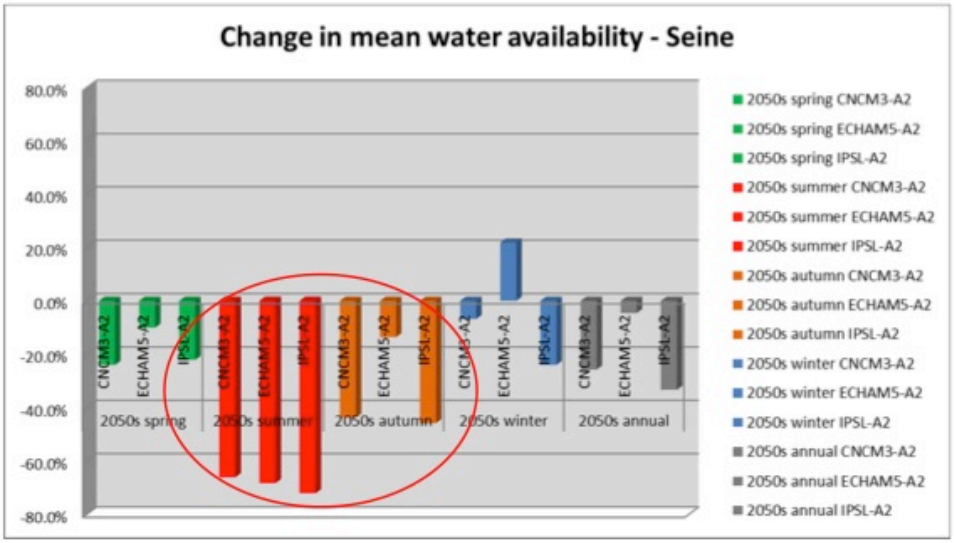
Change in state variables



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Analysis (Apulia region)

Indicators to identify
- Seasonal / monthly water stress
- Irrigation water requirements

Adaptation strategies with respect to the following questions:
- What is the impact of land use change on water resources / irrigation water requirements?
- Can a different selection of crops counteract the impacts of climate change?
- Can increasing water use efficiency counteract the impacts of climate change?

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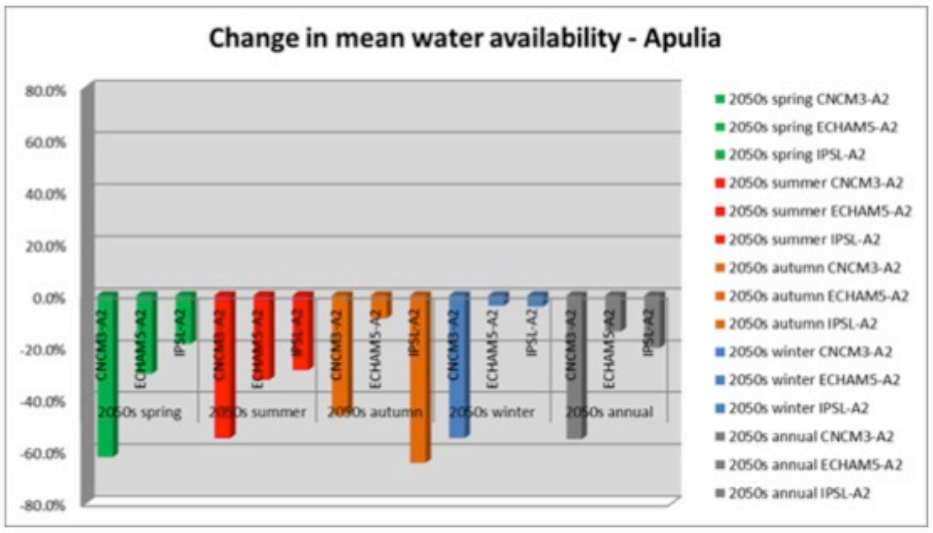
State variables (Apulia region)



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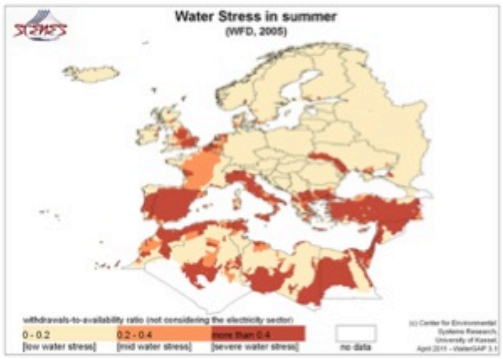
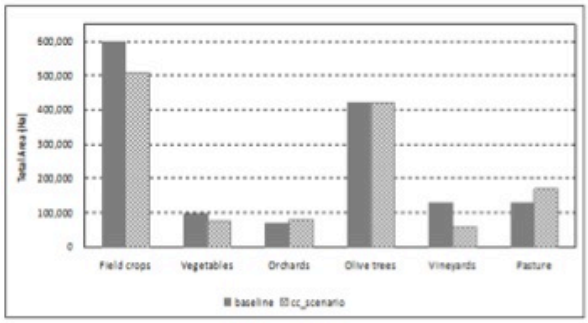
Impacts: seasonal water stress (Apulia region)

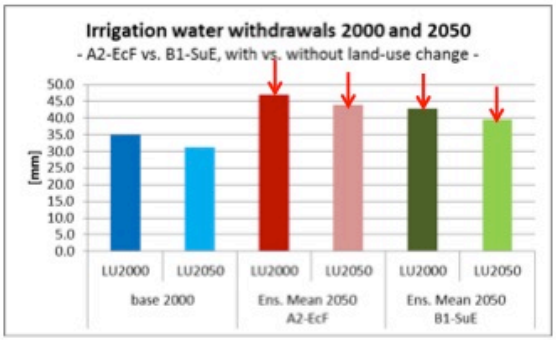


wta	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2005	0.08	0.07	0.10	0.19	0.72	1.57	2.31	2.34	1.37	0.39	0.12	0.09
2050 A2 EcF												
CNCM3	0.23	0.28	0.32	1.49	3.46	4.62	5.36	3.95	2.94	0.63	0.41	0.26
ECHAM5	0.14	0.11	0.19	0.56	1.73	3.38	4.71	4.71	2.36	0.33	0.26	0.12
IPSL	0.11	0.11	0.15	0.73	2.21	3.49	4.50	5.42	3.31	1.64	0.60	0.14
2050 B1 SuE												
CNCM3	0.05	0.05	0.08	0.29	1.57	2.33	3.24	3.11	0.78	0.29	0.11	0.05
ECHAM5	0.04	0.04	0.05	0.22	1.02	2.03	3.08	2.88	1.65	0.33	0.11	0.03
IPSL	0.04	0.04	0.08	0.35	1.21	2.09	3.44	3.20	1.71	0.34	0.09	0.05

Apulia region: impact climate change and land-use change



Crop	Perc. change
field crops	-15%
vegetables	-22%
orchards	+12%
olive trees	0%
vineyards	-54%
pasture	+31%



Climate	Land-use	withdrawals [mm]
base 2000	LU2000	35.0
	LU2050	31.2
Ens. Mean 2050	LU2000	47.0
A2-EcF	LU2050	44.0
Ens. Mean 2050	LU2000	42.7
B1-SuE	LU2050	39.4

Conclusions

- ClimAware operates on continental and regional scale
- Climate change is likely to impact river flow regimes in Europe
- Specific adaptation measures
  - Eder River, Germany
  - Seine River basin, France
  - Apulia region, Italy
- Transfer of knowledge
  - Identification of other regions with similar issues

Thank you for your attention!

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CLIMATE CHANGE IMPACTS ON THE MANAGEMENT OF WATER RESOURCES