SOUTH EAST EUROPE
Transnational Cooperation Programme
Co-funded by the EUROPEAN REGIONAL DEVELOPMENT FUND

CLIMATE CHANGE AND IMPACT ON PUBLIC WATER SUPPLY

–

case study of Ljubljana Field and Mura Valley (Slovenia)

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INTRODUCTION

the main drinking water supply problem

significant changes of groundwater quantity and quality observed in the last decades

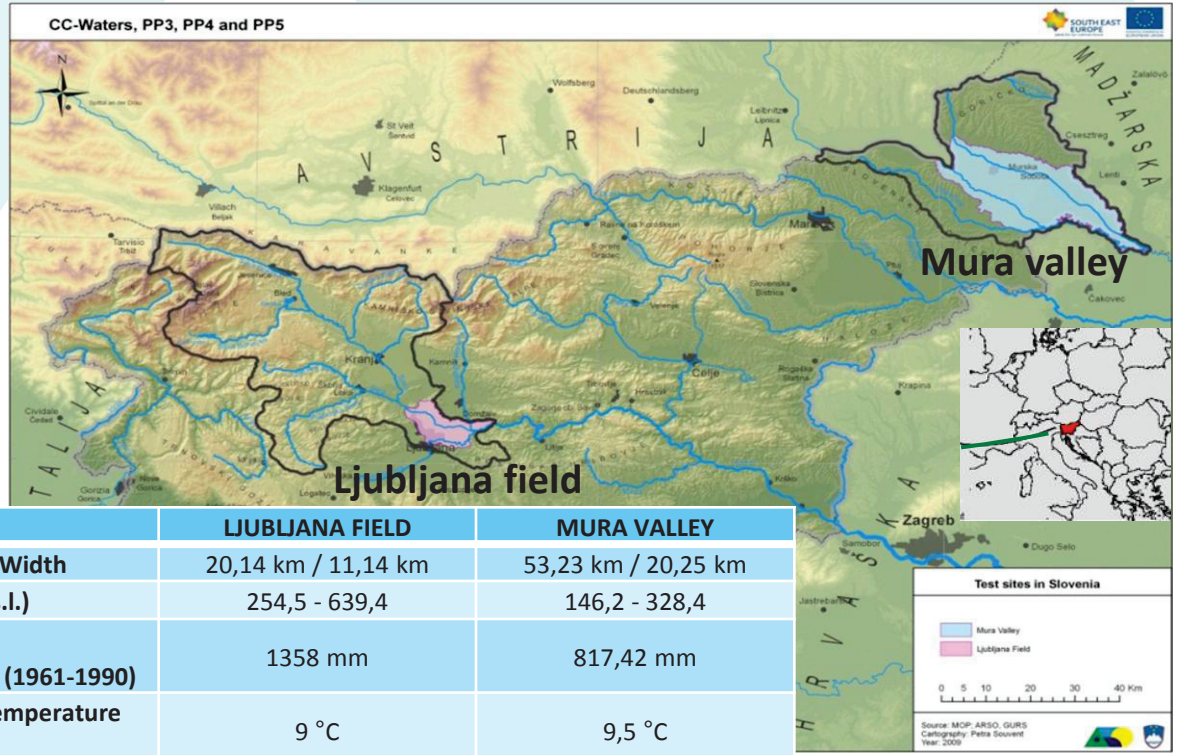
land use practices & very likely also climate change

SEE projects CC-WaterS (Climate Change and Impact on Water Supply) and CC-WARE (Mitigating Vulnerability of Water Resources under Climate Change)

→ a water supply management system

CC-WaterS - Climate Change and Impacts on Water Supply

SLOVENIAN TEST SITES



BASIC DATA	LJUBLJANA FIELD	MURA VALLEY
Size: Length/Width	20,14 km / 11,14 km	53,23 km / 20,25 km
Height (m a.s.l.)	254,5 - 639,4	146,2 - 328,4
Average ann. precipitation (1961-1990)	1358 mm	817,42 mm
Mean ann. temperature (1961-1990)	9 °C	9,5 °C
Permeability (mean)	10^{-2} - $3{,}7 \cdot 10^{-3}$ m/s	10^{-4} m/s
Depth to GW (mean)	5 - 30 m	4 m

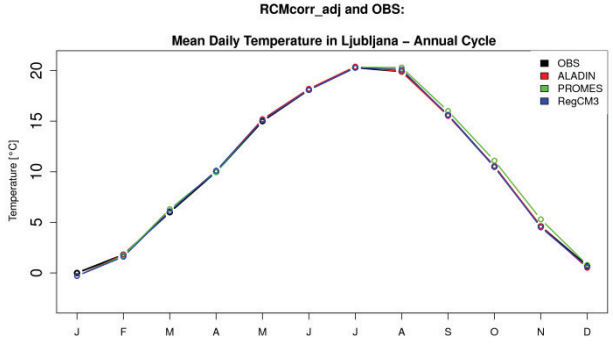
CLIMATE CHANGE SCENARIOS

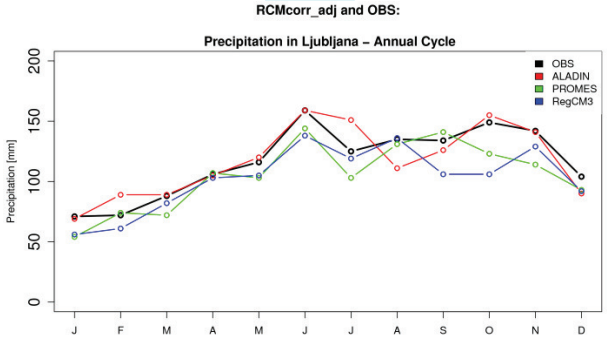
- Emission scenario SRES A1B
- Future periods: 2021-2051, 2071-2100
- RCM: ALADIN, Promes, RegCM3

RCM bias corrected to EOBS db grid 0,25°x 0,25° (averaged relief – differences in mountianous areas)

→ RCM adjusted to local observ. quantile mapping approach

Location	Monitoring station altitude	Corresponding EOBS cell altitude
Kredarica	2514 m	1336 m
Ljubljana	299 m	385 m
Murska Sobota	188 m	221 m





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CLIMATE CHANGE — TEMPERATURE

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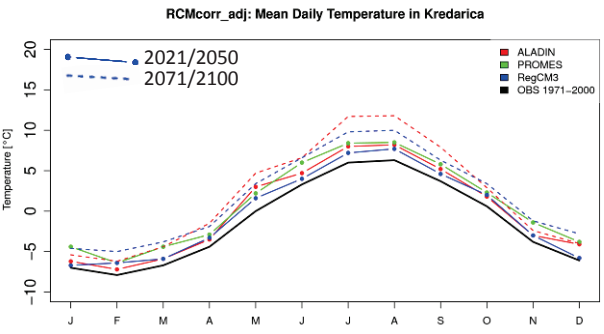
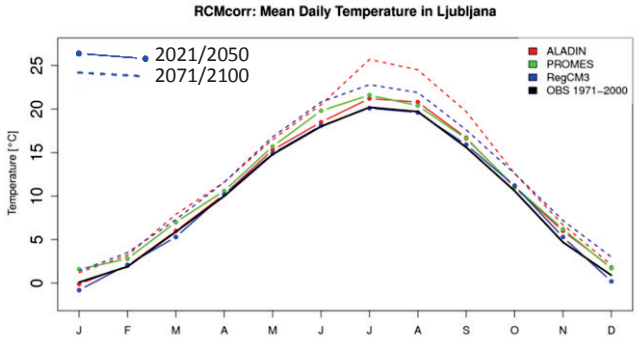
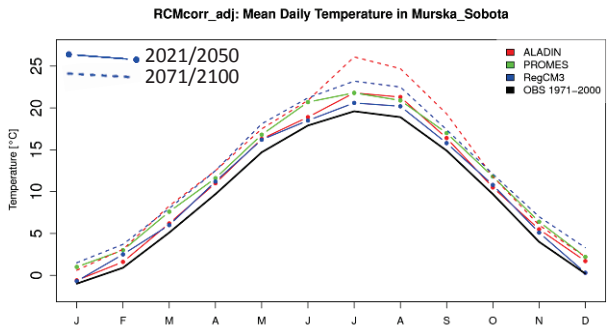
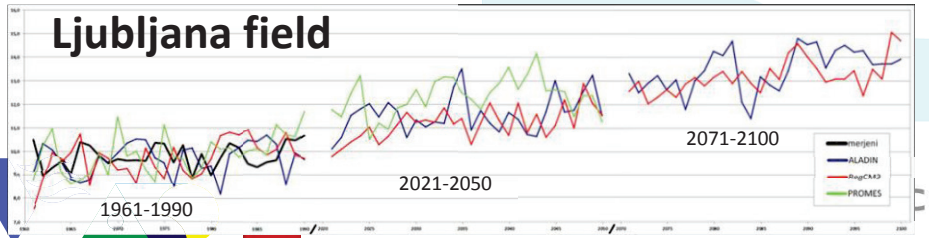


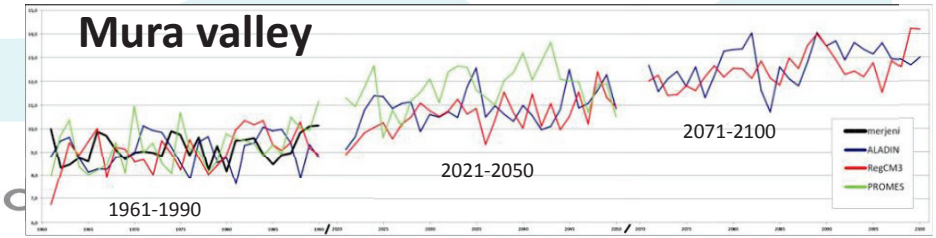




air temp. differences (yearly averages) between 2021-2050 / 2071-2100 and 1970-2000 [°C]

Model	KREDARICA	LJUBLJANA	MURSKA SOBOTA
ALADIN	1,4 / 3,1	1,4 /3,2	1,4 / 3,2
PROMES	2 / NA	2 / NA	2 / NA
RegCM3	1,2 / 3,3	1,3 / 3,0	1,2 / 3,0





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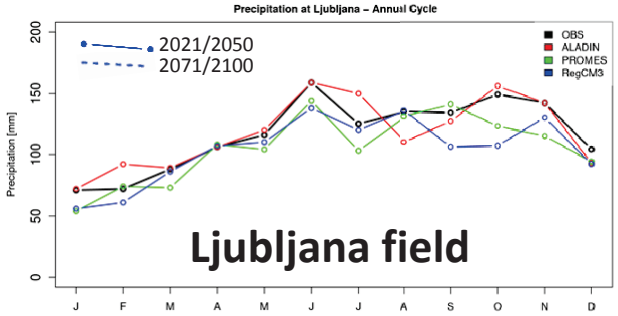
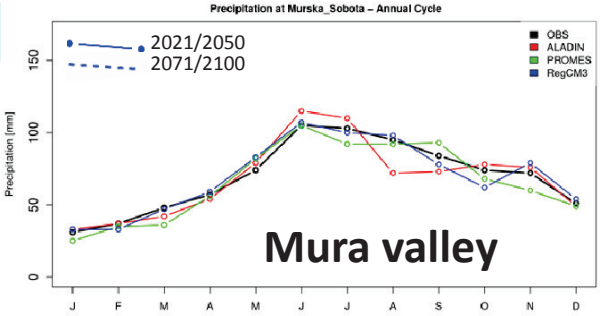
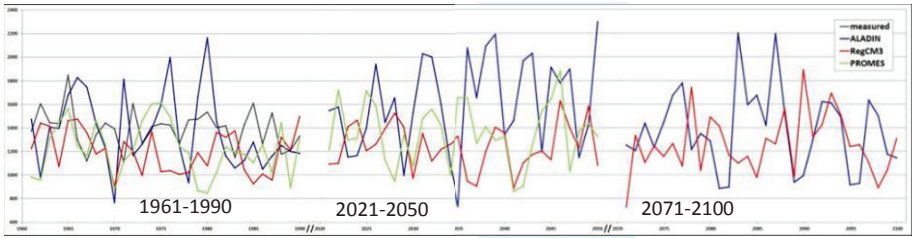
CLIMATE CHANGE PRECIPITATION

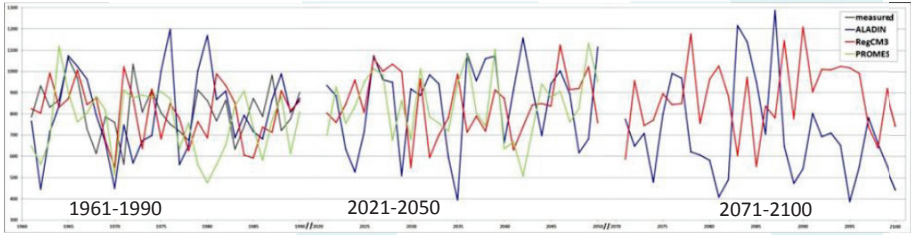


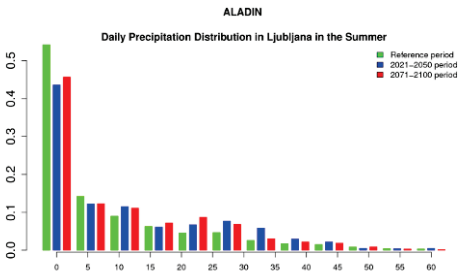
Ljubljana field



Mura valley

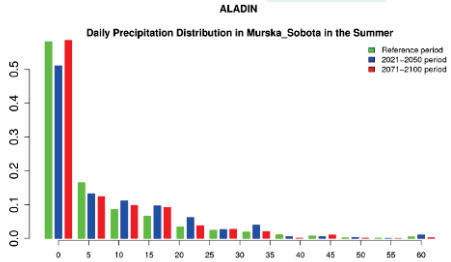






Annual precipitation in reference (1971-2000) and future periods (2021-2050 and 2071-2100) [mm]

Model	KREDARICA	LJUBLJANA	MURSKA SOBOTA
ALADIN	2119 / 2201 / 1973	1371 / 1611 / 1385	806 / 855/ 709
PROMES	2072 / 2186 / -	1219 / 1354 / NA	760 / 842 / -
RegCM3	2115 /2193 / 2138	1201 / 1244 / 1261	802 / 850 / 878



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CC SURFACE WATER DISCHARGE

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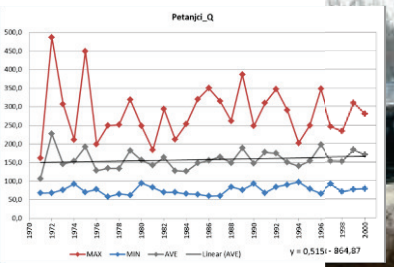

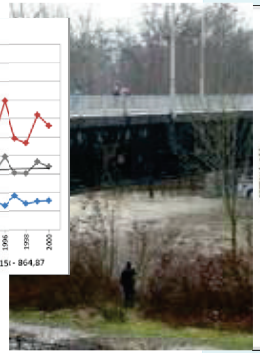

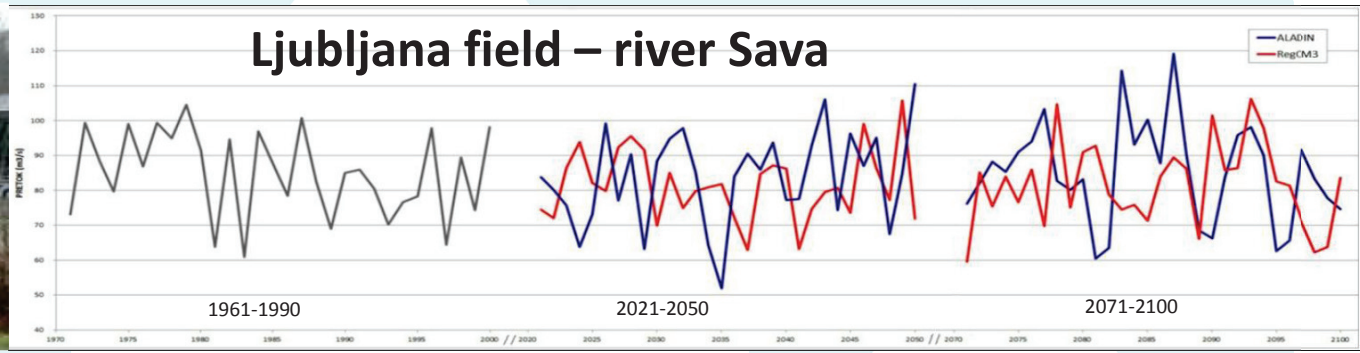

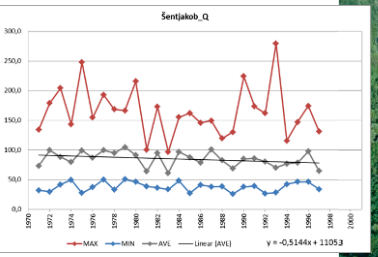

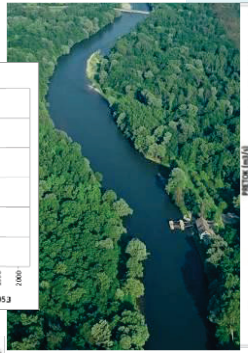

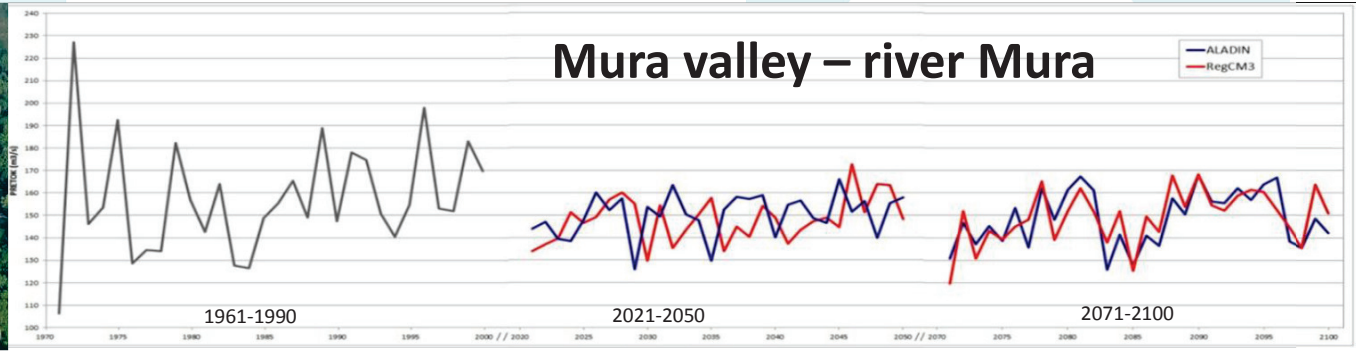

Jointly for our common future

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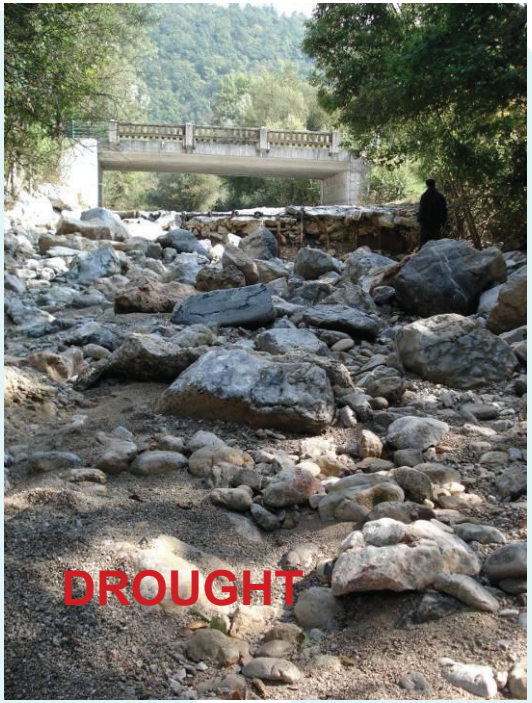
CC EXTREME EVENTS

water wellfield Mura valley

FLOODS

Ljubljana Vič 19.9.2010 (foto: J. Polajnar)

Ljubljana sep.2010



Ljubljana sep. 2011-Mar.2012

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GROUNDWATER LEVEL TRENDS

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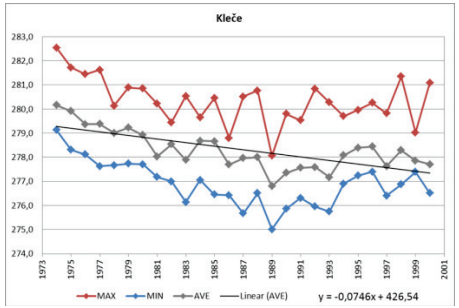
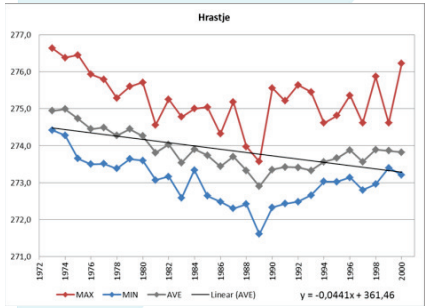
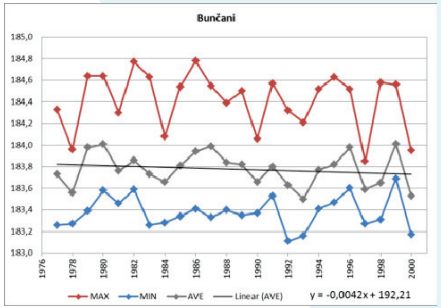
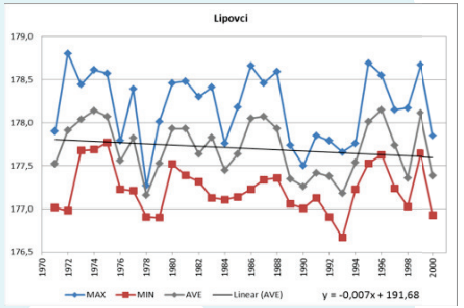
Ljubljana field

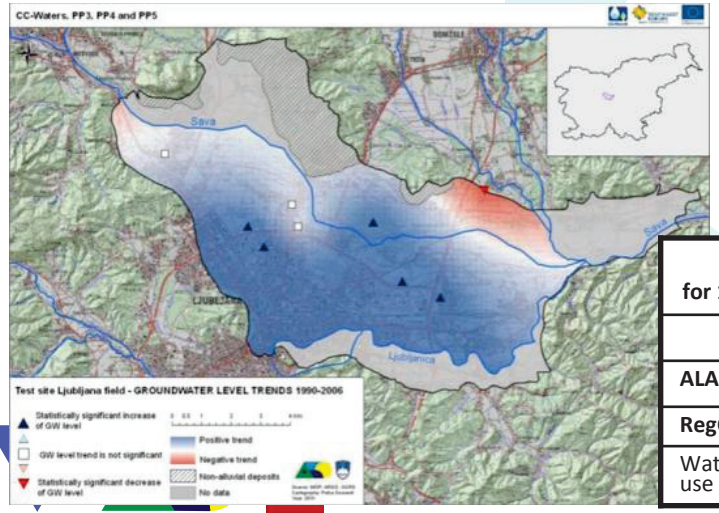


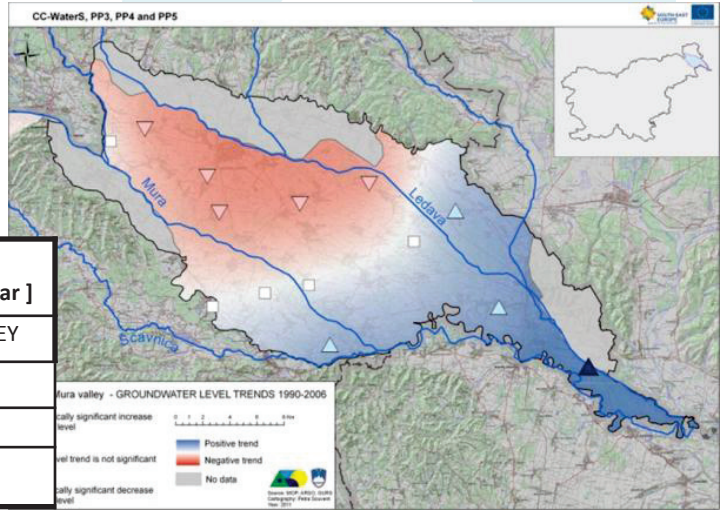


Mura valley





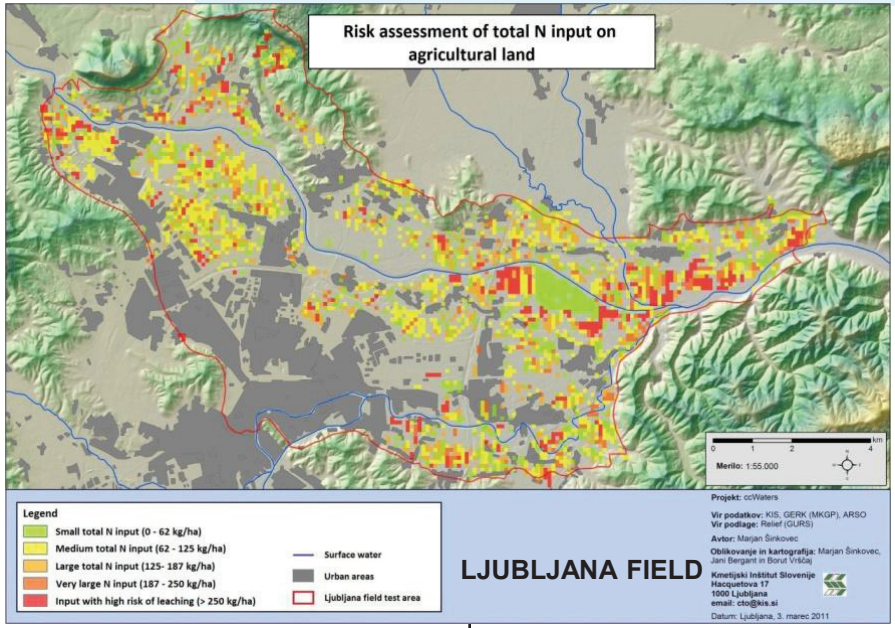




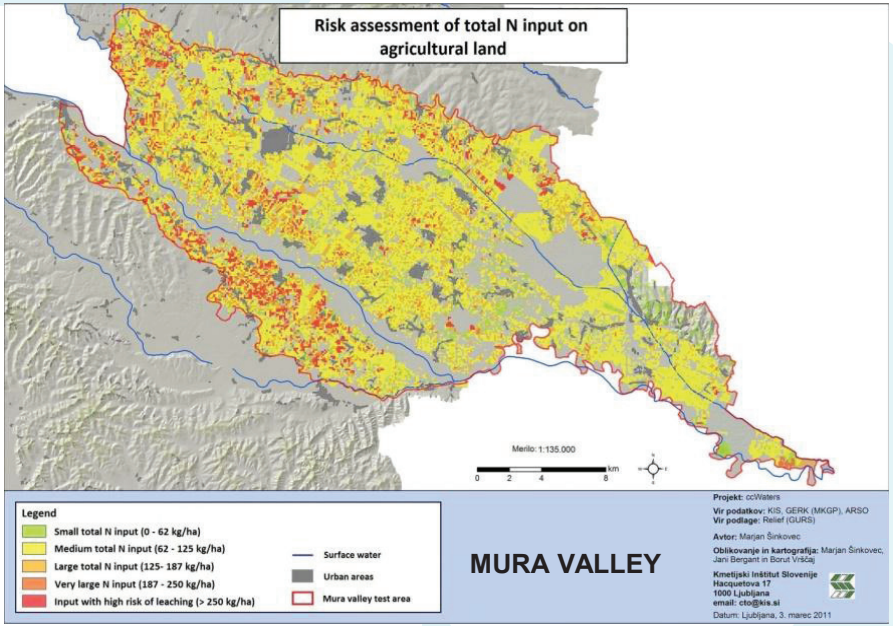
Available water resources and water use for 1971-2000 / 2021-2050 / 2071-2100 [Mm³/year]

	LJUBLJANA FIELD	MURA VALLEY
ALADIN	81 / 91 / 75	78 / 73 / 48
RegCM3	87 / 87 / 86	72 / 73 / 75
Water use	20,2 / 20,7 / 21,4	3,8 / 3,5 / 3,2

CC NITRATE LEACHING



LJUBLJANA FIELD



MURA VALLEY

	LJUBLJANA FIELD	MURA VALLEY
Agricultural areas	3.180 ha (43 %)	32.596 ha (73 %)
Crops	silage corn, vegetables, winter wheat, potatoes	corn, oil rape
N input > 250 kg/ha (red areas)	12,6 % of agricult. areas	6,3 % of agricult. areas
N leaching in next decades	increase of about 5 %	increase of about 5 %

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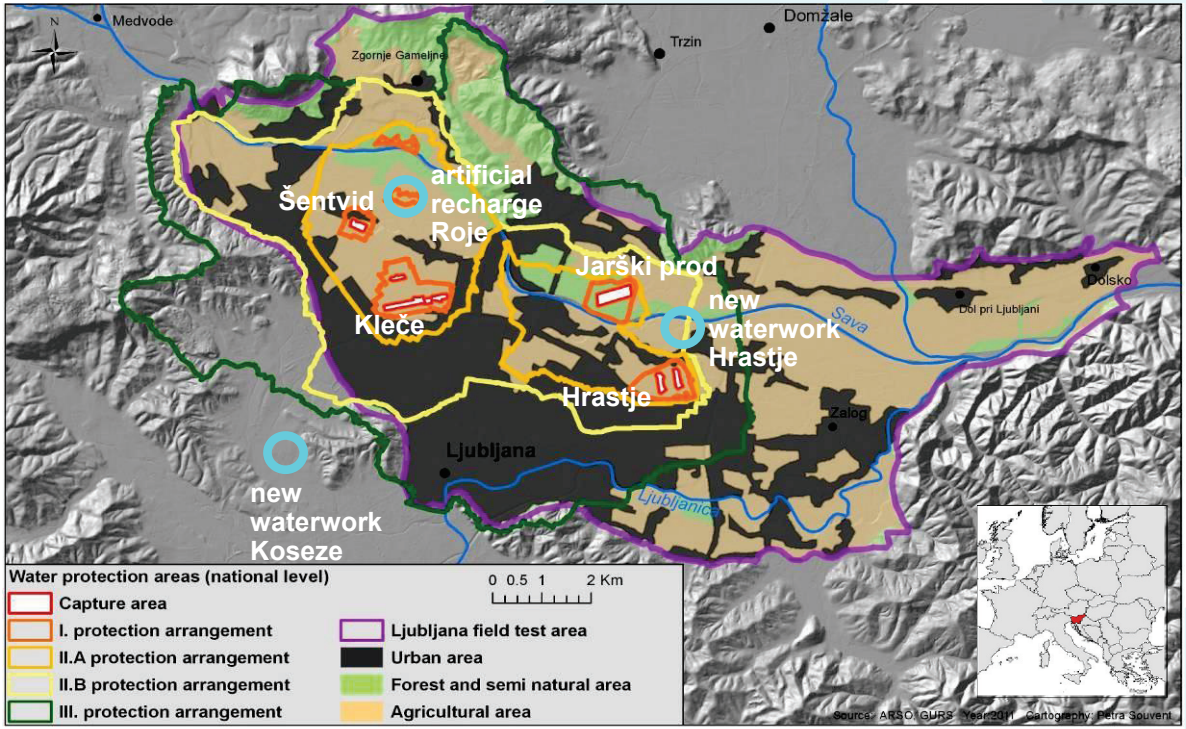
WATER SUPPLY MANAGEMENT OPTIONS



Fuzzy Decimaker' - a non-probabilistic risk analysis, based on simplified fuzzy set mathematics:

1. formulation of alternative manag. actions
2. defining of the ranking criteria structure
3. estimation of
each manageme
4. ranking of the
according to the

	2	CC 2021-2050
	3	CC1 A.I.Klece+VV01
	4	CC1 A.I.Klece+VV01+2
	5	CC1 A.I.Klece+W.Treat.
	6	CC1 W. treatment
	7	CC1 W.Hrastje+VV01
	8	CC1 W.Hrastje+VV01+2
	9	CC1 W.Hrastje+W.Treat.
	10	CC1 W.Koseze+VV01
	11	CC1 W.Koseze+VV01+2
	12	CC1 W.Koseze+W.Treat.

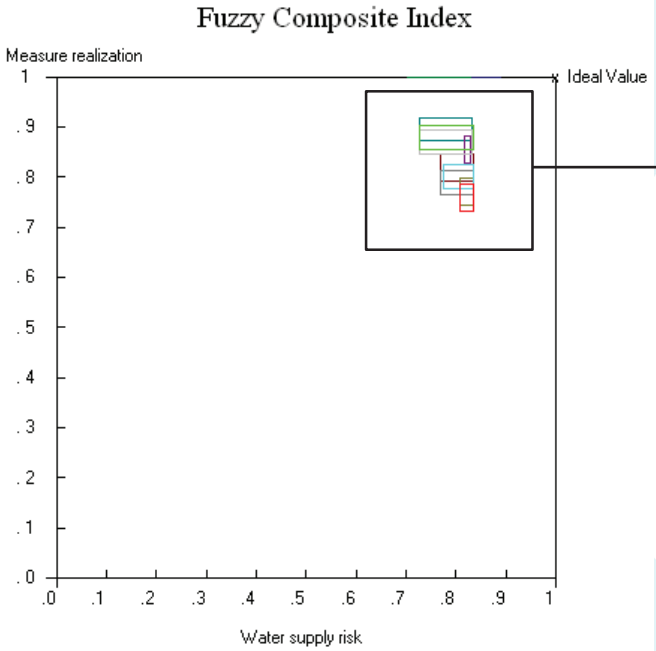
cost1 (€/m3)

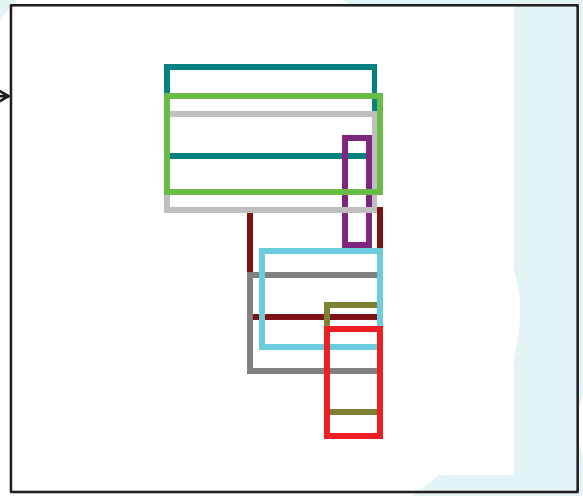
Lee, Y.W., Bogardi, I., Stansbury, J. 1991: Fuzzy Decision Making in Dredged-Material Mana

WATER SUPPLY MANAGEMENT OPTIONS

	Current price of water for standard use (€/m³)	Increase of price (€/m³)	New price of water (€/m³)
GW treatment	0,4963	0,1330	**0,6293**
Reimbursements for limited agricultural activities on VVO-I		0,0053	**0,5016**

WATER SUPPLY MANAGEMENT OPTIONS





CONCLUSIONS

- worst case scenarios (max T, P & min. river dicharges) decrease in future GW recharge
best case → no change in future GW recharge

	LJUBLJANA FIELD	MURA VALLEY →
2021-2050	↑ 12 %	↓ 6%
2071-2100	↓ 7 %	↓ 38 %

- There is a need for water supply management adaptation measures, that should managing the risks associated with future climate change impacts
- management options can be:
  - engineering interventions to enhance water resources, e.g. storage reservoirs, or to reduce water losses
  - legislative management options: higher restrictions of land uses in the recharge area or enlargement of water protection areas
  - water demand management
    - engineering interventions: e.g. recycling
    - economic actions: e.g. change of water pricing
    - social actions: public awareness for non wasteful water use

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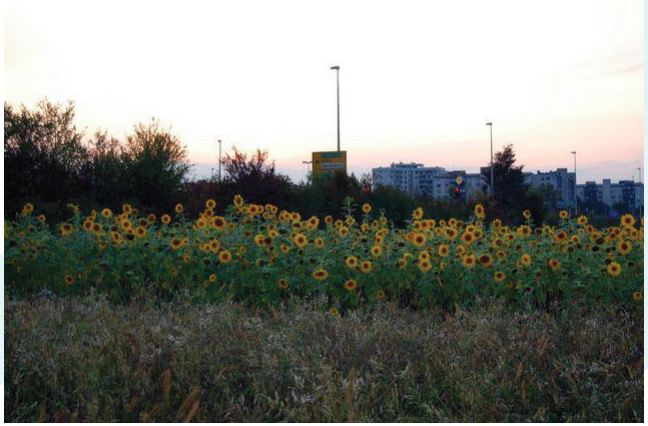

http://www.ccwaters.eu

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