Evaluation of trends of drought indices in SR and their potential on ecosystems (not only forest ES....) Drought Indices and Their Possible Trends in Terms of Climate Change in the Danubian Lowland

Bernard ŠIŠKA
Jozef TAKÁČ
Veronika ZUZULOVÁ

Soil Science and Conservation Research Institute Bratislava
Slovak University of Agriculture Nitra

The role of forest functions within ecosystem services,
Křtiny, Czech republic: 5-8th April, 2015

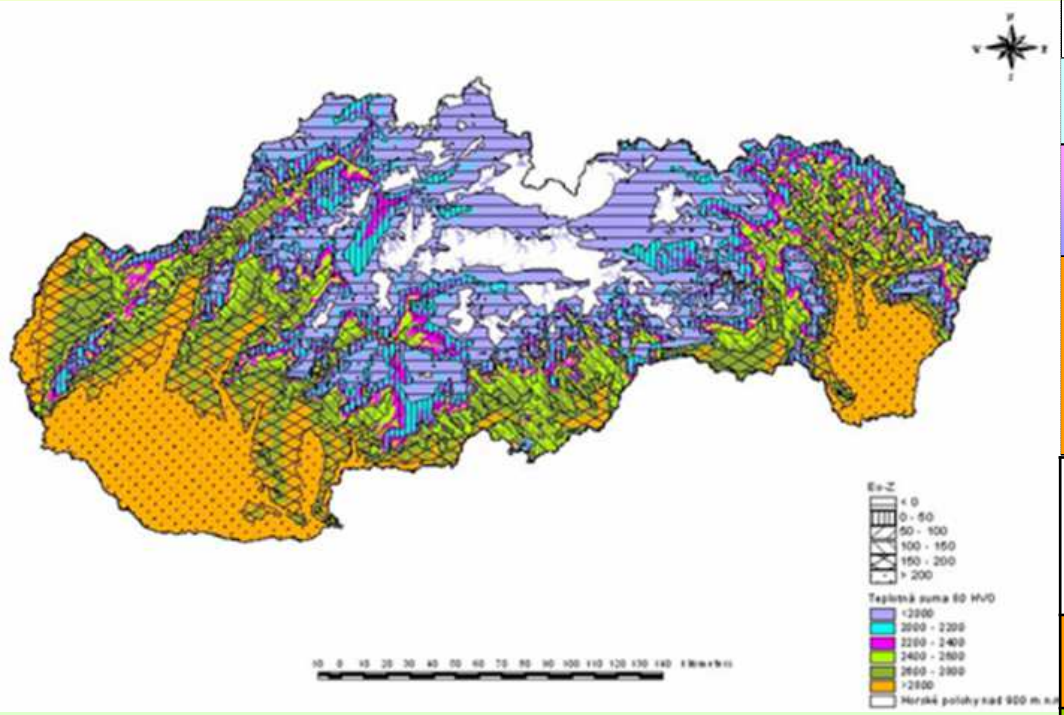
Motivation

- How atmospheric conditions during last decades of years influence the course of drought indices used in SR?
- How could climate change influence water need in future?
- Are drought indices good enough to describe impact on water shortage in real conditions?
- Comparision of DAISY simulation vs drought indicators

Model region

- Region: Danubian Lowland
- Meteorological Station: Hurbanovo

Agro-climatic regionalization



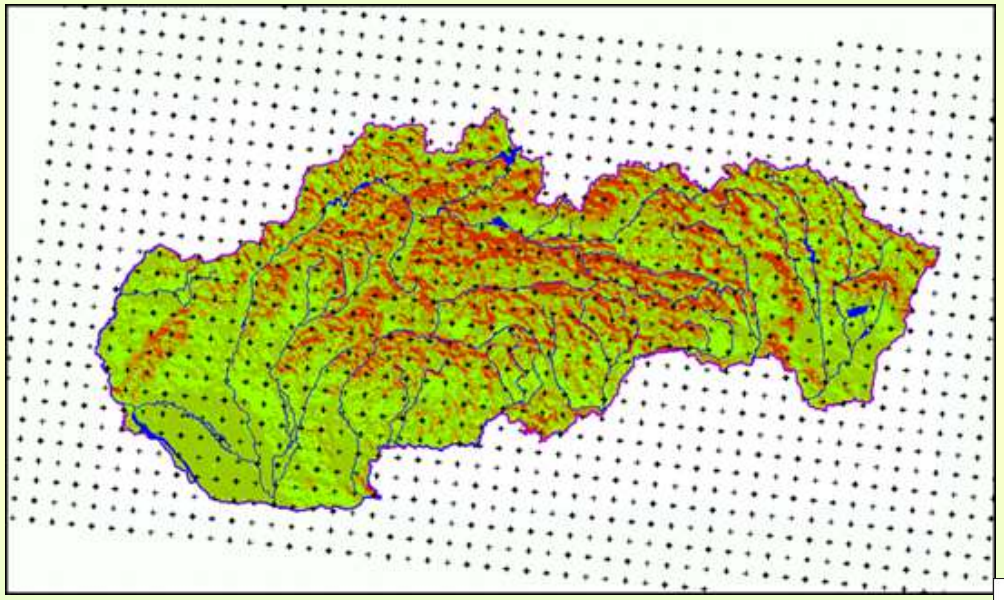
Region	Subregion	*TS10*	E_0-*R*	Agroregion
Cold	Wet	< 2000	< 0	**Mountainous**
Moderately warm	Normal	2000 – 2400	0 – 50	**Potato**
Warm	Semi Dry	2400 -2600	50 – 150	**Sugar beet**
	Dry	> 3000	> 150	**Maize**

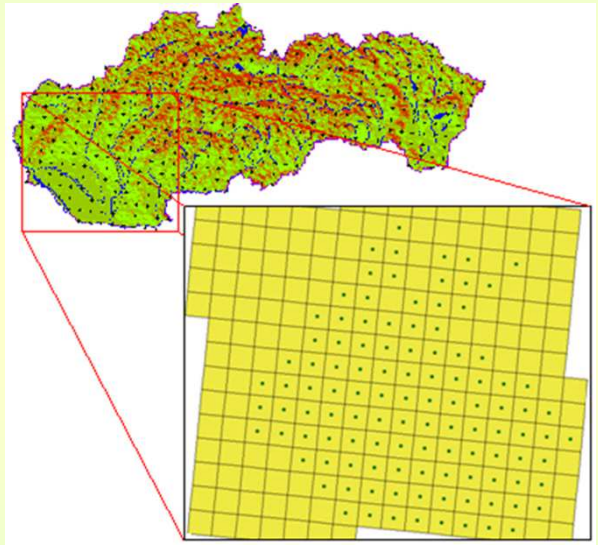
	PAR **[kWh.m^{-2}]**		***R*** **[mm]**	
	1xCO_2	**2xCO_2**	**1xCO_2**	**2xCO_2**
Maize	460 – 500	510 – 560	400 - 460	500 – 530
Sugar beet	435 – 460	485 – 510	460 -510	530 -580
Potato	400 – 435	465 – 485	510 -560	580 -650
Mountaineus	<400	<465	>560	>650

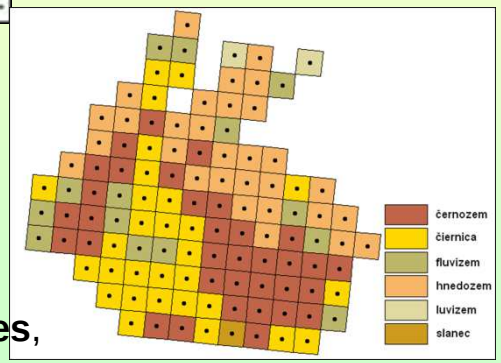
Methods and data

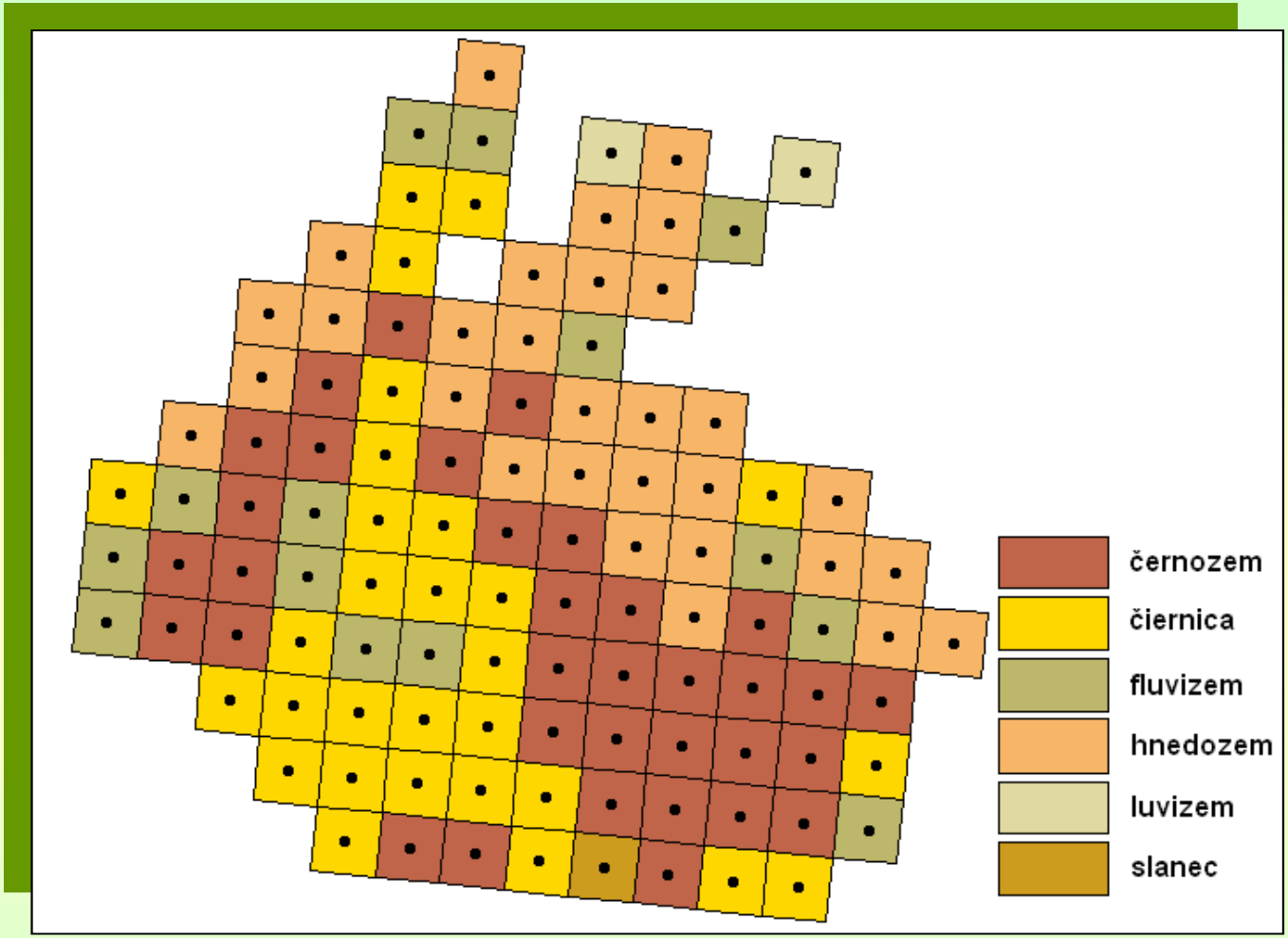
- Reference period: 1961-2000
- Emission scenarios: SRES A1B – gradual increase of CO_2 concentration
- Daily meteorological data (global radiation, temperature, precipitation) generated according to the outputs of GCM (CECILIA, Aladin - HRM) up to 2100
- Time slices 1xCO_2, 2xCO_2

Meteo-data and soil data









•*Soil types on Danubian lowland*

Present climate

- Agricultural drought
- Aridity index
- Water use efficiency

- Future climate
- Climatic water balance
- Evapotranspiration

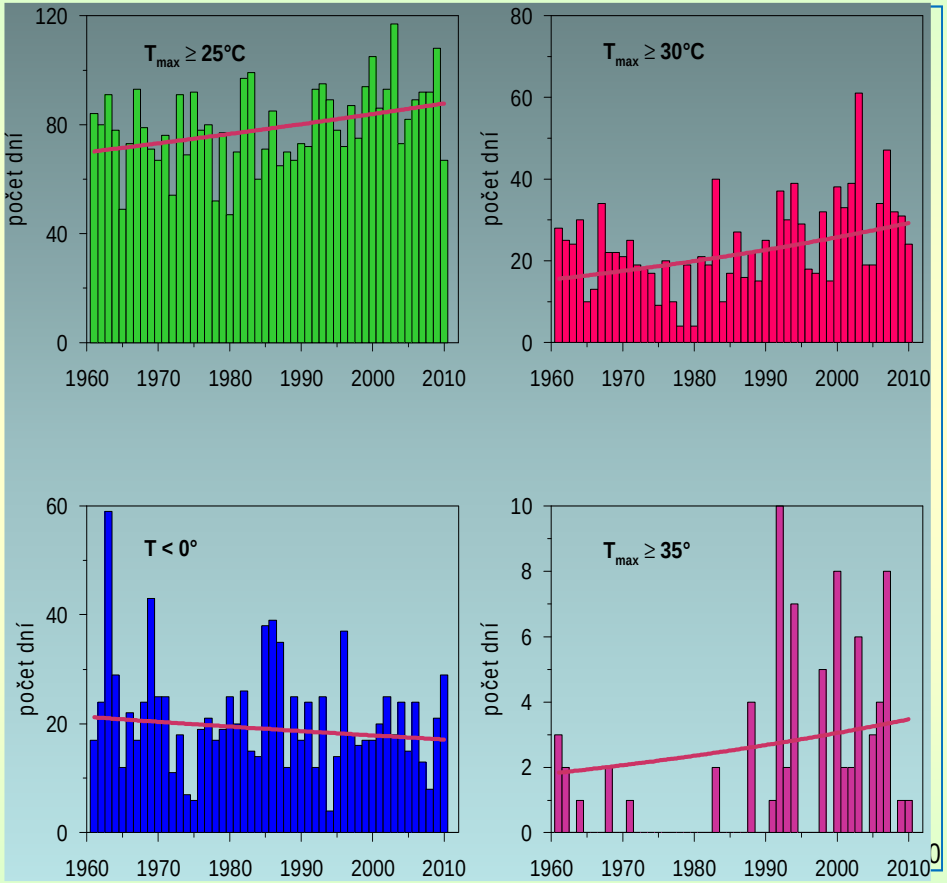
Warming trend

Mean values

- Annual temperature

Extreme values

- Hot days (T_{max} >25, 30, 35°C)
- Days with frost (T_{min} <0 °C)

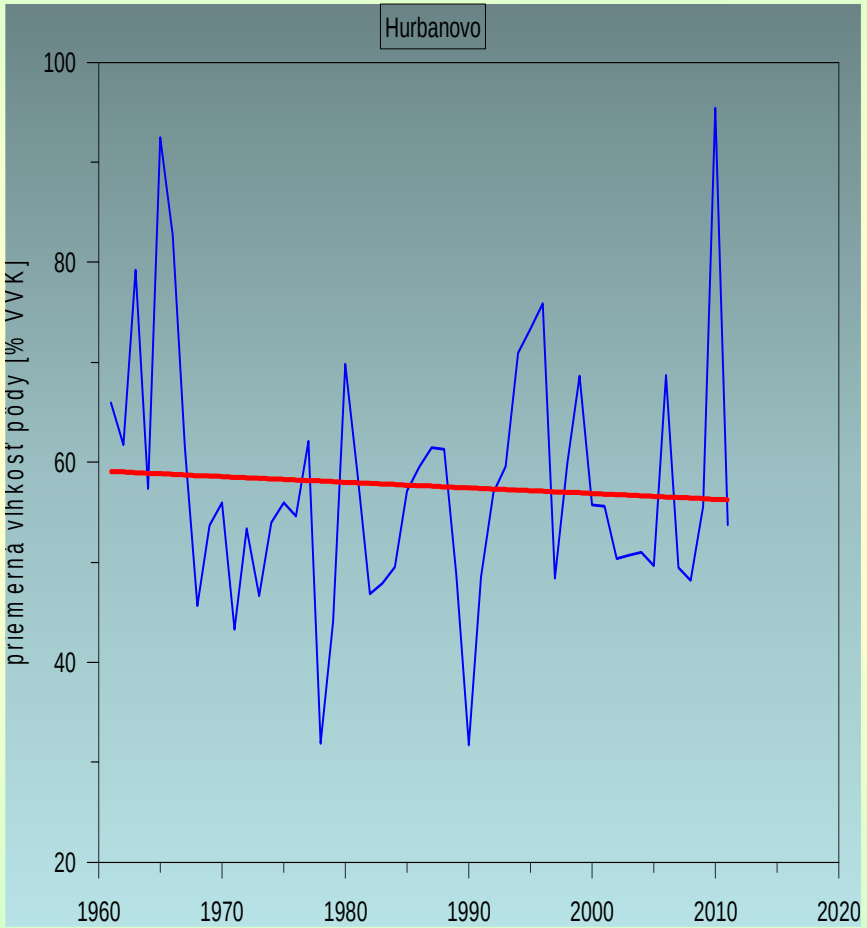


Agricultural drought 1961-2012

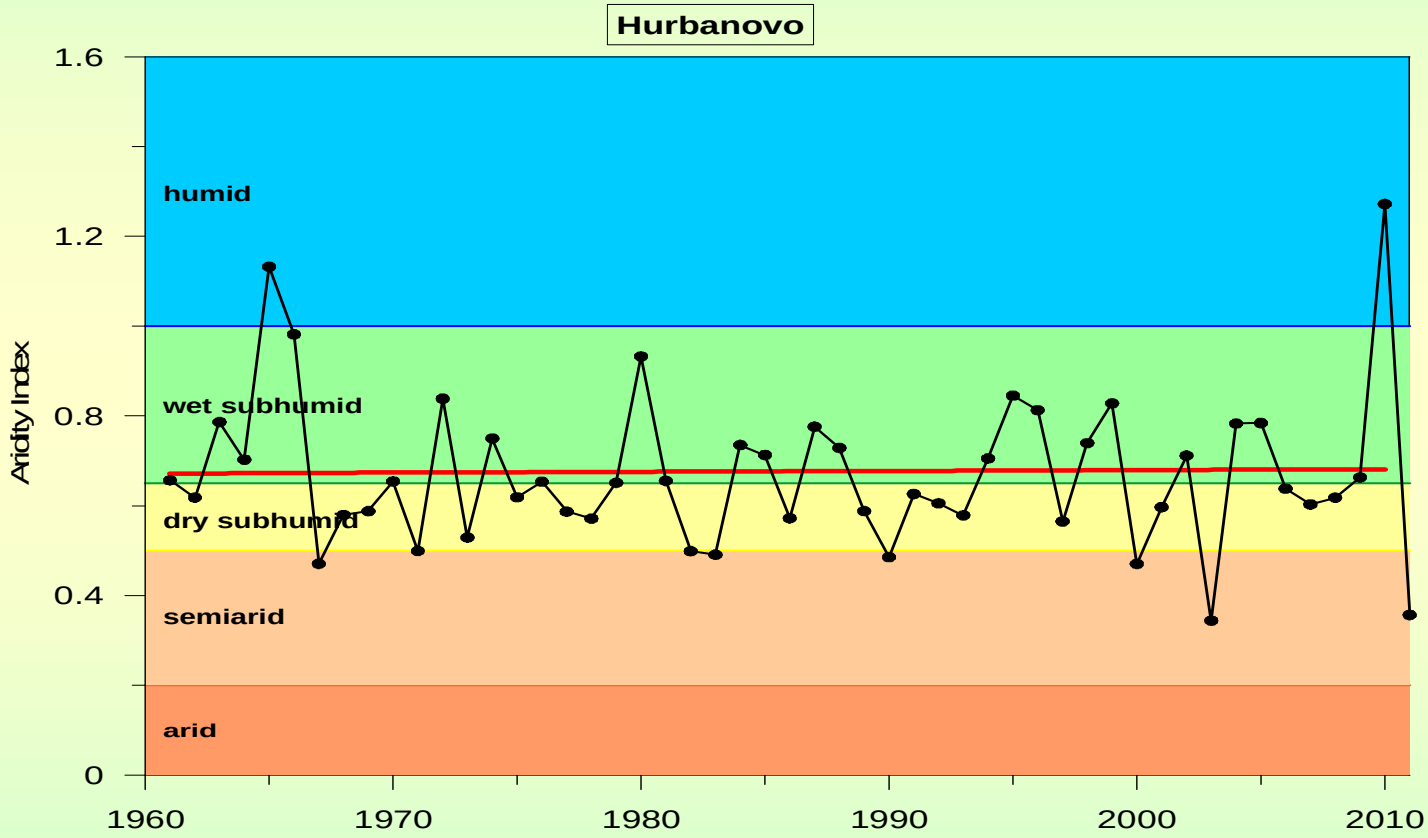
Criterion:

Water content in soil profile

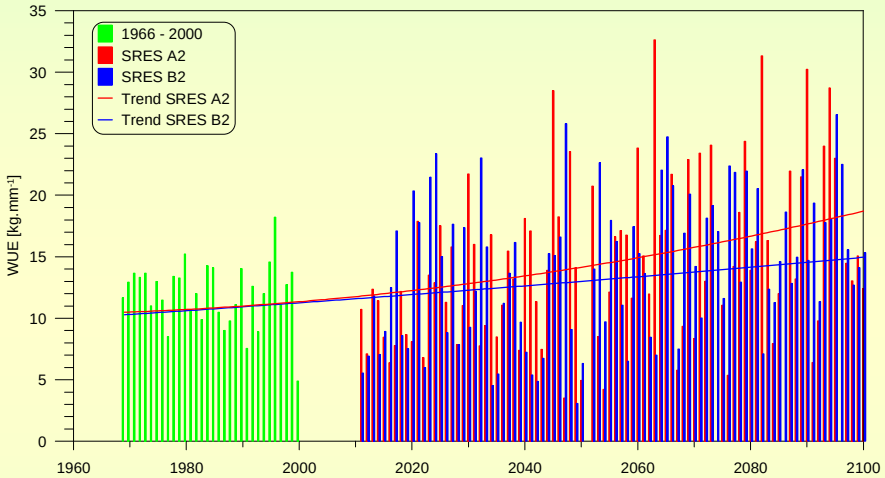
- bellow 50% dry periods
- higher then 50 % wet periods

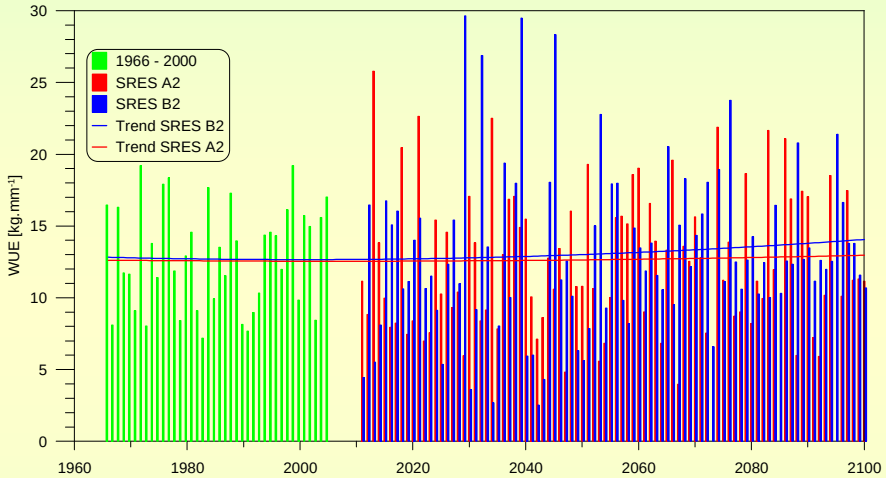


Aridity Index (R/E_0)



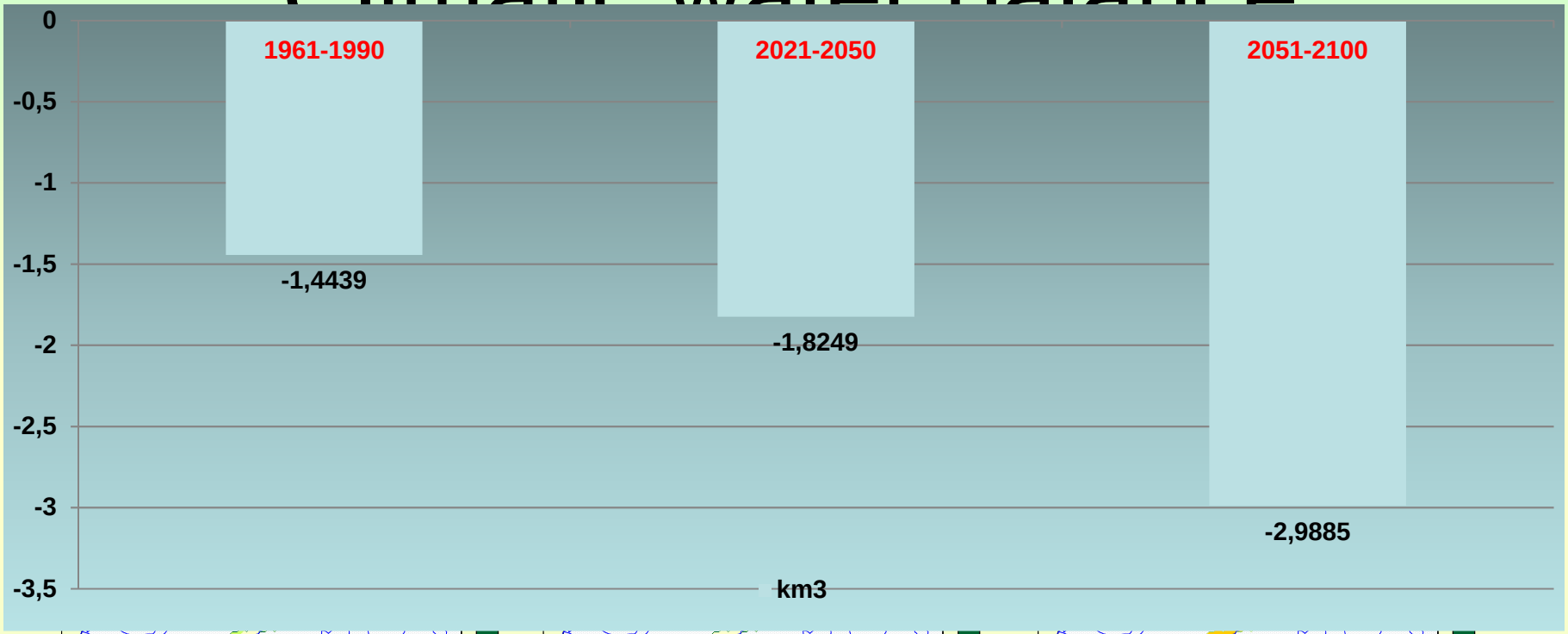
Water use efficiency

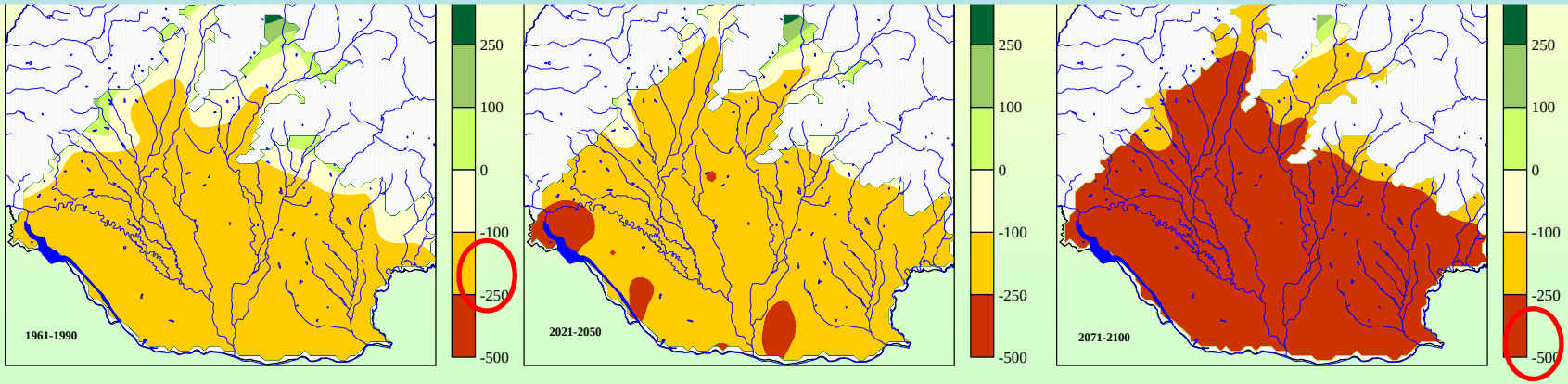




Concentration of CO_2 in the atmosphere can positively influence water use efficiency especially for C3 plants (more according to the SRES A2 scenario) while C4 plants would not be influenced significantly

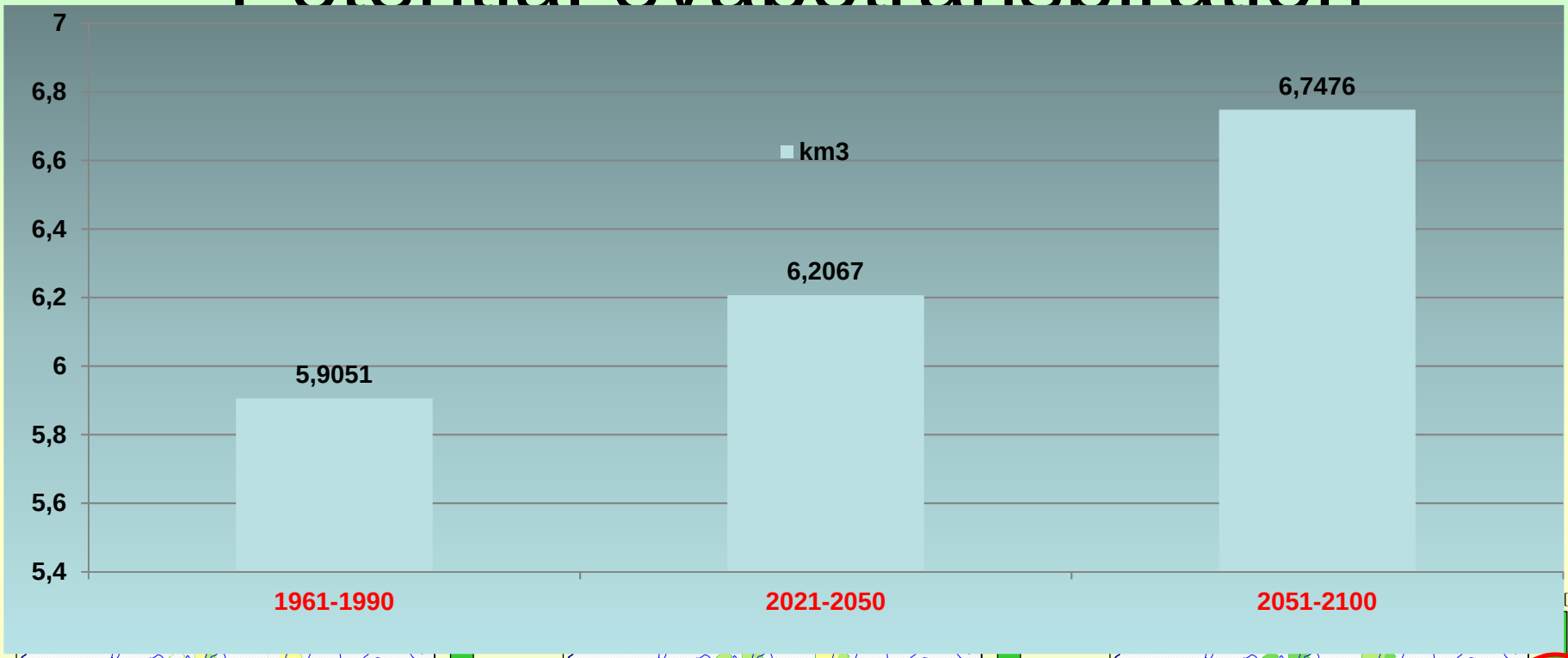
Climatic water balance

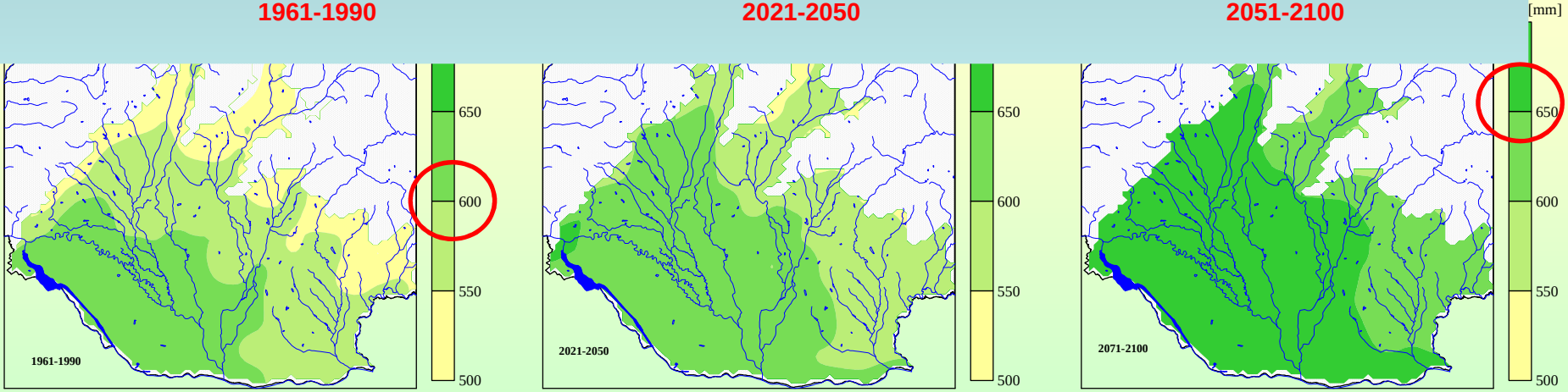




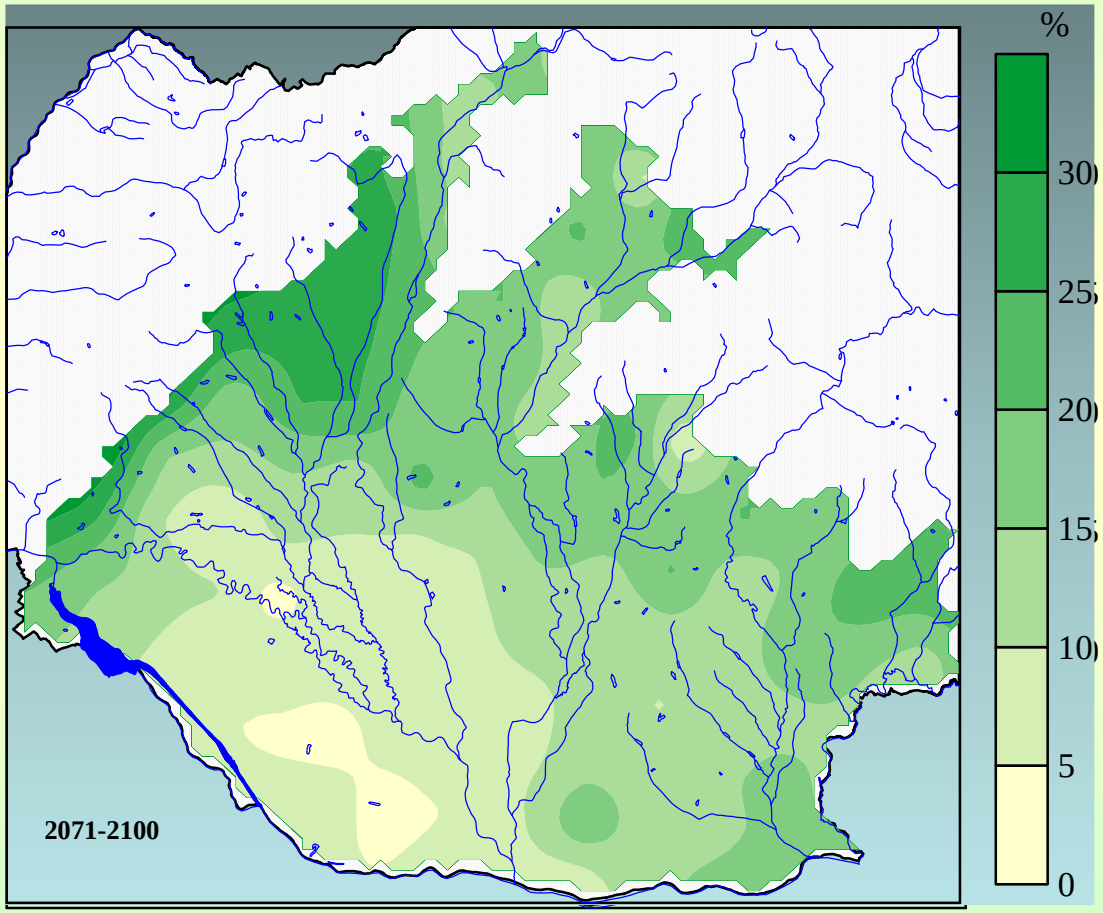
The role of forest functions within ecosystem services,
Křtiny, Czech republic: 5-8th April, 2015

Potential evapotranspiration



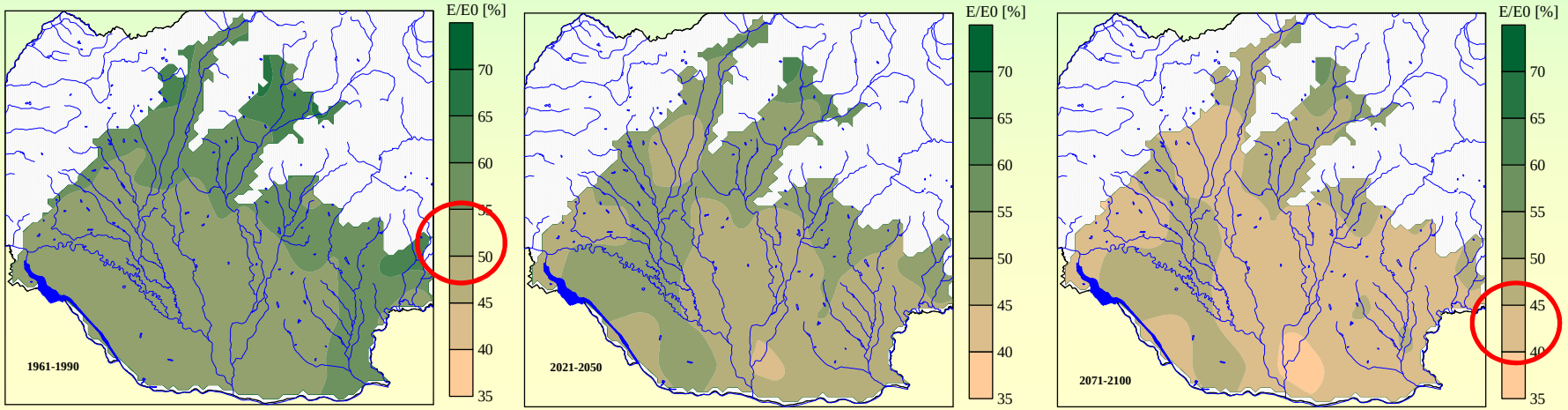


Relative changes o ET_0 in time slices 2021-2050 and 2071-2100 vs. 1971-2000

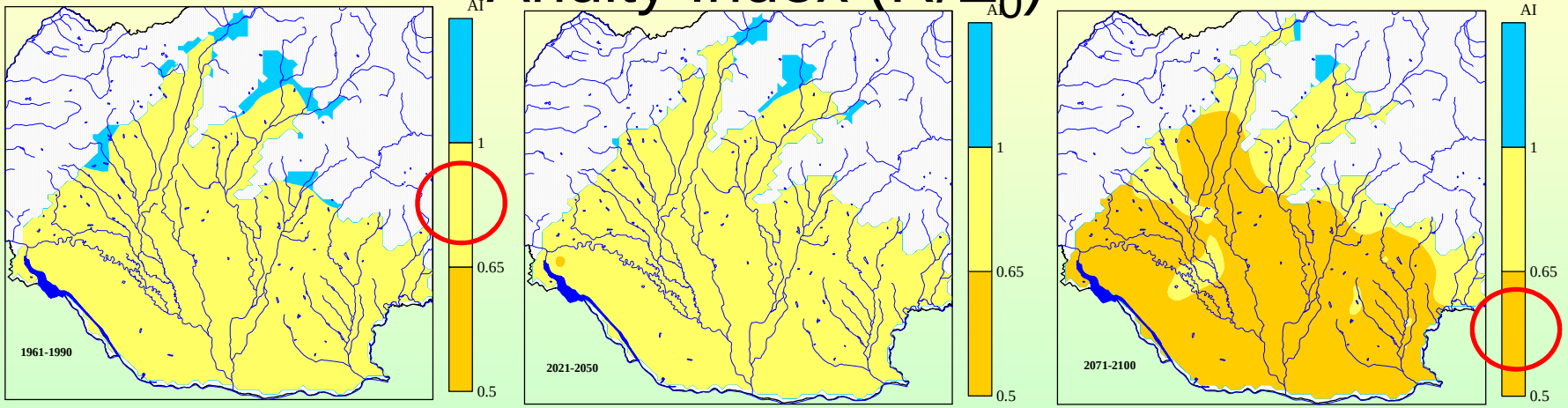


The role of forest functions within ecosystem services,
Křtiny, Czech republic: 5-8th April, 2015

Relative evapotranspiration summer half of year (April-September)

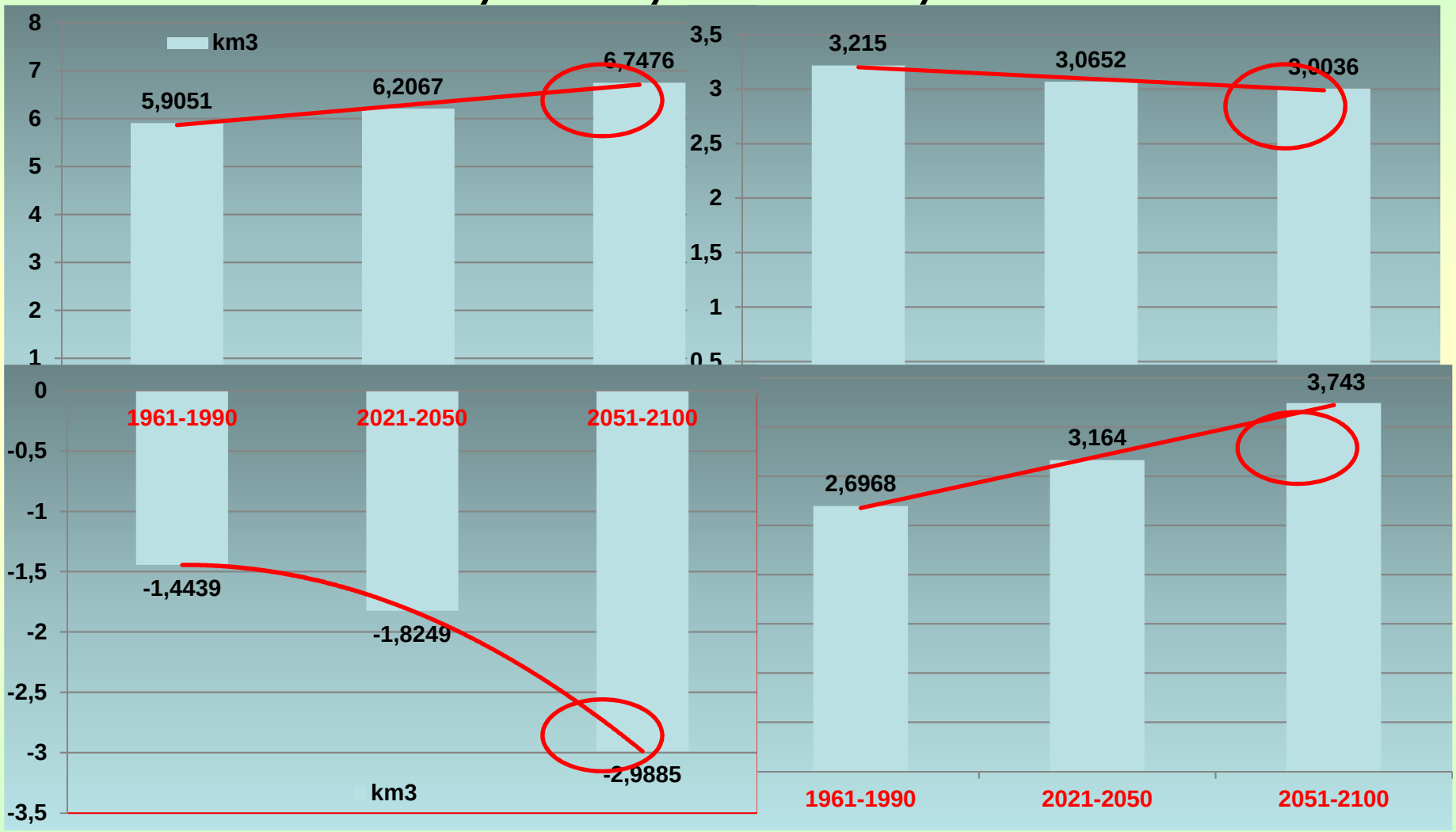


Aridity Index (R/E_0)



The role of forest functions within ecosystem services,
Křtiny, Czech republic: 5-8th April, 2015

PET, ET, CWB, ΔPET



The role of forest functions within ecosystem services,
Křtiny, Czech republic: 5-8th April, 2015

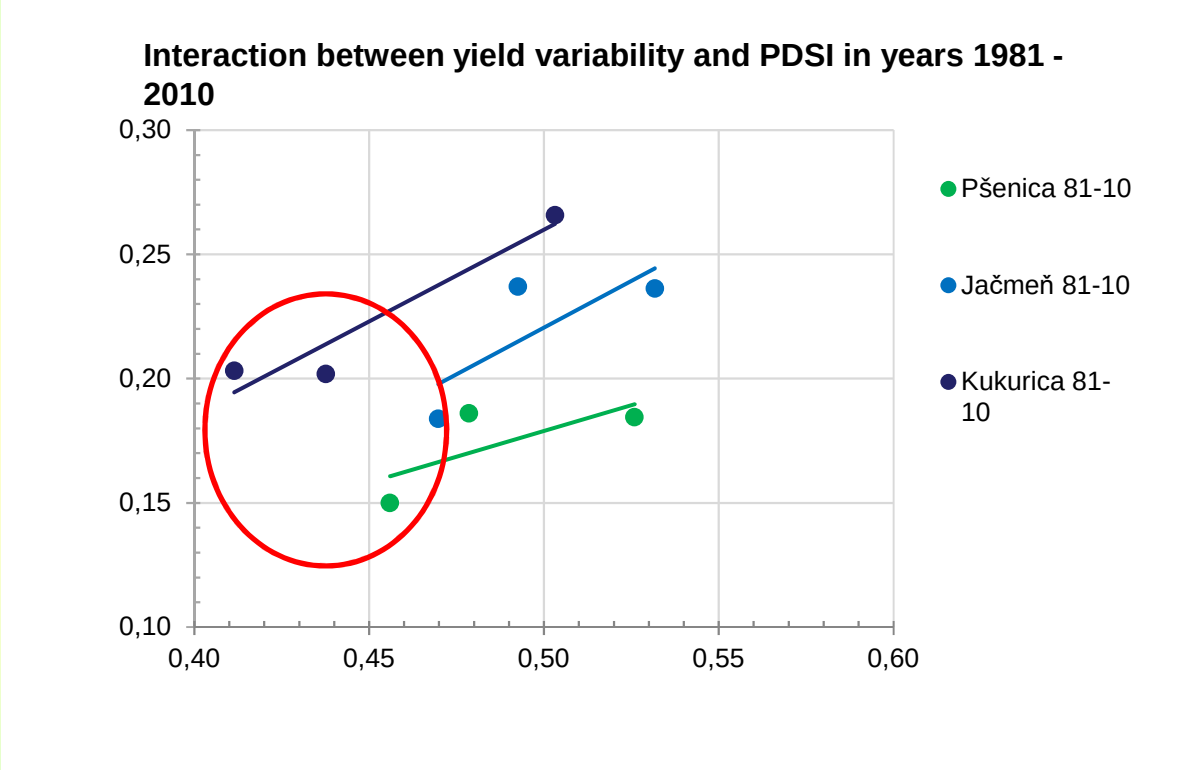
What will be the water shortage in ecosystems?

- CWB – +100%

  ΔPET – +40%
- ET – -7%

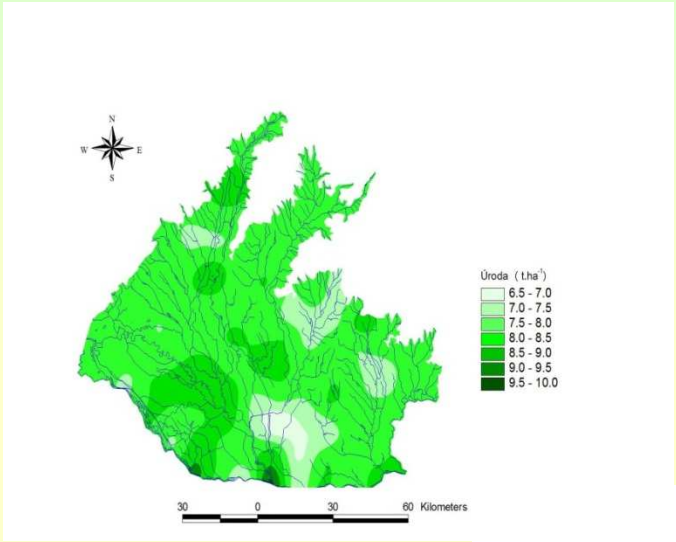
???

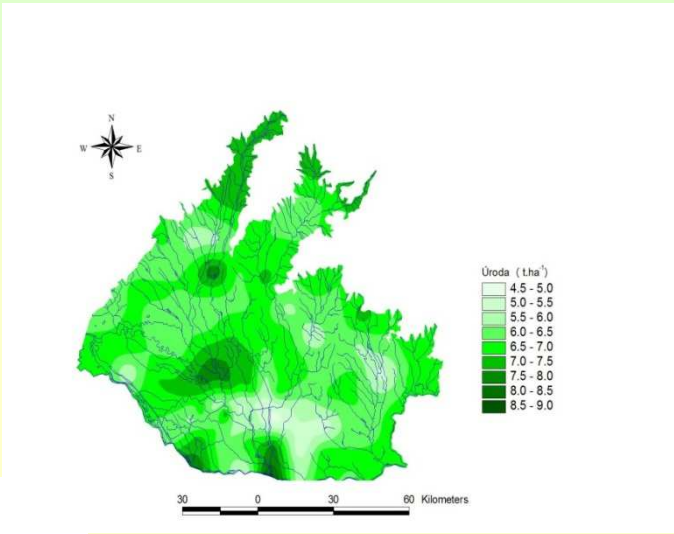
Production variability vs PDSI

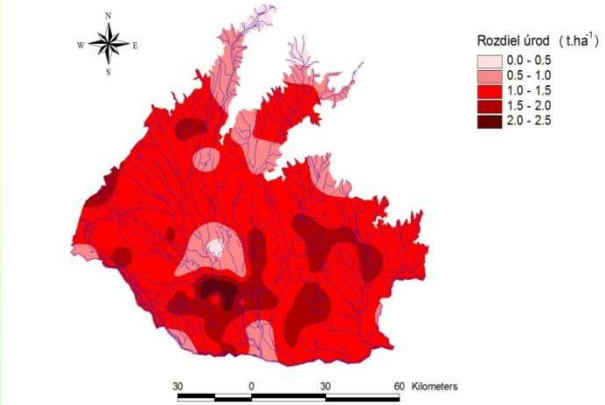


Spring barley yields 1971-2000 - upland biomass

mean (left), 90%reliability (right),
difference=mean-90%p.) (down)

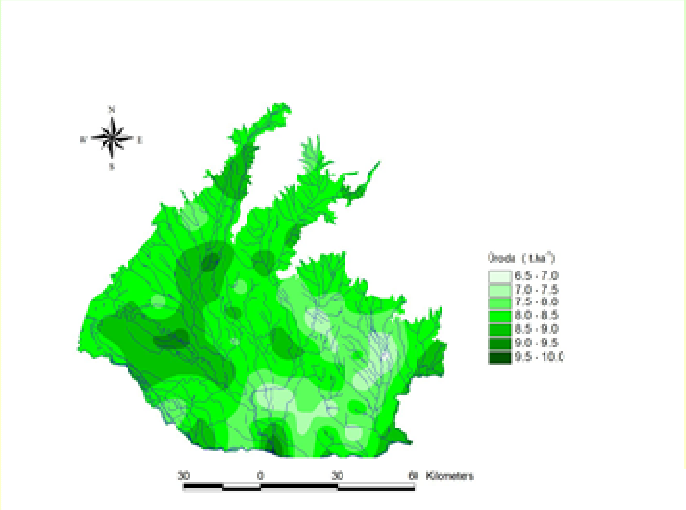


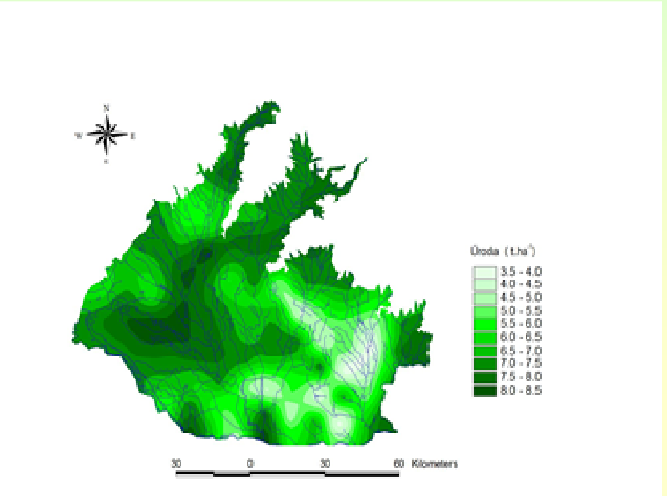


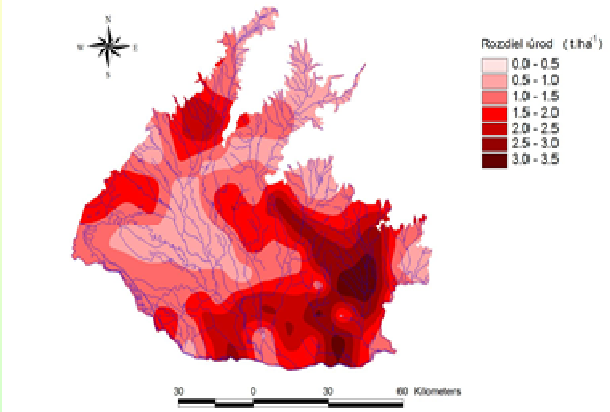


Spring barley yields 2071-2100 - upland biomass

mean (left), 90%probability (right),
difference=mean-90%p.) (down)

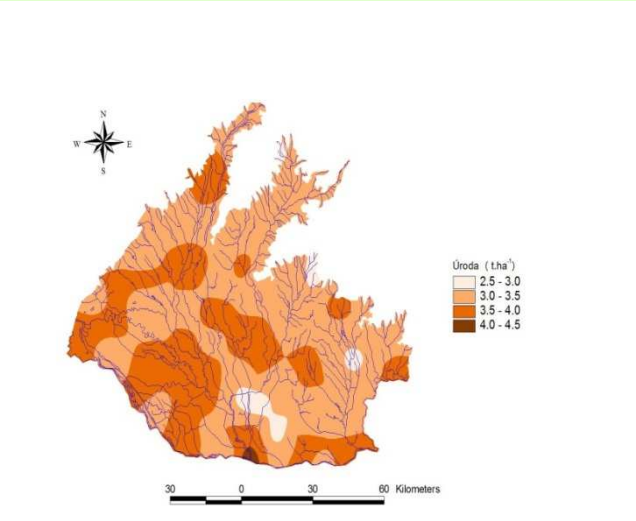


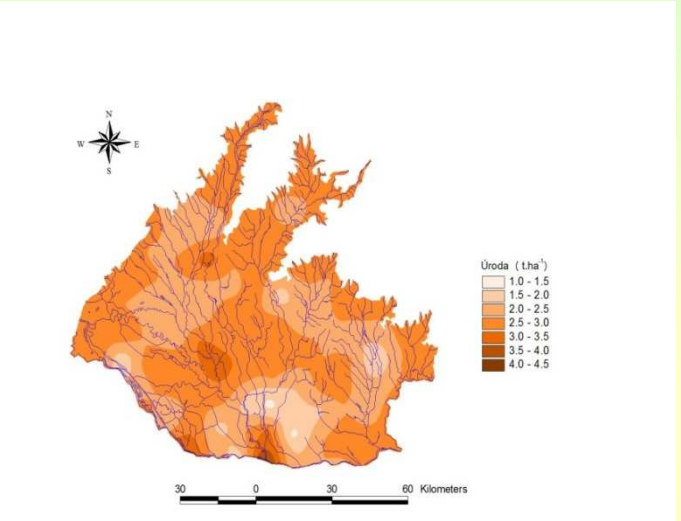


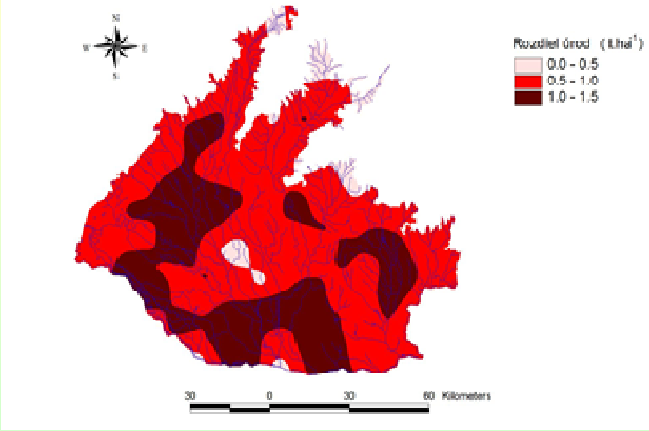


Spring barley grain yields 1971-2000

mean (left), 90%probability (right),
difference=mean-90%p.) (down)

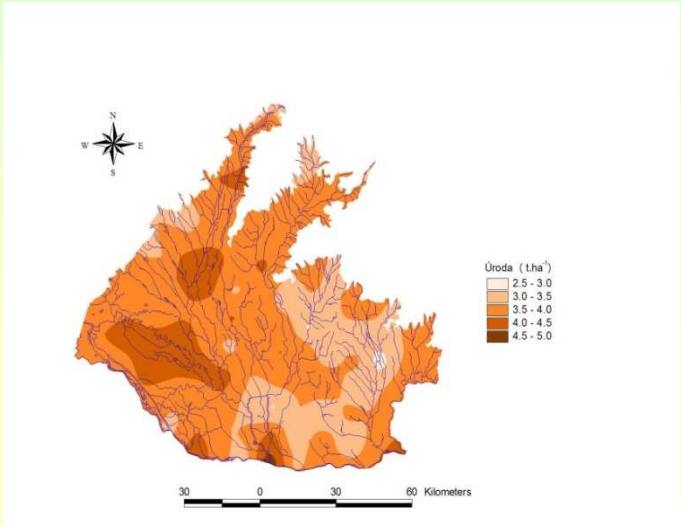


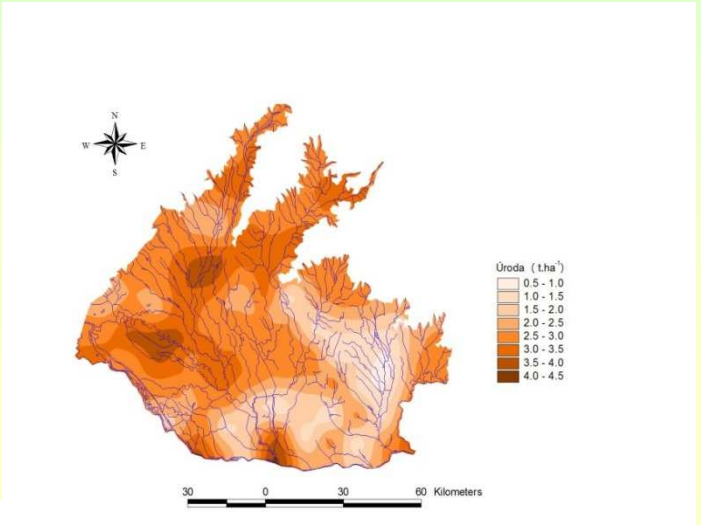


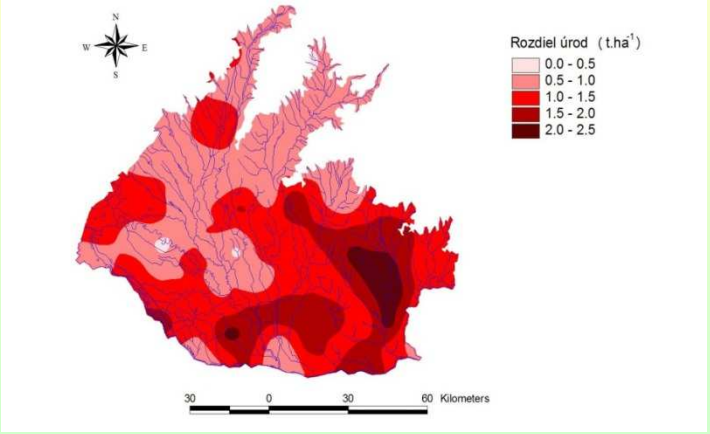


Spring barley grain yields 2071-2100

mean (left), 90%reliability (right),
difference=mean-90%p.) (down)







Conclusions

- Decrease of available soil water content during growing seasons especially in summer months
- Crop water requirements up to time horizon 2071–2100 will increase in avarage
- Rising concentration of CO_2 in the atmosphere can positively influence water use efficiency especially for C3 plants while C4 crops would not be influenced significantly
- Impact of water shortage will be very specific in different spot of Danubian lowland
- Drought indices can help to describe vulnerable areas
- Very important factor is heat stress that can influence productivity of ecosystems more than drought in many cases. Drought indeces on ecosystem level should be combined with heat stress indices
- Modeling is much more realistic in description of drought impact on ecosystem level with drought indices

Conclusions

- Most of the territory of Danubian lowland was recognized as the vulnerable region according to variability of yields. Increase of CO_2 concentration and consequent increase of photosynthesis rate can positively affect yields, but the variability of yield will very probably increase. – Sustainability?