

Findings on the climate change impact on flood  
discharge on the Sava river and preliminary  
identification of adaptation measures:

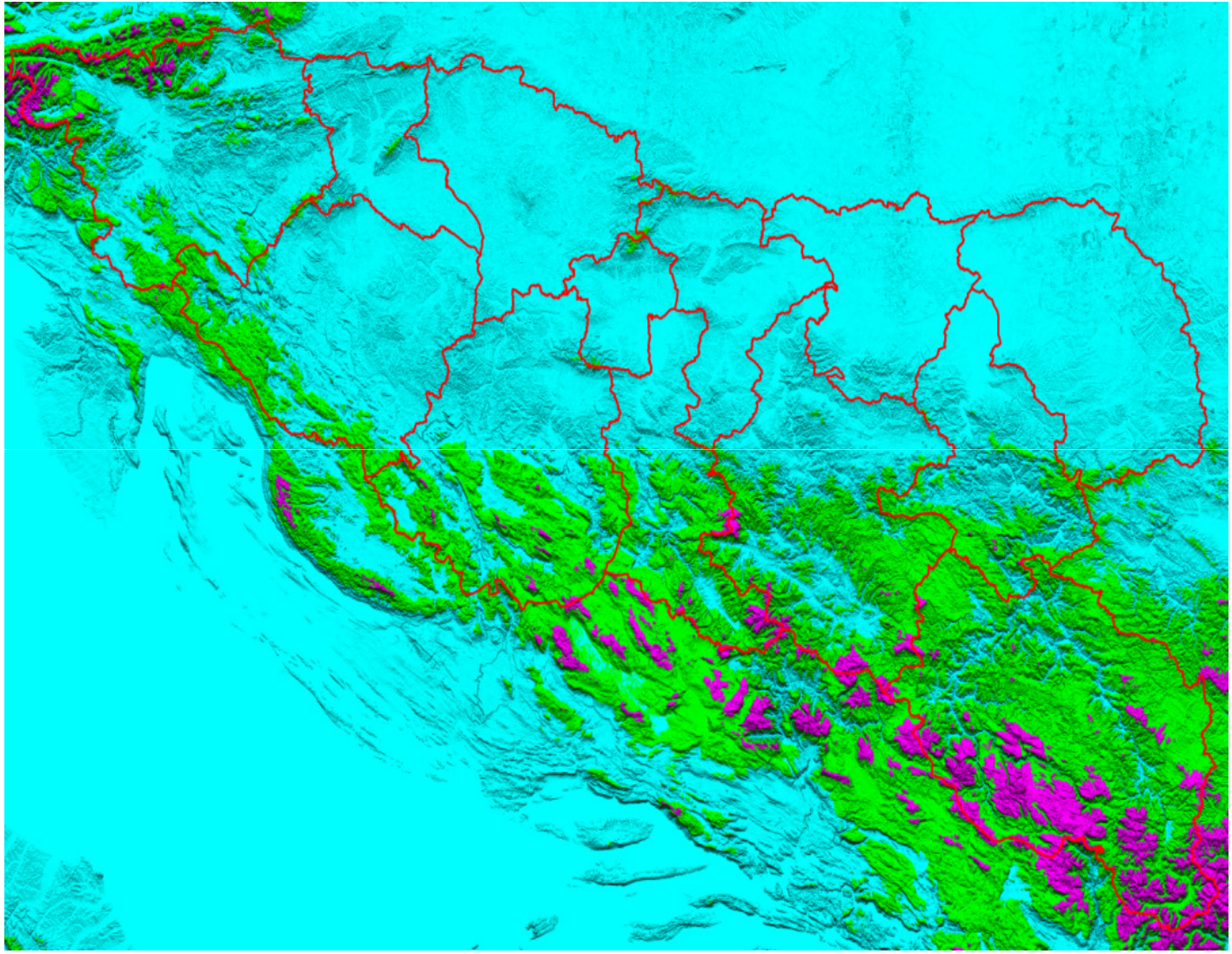
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## DATA

- 16 different ENSEMBLES GCM-RCM model runs
- simulations for the 21st Century by IPCC SRES A1B emission scenario
- horizontal resolution of RCM simulations is 0.25 degree.
- meteorological variables; daily precipitation, daily mean air temperature and monthly evapotranspiration.
- E-OBS data (daily precipitation) between 1961 and 2010

# climate projections for Sava River Basin

- transfer functions from the period 1961-1990
- validation period 1991-2010,
- Three periods were used for assessing future climate change: 2011-2040, 2041-2070 and 2071-2100.
- Daily maximum values for seasonal precipitation with 20 and 100 return period were determined



# Input data

The following input data are required to calibrate/run the model:

- precipitation (32 measurement stations)
- temperatures (8 measurement stations)
- discharge data (12 measurement stations)
- potential evapotranspiration (8 stations)

For the calibration - period from June 1 to December 31, 1974.

For verification - period September 1, 1978 to November 30, 1978

# Precipitation data

Probability of maximum daily precipitation (mm) in a year and data from Table 8.

Station name	return period			Max prec. in 1974	V1	V2	V3	V4
	1.000	100	20		EOBS_20	EOBS_100	20_41-70	100_41-70
Ljubljana	190,7	106,3	72,2	95,8	88,5	110,0	110,0	148,0
Rateče	214,9	121,2	83,2	42,6	131,9	171,1	147,5	191,3
Zagreb	117,2	65,9	45,2	34,5	43,6	50,3	52,0	67,4
Slavonski brod	104,1	59,1	40,9	31,6	31,1	38,6	36,3	47,8
Bihač	155,3	89,5	62,8	82,9	69,7	83,4	81,0	101,8
Bugojno	119,9	66,2	44,5	40,4	38,0	50,4	44,8	66,6
Sarajevo	120,0	67,0	45,5	36,0	37,6	42,6	49,6	66,5
Banja luka	86,0	57,4	45,8	56,2	34,0	44,0	38,9	53,4
Beograd	126,8	66,3	41,9	39,4	36,0	46,1	46,4	66,7
Sjenica	89,9	53,3	38,5	45,1	42,9	51,3	55,9	77,6

Result of modelling recent climate flood peaks (in m<sup>3</sup>/s).

Sub-basins	WS	measured	calibrated	EOBS_ret20	EOBS_ret100
Sava I	Čatež	2294	2308	2308	2780
Kolpa	Šišinec	1250	1419	1473	1522
Sava II	Crnac	2147	2295	2350	2510
Una	Kostajnica	1370	1445	1382	1407
Sava III	Jasenovac	2580	2515	2561	2718
Vrbas	Delibašino selo	691	762	620	707
Sava IV	Slavonski Brod	3460	3422	3411	3573
Bosna	Doboj	1095	753	742	767
Sava V	Županja	3930	4057	4068	4227
Drina I	Bajina Bašta	3359	2715	2336	2474
Drina II	Kozluk	3041	2640	2276	2407
Sava V	Sremska Mitrovica	6275	6540	6328	6603
confluence with Danube			6653	6432	6715

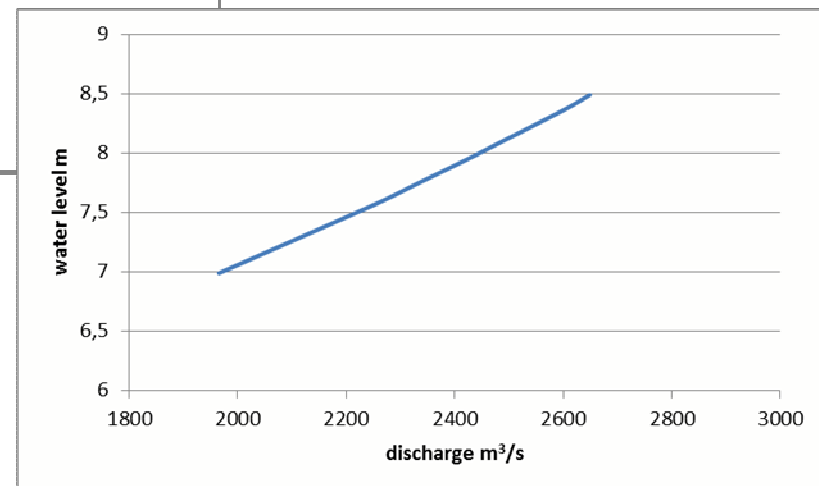
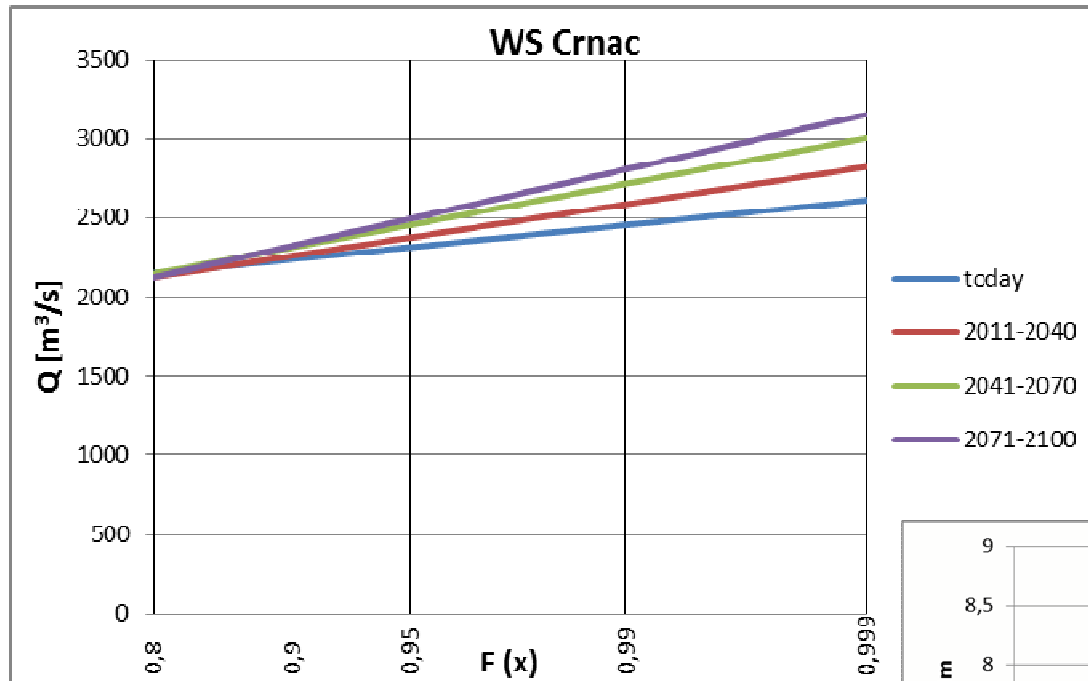
Results of modelling climate change flood peaks with EOBS data of the 100-year return period (in m<sup>3</sup>/s and %).

<b>Sub-basins</b>	<b>WS</b>	<b>EOBS</b> m <sup>3</sup> /s	<b>11-40</b> m <sup>3</sup> /s	<b>41-7</b> m <sup>3</sup> /s 0	<b>71-2100</b> m <sup>3</sup> /s	<b>11-40</b> %	<b>41-70</b> %	<b>71-2100</b> %
Sava I	Čatež	2780	3297	3770	4134	1.43	1.63	1.79
Kolpa	Šišinec	1522	1595	1664	1722	1.08	1.13	1.17
Sava II	Crnac	2510	2670	2817	2929	1.14	1.20	1.25
Una	Kostajnica	1407	2060	2245	2188	1.49	1.63	1.58
Sava III	Jasenovac	2718	2863	2993	3086	1.12	1.17	1.21
Vrbas	Delibašin o selo	707	813	845	825	1.31	1.36	1.33
Sava IV	Slavonski Brod	3573	3895	4062	4142	1.14	1.19	1.21
Bosna	Doboj	767	985	1025	1103	1.33	1.38	1.49
Sava V	Županja	4227	4699	4957	5270	1.16	1.22	1.30
Drina I	Bajina Bašta	2474	2683	3087	2719	1.15	1.32	1.16
Drina II	Kozluk	2407	2639	3059	2686	1.16	1.34	1.18
Sava VI	Sremska Mitrovica	6603	7143	7580	7409	1.13	1.20	1.17
confluenc e		6715	7253	7695	7509	1.13	1.20	1.17
					average	1.21	1.31	1.31
					max.	1.49	1.63	1.79
					min	1.08	1.13	1.16





# Probability function - WS Crnac





## Labor force - by occupation (CIA) 2008-2012

country	agriculture	industry	services
Slovenia	2,2	35	62,8
Croatia	2,1	29	69
Serbia	21,9	19,5	58,6
BiH	20,5	32,6	47
Montenegro	6,3	20,9	72,8

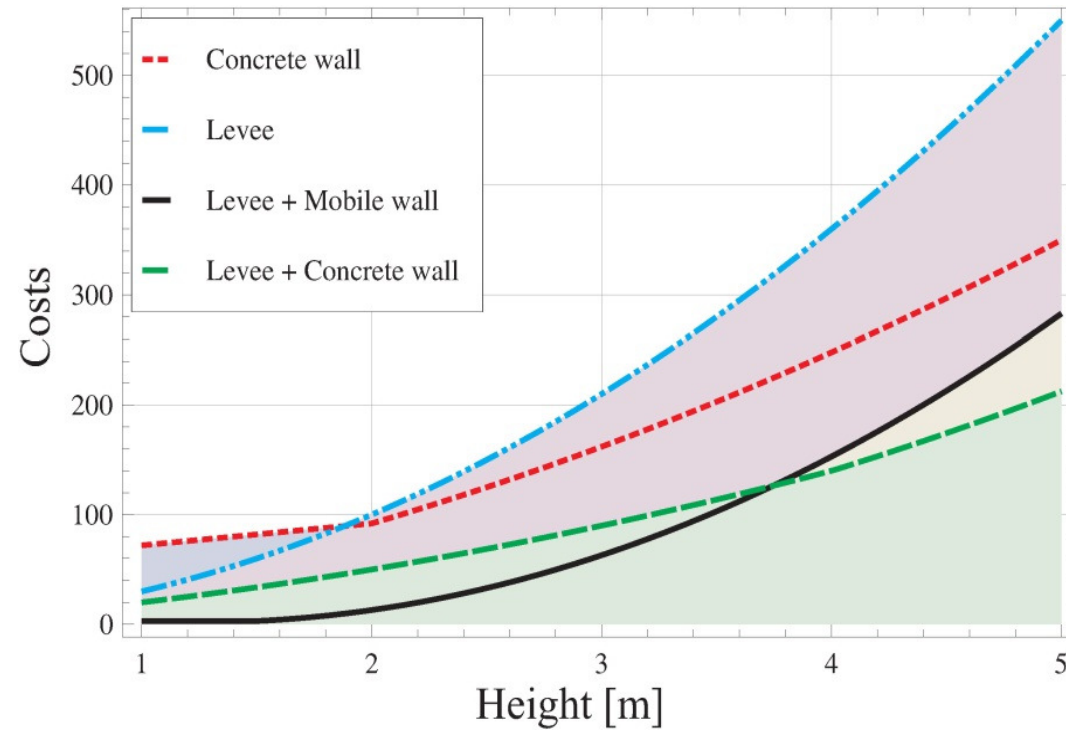
# Criteria for trans boundary impact assessment

No.	Criterion	Questions to be asked
1	Side-effects	Does the measure have potentially negative effects on other riparian countries?
2	Efficiency / costs and benefits	Is the measure beneficial for the basin as a whole? Is this measure taken at an effective and efficient location considering the entire basin?

## Program to mitigate the impact of climate change:

- Institutional strengthening
- Determination of cross sections for monitoring changes in the morphology
- The development of hydrologic and hydraulics models
- Increase protection of major cities along the Sava River
- Protection of other cities and populated areas
- Protection of agricultural areas
- Integration of flood protection measures with water management, Water Framework Directive and sustainable development.

# Cost in EUR/meter



# Development and cost

- Phase A: The short-term measures –  
50 million EUR

Phase B: The medium-term measures  
1 billion EUR

Phase C: The long-term measures  
2 billion EUR



Always Plan with the Big Picture in Mind!

