Co-financed by the Connecting Europe Facility of the European Union

Hydraulic and morphological modelling of the SRB-CRO common stretch of the Danube River

Task 1-2: Hydrological study - UPDATE

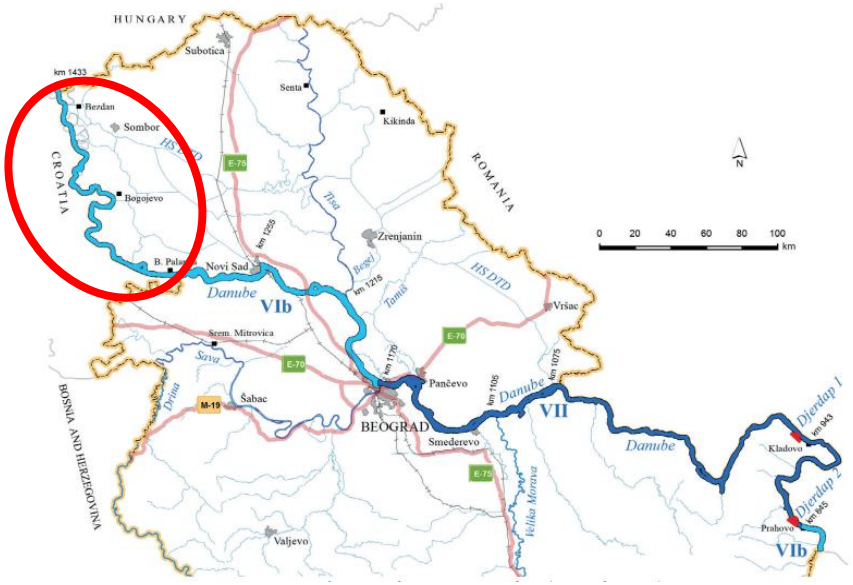
Stakeholders' Forum Meeting #10

28.10.2024, Jasna Plavšić / Hidrozavod DTD

Preparing FAIRway2 works in the Rhine Danube Corridor (2019-EU-TM-0262-S and 2019-HR-TMC-0263-S)

Main goals

- Characterisation of hydrological regime of the Danube in the common SRB-CRO sector
  - mean flows, flood flows, low flows
- Computation of reference discharges for low and high navigable water levels (LNWL and HNWL)



Source: http://www.iscgm.org/gmd

30 years of daily discharges, excluding ice periods → flow duration curves → reference discharges Q94% and Q1% → stage-discharge relationship → LNWL, HNWL

Hydrological data

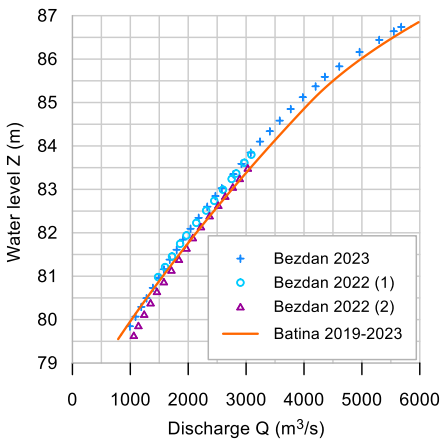
- Focus on last 30 years (1994-2023)
- Stations with discharge measurements
  - Serbia 3, Croatia 5
- Stage-discharge curves

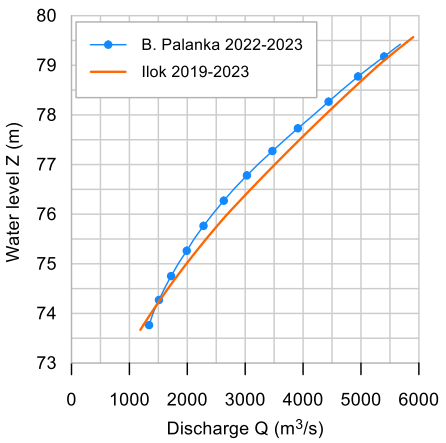
Available discharge data

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Bezdan																														
Bogojevo																														
Bačka Palanka																														
Batina																														
Aljmaš																														
Dalj																														
Vukovar																														
Ilok																														

Brief overview of previous results

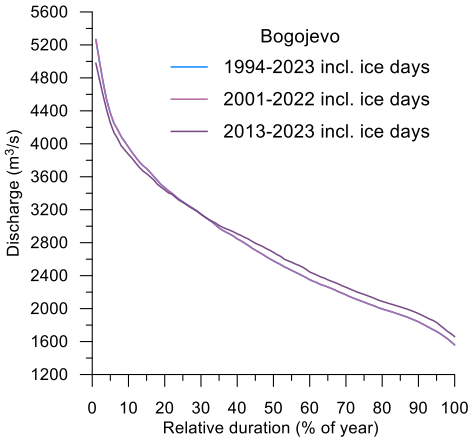
- Data consistency
  - Serbian and Croatian data on water levels and discharges are somewhat inconsistent
  - Main sources of uncertainty are:
    - differences in measured water levels (different sensors and techniques for measurement and data processing)
    - differences in stage-discharge curves





Brief overview of previous results

- **Flow duration curves**
  - Average curve for 1994-2023
- Excluding ice periods:
  - Serbian stations: yes
  - Croatian stations: no information on ice
- Short records:
  - Bezdan: 30 years, Bogojevo 26 years,
    B. Palanka 13 years, Croatian stations 22 years
  - Duration curve from short records affect the results



- **Adjustment for short records and lack of information on ice**
  - Based on transfer functions identified for the period of shorter record, Bogojevo as the reference station

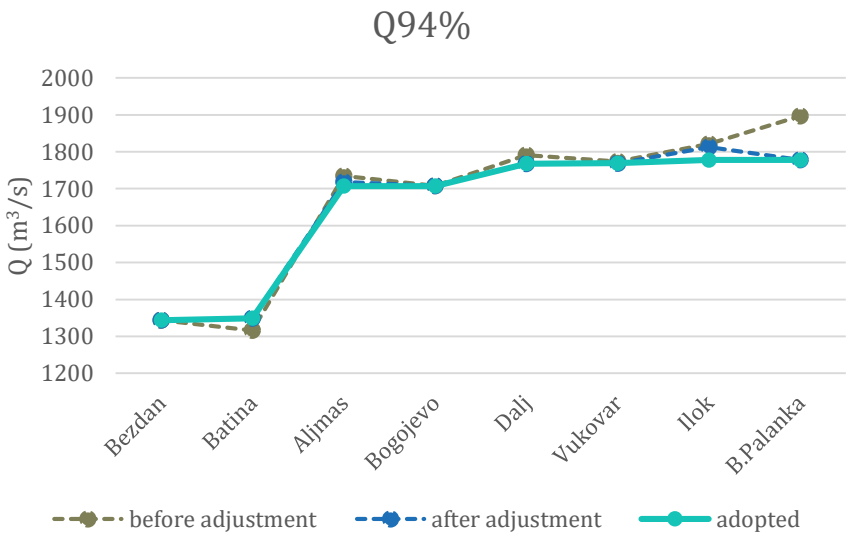
Brief overview of previous results

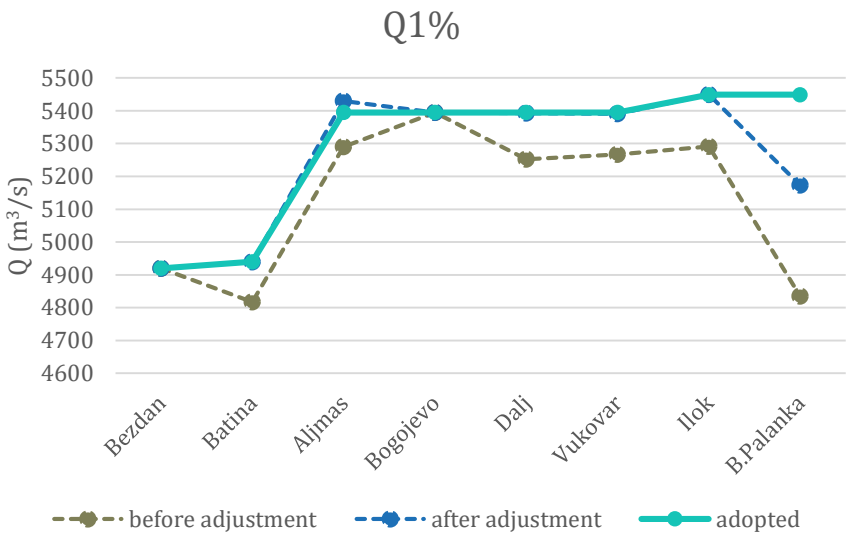
- Reference discharges

Station	Q94% (m^3/s)			Q1% (m^3/s)		
	Before adjustment	After adjustment	Adopted	Before adjustment	After adjustment	Adopted
Bezdan	1344	–	1344	4920	–	4920
Batina	1316	1349	1349	4817	4940	4940
Aljmas	1735	1719	1707	5290	5430	5395
Bogojevo	1707	–	1707	5395	–	5395
Dalj	1791	1768	1768	5252	5392	5395
Vukovar	1774	1769	1769	5266	5391	5395
Ilok	1821	1813	1778	5292	5449	5449
Backa Palanka	1897	1778	1778	4835	5173	5449

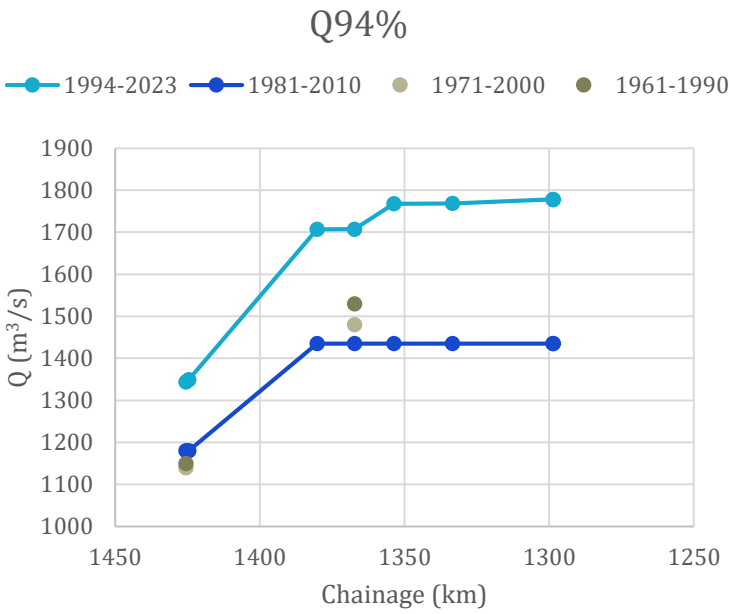
Brief overview of previous results

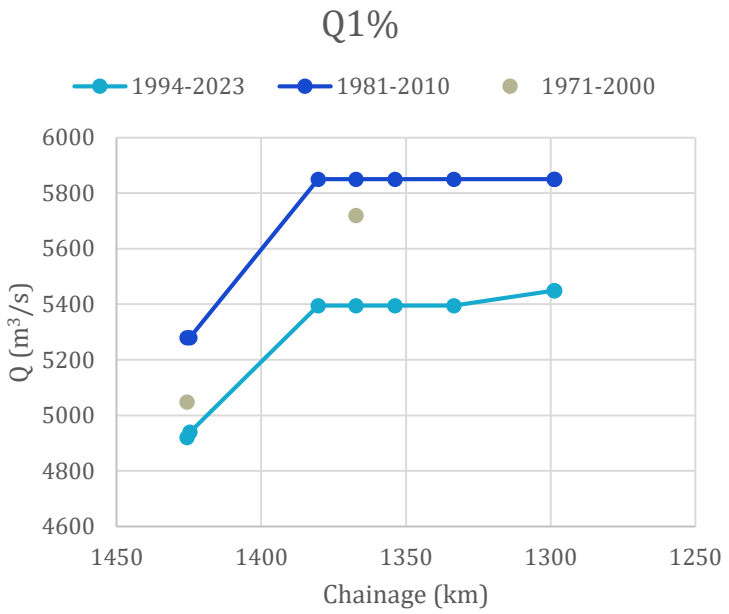
- Reference discharges





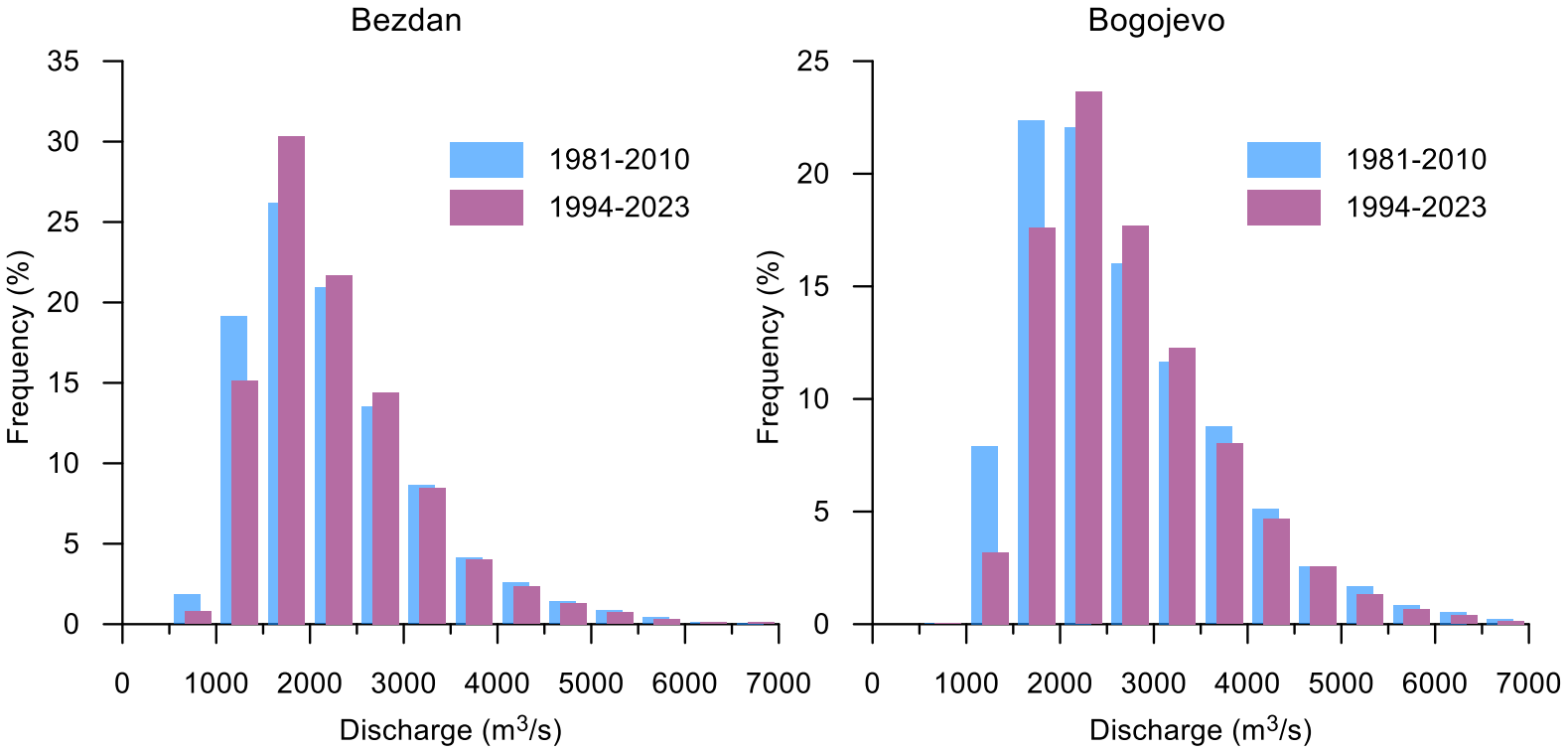
Comparison of reference discharges





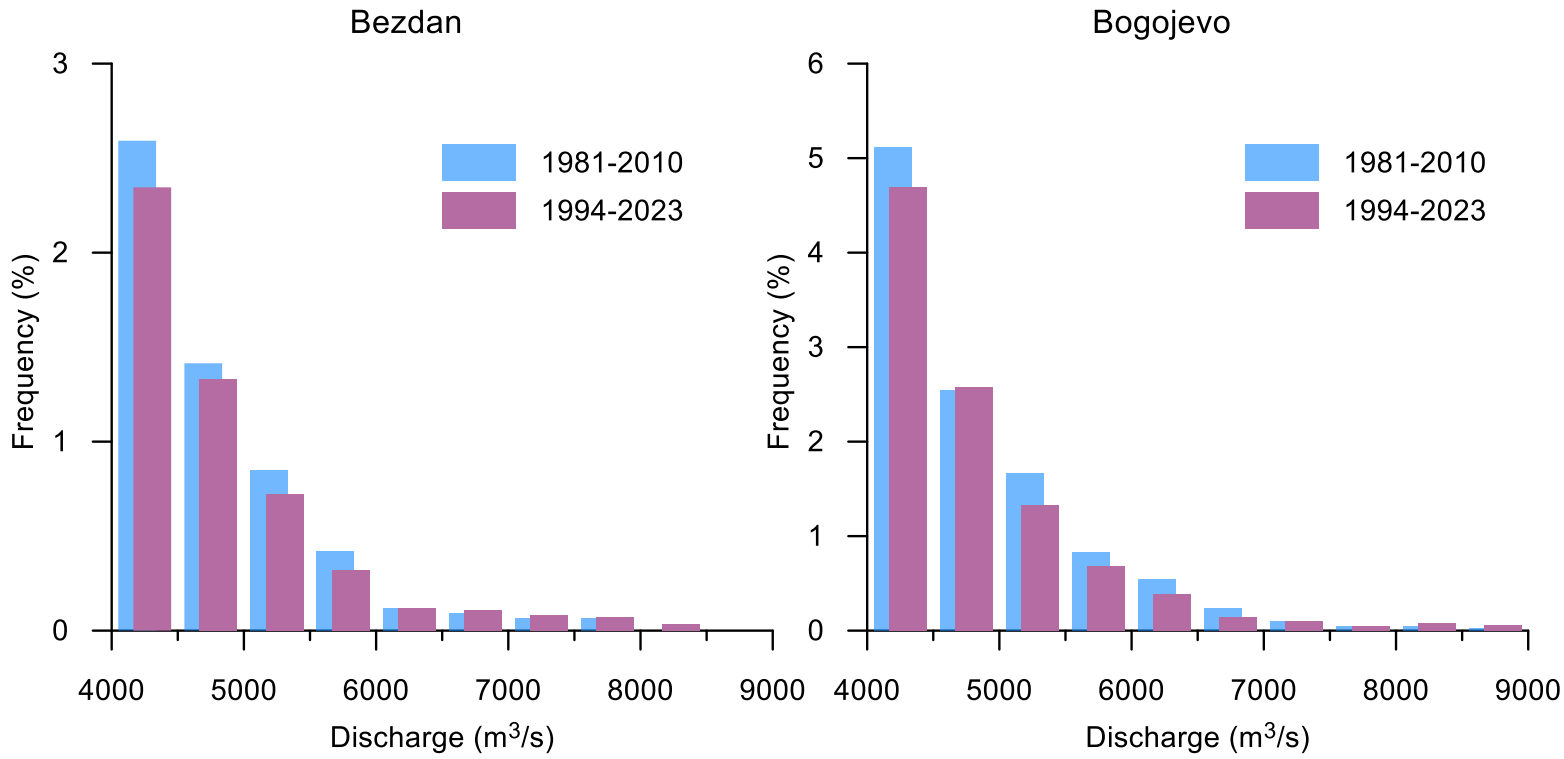
Comparison of discharges

- Distribution of daily discharges

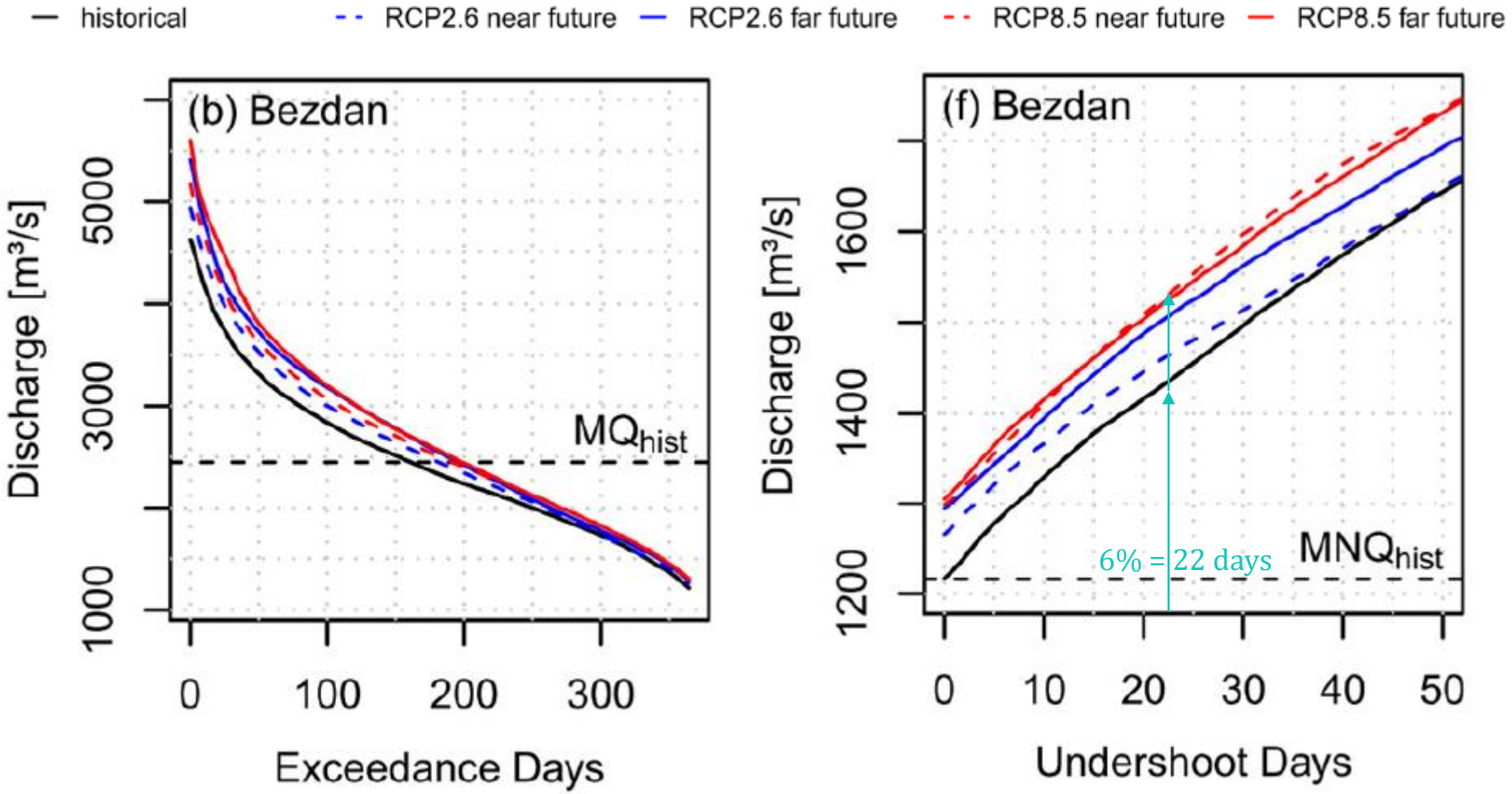


Comparison of discharges

- Distribution of daily discharges – high flow domain



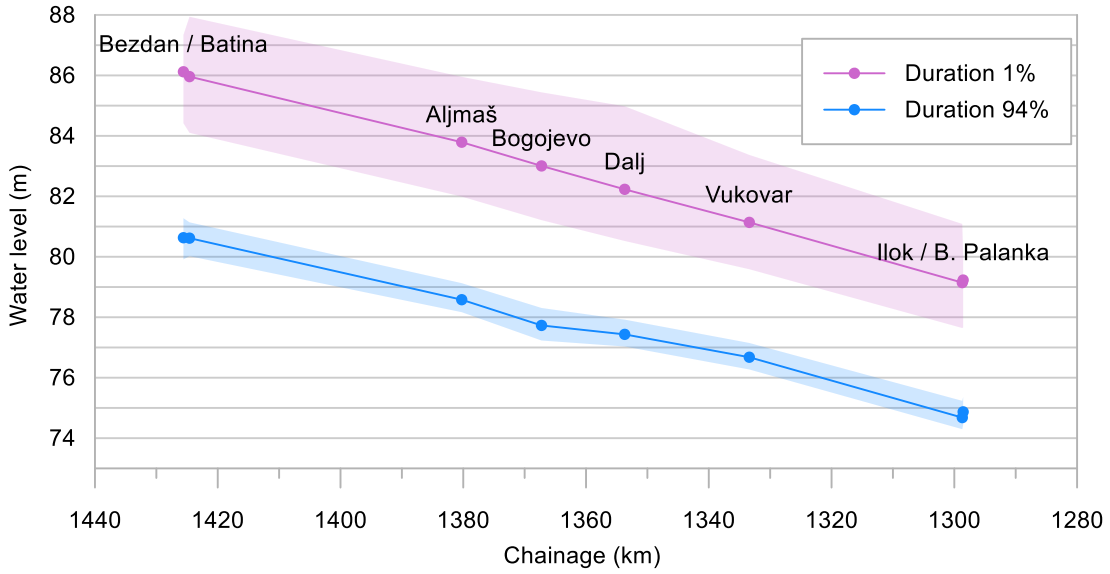
Climate change impacts for the middle Danube basin



Probst & Mauser (2023) https://doi.org/10.3390/w15010008

Reference water levels

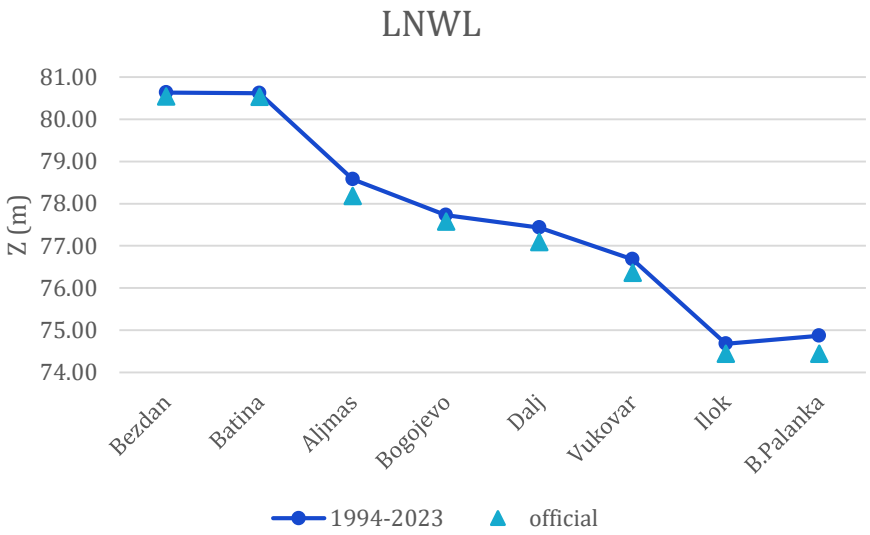
- LNWL and HNWL obtained from adopted reference discharges and the most recent stage-discharge curves, with 90% confidence intervals

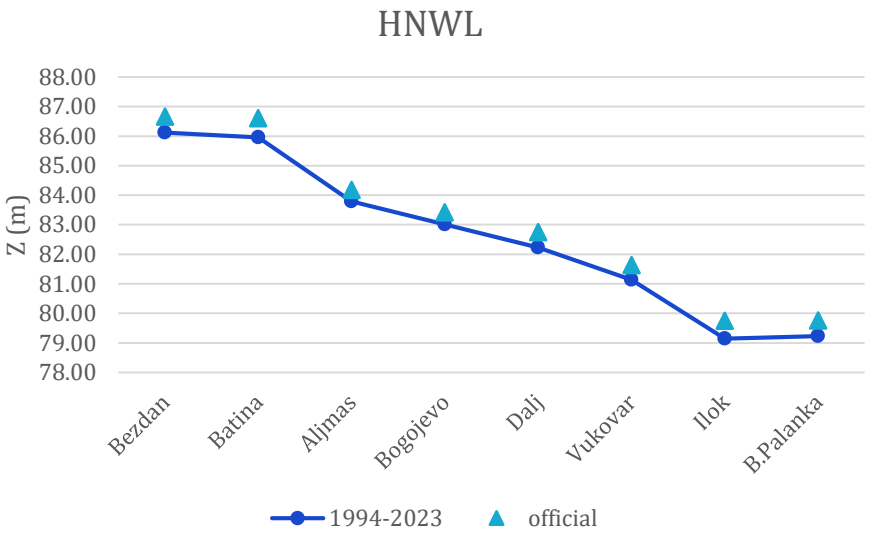


some inconsistency at B. Palanka and Ilok for LNWL

Reference water levels

- Comparison to previous reference levels





Stage (cm)		Bezdan	Batina	Aljmaš	Bogojevo	Dalj	Vukovar	Ilok	Bačka Palanka
LNWL	this study	-1	17	50	27	223	49	71	90
	official	-10	8	10	11	189	17	47	47
HNWL	this study	548	551	571	555	703	495	518	526
	official	602	615	610	596	754	544	577	578

Conclusions

- Reference discharges at stations are consistent
- Reference levels at stations derived from stage-discharge curves are consistent everywhere except at Ilok/Backa Palanka
- Final ENRs at all relevant cross-sections will be adopted based on hydrodynamic simulations

Thank you