



VITUKI
BUDAPEST



Climate Change Impact on Navigation Condition

Central Danube

Coordination Action



- ENSEMBLES Project based 4 climatological model chains
- Downscaling and interpolation (keeping the areal means)
- Modified NHFS hydrological model runs
- EWENT Project results
- Ice phenomena (results of ongoing research)

Impact on navigation



1. Low water - shallows
 - Limiting loads
 - Suspension of navigation
2. Floods - suspension, bridge clearance
3. Ice – suspension

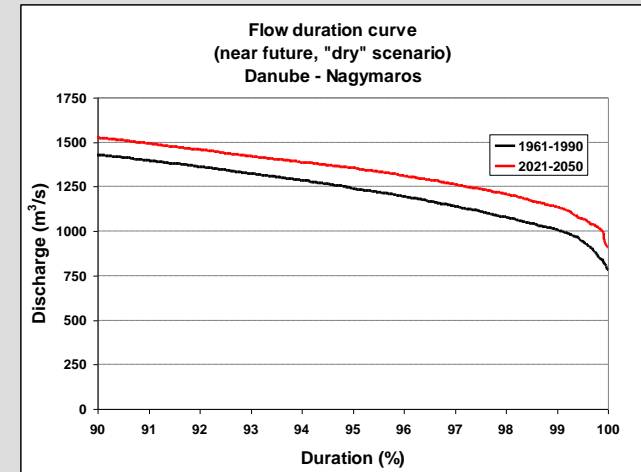
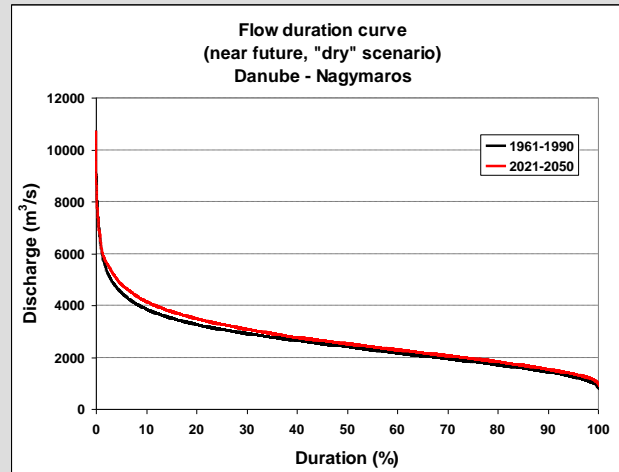
Impact on navigation – Low Flow



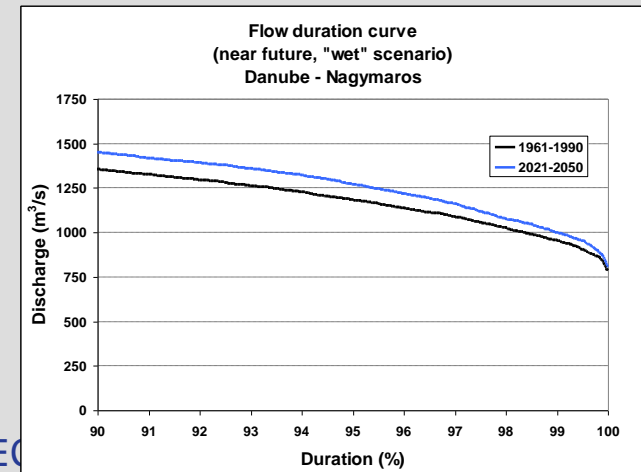
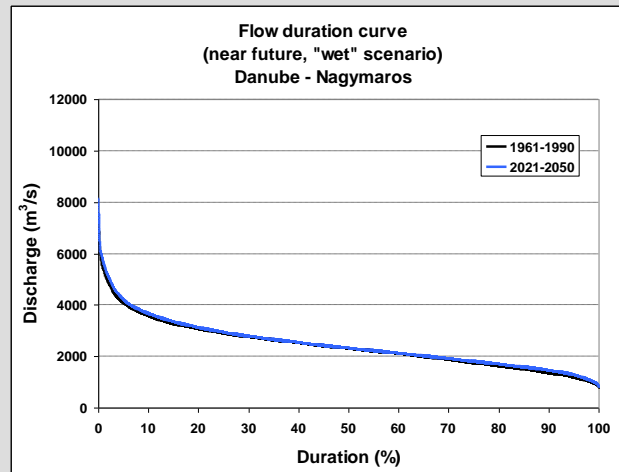
Whole range

Low water range

„Dry”
scenario



„Wet”
scenario



Impact on navigation



1. Low water - shallows
 - Limiting loads
 - Suspension of navigation
2. Floods - suspension, bridge clearance
3. Ice – suspension

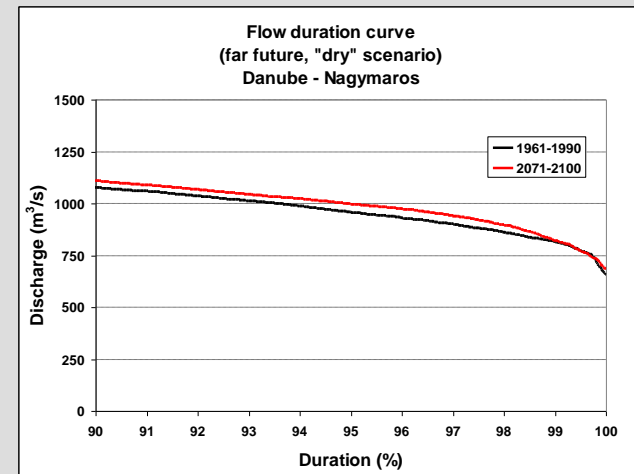
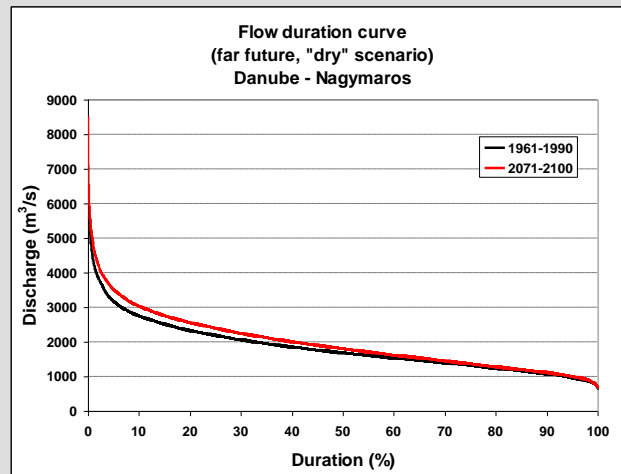
1. Flow duration curve – Far future



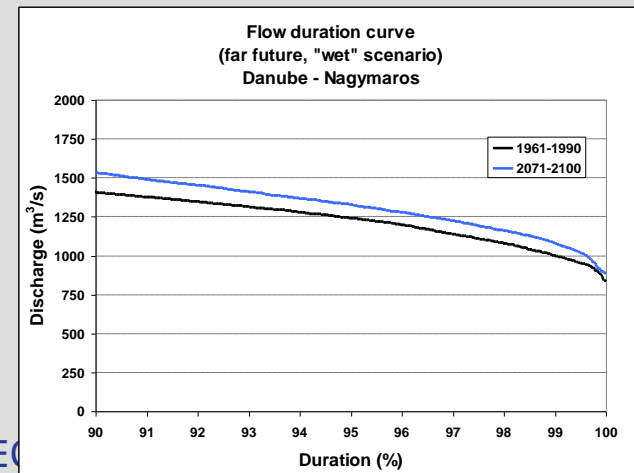
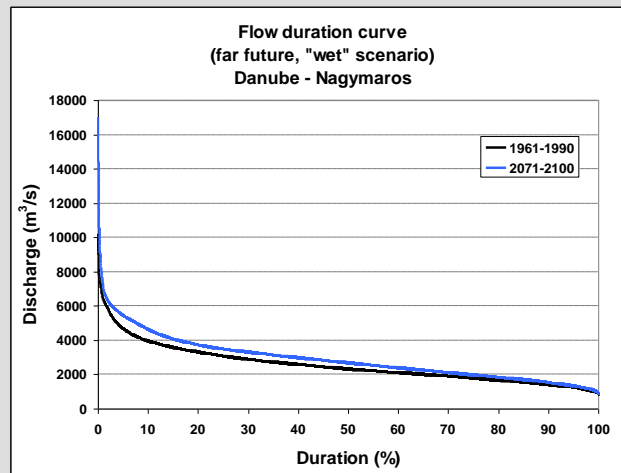
Whole range

Low water range

„Dry”
scenario



„Wet”
scenario



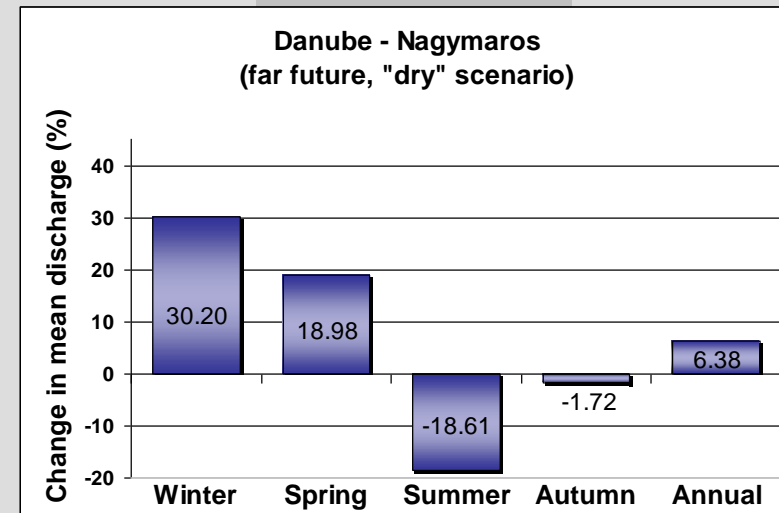
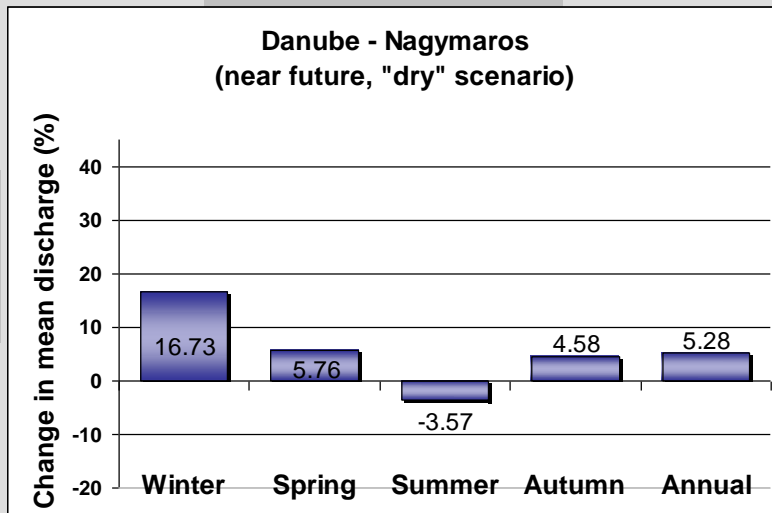
Seasonal changes



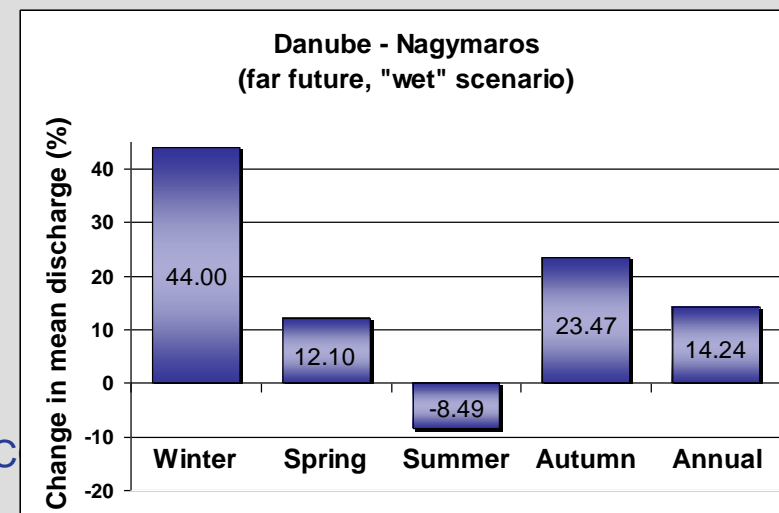
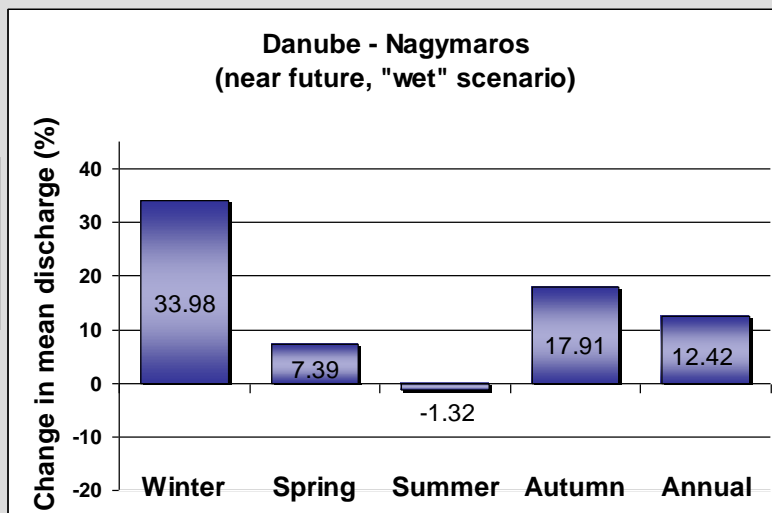
Near future

Far future

„Dry”
scenario



„Wet”
scenario



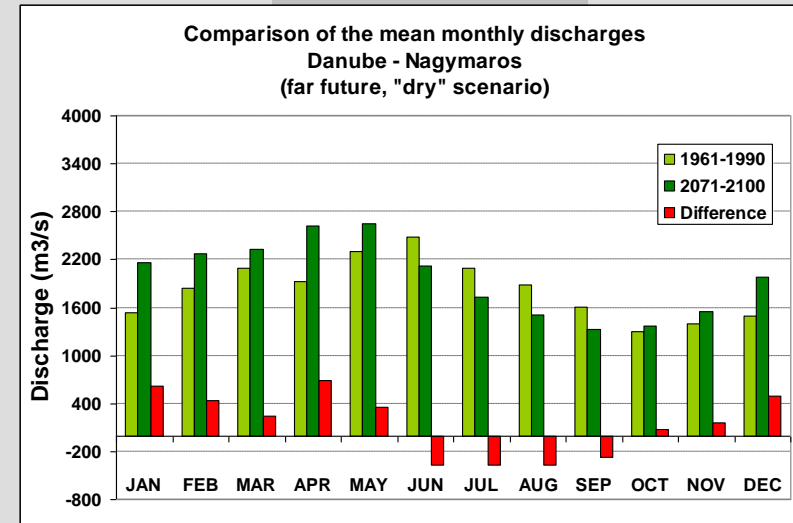
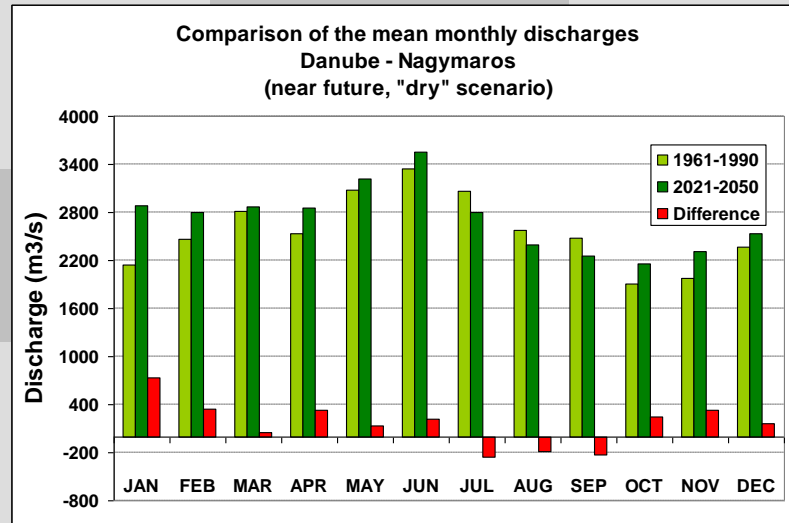
Seasonal changes (monthly time step)



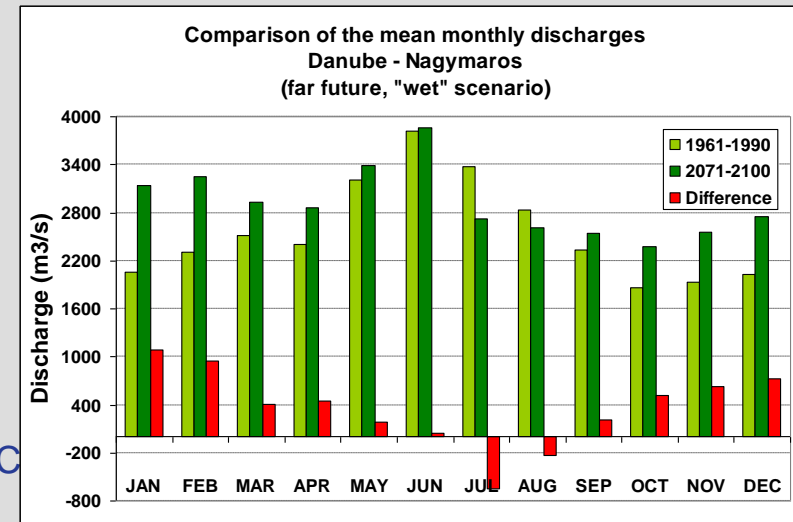
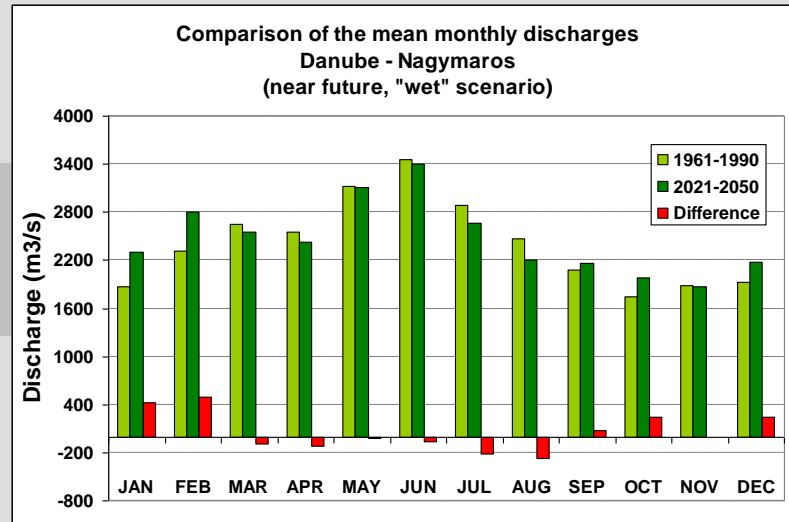
Near future

Far future

„Dry”
scenario



„Wet”
scenario



Changes in low water conditions

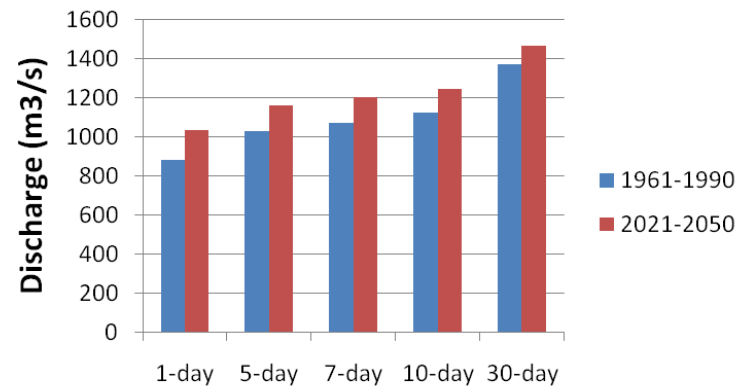


Near future

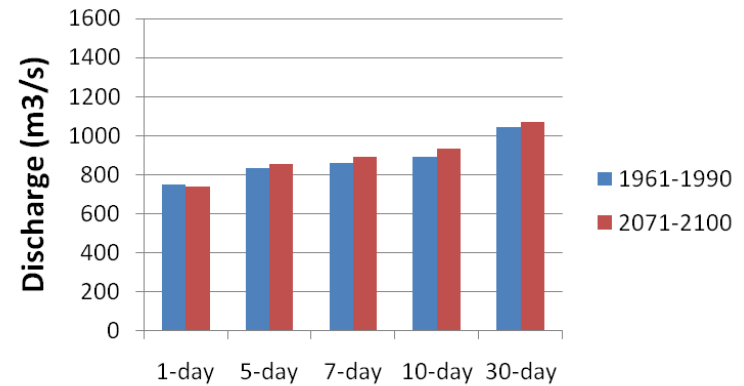
Far future

„Dry”
scenario

Danube - Nagymaros
(near future, "dry" scenario)

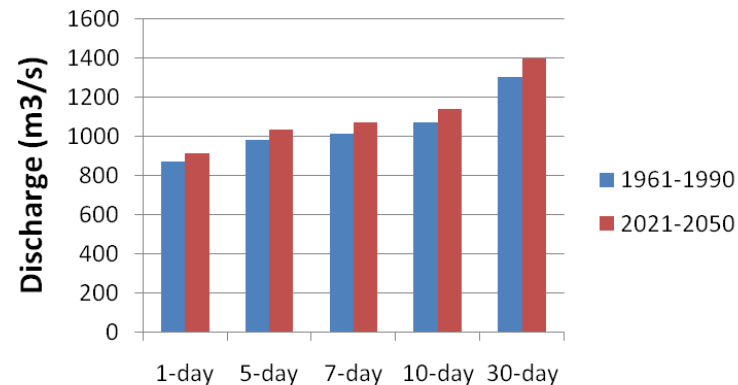


Danube - Nagymaros
(far future, "dry" scenario)

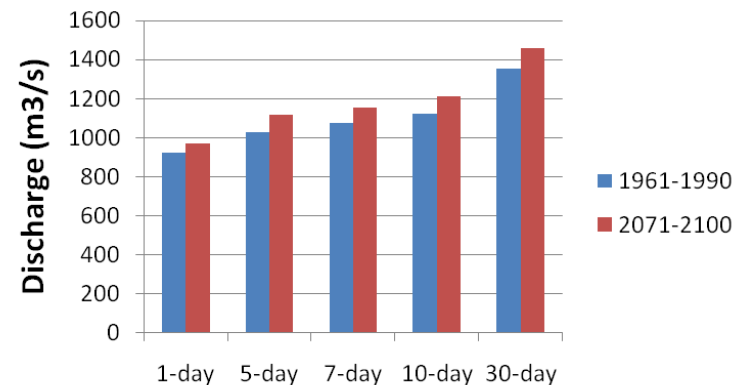


„Wet”
scenario

Danube - Nagymaros
(near future, "wet" scenario)



Danube - Nagymaros
(far future, "wet" scenario)



Changes in low water conditions

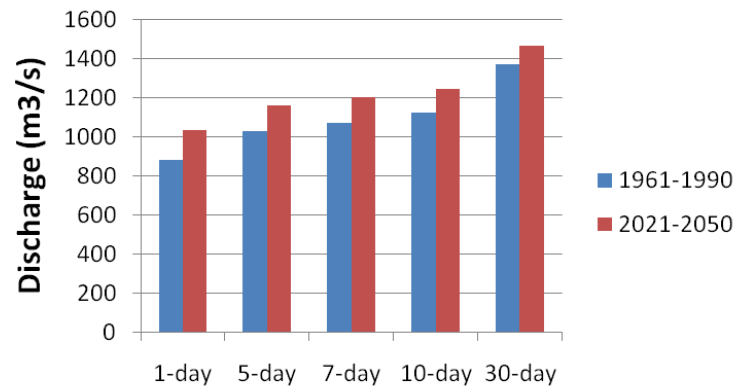


Near future

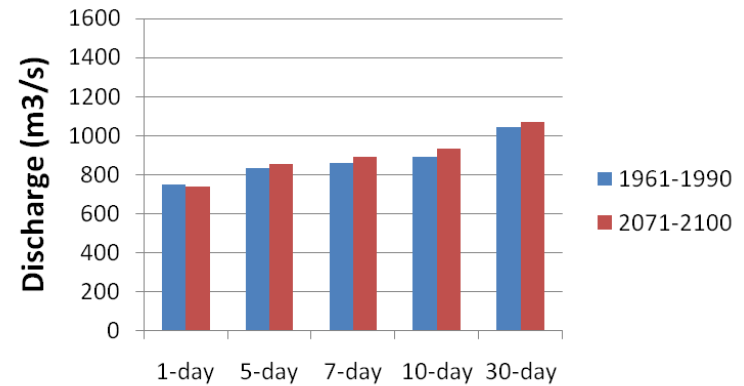
Far future

„Dry”
scenario

Danube - Nagymaros
(near future, "dry" scenario)

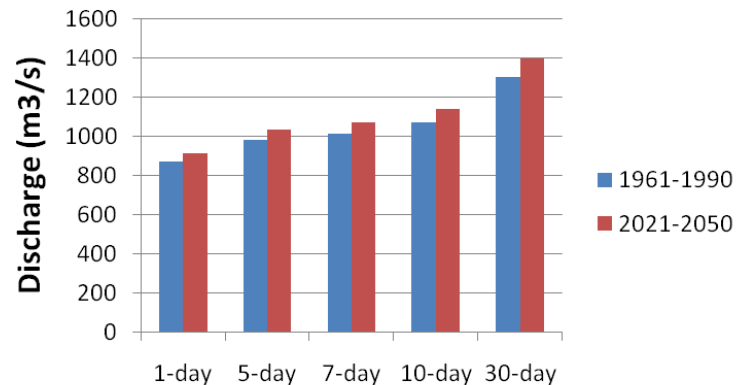


Danube - Nagymaros
(far future, "dry" scenario)

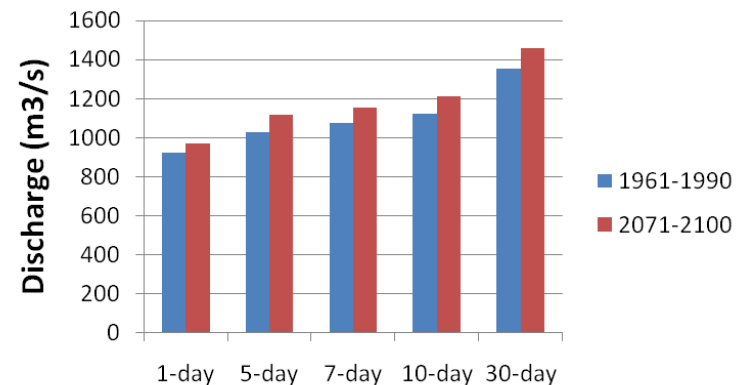


„Wet”
scenario

Danube - Nagymaros
(near future, "wet" scenario)



Danube - Nagymaros
(far future, "wet" scenario)



Changes in low water conditions



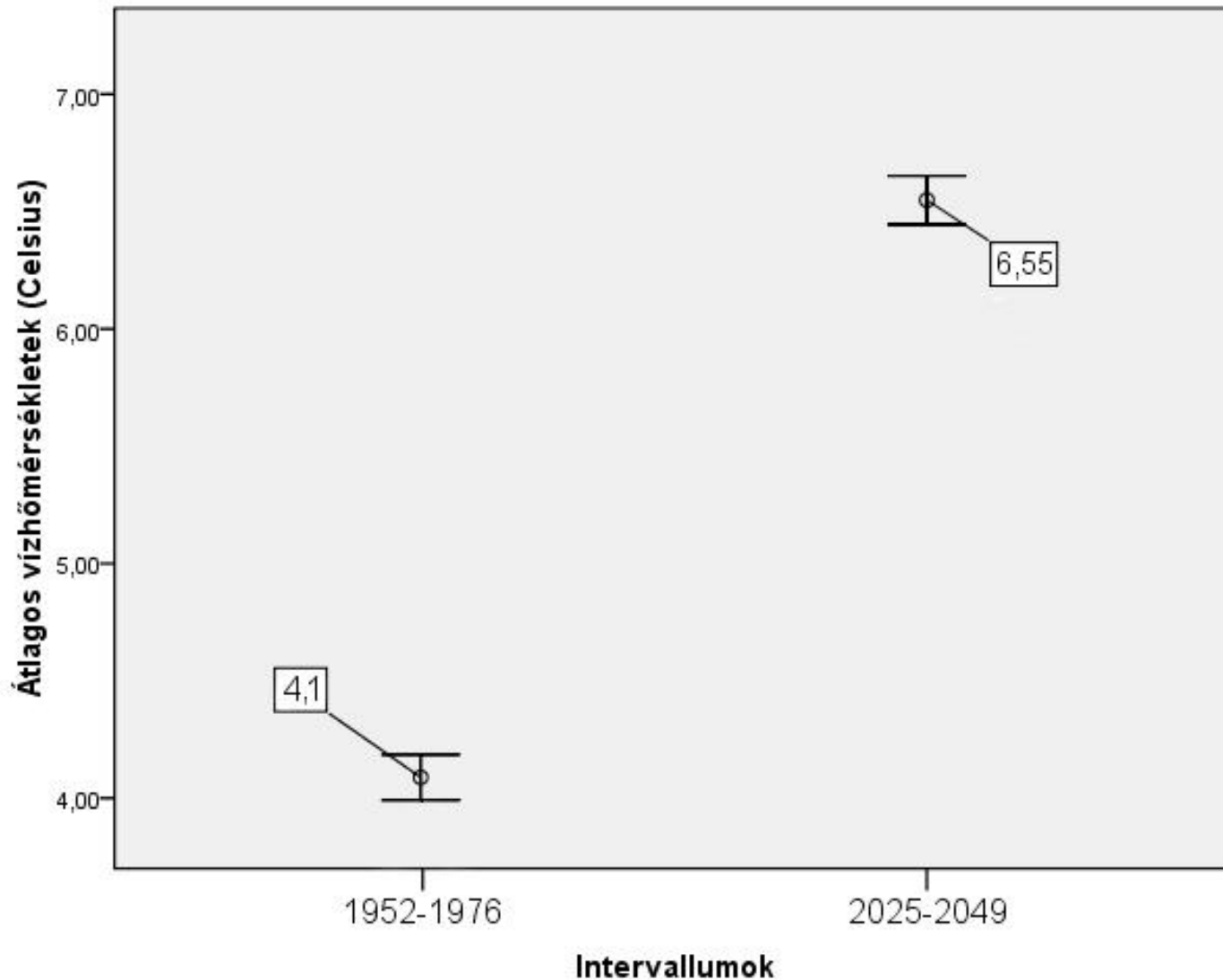
- Shift in the Alpine type of hydrological regime
 - Warm winters: thaw, rising winter low water
 - Reduction of the glacier covered area and melt on the long run
- Slight improvement (near - or non - significant) improvement
 - Longer late summer autumn low flow

Changes in Flood Situation

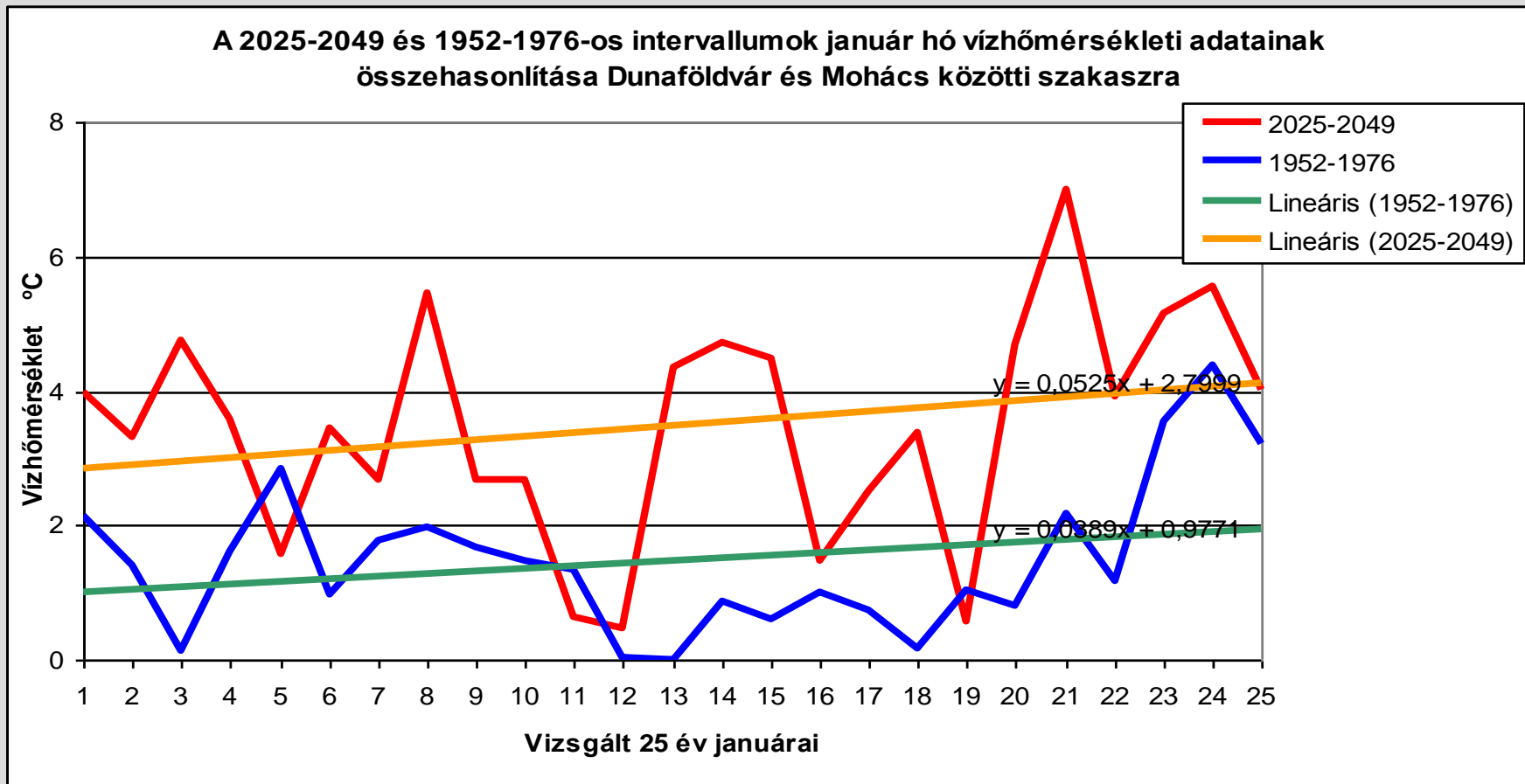


- Some analyses suggest of growing extremes
 - No significant changes relative to navigability
 - Growing number of smaller flood waves (not climate change related)

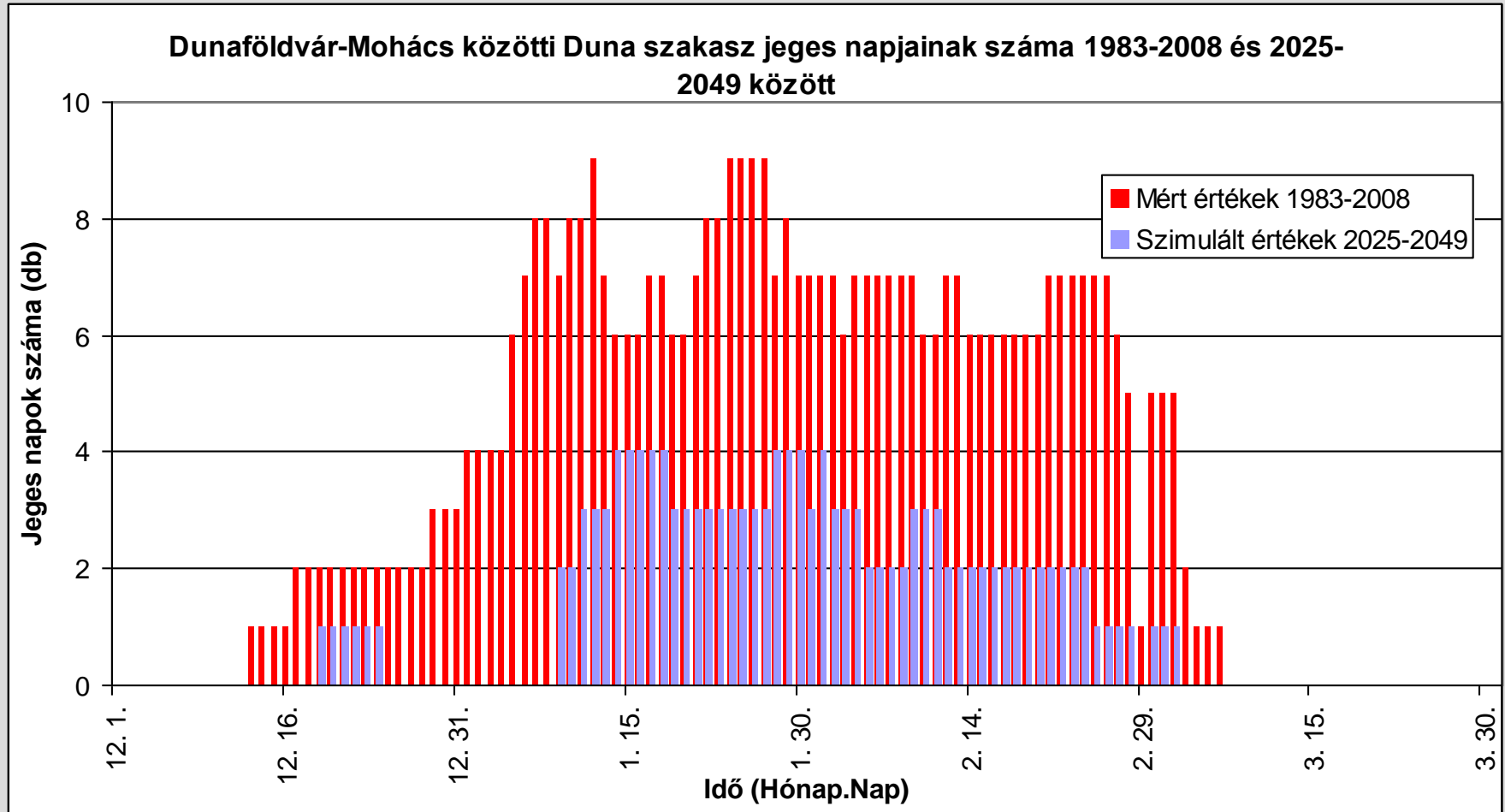
Change of annual water temperature



Winter (February) water temperatures 1952–1976 vs. 2025–2049 and trends



Duration of Ice phenomena, 1983-2008 vs. 2025-2049



Ice Phenomena



- Observed reduction –
 - positive for navigation conditions, enhanced by rising winter low water
- Continuing tendency –
 - Projections show the same trend
 - Piece of bad news: ice phenomena (with possible extremes) remain part of the climate