Impact of Climate Change on Lake Neusiedl and potential adaptation strategies

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Adaptation to Climatic Change in the European Alps
Wengen 2006 Workshop 04 – 06 October 2006

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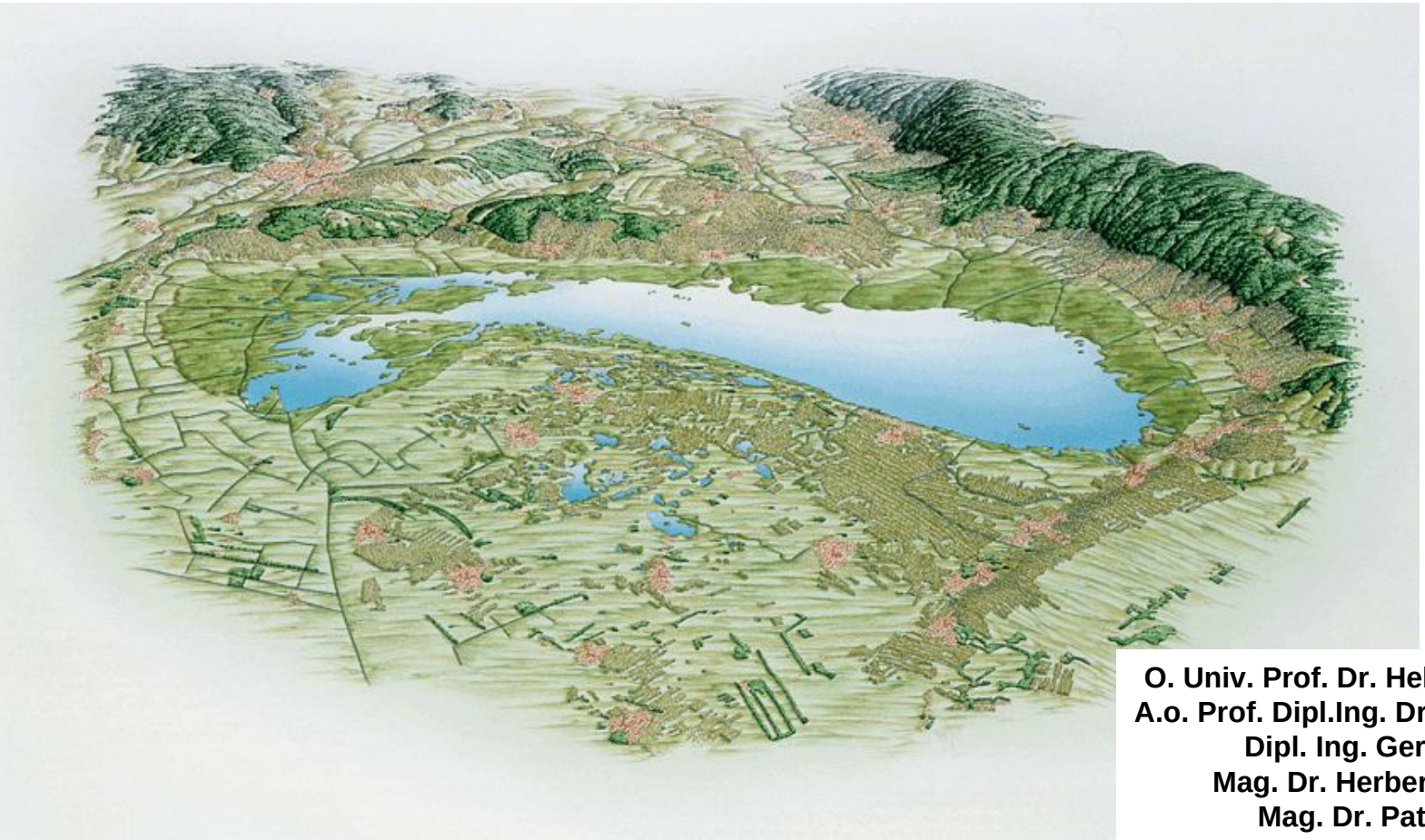
Bases on the results of the research project financed by the “Landesregierung Burgenland”

„Auswirkungen einer Klimaänderung auf den Wasserhaushalt des Neusiedler Sees“



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Outline

- Motivation
- Methods
- Results
- Adaptation strategies
- Some Conclusions

Motivation

- Lake Neusiedl is a shallow “Steppensee” which means, that he has no natural outflow.
- Observed low lake levels showed first negative effects on tourism (especially sailing) in 2003.
- Drying out of lake Neusiedl has been observed several times in the past (last time in 1860s).
- Tourism at Lake Neusiedl and surrounding is an important regional economic factor.
- This region is an important European bird breeding region.

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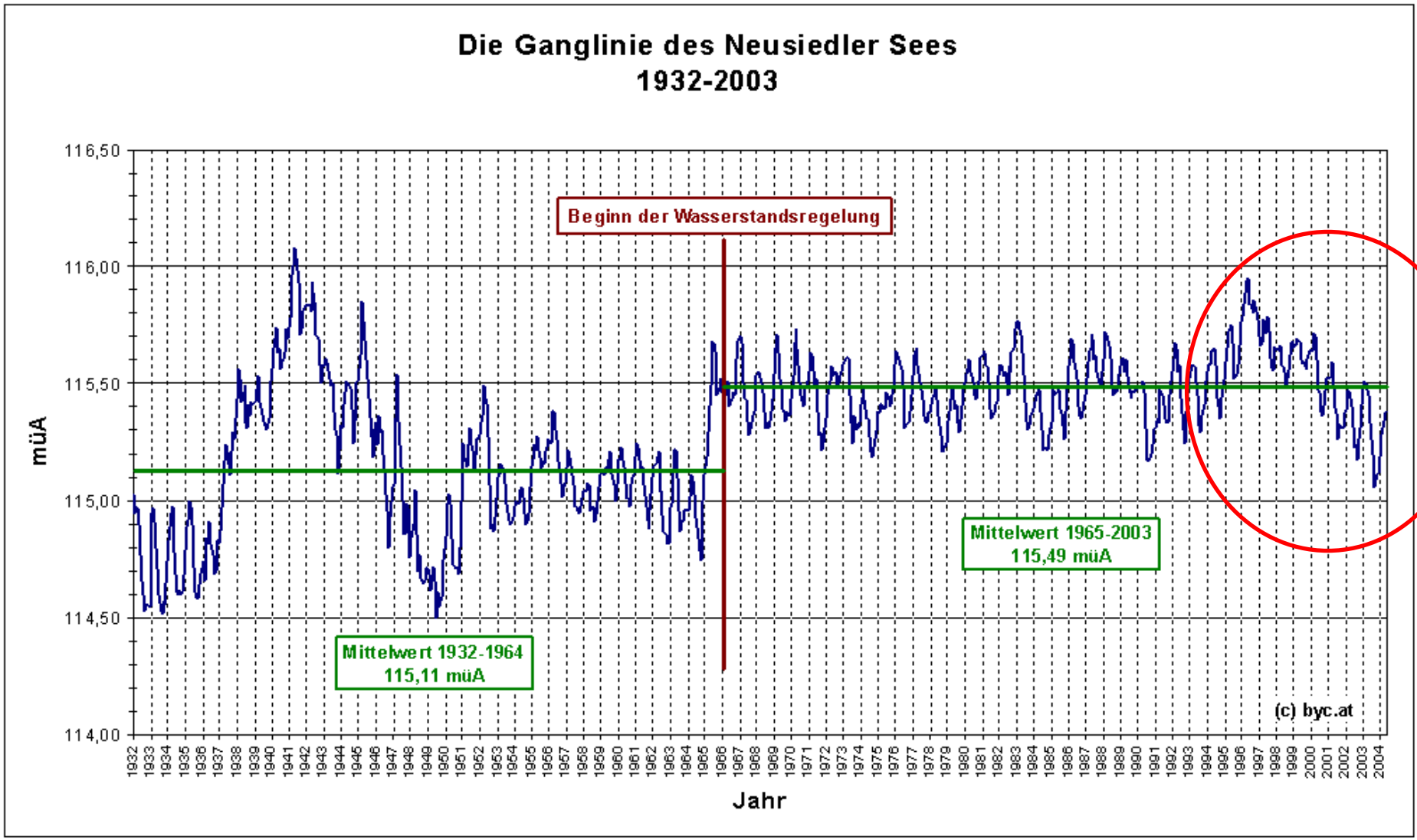
Motivation

Observed lake level fluctuations



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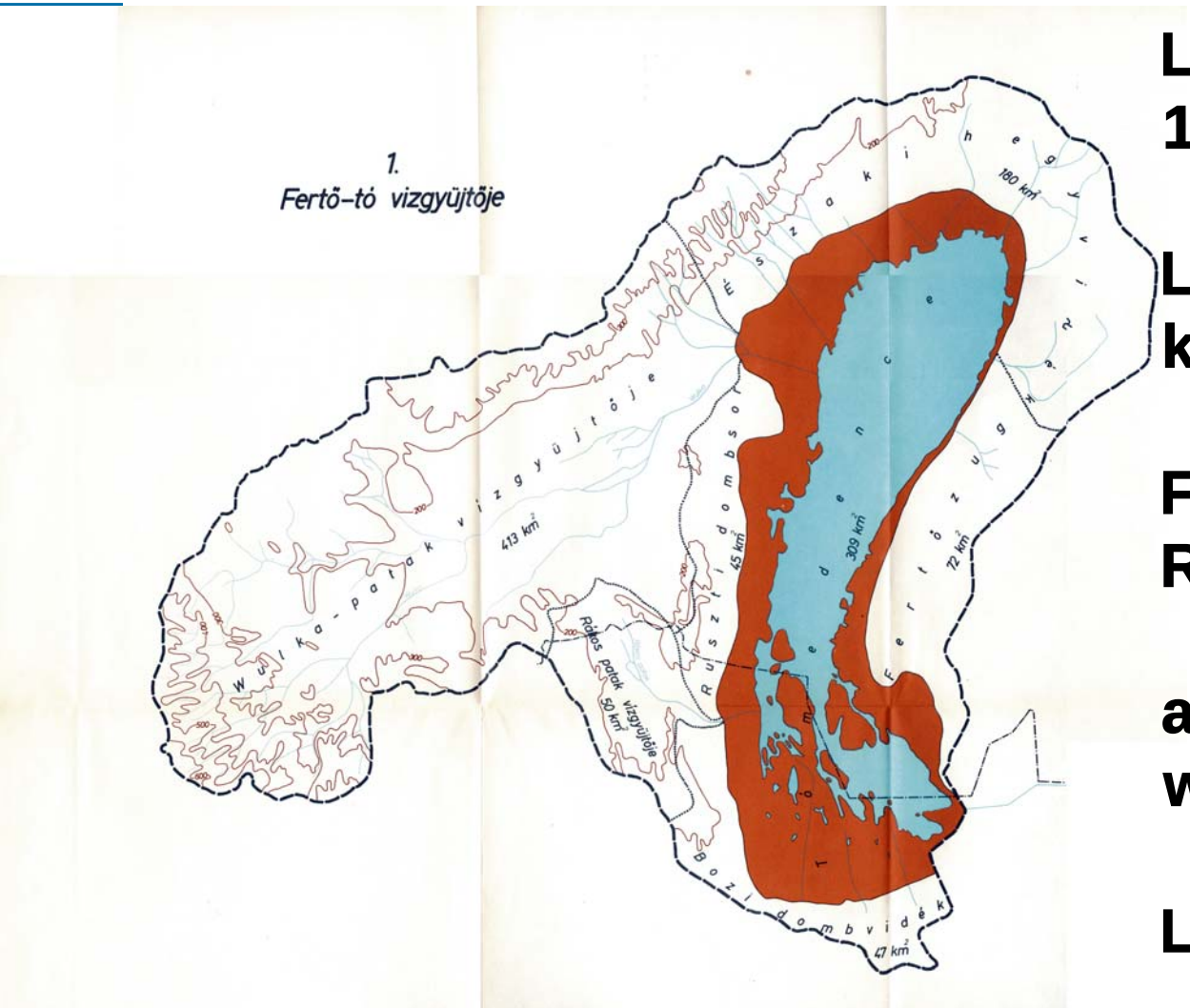
Method - Hydrology



Lake Catchment: 1.120 km²

Lake Area: ~ 315 km²

From this ~ 175 km² Reed

and 140 km² free water:

Lake depth: < 2m

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Method - Hydrology

Water balance

Inflow:

Precipitation on the Lake	78 %
River discharge (manly the river Wulka)	20 %
Ground water inflow	2 %

Losses:

Evaporation	90 %
Channel (flood protection)	10 %

Method - Hydrology

Lake evaporation:

Dalton approach with reed correction

$$E_W = f(v) \times (e_s(T_{WO}) - e)$$

E_w = Evaporation
e_s = saturation water vapour at water temperature
e = water vapour in air
f(v) = wind function (linear for lake Neusiedl)

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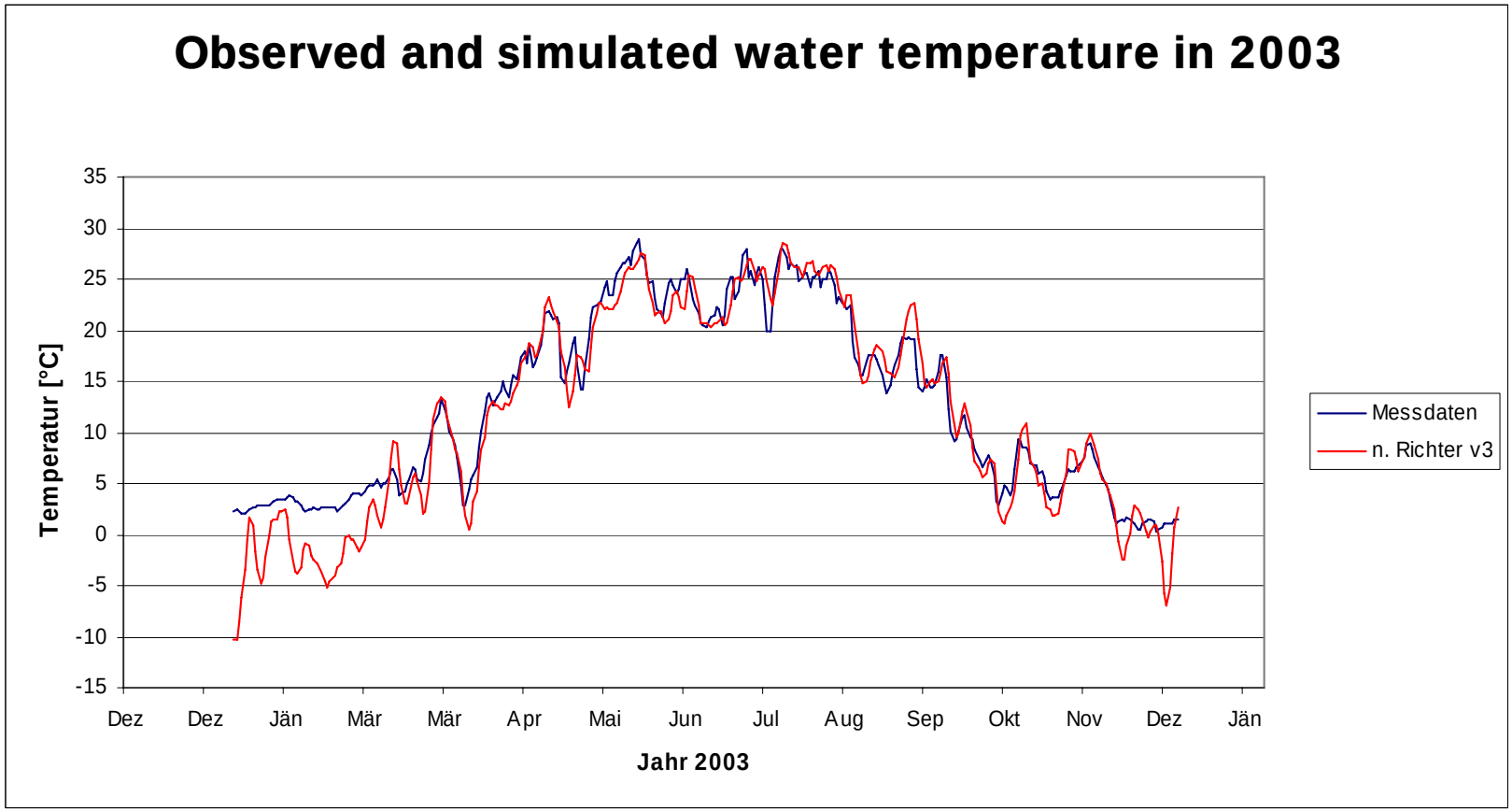
Method - Hydrology

Lake temperature: Richter approach



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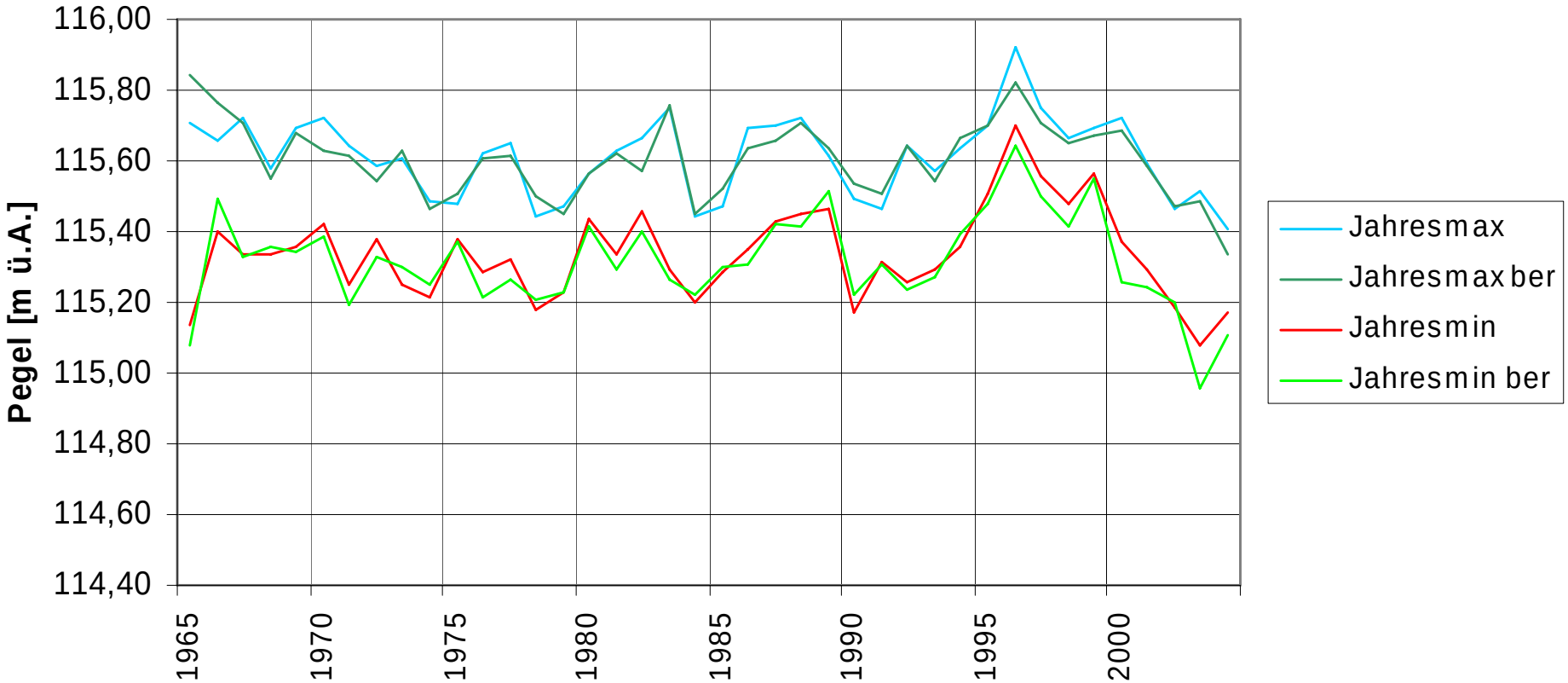
Method - Hydrology

Skills of the lake level model



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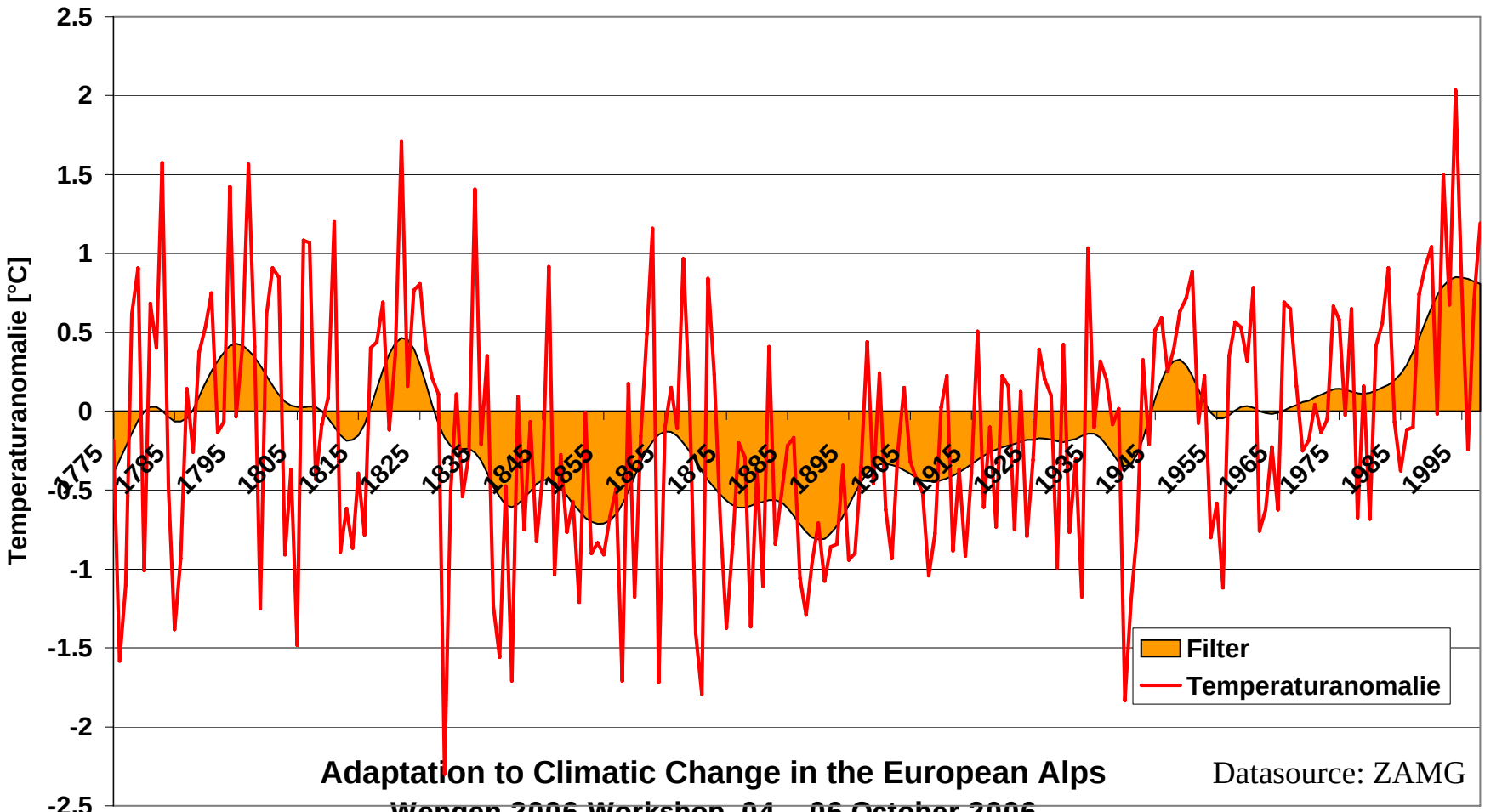
Method - Climate

Observed climate

Temperature anomaly at the lake Neusiedl area



Datasource: ZAMG

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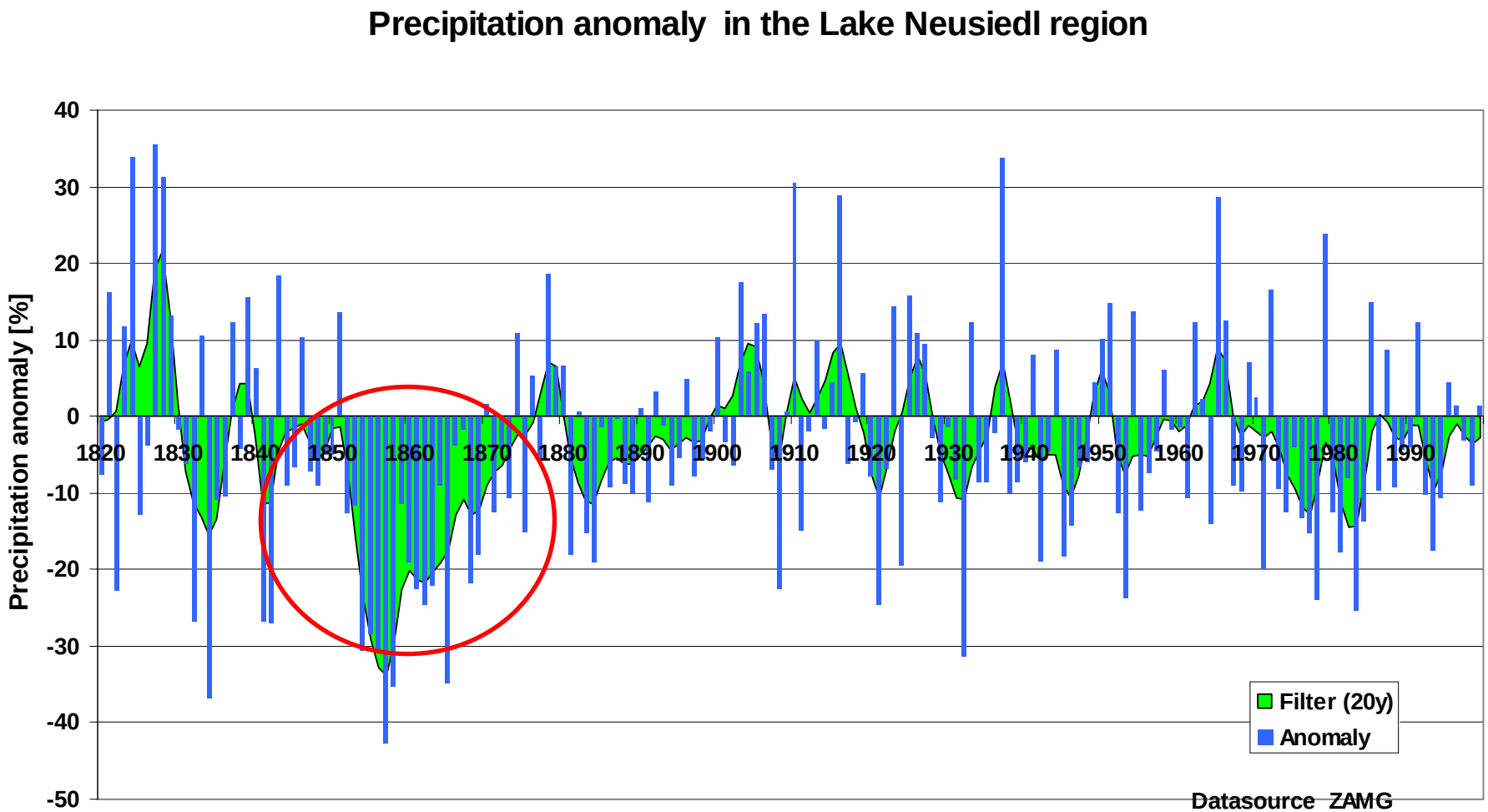
Method - Climate

Observed climate



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Method - Climate

Scenario preparation:

- Based on ECHAM4 IS92a GHG only for 2000 - 2049.
- Statistical downscaling for temperature with analogue technique using relative topography 850-700 hPa as predictor field on daily base.
- Calibrating a weather generator (Lars Wgen) for periods 1961-1990 and 1991-2004 to Station Neusiedl.
- Run the weather generator for the periods 2010-2030 and 2030-2049 using only the temperature changes.
- Relative humidity is estimated from the Temperature diurnal range.
- Wind speed is set to observed monthly means.

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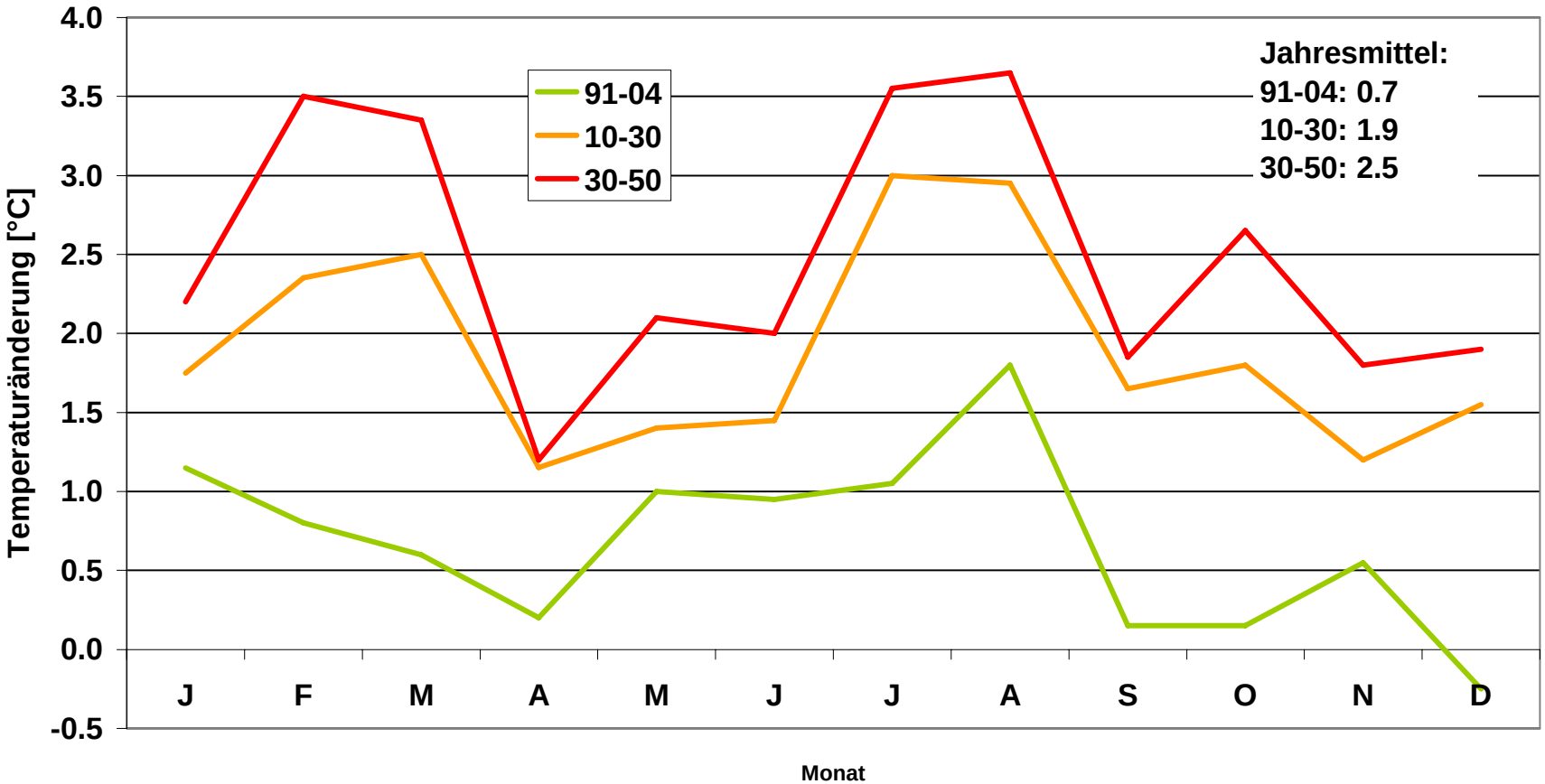
Method - Climate

Climate change signal:

Observed and scenario for Temperature change in the lake Neusiedl region compared to 1961-1990



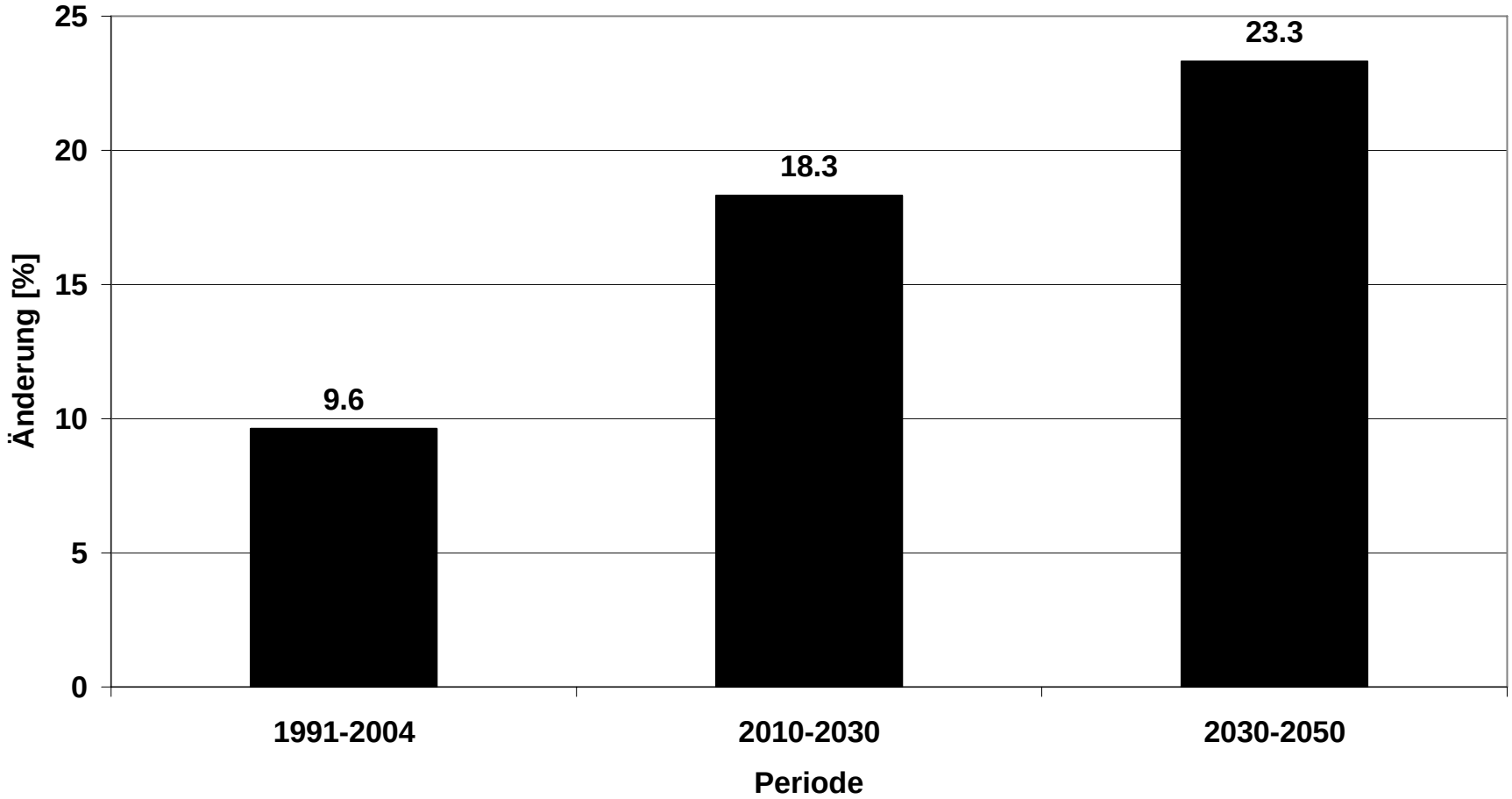
Method - Climate

Model set up:

- With the average climate of the periods 1961-1990, 1991-2004 and the temperature change for 2010-2030 and 2030-2049 the weather generator was run for 500 years.
- For the scenario periods the weather generator was rerun with modified precipitation from – 20 % to + 20 % in 5 % steps
- The Lake model was driven by the several 500 year weather data on daily base.

Results

Increase of Lake Neusiedl evaporation compared to 1961-1990 due to temperature increase.



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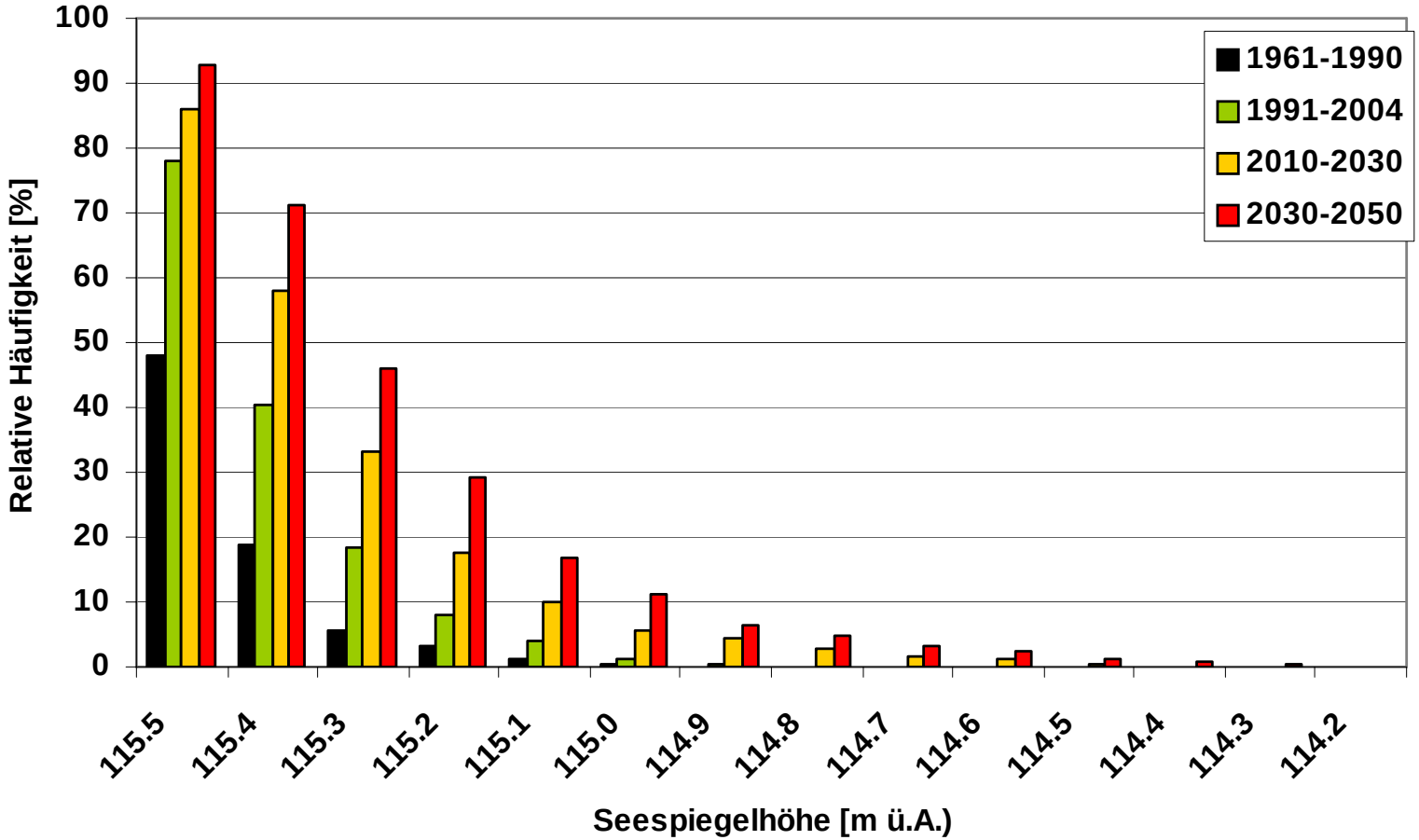
Results

Modelled frequency distribution of lake levels beyond a given threshold (no precipitation change).



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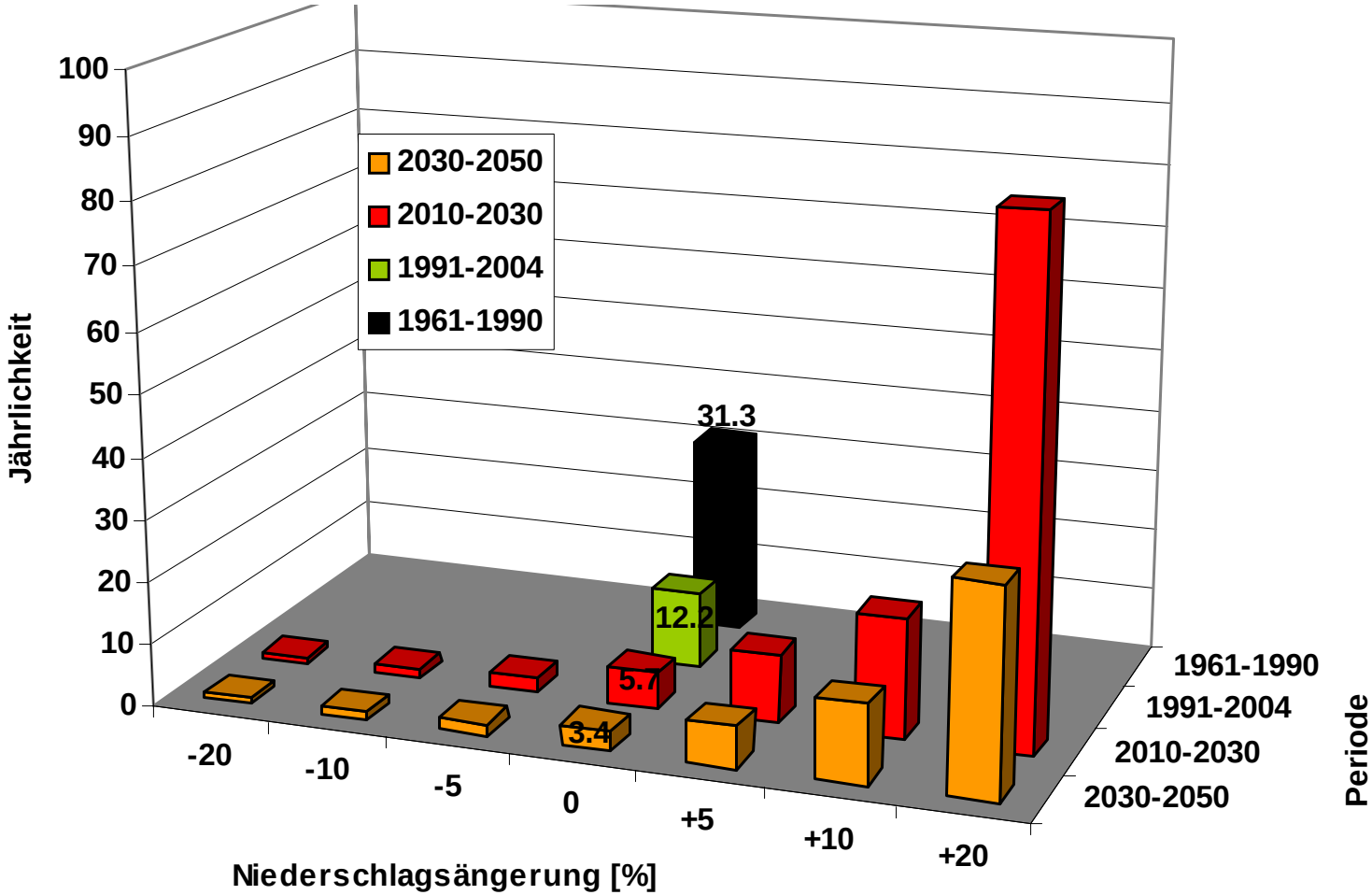
Results

Return periods for lake levels beyond 115.2 m for different periods and precipitation changes.



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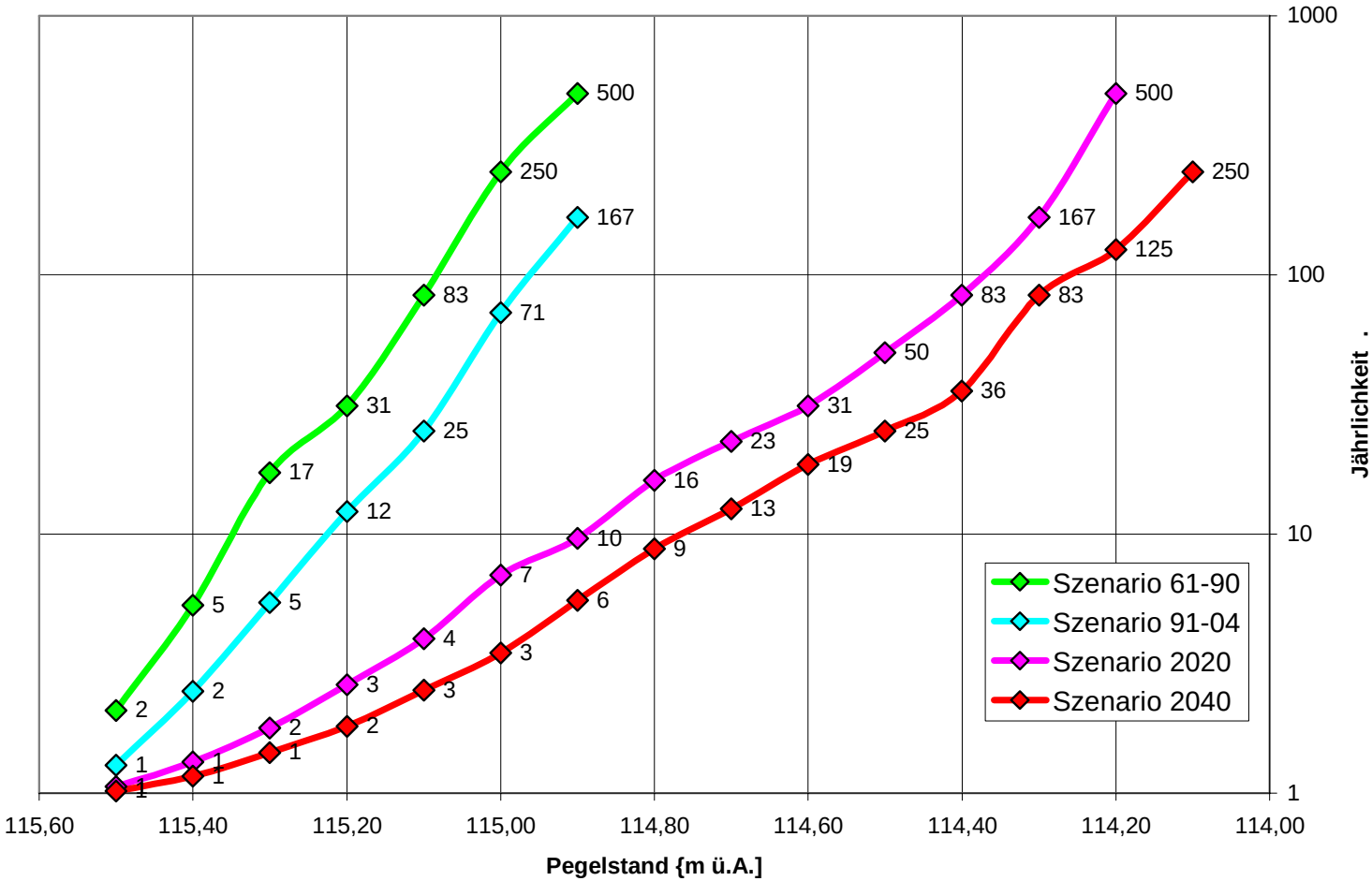
Results

Return periods for different lake levels for the different periods and precipitation as in 1991-2004.



Adaptation strategies

Only possibility to stabilize the lake level is to bring in water -
Two options are discussed:

- **Water from the ground water table (Uferfiltrat) of the Danube.**
- **Water from the river Raab from the Hungarian side.**

Adaptation strategies

Problem is the large amount of water – to rise the lake level 1 mm ~ 300.000 m³ water are needed.

To bring the water from the Danube to lake Neusiedl it has to be bumped an altitude of more than 30 m – Very energy intensive.

When the water is needed most, the river Raab also has very low discharge.

Adaptation strategies

Additional problems:

The mixing of the salty lake water with the Danube water may cause a clearing of the water, leading to massive growth of water plants.

Large additional water inflow may decrease the salinity and accelerate the growth of reed.

Some Conclusions

- Lake Neusiedl is very sensitive to climate change.
- A warming of 2.5 K leads to an evaporation increase of more than 20 %.
- To compensate the evaporation losses an precipitation increase of + 20 % is needed, which is not very likely looking on state of the art regional scenarios.
- Critical lake levels for tourism as 150.0 m will change there return period from some 250 years in the past to less then 10 years within the next decades.
- Adaptation seems to be possible but may be expensive and include some possible negative biological reactions in the lake.

Thank you for your attention!