On the water level measurements in the Gulf of Riga during 1961–2016

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WAVE ENGINEERING

Outline of the presentation

- Why to analyse components of water levels (WL)?
- Study area with observation stations
- Description of the data
- Quality analysis of data

- Previous study with modelled WL
- Distributions of WL components
- Comparing results with modelled ones
- Conclusion and further work

Motivation for the study of WL

- Water level (WL) is core input for coastal management and engineering projects
  - Means, extremes, quantiles, trends, distributions
- Main contributors to total WL:
  - Tides, storm surges (low atmospheric and wind-driven surges), wave-induced set-up, local effects
  - Usually assumed to be independent
    - Hence, **analyse components separately**
    - Most are well studied in Baltic Sea
- What about specific reaction to WL from sub-basins?
- **Latvian WL observations used 1st time here**

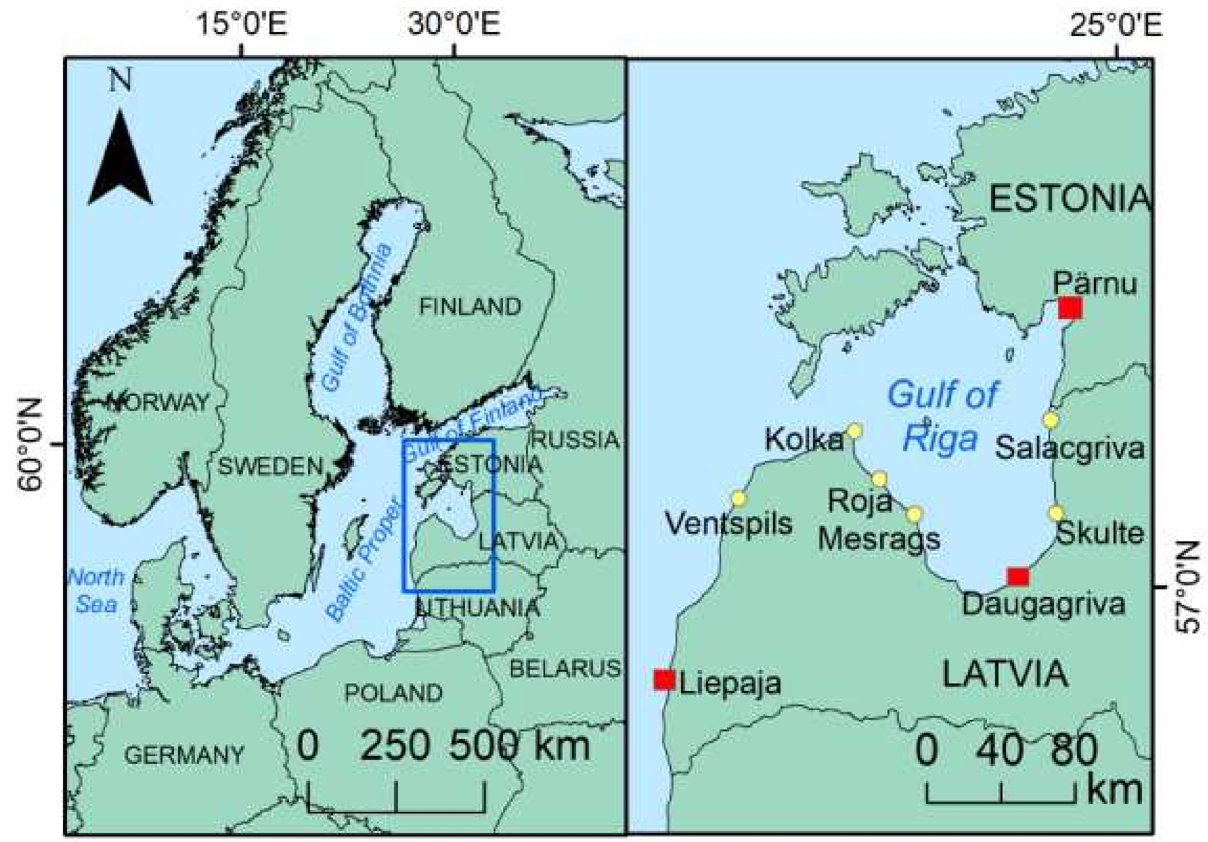
Study area

Gulf of Riga (GoR)

- 130 x 140 km
- Surface area 17913 km^2
- Volume 406 km^3
- Average depth 23 m

<u>Similarly with Baltic Sea:</u>

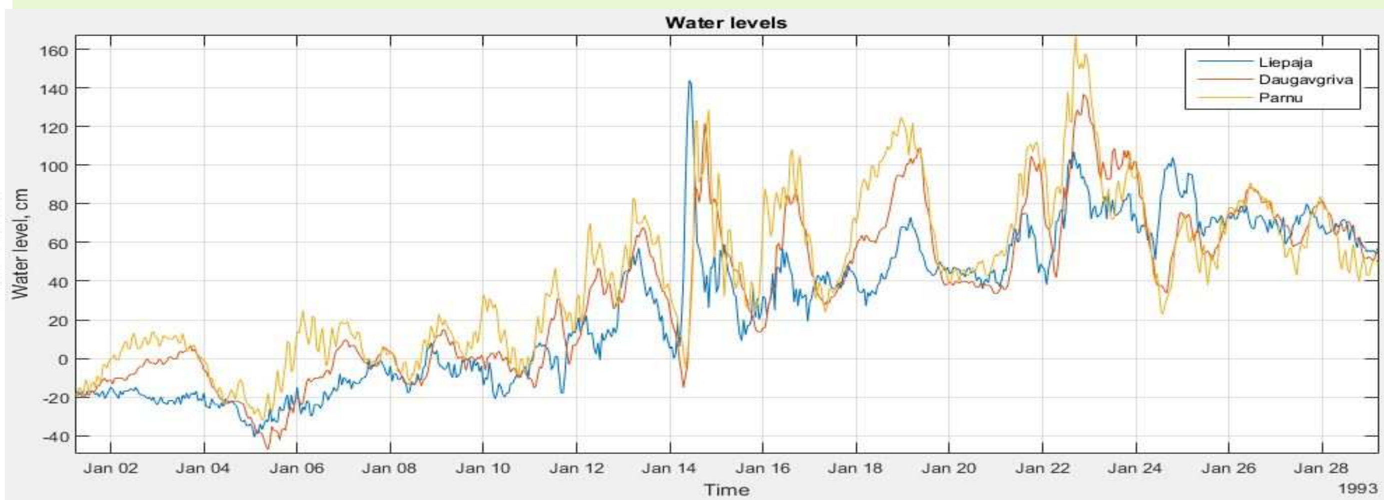
Temporary increase in water volume may lead to devastating results



Description of observed data

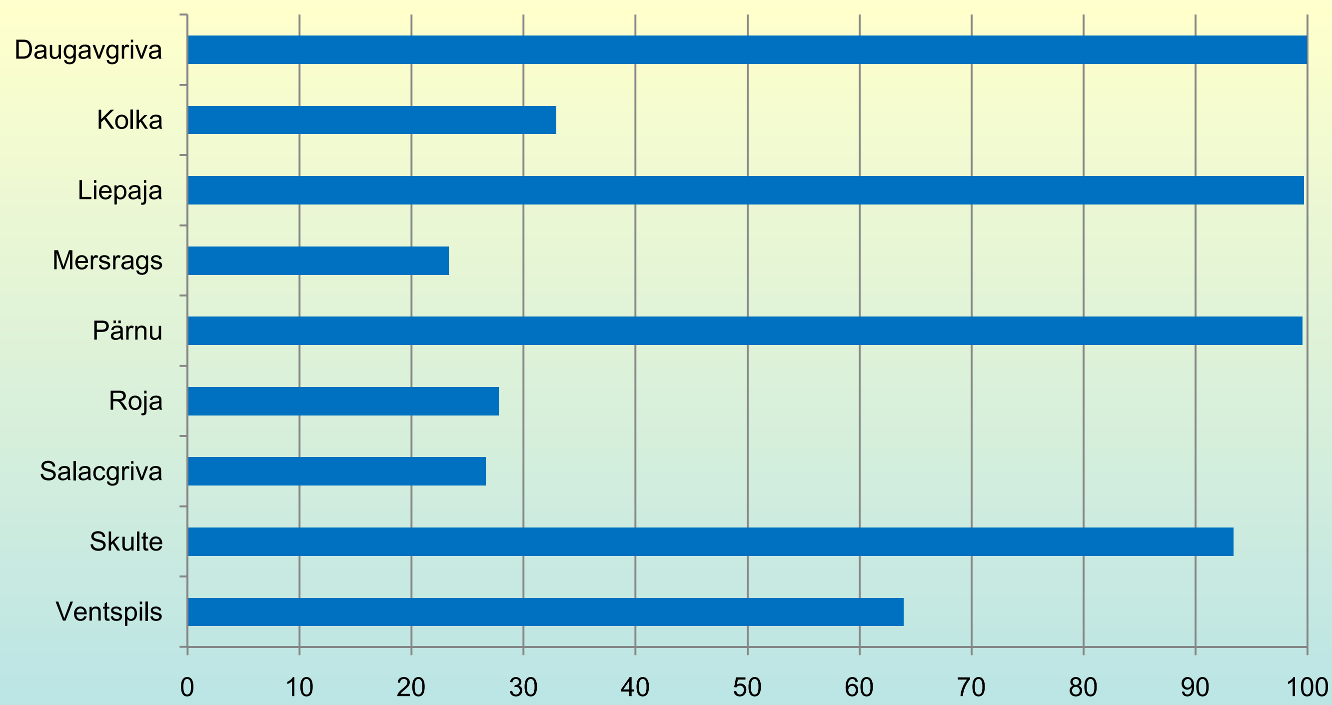
- Observed data mainly from Latvian Environment, Geology and Meteorology Centre
- Supplemented with data of Pärnu (Estonia)

- 1961–2016.
- Mostly hourly data.
  - Gaps and missing values (some stations recorded 2–4 times a day).
  - Some erroneous values (*e.g.* sudden peaks)



- **Focusing on data from Liepaja (L), Daugavgriva (D) and Pärnu (P).**
  - Exclude gaps from all time-series (1961–2016).
  - Correlation for L and D/P ==> 0,845/0,890.
  - Small uncertainties: L=1,2 cm, D=0,7 cm, P=1,6 cm.

Completeness of hourly data

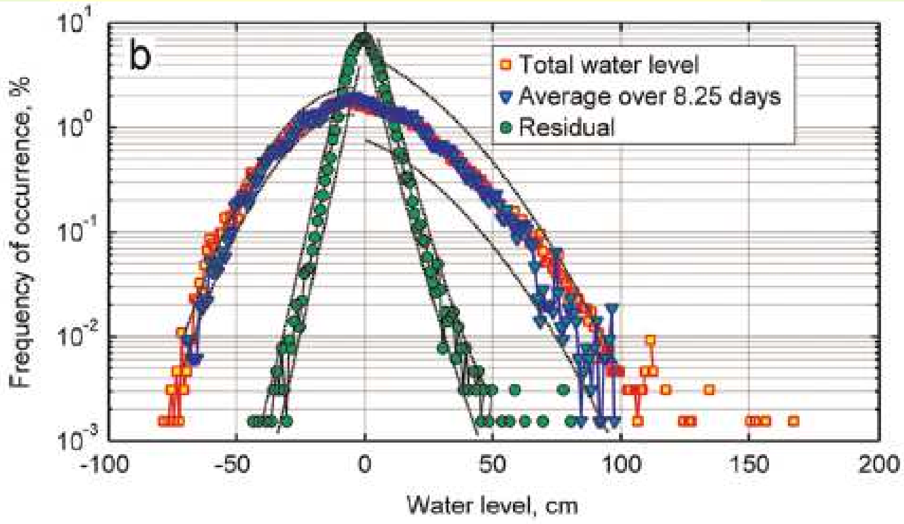


Previous study with modelled WL data

Soomere, Eelsalu, Kurkin, Rybin. 2015. **Separation of the Baltic Sea water level into daily and multi-weekly components**. Continental Shelf Research 103.

Modelled WL values (1961–2005)

- Rossby Centre Ocean (RCO) Model (SMHI)
- Grid cell (2x2 nm) away from coast in the depth range of 6–30 m.

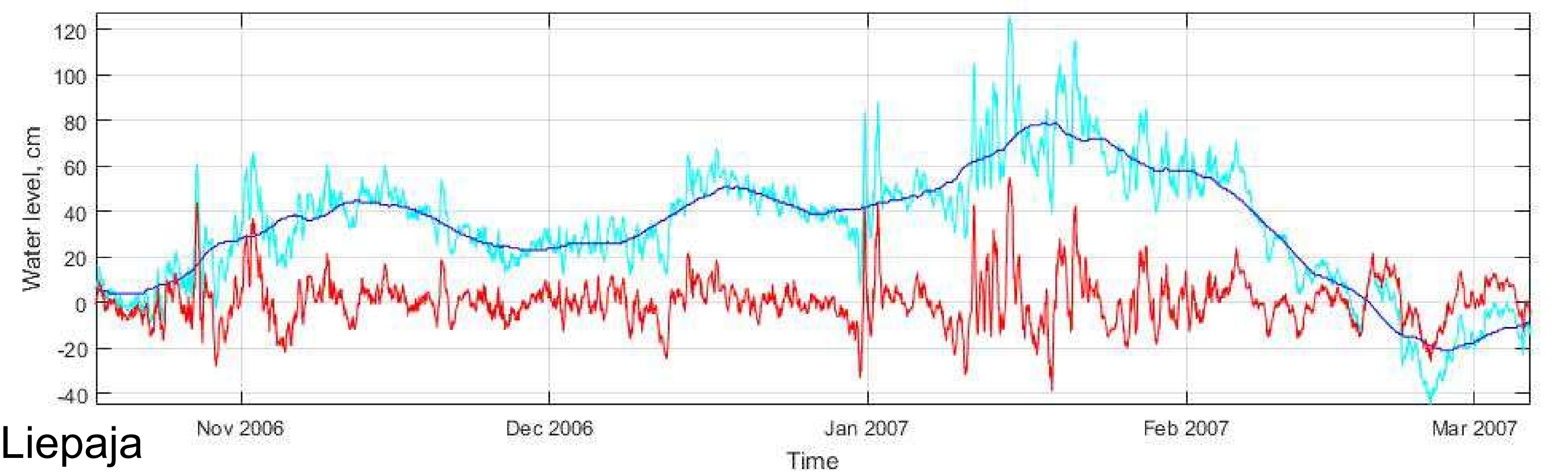


Used running averaging technique on WL time-series to extract components and their distributions

Components of water levels (WL)

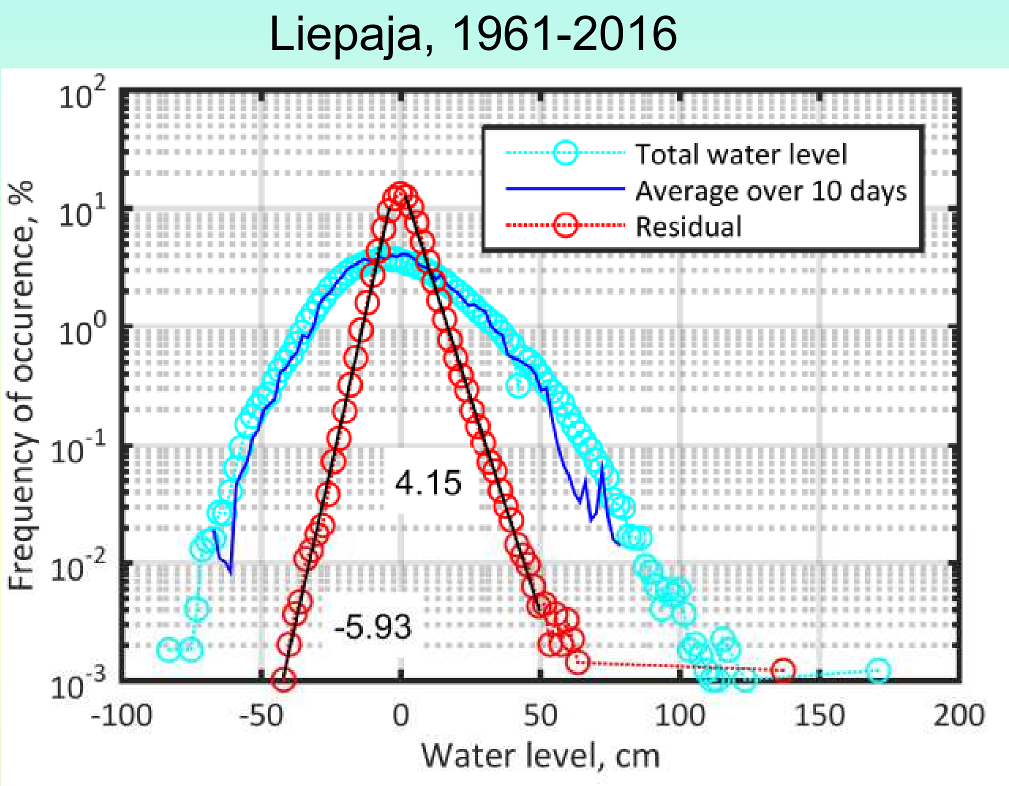
- Running average technique for WL time-series

TOTAL WATER LEVEL (WL)	All factors and components included
Weekly-scale average (WA)	Shows fluctuations in the Baltic Sea water volume
Residual (Re = WL–WA)	Proxy for the local wind-driven surge (e.g. Soomere *et al.*, 2015)



Liepaja

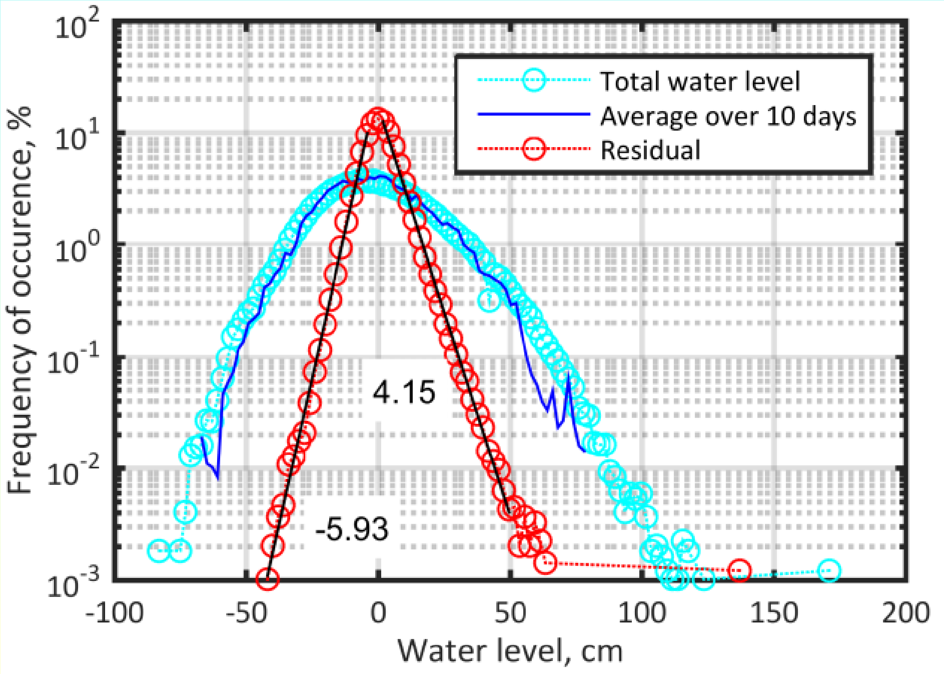
Distribution of WL values



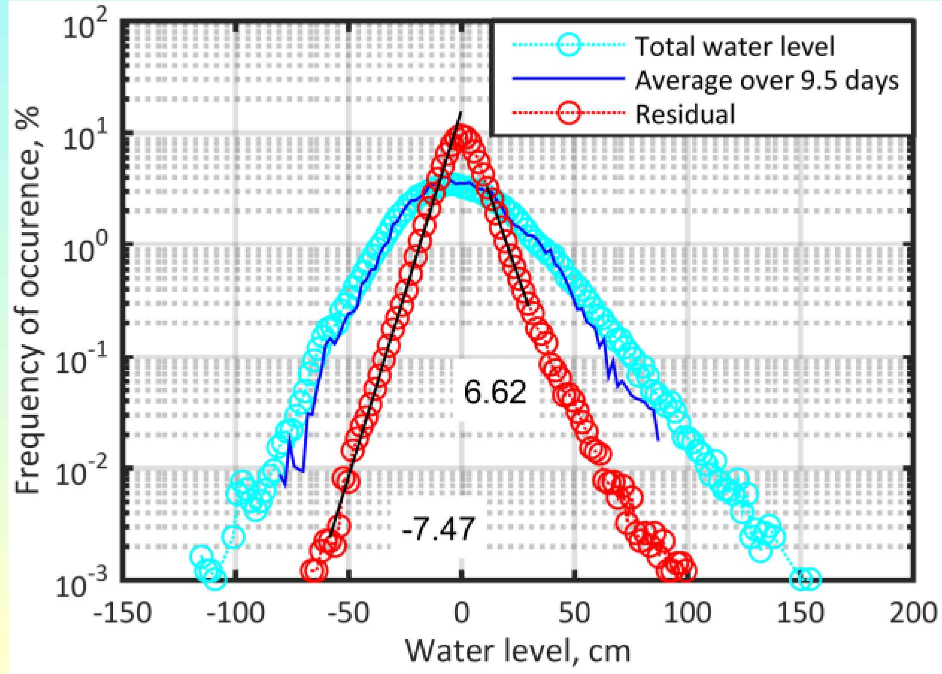
WL	Approx. Gaussian
WA	Approx. Gaussian
Re	Exponential distribution?

- For residual: shape of distr. and outliers depend on averaging interval t_A.
- **Search for suitable t_A.**
  - **$f(t_A)=ax^2+\lambda x+c$** (a → 0)
  - Residual reduces to exp distribution.

Liepaja



Daugavgriva



Averaging intervals

Tallinn	8,25 days
Liepaja	10 days
Daugavgriva	9,5 days
Pärnu	9 days

- Possible to quantify the probability of high and low local storm surges
- Scale parameter -1/ λ

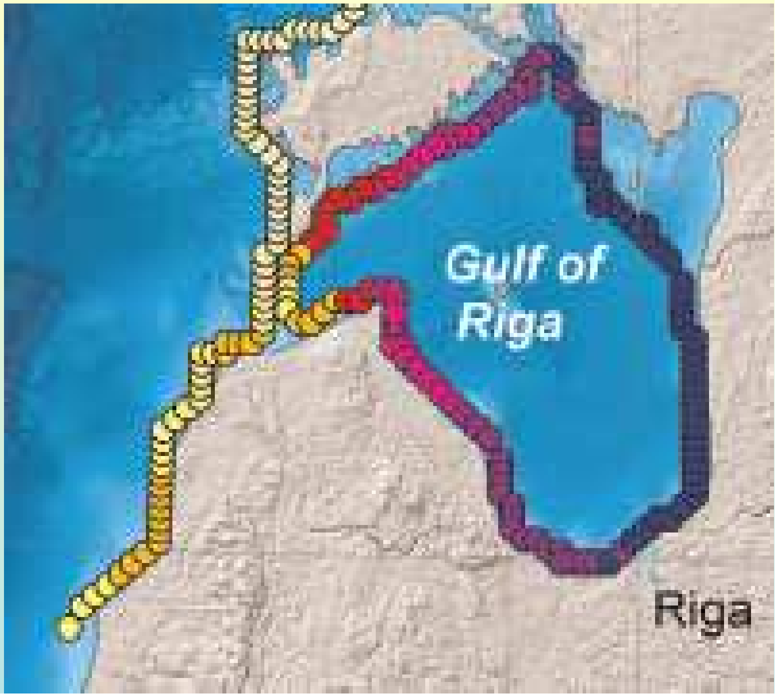
Comparison of $-1/\lambda$

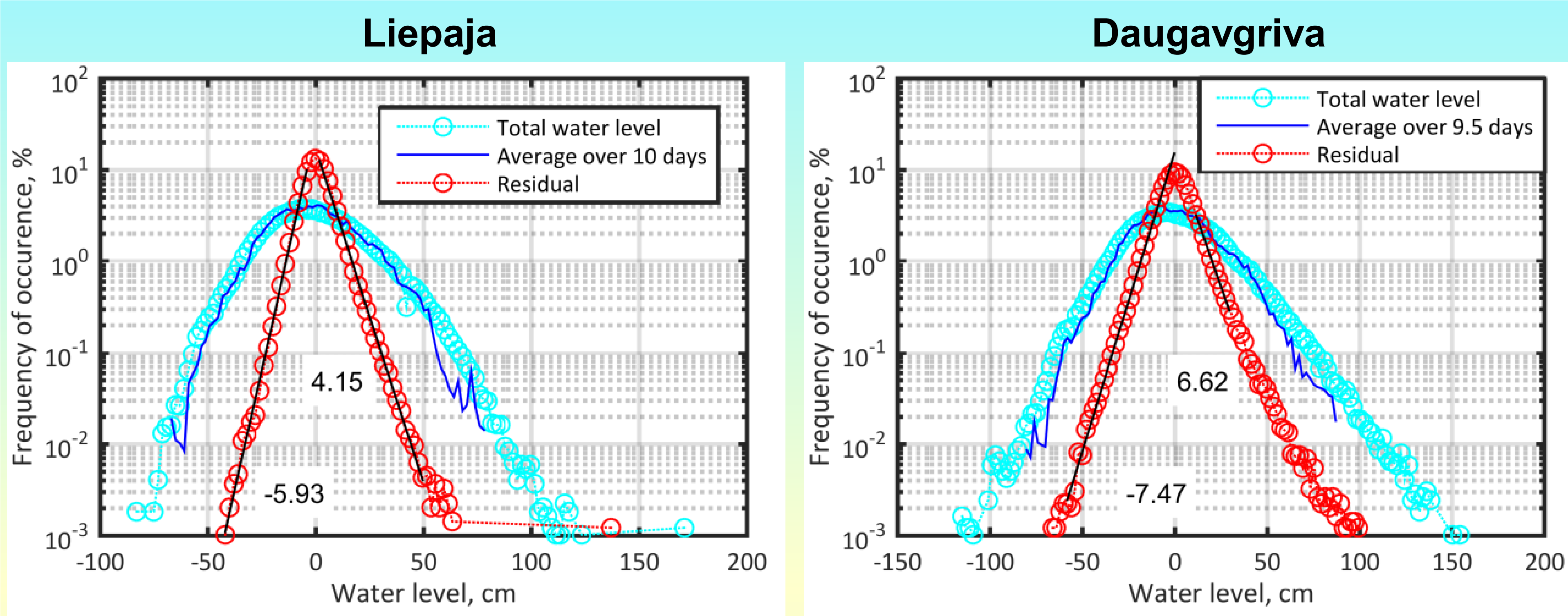
Location	Measured WL		Modelled WL	
	Left	Right	Left	Right
Liepaja	-5,93	4,15	-2,8...-2,5	4,2...4,6
Daugavgriva	-7,47	6,62	-5,0...-4,3	6,0...6,3
Pärnu	-8,49	7,50	-5,0...-4,3	6,0...6,3

Higher values mean higher water levels. Lower vice versa.

Modelled WL values (1961–2005)

- Mismatch probably caused by location differences and time period
- Sensitive to length of regression line





- Several occasions WL in GoR was higher or lower than in the Baltic Sea
  - Systematic increase in the water volume in GoR?
  - Small cross-sections of Irbe and Suur Strait

Conclusion and further work

Observed WL time-series first time used in this study

- (Hourly) data of 1961-2016 has some gaps and errors, but suitable for analysis

Idea of the study:

- Total water level = weekly average + residual
- Distribution of residual turns to exp with suitable t_A.
- Possible to quantify the probability of high and low local storm surges

Further work:

- Another component in GoR?
- Duration of high/low waters

Thank you for your attention!

Photo: Küllike Rooväli, Postimees