CONFERENCE BROCHURE

OF THE

20th Congress of Hungarian Geomathematicians and
9th Congress of Croatian & Hungarian Geomathematicians
“Geomathematics in multidisciplinary science -
The new frontier?”

2017
Organizers

Hungarian Geological Society (HGS)

Geomathematical & Informatics Section of the HGC

MTA CSFK 2ka Palaeoclimatic Research Group

Cluster of Applied Earth Sciences

Geomatematical Section of the Croatian Geological Society

University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering

Geochem Ltd.

Szent István University, Faculty of Mechanical Engineering

The South Transdanubian Regional Branch of the Hungarian Geological Society

Hungarian Academy of Sciences, Geomatematical Subcommittee of Committee on Geology and the Regional Committee in Pécs
Sponsors

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Hungarian Academy of Sciences

Chamber of Commerce and Industry of Pécs-Baranya

Enterprise Europe Network

European Commission
SCIENTIFIC PROGRAM

**Wednesday (10.05)** - Geostatistics today – pre-conference short course by János Geiger
(Venue: Chamber of Commerce and Industry of Pécs-Baranya, Pécs, Majorossy I. u. 36., 7625)

10:00- Registration  
10:30-12:00 Course lecture  
12:00-13:00 Lunch  
13:00-14:30 Course lecture  
14:30-15:00 Coffee break  
15:00-16:30 Course lecture

**Thursday (11.05)** –
09:00- Registration

11:00-11:30 Opening ceremony with speeches by:  
**Ferenc Fedor** - President of the Geomathematical and Informatics Section of the Hungarian Geological Society  
**Tamás Síkfői** - President of the Chamber of Commerce and Industry of Pécs-Baranya  
**Zoltán Unger** - Associate President of the Hungarian Geological Society

11:30-12:00 Opening lecture by János Geiger - Statistical Process Control in The Evaluation of Geostatistical Simulations

12:00-13:00 Lunch

13:00-14:30 Climate modelling past and future – chair: István G. Hatvani
  - Keynote speaker: Gabriella Szépszó - Climate adaptation in Hungary: from the climate model outputs to the end-users
  - Dániel Topál - Detecting breakpoints in annual δ¹⁸O ice core records from North Greenland
  - Csaba Ilyés - Examination of 110 year long Rainfall Data using Spectral and Wavelet Analysis
  - Tímea Kalmár - Regional climate modelling with special focus on the precipitation-related fine scale processes
  - Péter Szabó - Sources of uncertainties in climate model results

14:30-15:00 Coffee break
Conference venue

Hotel Makár
Pécs Középmakár dűlő 4, 7635

Chamber of Commerce and Industry of
Pécs-Baranya
INTRODUCTION

• On Earth approximately 400 000 km$^3$ volume of water is being transported annually in the water cycle.

• Which is affected by the changing climate and the meteorological extremities present in recent years.

• These changes in the behaviour of precipitation have an impact on the groundwater resources through the recharge, so we chose to investigate the precipitation
DATASET

• Hungarian Meteorological Service Online Database

• Cyclic properties of 110 year long data of annual and mothly rainfall

• Forecasting in Debrecen

• Wavelet-analysis from Debrecen and Pécs datasets

Where, $f$: frequency, $T = 2\pi$: period length

$A \cdot \cos (2\pi ft + \phi)$

Where, $A$: amplitude, $\phi$: phase angle

The real and imaginary spectrum gives the weights of the sin-cos components.

Fourier-spectrums based on the $\cos(2\pi ft)$ and $\sin(2\pi ft)$ functions.

Search for periodic components in $y(t)$ precipitation functions.
• Debrecen
  • 16 cycles
  • 10 major, 6 additional
  • Most dominant: 3,6 year long

• Pécs
  • 17 cycles
  • 16 major, 1 additional
  • Most dominant: 4,5 year long
  • 2nd: 5 year long

• The annual dataset:
  • Time period: 1901-2010
  • 110 year
  • Number of samples: 110
  • Sampling rate: 1 yr

• Most dominant:
  • 1 year long
  • 6 months long

• Debrecen
  • 43 cycles
  • Dominant:
    • 59, 14.7, 378 month long

• Pécs
  • 65 cycles
  • Dominant:
    • 5.5, 54, 12.2, 60 month long

• The monthly dataset:
  • Time period: Jan 1901. – Dec 2010.
  • 1320 months
  • Sampling rate: 1 month
ACROSS HUNGARY

- Budapest
- Debrecen
- Pécs
- Szombathely

- 7 cycles from annual
- 13 cycles from monthly

<table>
<thead>
<tr>
<th>From annual precipitation [yr]</th>
<th>From monthly precipitation [month]</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5 80,17 %</td>
<td>1 94,16 %</td>
<td></td>
</tr>
<tr>
<td>3,5-3,6 71,25 %</td>
<td>0,5 61,97 %</td>
<td></td>
</tr>
<tr>
<td>11,8-13,5 66,11 %</td>
<td>4,92-5,00 28,61 %</td>
<td></td>
</tr>
<tr>
<td>2,8-3,1 57,27 %</td>
<td>1,13-1,15 23,14 %</td>
<td></td>
</tr>
<tr>
<td>6,1-6,3 52,36 %</td>
<td>1,2-1,21 23,08 %</td>
<td></td>
</tr>
<tr>
<td>4,5-4,6 47,36 %</td>
<td>3,42-3,67 22,83 %</td>
<td></td>
</tr>
<tr>
<td>7,5-7,8 38,79 %</td>
<td>0,4-0,43 22,76 %</td>
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<tr>
<td></td>
<td>2,36-2,39 21,85 %</td>
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<tr>
<td></td>
<td>4,17-4,50 20,88 %</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11,75-13,67 19,34 %</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2,8-3,17 17,35 %</td>
<td></td>
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<tr>
<td></td>
<td>6,08-6,25 15,21 %</td>
<td></td>
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<tr>
<td></td>
<td>7,58-7,67 10,56 %</td>
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</table>

FORECASTING - THEORETICS

- With the $A(f)$ amplitude spectra and the $\Phi(f)$ phase spectra, the original measured data can be recalculated:

$$y(t) = \bar{Y} + \int_0^{f_N} A(f)e^{j[2\pi ft + \Phi(f)]} df$$

- With the major and minor cycles, and their period of time, amplitude and phase spectra values, the deterministic precipitation time series can be calculated:

$$y(t)_{det} = \bar{Y} + 2 \sum_{i=1}^{18} A_i \cos \left[ \frac{2\pi}{T_i} (t - 1901) + \Phi(T_i) \right]$$
FORECASTING

• 10 fmajor cycles
  • R=0.6893
  • Medium correlation

<table>
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<th>Annual prec.</th>
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<tbody>
<tr>
<td>2011</td>
<td>632,2241</td>
</tr>
<tr>
<td>2012</td>
<td>494,7366</td>
</tr>
<tr>
<td>2013</td>
<td>576,3424</td>
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<tr>
<td>2014</td>
<td>526,2386</td>
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<tr>
<td>2015</td>
<td>537,4061</td>
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<tr>
<td>2016</td>
<td>567,6647</td>
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<tr>
<td>2017</td>
<td>594,0211</td>
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<tr>
<td>2018</td>
<td>592,067</td>
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<td>2019</td>
<td>490,4126</td>
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<tr>
<td>2020</td>
<td>599,6852</td>
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<td>2023</td>
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<td>563,8536</td>
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<td>507,218</td>
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<td>2028</td>
<td>480,0853</td>
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<td>2029</td>
<td>437,4212</td>
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<td>2030</td>
<td>638,9421</td>
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</table>

FORECASTING

• All 18 cycles
  • R=0.7339
  • Strong correlation

<table>
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<td>2013</td>
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<td>2017</td>
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<td>2019</td>
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<td>2020</td>
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<td>471,7733</td>
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<td>2029</td>
<td>494,1645</td>
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<td>2030</td>
<td>669,1239</td>
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</table>
Wavelet time series analysis is a well-known method to investigate the time-dependence of a cycle within a time series.

The periodic components from the previous examinations were used for this analysis.

The wave packet used for the calculation was a 1 year long period of time sine wave.
• Local Maximum:
  • Debrecen
    • 1956, 1963, 1916, 1945 and 1938
  • Pécs
    • 1918, 1971, 1973 and 1916

• Local Minimums:
  • 1910’s, 30’s and in the 70’s

Time-dependence in Debrecen
Hungary
CONCLUSIONS

• Several cycles calculated from long-term rainfall timeseries'

• Both locally and country-wide

• From these cycles forecasting can be calculated

• Future:
  • Connection with the shallow groundwater.
  • Calculating the time lag between rainfall cycles and groundwater.

ACKNOWLEDGEMENTS

The research was carried out within the GINOP-2.3.2-15-2016-00031 “Innovative solutions for sustainable groundwater resource management” project of the Faculty of Earth Science and Engineering of the University of Miskolc in the framework of the Széchenyi 2020 Plan, funded by the European Union, co-financed by the European Structural and Investment Funds.

THANK YOU FOR YOUR ATTENTION!