Spatial and temporal characteristics of the yearly rainfall frequency distribution in Cyprus

F.S. Tymvios and S.C. Michaelides
Department of Meteorology, Cyprus
What triggered this work?

- Climate change:
  - Myth or reality?
  - Fact or exaggeration?
  - Can we provide evidences?

- We need concrete proof USING REAL DATA:
  - The kind of proof that the “science of the averages” is not able to offer
Let’s talk “Math” : Model an indicator

- Parameters used as indicators of the Climate change:
  - Temperature and Rainfall
  - Long time series of accurate Temperature Records with high spatial coverage are not available for Cyprus.
  - On the other hand, continuous precipitation records are available from the beginning of the previous century, at more than 30 stations spread around the island.

- Inevitably we modeled precipitation..
Precipitation in Cyprus
Modeling the yearly average precipitation

- This is the yearly average value. HUGE variability
Modeling the yearly average precipitation

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- We have the climatological periods (30 years).
- 1920-1949
- 1921-1950
- 1922-1951
- ...
- 1976-2007
- ...
Modeling the yearly average precipitation

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- We have the climatological periods (30 years). Smoooooooooth!!
Modeling the yearly average precipitation

- This is the yearly average value. HUGE variability
- We have the climatological periods (30 years). Smoooooooooth!!
- How can we combine the two and make our climate change assumptions solid?
Modeling the yearly average precipitation: The Gamma Distribution (probability density function, pdf)

\[ f(x, \alpha, \beta) = \frac{\beta^{\alpha} x^{\alpha-1} e^{-\beta x}}{\Gamma(\alpha)} \]

- \( X \) – precipitation
- \( \alpha \) – shape parameter
- \( 1/\beta \) – size parameter
Modeling the yearly average precipitation: The Gamma Distribution

\[ f(x, \alpha, \beta) = \frac{\beta^\alpha}{\Gamma(\alpha)} x^{\alpha-1} e^{-\beta x} \]

Shape parameter \( \alpha \)
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Size parameter \(1/\beta\)
Modeling the yearly average precipitation: The Gamma Distribution

Size parameter $\frac{1}{\beta}$

$$f(x, \alpha, \beta) = \frac{\beta^\alpha}{\Gamma(\alpha)} x^{\alpha-1} e^{-\beta x}$$
Results: Troodos

Repeating previous slides:
Average yearly precipitation

Repeating previous slides:
Consecutive climate periods
Results: Troodos

Gamma distribution at the beginning, middle and end of the time series

Alpha and beta: Consecutive climate periods
Results: anatoliko

Average yearly value

Rolling climatological periods
Results: anatoliko

Gamma distribution at the beginning, middle and end of the time series

Alpha and beta: Consecutive climate periods
Temporal analysis of the results

Period 1 (1917-1946)

Period 2 (1947-1976)

Period 3 (1977-2006)
### Spatial analysis of the results

<table>
<thead>
<tr>
<th>Group A (b3&gt;b1&gt;b2)</th>
<th>Group B (b3&gt;b2&gt;b1)</th>
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</thead>
<tbody>
<tr>
<td>- 15 stations</td>
<td>- 8 stations</td>
</tr>
<tr>
<td>- Semi-mountainous and mountainous stations</td>
<td>- Mainly on the eastern flank of Troodos mountains</td>
</tr>
<tr>
<td>- Forests</td>
<td>- Low bushy vegetation</td>
</tr>
<tr>
<td>- High average rainfall &gt;800mm</td>
<td>- Mediocre rainfall</td>
</tr>
</tbody>
</table>
Spatial analysis of the results:
Spatial analysis of the results: Surprises!!
Concluding ..

- The shape parameter $\alpha$ shows a clear tendency to decrease while the size parameter $1/\beta$ increases.
- The increase of $1/\beta$ can be interpreted as a tendency for reduced probability of large annual rainfall amounts in the most recent years.
- The reduction of $\alpha$ shows increase of asymmetry of the P.D.F. of annual rainfall.
- The combination of 2 increases the probability of appearance of extreme amounts of annual rainfall: excessive rainfall and extended drought.
- Clear distinction between the temporal behavior of low and high rainfall stations.
Future plans

- Expand the database with more stations (46)
- Introduce homogenization techniques for the problematic stations
- Include latest data
- Future projections from climate models ??
THANK YOU :-) 

- Contact info: 
  - silas@ucy.ac.cy 
  - f.tymvios@cyi.ac.cy