An Overview of Stochastic Modeling of Extreme Rainfall Processes

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Sarah El Outayek, PhD Student

Van-Thanh-Van Nguyen, Professor

McGill University

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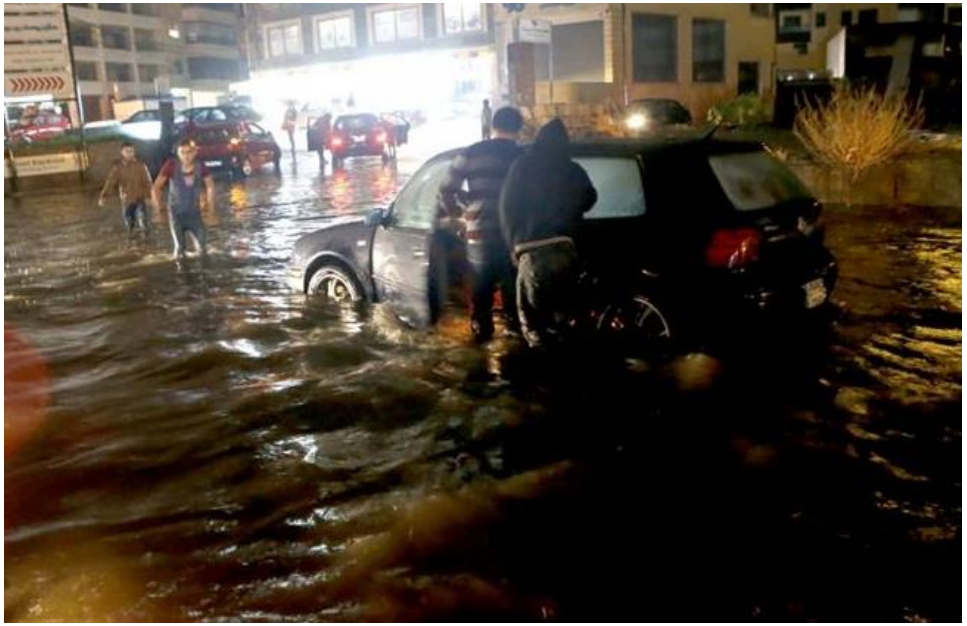
Outline

1
- **Introduction**: Extreme rainfall estimation issues*?*
- **Methodology**: Existing methods for extreme rainfall modelling: Limitations?
- **Objective**: Which method provide the “best” extreme rainfall estimate?

2
- Partial Duration Series Stochastic Models

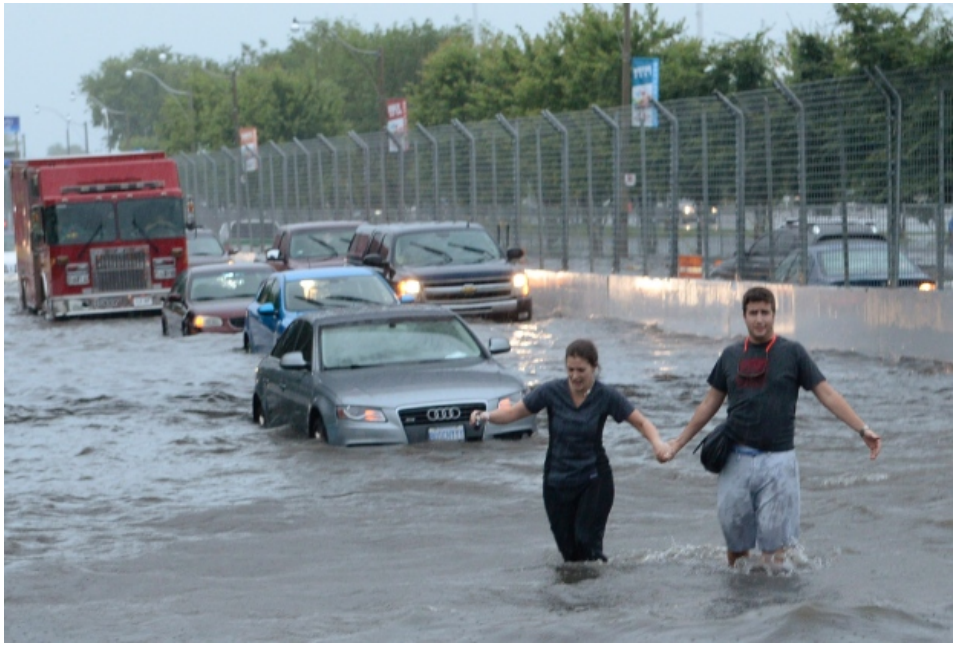
3
- Cluster-based Point Process Stochastic Models

Introduction



Beirut, Lebanon, 2014

(http://www.dailystar.com.lb/News/Lebanon-News/2014/Nov-17/277876-lebanon-transportation-minister-launches-probe-into-road-flooding.ashx)



Calgary, Toronto, 2015

(http://www.ctvnews.ca/canada/flooding-in-calgary-toronto-named-top-weather-stories-of-2013-1.1600496)

Methodology

Approach	Model	Rainfall Indices			
		Intensity	Occurrence frequency (Return Period)	Events arrival time	Spatial distribution
Probabilistic	Annual Maximum Series	X	X		
Stochastic	Partial Duration Series	X	X	X	
	Cluster-based Point Processes	X	X	X	X
Other	ANN	X			

Objective

Problem

- **Rainfall structure**
  - Spatial and Temporal Variability
  - Limitations of existing models: Consideration of rainfall properties over different temporal and spatial scales???

Suggested method

- **<u>Stochastic approaches:</u>**
  - Capable to provide a good description of the underlying rainfall process

Objective

- To develop a stochastic model that could provide the "best" extreme rainfall estimates.

Partial Duration Series Stochastic Models

Author	Data duration	Rainfall occurrences	Rainfall intensities	Comments
(Katz, 1977)	Daily	Markov Chain	Log-normal	Good fit
(Nguyen & Rousselle, 1981)	Hourly	First and second order Markov-chain	Exponential	Good fit
(I. Rodriguez-Iturbe, D. R. Cox, 1987)	Hourly and 6-hours	Poisson	Exponential and Pareto distributions	Cluster models (Bartlett/Lewis) are more flexible

Cluster-based Point Process Stochastic Models

- **Most popular models:**
  - **Neyman-Scott Rectangular Pulses (NSRP)**
  - **Bartlett-Lewis Rectangular Pulse (BLRP)**

- **NSRP has been modified to account for spatio-temporal variability:**
  - **Spatiotemporal Neyman-Scott Rectangular Pulses (STNSRP)**

- **NSRP extended to come up with new models:**
  - **Non-homogeneous Spatial Activation of Rain Cells (NSAR)**
  - **Space-Time Realizations of Areal Precipitation (STREAP)**

Cluster-based Point Process Stochastic Models

Parameter	Point Process Models			Description
	NSRP/ BLRP	STNSRP	NSAR	
λ	-	-	-	Storm original arrival rate
β	-	-	-	Positions of cells relative to the storm origin
$\rho(x)$			-	Spatially varying rain cell density field
ρ		-		Uniform rain cell density field
ν	-			Number of rain cells affecting a rain gauge
δ		-	-	mean rain cell radius
η	-	-	-	mean rain cell duration
ξ	-	-	-	mean rain cell intensity
$\psi(x)$		-	-	Spatially varying intensity scaling field
ψ_m	-			Intensity scaling at a specific location

Gumbel type II

Burton, A., Fowler, H. J., Kilsby, C. G., & O'Connell, P. E. (2010). A stochastic model for the spatial-temporal simulation of nonhomogeneous rainfall occurrence and amounts. Water Resources Research, 46(11), 1–19. http://doi.org/10.1029/2009WR008884

Concluding Remarks and Work Plan

- **A good stochastic model?**
  1) **It can describe accurately the spatial and temporal variability of rainfall properties over different temporal and spatial scales.**
  2) **It can provide accurate extreme rainfall estimates:**
     - **in the context of stationarity and nonstationarity; and**
     - **for ungauged sites and for sites with limited data.**

Thank you for your attention !

Questions?

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