Kije Sipi

RadHyPS

THE CITY OF Edmonton DRAINAGE SERVICES

Towards a New Rainfall Storm Classification Method

Erik Jobin
Ioan Nistor
Daniel Jobin
Sid Lodewyk

uOttawa
L'Université canadienne
Canada's university

July 7th, 2010

Kije Sipi

Presentation Topics

- Introduction
- Study Objectives
- General Study Approach
- Rainfall Storm Classification Method
- Sources of Data
- Storm Database
- Findings
- Conclusions/Next Steps in Research

Kije Sipi

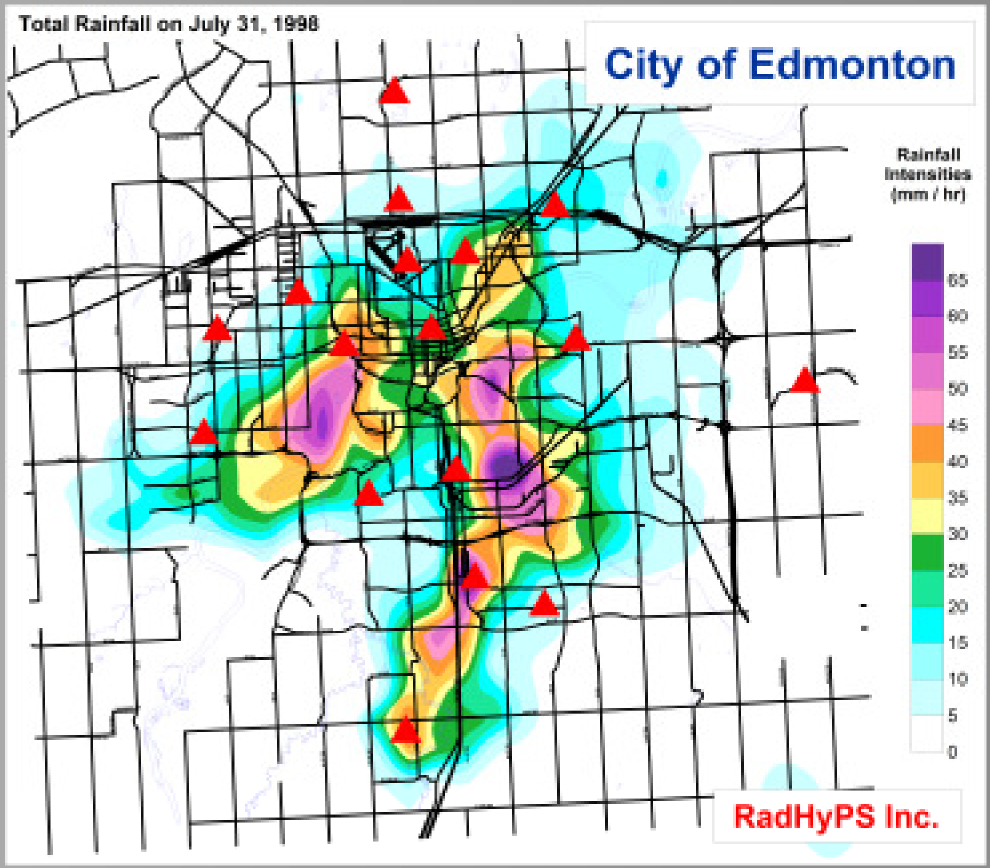
Introduction

- Improper extension of <u>point source</u> rainfall-derived <u>stationary</u> <u>IDF statistics</u> to represent a surrounding future area's expected rainfall is:
  - The current engineering practice
  - **<u>An unrealistic basis for design</u>**

Kije Sipi

Introduction

- Describing rainfall events with a rain gauge network is comparable to watching a movie on a broken TV screen with only a handful of scattered pixels working.



Kije Sipi

Study Objectives

- Provide an alternative rainfall storm importance classification method that:
  - is a more representative spatial approach of classifying rainfall storm importance and recurrence then the traditional IDF relations;
  - present the storm’s importance in such a way that it can easily be understood with confidence by the public, and;
  - would be technically straightforward for water resources design and planning.

Kije Sipi

General Study Approach

- The classification method is developed based on using:
  - storm parameters that are derived from high spatial & time resolution storm characteristics using rain gauge-calibrated radar rainfall estimates, and;
  - calibrated & validated with basement flooding data from the City of Edmonton while using a multivariate stepwise regression analysis.

Kije Sipi

Sources of data

- While rain gauges & weather radar measure the same phenomena, each observes rainfall in a unique way.
  - Sampling surface:
    - ~320 cm^2 (rain gauge)
    - 1 km^2 (radar)
  - Measuring plane:
    - near ground (rain gauge)
    - 1.5 km altitude (radar)
  - Sampling interval:
    - variable (rain gauge)
    - 5 minutes (radar)

Kije Sipi

Sources of Data


Daniel Jobin

- **Weather radar rainfall data**
  - Environment Canada's Carvel Station (Alberta)
- **Rain gauge data from nearby meteorological stations**
  - Environment Canada
  - City of Edmonton
- **Basement flooding database**
  - City of Edmonton
    - 11 significant events

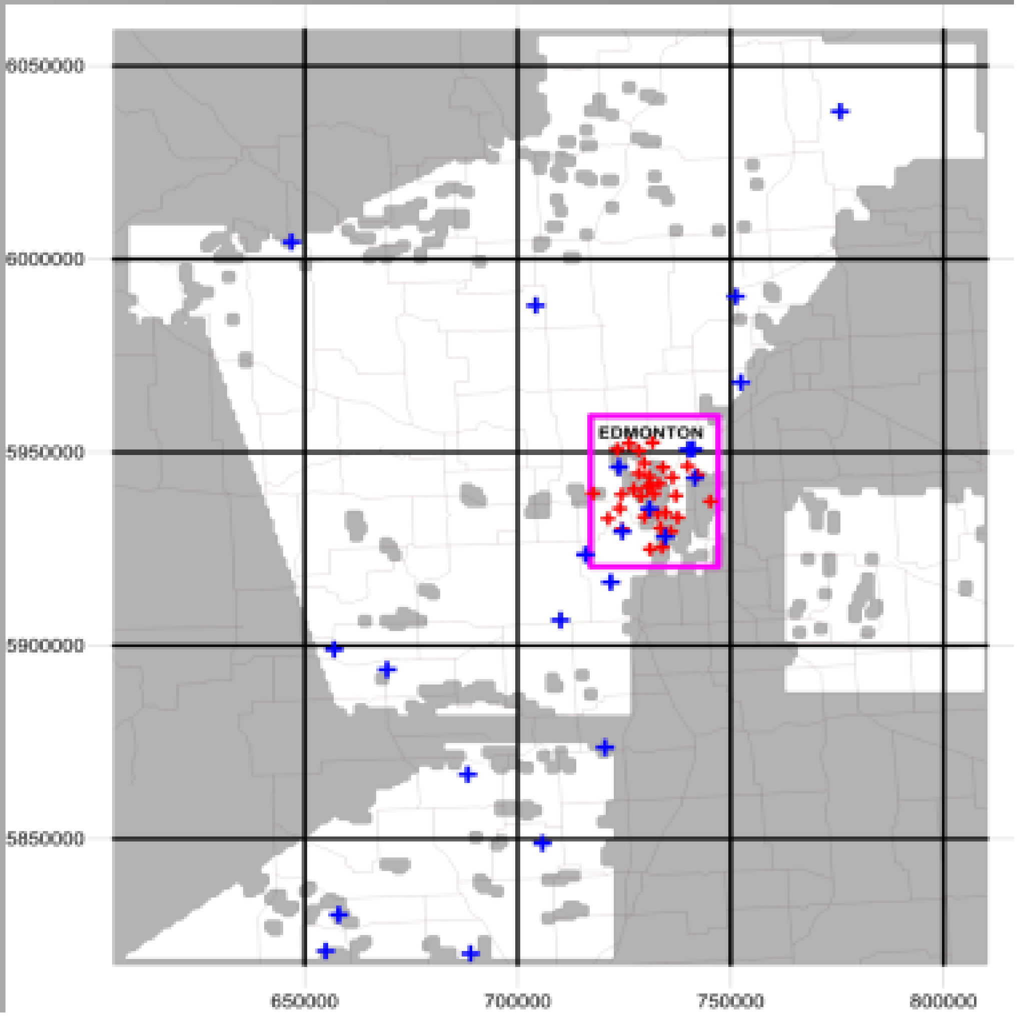

City of Edmonton

Kije Sipi

Sources of Data: Weather Radar

Effective Study Area

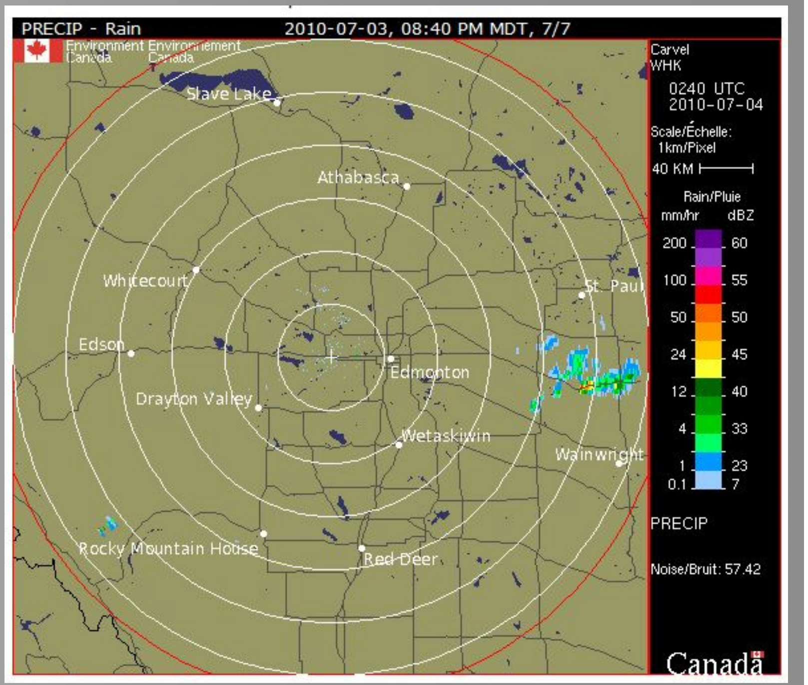
- White regions
  - Areas analysed
  - > 22,500 km^2
- Grey regions
  - Masked erroneous areas excluded from analyses
  - Produced for every year of data
  - May be the result of structures or orographic features



Kije Sipi

Sources of Data: Weather Radar

- Study Period
  - 11 years from 1998-2009 [May to September]
- Carvel Radar (40 km)
- <u>Digital Radar Product</u>
  - 1 km^2 Grid Cells (UTM Aligned)
  - 5-Minute Interval (every 10 minutes)
  - 1.5 km CAPPI
  - Radial Reflectivity



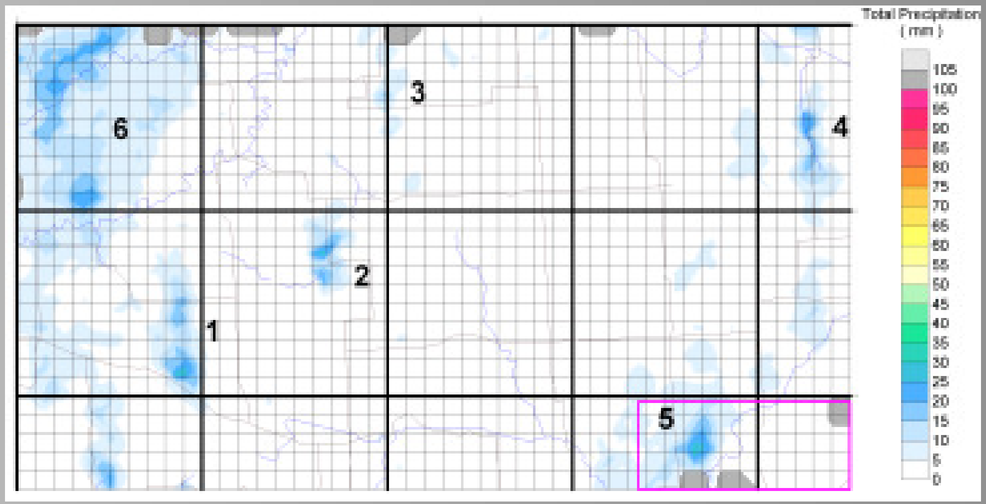
Environment Canada

Kije Sipi

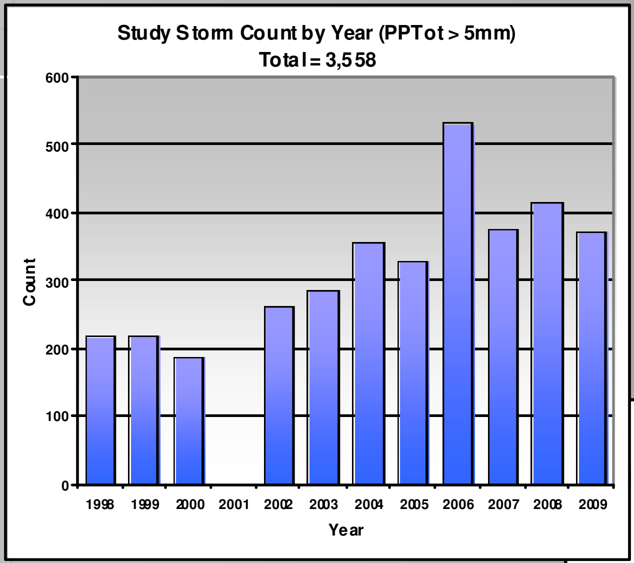
Storm Definition

- The Hydrometeorological Criteria used to delineate, in time and space, rainfall storms are defined as:

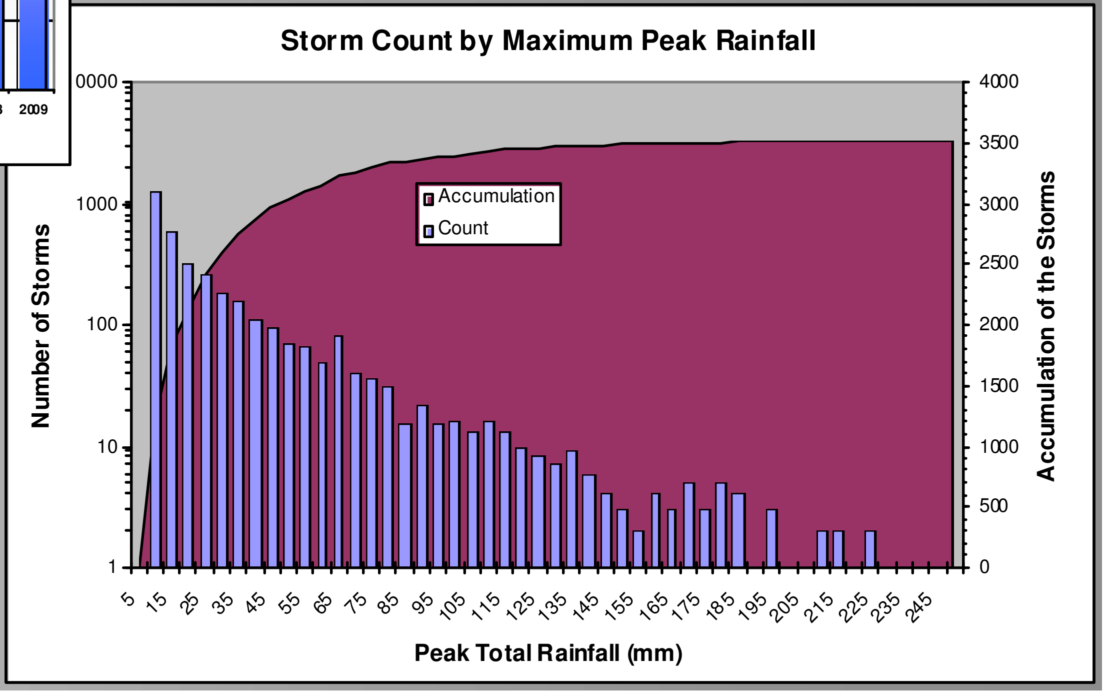
1. Minimum rainfall intensity per radar grid cell > 0.2mm/hr;
2. Inter-event spacing of ≤ 4 radar grid cells (1km^2), and;
3. Inter-event time of ≤ 6 hours.



Storm Database Statistics



- After 2001, the radar doubled its effective sensing range
- Radar data for 2001 was not available
- Storms are characterized by more than 18 characteristics [.i.e Maximum peak rainfall…]

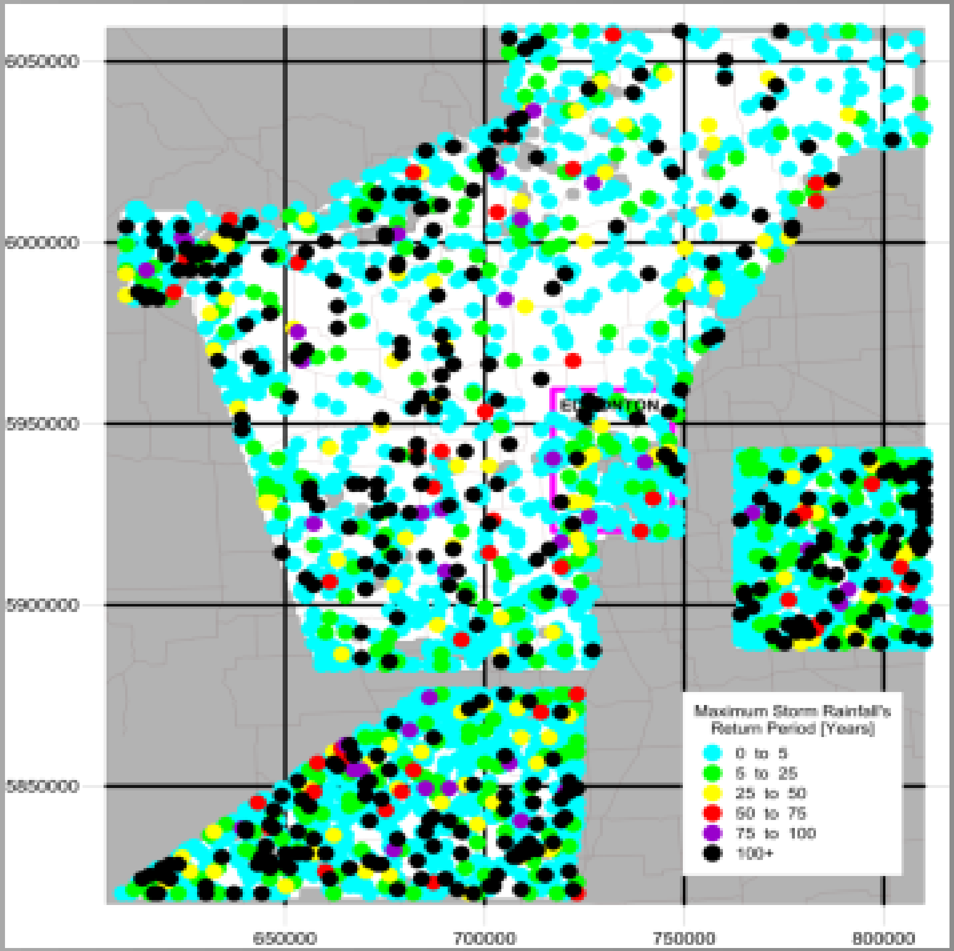


Kije Sipi

Findings

Distribution of Maximum Storm Rainfall Cell's Return Period

- 11 years of storm data
- 3,558 storms cells > 5mm
- 42 storms cells with ~100-year
- 379 storms cells >100-year



Kije Sipi

Preliminary Results:

New Rainfall Storm Classification Method

$$Classification = f\left(Ae^{Bx_1} + \frac{C}{\left(x_2 + D\right)^E} + Fx_3{}^G\right)$$

Where x_1 is the storm's average rainfall, x_2 is the peak total & x_3 is the peak intensity.

A multivariate stepwise regression analysis was completed on a split sample of the available basement flooding events from the City of Edmonton as the dependent variable. So far only these 3 storm characteristics have shown significant correlation to the calibration dataset.

Kije Sipi

Next step in research

- Finalize the optimum classification relation
- Consider use of censored GEV distributions for best trend fit of parameters to importance scale
- Refine duration to describe time from start to finish
- Case study on another city
- Consider other storm parameters
- Review storm definition
- Perform a sensitivity analysis on the classification equation

Kije Sipi

References

Casas, M.C., Codina, B., Redaño, A. & Lorente, J. (2004). A methodology to classify extreme rainfall events in the western Mediterranean area. Theoretical and Applied Climatology, 77(3-4), 139-150.

City of Edmonton [1998-2009]. Drainage Services. City rain gauge network observations.

City of Edmonton [2004]. Flood Prevention and Drainage Banner. from www.edmonton.ca/for_residents/FloodBanner.JPG.

Environment Canada. [1990]. Weather Office. Weather station IDF relations for Edmonton (AB) and surrounding stations. from http://www.weatheroffice.gc.ca/

Environment Canada. [1998-2009]. Carvel radar WHK data. Stored in Radhyps corporate archives.

Environment Canada. [1998-2009]. Weather Office. Weather station weather observations for Edmonton (AB) and surrounding stations. from http://www.weatheroffice.gc.ca/

Jolly, J.P., Jobin, D.I. & Lodewyk, S. (2008). Weather Radar Derived Rainfall Area Reduction Factors (Final Version). Weather Radar and Hydrology 2008 International Symposium, Kije Sipi Ltd..

Palynchuk, B. & Guo, Y. (2008). Threshold analysis of rainstorm depth and duration statistics at Toronto, Canada. Journal of Hydrology, 348 (3-4), 535-545.

Ramos, M.H., Leblois, E. & Creutin, J.-D. (2006). From point to areal rainfall: linking the different approaches for the frequency characterization of rainfalls in urban areas. Water Science & Technology, 54(6-7), 33-40.

Kije Sipi

Thank You....

- Erik Jobin
  - Erik.Jobin@KijeSipi.com