PROJECT 1-4:
Development of New Methods for Updating IDF Curves in Canada

Van-Thanh-Van Nguyen
and Research Team
(PDFs, Graduate Students, and Others)

OUTLINE

- ❑ **Project Objective and Key Challenges**
- ❑ **Estimation of Extreme Rainfalls - IDF Relations: Issues?**
- ❑ **Summary of Research Progress:**
  - ❖ **Decision-Support Tools: SMexRain**
  - ❖ **New Rainfall Modeling Methods:**
    - ❖ **Multi-Site Rainfall Modeling**
    - ❖ **MCME**
- ❑ **Further Works**

PROJECT OBJECTIVE AND KEY CHALLENGES

**OBJECTIVE:**

Evaluate climate change impacts on Intensity-Duration-Frequency (IDF) curves and develop new regional IDF curves for selected cities in Canada.

KEY CHALLENGES:

- **Climate Change Impacts:**
  - ➢ **Downscaling Approaches**
  - ➢ **Non-stationarity Process**
- **Single-Site and Regional Rainfall Modeling:**
  - ➢ **Multi-site Modeling Methods**
  - ➢ **Regionalization Methods (Ungaged Sites)**

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IDF RELATIONS

Observed Rainfall Data – Complete Time Series

X_o
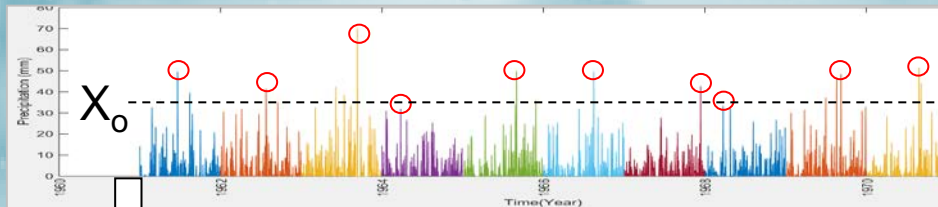
→ Extreme Rainfall Series

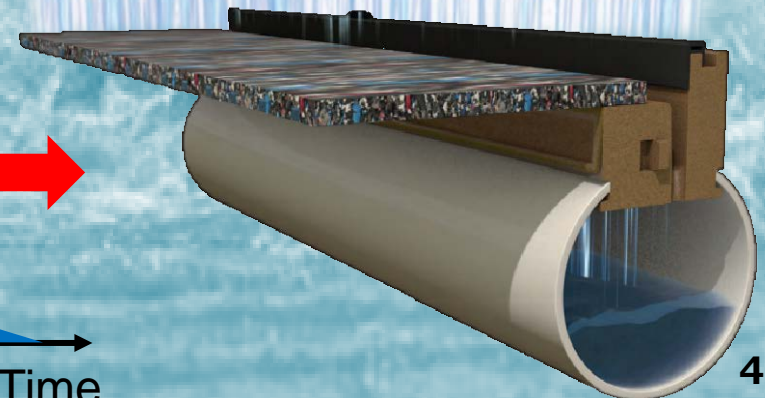→ Rainfall frequency analysis

→ IDF Curves

→ Design Storm

Intensity (in/hr) vs **Duration (min)**

Frequency

Return period
- 100 years
- 50
- 25
- 10
- 5
- 2

(Chow, 1988)

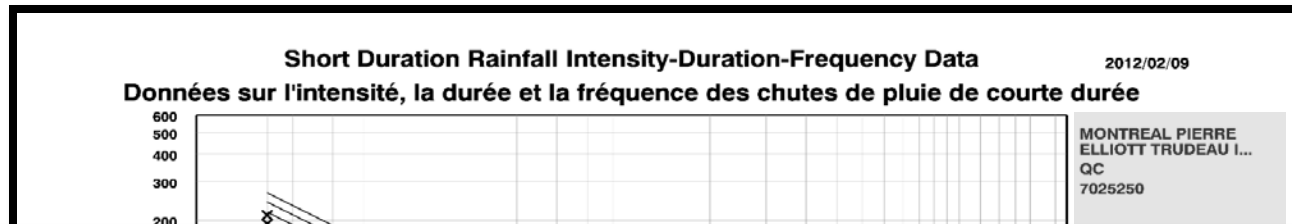**ISSUES:**
- To analyze **a large amount of data** for different time scales and for different stations.
- To select **a suitable probability distribution** for a given site or region.
- To develop IDF relations **for the current climate**.
- To assess **the climate change impacts** on IDF relations.
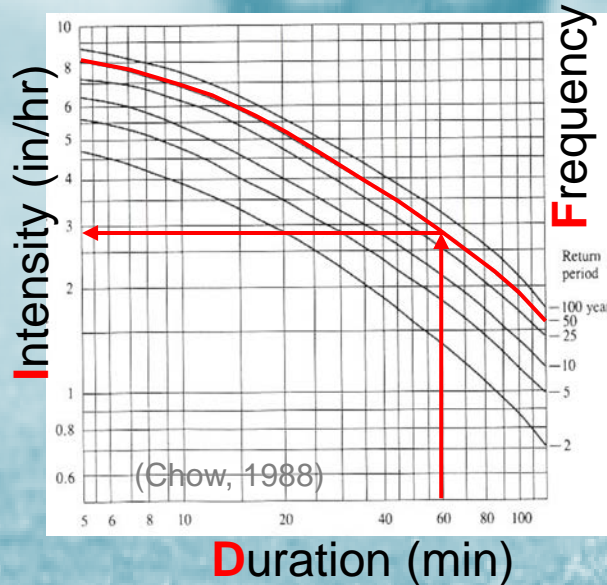
Probability of extreme rainfall occurrence & amount ???

Intensity

I_{max}

T_p Time

4

Extreme rainfall estimation

Design Rainfall = to estimate maximum amount of rainfall at a given site for a *specific duration* and *return period* ⇒ *Intensity-Duration-Frequency (IDF) curves*

Short Duration Rainfall Intensity-Duration-Frequency Data   2012/02/09
Données sur l'intensité, la durée et la fréquence des chutes de pluie de courte durée

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QC
7025250

Traditional IDF estimation methods

Time scale problem: no consideration of rainfall properties at different time scales;

Space scale problem: results limited to data available at a local site;

Climate change problem: no consideration.

SUMMARY OF RESEARCH PROGRESS:
Climate Change Impacts on Extreme Rainfalls - SDExRain

At-site Rainfall Estimation for a Gaged Site

Regional Rainfall Estimation for an Ungaged Site

Regional Rainfall Estimation for Multi-sites

(Spatial) SD model: *SDRain*

Regionalization method to identify homogenous daily rainfall regions: OFA

(Temporal) SD model: *Scaling-GEV*

Stochastic estimation method for estimating *missing data*

Multi-site SD method for daily precipitations

Construction of IDF relations in the context of climate change

Climate change impacts on daily precipitation at a gaged site

(Spatial) SD *SDRain* for *an ungaged site*

Construction of missing daily precipitation at an ungaged site

Climate change impacts on daily precipitation at an ungaged site

Climate change impacts on daily precipitations over many sites concurrently

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PUBLICATIONS

1. Herath, S.M., Sarukkalige, P.R., and Nguyen, V-T-V. (2016), A spatial temporal downscaling approach to development of IDF relations for Perth airport region in the context of climate change, *Hydrological Sciences Journal*, 61:11, 2061-2070, DOI:10.1080/02626667.2015.1083103.

2. Yeo, M, and Nguyen, V-T-V. (2016), Downscaling of daily rainfall process at an ungaged site, *Chapter 20 in Advances in Hydroinformatics*, Gourbesville, P. et al. (eds.), Springer Water, DOI 10.1007/978-981-287-615-7_20.

3. Nguyen, T-H, and Nguyen, V-T-V. (2016), Statistical Modeling of Extreme Rainfall Processes (SMExRain): A Decision Support Tool for Extreme Rainfall Frequency Analyses, *Procedia Engineering,* 154, pp. 624 – 630.

4. Khalili, M. and Nguyen, V-T-V. (2016), An efficient statistical approach to multi-site downscaling of daily precipitation series in the context of climate change, *Climate Dynamics*, DOI 10.1007/s00382-016-3443-6.

5. Herath, S.M., Sarukkalige, R., Nguyen, V.T.V. (2017), Evaluation of empirical relationships between extreme rainfall and daily maximum temperature in Australia, *Journal of Hydrology*, DOI: http://dx.doi.org/10.1016/j.jhydrol.2017.01.06.

PUBLICATIONS

6. Khalili, M. and Nguyen, V-T-V. (2017), A Statistical Approach to Multi-Site Downscaling of Daily Precipitation Series for Efficient Climate Change Impact Assessment, *Journal of Hydrology* (under revision).

7. Khalili, M. and Nguyen, V-T-V. (2017), Statistical Approach to Multi-Site Downscaling of Extreme Temperature in the Climate Change Context, *ASCE Journal of Hydrologic Engineering* (under revision).

8. Nguyen, T-H., El Outayek, S.; Lim, S-H., and Nguyen, V-T-V. (2017), A systematic approach to selecting the best probability model for annual maximum rainfalls, *Journal of Hydrology* (under revision).

A combination of

- **A spatial downscaling** method: the statistical downscaling model such as SDSM (Wilby et al., 2002) or SDRain (Yeo and Nguyen, 2011)

- **A temporal downscaling** method: the scaling GEV model (Nguyen et al. 2002).
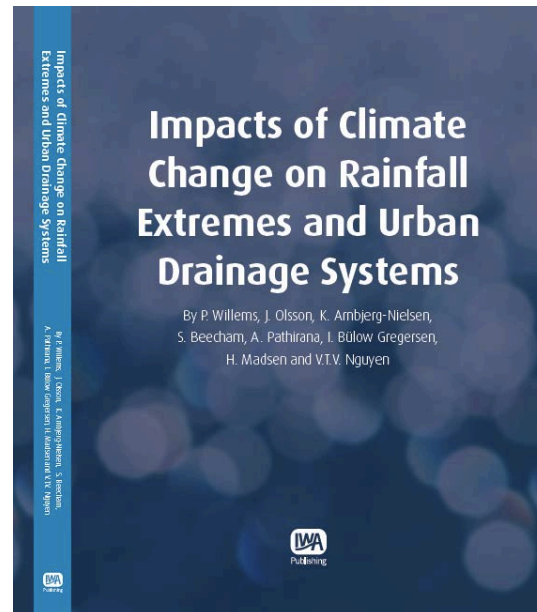
GCM Climate Predictors
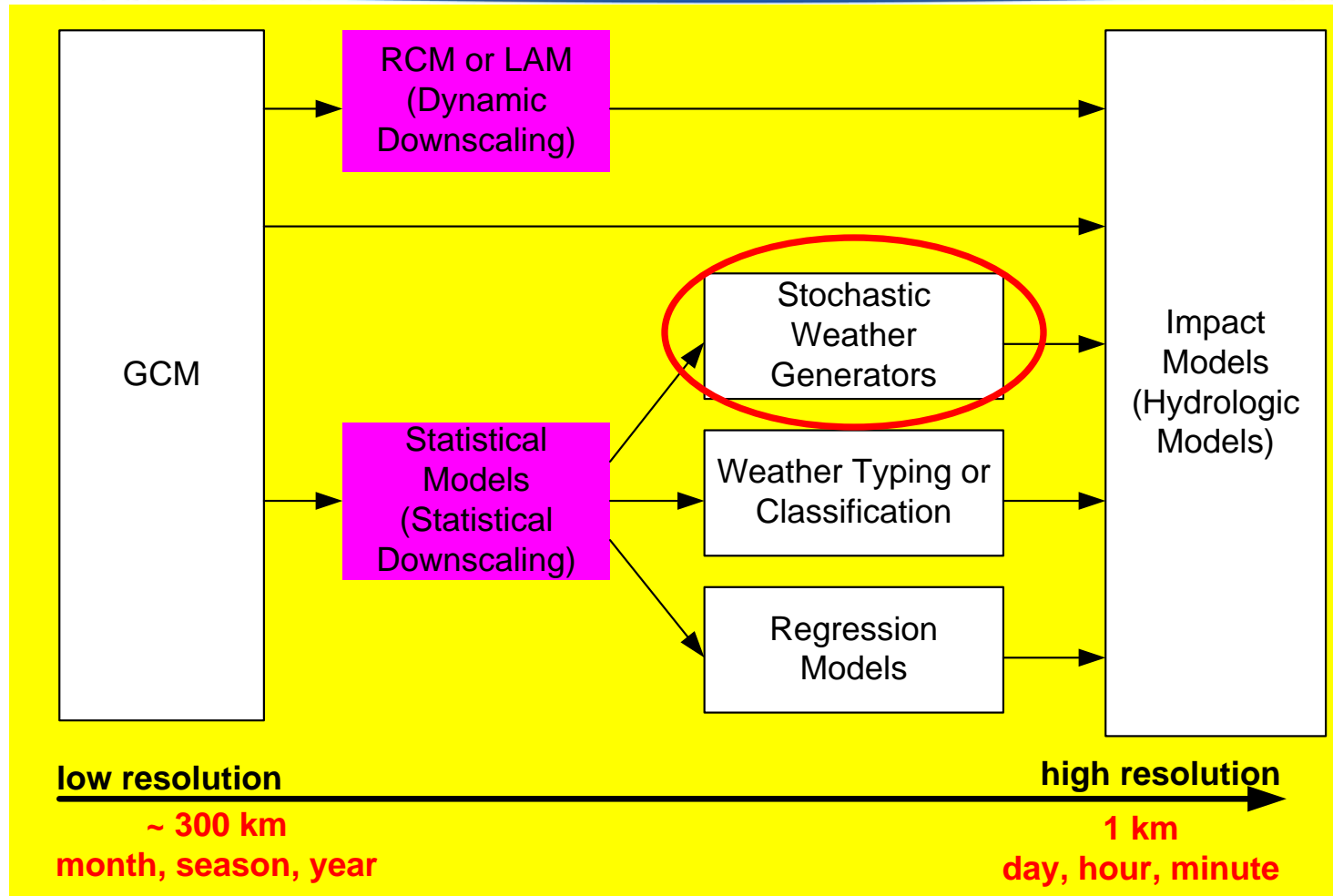
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Local Daily Precipitation Series

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Daily Extreme Precipitations

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Sub-Daily Extreme Precipitations

Impacts of Climate Change on Rainfall Extremes and Urban Drainage Systems

By P. Willems, J. Olsson, K. Arnbjerg-Nielsen, S. Beecham, A. Pathirana, I. Bülow Gregersen, H. Madsen and V.T.V. Nguyen

IWA Publishing

ATMOSPHERIC RESEARCH

DOWNSCALING METHODS

FURTHER WORKS

- ❑ **Modeling of Rainfall Processes in Consideration of Nonstationarity (Journal of Hydrology, 2016a and 2016b for GEV)**
- ❑ **Stochastic Modeling of Extreme Rainfall Processes in the Context of Climate Change**
- ❑ **Regional Rainfall Maps for Selected Cities**
- ❑ **Guidelines for Developing IDF Relations**