UPDATING PMP FOR THE ELBOW RIVER: COMPELX TERRAIN, UNIQUE SOLUTIONS

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CDA Conference October 16-19, 2016 Halifax, Nova Scotia, Canada



Probable Maximum Precipitation

- **Definition:** The <u>theoretically</u> greatest depth of precipitation for a given duration that is <u>physically</u> <u>possible</u> over a given storm area at a particular <u>geographic location</u> at a certain time of year (HMR 59, 1999)
- Types of PMP studies:
 - Generalized (Hydrometeorological Reports)
 - Provides PMP values for a region
 - HMR 51 East of the 105th Meridian from Canada to Mexico
 - Regional/Provincial/Statewide
 - Provide PMP values over regions with varying topography
 - Individual basins are included in the regional/statewide results
 - Site-Specific
 - Provides PMP values for individual drainage basins
 - Considers unique meteorology and topography

PMP History

- Numerous PMP studies completed in Canada over the years
 - Inconsistent methods and data
- In the US, National Weather Service published first HMR in 1940
 - HMR 1-Ompompanoosuc Basin, Vermont
- Latest HMR published in 1999
 - HMR 59-California
- Most followed the storm-based approach
- Advancement/new understanding applied throughout the years
 - HMRs no longer updated
 - Have become out-of-date
- No standard across Canada

PMP History

- Storm database has become out-of-date
 - Based on outdated methods and techniques
 - Better understanding of meteorology
- Effect of topography not accurate
 - Subjective
 - Lack of empirical data-unknowns
- Many processes subjective and not reproducible
 - Several inconsistencies between each report
 - Not clear how storm data used to develop the PMP values
 - No or limited working papers/notes
 - Limited to no external/independent review

AWA Project Locations



How Is PMP Computed?

Storm Based Approach-Deterministic
Maximize storms
Transposition storms
Combine into PMP design storm
By storm type
Subjective decisions involved

PMP Improvement Used Today

- NEXRAD weather radar
 - Very important for spatial distribution
 - Must be calibrated first
- GIS
- Computing power/speed
- Updated understanding of rainfall
- Updated understanding of topographic effects
- Updated climatologies for maximization
- Storm database updated continuously

AWA SPAS Storm Locations



Current PMP Work

• Elbow River-Springbank Offstream storage site-specific PMP example

•Elbow River Basin Complex Terrain •Plains to Mountains Topography very important



Elevation Contours Across the Region



•Storm Search Domain

•Regions of similar meteorology and topography



•Short List of Storms

- •Important for PMP Development
- •Include both storm types
- •Include storms over plains and Mountains
- •Must be comprehensive



Storm Precipitation Analysis System (SPAS)

- All storms analyzed with SPAS
- Provided hourly gridded rainfall data
- Provides Depth-Area-Duration data
- Provides temporal and spatial information
 - Required to analyze rainfall over complex terrain
 - Allows for unique use of storm data at various locations within the basin

June 2013 SPAS Analysis Total storm isohyetal



2.01 - 3.00 5.01 - 6.00 8.01 - 9.00 11.01 - 12.00

June 2013 SPAS Analysis



June 2013 Storm Adjustments

SPAS 1320 June 19 - 22, 2013



Hysplit

Surface
 750 mb

75 150 300

0

Storm Name: SPAS 1320 Calgary, AB Storm Date: 6/19-22/2013 AWA Analysis Date: 10/4/2016				Storm Adjustment Summary					
Temporal Transposition Date	10-Jul								
	Lat	Long			Moisture I	nflow Direction	SE @ 150	miles	
Storm Center Location	50.64 N	114.86 W			Basin Aver	rage Elevation	N/A*	feet	
Storm Rep Dew Point Location	49.00 N	112.50 W			Storm Cen	ter Elevation	8,500	feet	
Transposition Dew Point Location	N/A*	N/A*			Storm Ana	lysis Duration	24	hours	
Basin Location	50.89 N	114.69 W							
The storm representative	dew point is	65.5 °F	with tot	al precipitabl	e water abo	ove sea level of	1.82	inches.	
The in-place maximum	dew point is	69.5 °F	with tot	al precipitabl	e water abo	ove sea level of	2.20	inches.	
The transpositioned maximum	dew point is	N/A*	with tot	al precipitabl	e water abo	ove sea level of	N/A*	inches.	
The in-place storn	elevation is	8,500	whice	h subtracts	1.16	inches of precipi	table water at	65.5	
The in-place storn	elevation is	8,500	whic	h subtracts	1.35	inches of precipi	table water at	69.5	
The transposition basin	elevation at	N/A*	whic	h subtracts	N/A*	inches of precipi	table water at	N/A*	
The in-place sto	rm maximizat	ion factor is	1.29		Notes: Stor	m rep dew point taken t	from 24hr ave at C	YQL and	1
The transposition/elevation to basin factor is		N/A*		KCTB 0100	Z 19th to 0100Z 20th.				
The ba	rrier adjustm	ent factor is	N/A*						l I

Observed Storm Depth-Area-Duration (inches)									
	1 Hours	2 Hours	3 Hours	4 Hours	5 Hours	6 Hours	12 Hours	24 Hours	48 Hours
3 km ² (1 mi ²)	1.7		3.0			4.4	7.1	10.1	13.1
26 km ² (10 mi ²)	1.6		2.9			4.3	7.1	10.0	13.1
259 km ² (100 mi ²)	1.6		2.5			4.0	6.5	9.0	12.1
518 km ² (200 mi ²)	1.5		2.3			3.7	6.0	8.4	11.4
1,295 km ² (500 mi ²)	1.3		2.1			3.1	5.5	7.4	10.3
2,590 km ² (1,00 mi ²)	1.1		2.0			3.0	4.9	6.9	9.7
5,180 km ² (2,000 mi ²)	0.8		1.7			2.7	4.7	6.0	9.0
12.950 km ² (5000 mi ²)	0.6		1.4			2.3	3.9	5.5	7.9
25,900 km ² (10,000 mi ²)	0.4		1.1			2.0	3.4	4.5	6.0
51,800 km ² (20,000 mi ²)	0.3		0.8			1.4	2.6	3.7	4.9

The total adjustment factor is N/A*

Storm or Storm Center Name	SPAS 132	SPAS 1320 Calgary, AB							
Storm Date(s)	6/19-22/20	6/19-22/2013							
Storm Type	Synoptic	Synoptic							
Storm Location	50.64 N	114.86 W							
Storm Center Elevation	8,500	feet		-					
Precipitation Total & Duration	13.78	Inches in 72-hours							
Storm Representative Dew Point	65.5 °F	24							
Storm Representative Dew Point Location	49.00 N	112.50 W	June	July					
Maximum Dew Point	69.5 °F		66.78	70.39					
Moisture Inflow Vector	SE @ 150	Miles							
In-place Maximization Factor	1.29								

PMP Results

Scenario	Drainage Basin	Basin Area	Sub-basin Count	PMP Type	Spatial Redistribution
1	Upstream of Glenmere Dam	1212 km²	11	General Storm	Jun. 2005, Jun. 2013, PF Climatology
2	Upstream of SR1 Diversion	863 km²	8	General & Local Storm	Jun. 2005, Jun. 2013, PF Climatology
3	Upstream of SR1 Dam	31 km²	1	Local Storm	None



PMP Results 48-hr Full Basin



PMP Results Full Basin-June 2005 Distribution



PMP Results Full Basin-June 2013 Distribution



PMP Next Steps

- Deterministic, but probability can still be estimated
- Recent work completed to derive recurrence interval of PMP
 - Follows methods developed by Corps and Bureau
 - Utilize Area of storm search domain, period of record, observed values compared to PMP
- Quantification of uncertainty
 - Storm selection; Storm maximization choice; Storm transposition; Storm analysis.
- •Lesson Learned
 - •Work with hydrologist who will be using data
 - •Only peel back conservatism where data support
 - •Need more rain and stream gages

QUESTIONS

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PMP Probability Example

- Regional L-moments Method
- Stochastic Storm Transposition (SST) Method

