2019 Hurricane Season Flood Alert System Final Report

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FINAL REPORT

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1 Flood Alerts Summary

The Wood Hurricane Season Flood Alert System (HSFAS) Product is the result of professionally trained meteorologists applying their full knowledge of atmospheric science to Newfoundland and Labrador's weather patterns and pairing that with existing trends, known observations, and weather prediction models. Examining maximum precipitation predictions from many different dynamic models allows forecasters to produce a better forecast of the maximum precipitation potential based on the strength of different models in handling the atmospheric physics of differing weather patterns.

From June 2019 to December 2019, 59 alerts were issued in total. There were no missed alerts (i.e., the case when observations from a station trigger an alert that had not been issued). Monthly PDF reports containing all alerts have been provided to WRMD, and a summary of these alerts is below.

Table 1 Summary of Flood Alerts

		Issue Date	12-hourly Precipitation Forecast (mm)	24-hourly Precipitation Forecast (mm)
1	Deer Lake, Steady Brook	2019-06-21 09:00	55	63
2	Corner Brook	2019-06-21 09:00	45	68
3	Deer Lake, Steady Brook	2019-06-21 16:00	40	63
4	Corner Brook	2019-06-21 16:00	37	66
5	Nain (NAIN A)	2019-08-19 07:00	53	73
6	Happy Valley-Goose Bay (GOOSE A)	2019-08-20 09:00	51	62
7	Nain (NAIN A)	2019-08-20 09:00	65	87
8	Wabush (WABUSH LAKE A)	2019-08-20 09:00	56	65
9	Churchill Falls	2019-08-22 09:00	47	63
10	Wabush (WABUSH LAKE A)	2019-08-22 09:00	48	66
11	Churchill Falls	2019-08-22 16:00	45	56
12	Wabush (WABUSH LAKE A)	2019-08-22 16:00	38	55
13	Nain (NAIN A)	2019-09-04 09:00	59	66
14	Nain (NAIN A)	2019-09-04 16:00	84	88
15	Nain (NAIN A)	2019-09-05 09:00	58	75
16	Happy Valley-Goose Bay (GOOSE A)	2019-09-07 09:00	54	54
17	Happy Valley-Goose Bay (GOOSE A)	2019-09-07 16:00	58	58
18	Happy Valley-Goose Bay (GOOSE A)	2019-09-08 09:00	51	49
19	Deer Lake, Steady Brook	2019-10-30 09:00	51	100
20	Stephenville	2019-10-30 09:00	58	105
21	Trout River	2019-10-30 09:00	51	100
22	Stephenville Crossing, Black Duck Siding	2019-10-30 09:00	58	105
23	Corner Brook	2019-10-30 09:00	52	100

		Issue Date	12-hourly Precipitation Forecast (mm)	24-hourly Precipitation Forecast (mm)
24	Daniel's Harbour (DANIELS	2019-10-31 09:00	77	90
25	Deer Lake, Steady Brook	2019-10-31 09:00	55	90
26	Stephenville	2019-10-31 09:00	68	105
27	Trout River	2019-10-31 09:00	70	110
28	Stephenville Crossing, Black Duck Siding	2019-10-31 09:00	61	105
29	Corner Brook	2019-10-31 09:00	60	90
30	Cold Brook, Kippens (Gaudon's Brook)	2019-10-31 16:00	75	110
31	Daniel's Harbour (DANIELS	2019-10-31 16:00	82	110
32	Deer Lake, Steady Brook	2019-10-31 16:00	55	90
33	Stephenville	2019-10-31 16:00	68	105
34	Trout River	2019-10-31 16:00	70	110
35	Stephenville Crossing, Black Duck Siding	2019-10-31 16:00	61	105
36	Corner Brook	2019-10-31 16:00	60	95
37	Daniel's Harbour (DANIELS	2019-11-01 09:00	111	111
38	Trout River	2019-11-01 09:00	88	88
39	Mary's Harbour (MARY'S HARBOUR	2019-11-28 10:00	55	63
40	Battle Harbour (BATTLE HARBOUR	2019-11-28 10:00	55	63
41	Burgeo (BURGEO NL)	2019-12-09 10:00	86	86
42	Cold Brook, Kippens (Gaudon's Brook)	2019-12-09 10:00	76	88
43	Deer Lake, Steady Brook	2019-12-09 10:00	62	84
44	Stephenville	2019-12-09 10:00	79	86
45	Stephenville Crossing, Black Duck Siding	2019-12-09 10:00	85	88
46	Corner Brook	2019-12-09 10:00	69	69
47	Cold Brook, Kippens (Gaudon's Brook)	2019-12-09 17:00	69	86
48	Deer Lake, Steady Brook	2019-12-09 17:00	54	59
49	Stephenville	2019-12-09 17:00	79	88
50	Corner Brook	2019-12-09 17:00	38	66
51	Deer Lake, Steady Brook	2019-12-10 10:00	49	64
52	Corner Brook	2019-12-10 10:00	54	73
53	Burgeo (BURGEO NL)	2019-12-13 10:00	87	95
54	Burgeo (BURGEO NL)	2019-12-13 17:00	88	95
55	Burgeo (BURGEO NL)	2019-12-14 10:00	108	143
56	Cold Brook, Kippens (Gaudon's Brook)	2019-12-14 10:00	86	86
57	Channel-Port aux Basques (Port Aux	2019-12-14 10:00	92	115
58	Stephenville	2019-12-14 10:00	86	86
59	Stephenville Crossing, Black Duck Siding	2019-12-14 10:00	86	86

Note:		
	Exceeded 12-Hourly 20-yr flood limit	Exceeded 24-Hourly 20-yr flood limit
	Exceeded 12-Hourly 100-yr flood limit	Exceeded 24-Hourly 100-yr flood limit
	WRMD or EC Exceeded flood limit	

The 2019 season was slightly less active than the 2018 season (59 vs 72 alerts). This is a result of a relatively quiet summer this season. A large portion of the 2019 alerts were issued in the fall/winter, specifically October and December.

Table 2 Monthly Analysis of Flood Alerts

Month	Total Alerts	12-hourly 20-yr alerts	12-hourly 100-yr alerts	24-hourly 20-yr alerts	24-hourly 100-yr alerts	Env. Can. & WRMD Obs.
June	4	1	0	3	0	0
July	0	0	0	0	0	0
August	8	5	2	1	0	0
September	6	5	1	0	0	0
October	18	3	0	9	6	0
November	4	3	1	0	0	0
December	19	13	3	2	1	0
Total:	59	30	7	15	7	0

The geographical spread of the alerts this season was small, spanning largely the west coast of Newfoundland, and Labrador.

Table 3 Regional Analysis of Flood Alerts

Community	Region	Total Number of Alerts
Battle Harbour	Labrador	1
Churchill Falls	Labrador	2
Happy Valley-Goose Bay	Labrador	4
Mary's Harbour	Labrador	1
Nain	Labrador	5

Community	Region	Total Number of Alerts
Wabush	Labrador	3
Corner Brook	Western	8
Daniel's Harbour	Western	3
Deer Lake, Steady Brook	Western	8
Stephenville	Western	6
Stephenville Crossing, Black Duck Siding	Western	5
Trout River	Western	4
Cold Brook, Kippens	Western	4
Burgeo	Southern	4
Channel Port aux Basques	Southern	1

From a geographic perspective, thirty-eight (38) alerts were triggered for the Western region, zero (0) alerts were issued for the Eastern Region, zero (0) alerts were issued for the Central Region, five (5) alerts were raised for the Southern Region, and sixteen (16) alerts were issued for Labrador. This season's geographic variability is much smaller compared to previous years. Most of the alerts this year were issued for Labrador and the Western Region, with virtually no alerts for the central and eastern parts of the island. This is a reflection of the weather pattern during this period whereby the storm track was further west than usual, resulting in drier conditions in the east.

2 Verification of Alerts

The flood alerts were verified monthly using three data sources/methods to compare with the forecasted values: ECCC rain gauge data, WRMD rain gauge data, and qualitative community-based reports. There remain some significant challenges with verification. Rainfall has very high spatial variability, meaning that stations only a few kilometres apart may record vastly different values. Nearby gauge comparison is a limited verification method due to the intense variability of precipitation over the changing terrain and within small (meso-) scale atmospheric features.

Due to the risk involved with missed alerts, the forecasting approach that has been implemented represents a worst-case scenario. The forecast is essentially the highest possible rainfall based on the current conditions as opposed to the most likely scenario rainfall. Every season, by design, there is a large number of alerts issued that are not required. As such, any issued alert will generally overestimate what is observed, creating a large number of alerts that will not verify. The system was designed in this manner to avoid missing an alert as the consequence for missed alerts are very serious for the people and resources involved. This practice of forecasting based on the wost-case scenario should remain the approved practice.

For the 2019 season, validation was not possible for 14 alerts because there were no nearby gauges to provide a comparison.

2.1 Community Based Flood Reports

Wood works with Fire & Emergency Services – NL (FES-NL) whenever there are reports of flooding that may not have been forecasted. The concept is to create a qualitative field verification measurement that could further validate the statistical methods. Following a forecasted flood event, the intention was for local officials to classify the event as having no, minor, or catastrophic flooding and these eyewitness reports would be noted on the monthly verification. In the absence of community accounts, local newspapers and social media were scanned to verify the alerts qualitatively. This season, there were no reports of flooding that were not forecasted.

There were four reported instances of flooding in the province this season (June-December). The two most significant ones were on the west coast of Newfoundland, generally in the Stephenville-Corner Brook area, and both were significant. Alerts were issued for both events, with considerable lead time. Wood provided detailed reports to NL MAE shortly after the events. There was another report of flooding on social media in Little Heart's Ease on November 30th and another one observed on the road weather camera in Goose Bay on September 8th. The amounts for these alerts did not verify at the ECCC stations. Alerts had been issued for the Goose Bay event. No alerts were issued for the nearest community, Hodge's Cove, for the other event.

2.2 Potential Missed Alerts

No events were triggered by stations exceeding 20- or 100-year limit amounts.

Table 4 Potential Missed Alerts

Community	Nearby Flood Report	Issue Date	12-hour Precip Forecast	24-hour Precip Forecast	EC Observed	WRMD Observed	Conclusion
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

2.3 Climate Normals

Airport reports of rainfall across NL were examined to determine how the 2019 HSFAS season compared to the climatological normals. The 2019 months are colour-coded in red if they were substantially above

normal and blue if they were substantially below normal.

Table 5 Monthly Rainfall Totals (in millimetres) compared to climate normals

Location	Jun 2019	Jun Norm	Jul 2019	Jul Norm	Aug 2019	Aug Norm	Sep 2019	Sep Norm	Oct 2019	Oct Norm	Nov 2019	Nov Norm	Dec 2019	Dec Norm
St. John's	93.2	97.5	134.2	91.6	62.6	100.0	154.4	129.6	84.1	153.7	217.8	124.8	71.4	102.9
Gander	102.6	85.7	104.0	95.4	36.8	104.2	112.9	114.7	60.1	102.3	97.4	75.2	45.0	48.9
Deer Lake	86.2	87.8	66.2	95.1	59.2	109.6	120.4	99.9	69.7	84.9	155.2	60.2	39.3	27.6
Goose Bay	91.8	90.0	92.6	121.3	197.6	99.3	85.6	90.6	33.4	63.3	41.0	22.7	1.8	6.6

June was near normal for rainfall across the province. July was wetter than normal in eastern and central Newfoundland but drier than normal in western Newfoundland and Goose Bay. August was significantly drier than normal across Newfoundland but significantly wetter than normal in Labrador. September was generally wetter than normal across the province. October was drier than normal across the board and November was significantly wetter than normal across the province and the wettest month of the year for Newfoundland. December was drier than normal for rainfall for most areas except in Deer Lake, where it was wetter than normal.

Only two actual hurricane or tropical storm remnants reached Newfoundland's vicinity this season, Dorian and Humberto, which were both in September. Humberto passed southeast of the island as an extra-tropical cyclone and did not bring any significant precipitation. Dorian was a much more significant system, but it also did not have any significant impacts on Newfoundland. In Canada, the Maritimes were hit harder by the wind and rain due to the hurricane making landfall in Nova Scotia and then weakening significantly.

2.4 Summary

Four flooding events occurred in the province this season, three of which were forecasted. The fourth one occurred in a community that is not part of this forecast alerting system. Two of the flooding events were significant, and the issued alerts had significant lead time. No missed alerts were triggered this season.

3 Lessons Learned and Suggested Improvements

The geographic spread of alerts and flooding events from this season are unique compared to previous seasons. As individual seasons continue to depart further from climate normals, customized alerting services such as this become more critical. Record-breaking dry or wet spells emphasize the growing importance of nowcasting and advanced weather monitoring, on a very local scale.

This report highlights an issue with predicting flooding based on 20-year or 100-year threshold being met. Flooding is a complex phenomenon and can occur with amounts significantly less than those thresholds and vice versa – no flooding may occur with amounts significantly higher than those. It is

thereforth recommended that we re-examine the format of the product to see where improvements can be made. For example, including probabilistic flooding forecasts that are based on the forecasters' knowledge of the current situation, as well as the hydrometeorological data available at the time of the forecast, may help with forecast accuracy.

As we have indicated in the past, there is a need to fill the gaps in the available monitoring networks. Using only the ECCC and WRMD gauge data limits the ability to verify the forecasts in some areas. Many communities would benefit from additional measurements, access, and/or studies. Without instrumentation for measuring precipitation, it can be very dificult to know for certain areas whether the forecasted precipitation was accurate.

More accurate monitoring solutions have been developed in recent years, and with increasing communication options across the province, with the expansion of cellular coverage, it may be the time to revisit additional investment in quantitative measuring equipment. To advance the service, additional rain gauges could be installed, particularly in the regions that have generated significant alerts in the past. An attempt should also be made to obtain the data from other existing gauge networks in use across the Province by commercial/private agencies.

Attempts have been made to fill these gaps through community-based flood reports and use of local media sources to try to corroborate sparse gauge data. In several cases over the past few years, these community based reports can be subjective and as a result may lead to false alarms. As these reports are subjective and not scientific we are recommending that we discontinue this practice.

For next season we recommend a study of the benefits of using the ECCC CaPA data to see if this would help with forecast validation. The CaPA data uses a combination of observations and RADAR data to estimate rainfall over a larger area.

4 Conclusion

It would be highly beneficial to pursue additional improvements to the data sources:

1. Additional rain gauges could be installed, particularly in the regions that generated significant alerts.
2. Access could be obtained for other rain gauge networks in use across the province, and the existing Department of Transportation Road Weather Information System monitoring network could add rain gauges to their existing stations.
3. Flood Risk Mapping Studies could be considered for the communities that triggered alerts based on Intensity-Duration-Frequency (IDF) curves.
4. The format of the forecast could be improved to include additional predictors of flooding.
5. Investigation the use of CaPA data to see if CaPA data would be beneficial as a tool to validate the forecasts.
6. Discontinue the use of community based flood reporting as a method of validating forecasts.

5 Closure

We trust that this report meets your needs. Please do not hesitate to contact the undersigned if you have any questions or comments regarding the hurricane season outlook.

Yours sincerely,

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