PRECIPITATION EVENTS REMOTE MONITORING PILOT PROJECT ON BAF-5 RESOLUTION ISLAND

Prepared by Analytical Services Unit, Queens University Kingston for CIRNAC, 2022

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1 INTRODUCTION

The client commissioned ASU at Queens University to conduct a study into the continued effects of precipitation on the stability of several engineered features at a contaminated site. The site is located at a remote island in a sub-arctic region of the Canadian north and the goal of the study was to investigate, compile and collate readily available weather data along with modelled projections of how climate change will affect relevant weather parameters as they relate to these features in the future.

2

Table 1: Features requiring specific monitoring on BAF-5

1	**Furniture Dump PRB**
2	**S1/S4 Beach PRB**
3	**Airstrip Landfill**
4	**TIER II Soil Landfill**
5	**PCB Storage Facility (building – not currently in use)**
6	**Beach Non-Hazardous Landfill**
7	**East and West Camp Non-Hazardous Landfill**

The approximate locations of these features are shown in Figure 1.

Figure 1: General Layout and Site Features at Resolution Island

RCP 4.5, RCP 6.0, and RCP 8.5, although others are also being considered. The numerical values associated with the RCP designation correspond to an increase in heat (in terms of watts per square meter (W/m) on the Earth’s surface), which is referred to as a radiative forcing.

Each RCP results from various mitigation measures (or the lack fuel powered with minimum adoption of cleaner technology. The predicted temperature increase is 3.7 C. Sea level rise is calculated at 0.63 m and changes in extreme weather is estimated at a “large increase”.

The four RCP pathways summarized above can therefore be categorized as low, average, high and severe, although sometimes different terminology will be used – ClimateData.ca refers to RCP 2.6 as low, RCP 4.5 as moderate and RCP 8.5 as high (emissions), with RCP 6.0 not discussed. PCIC use the terms: very low carbon for RCP 2.6, low carbon for RCP 4.5. and high carbon for RCP 8.5.

4.5 Data Presentation – ClimateData.ca

This website was constructed collaboratively by many leading climate organizations and is supported by the Government of Canada. Information obtained from this website is used to inform and aid climate influenced decision-making by providing up-to-date climate data in a variety of different formats.

“61.508333ºN, 65.008333º W

Resolution Island, NU

For the 1951–1980 period, the annual average temperature was -7.4 ºC; for 1981–2010 it was -7 ºC. Under a high emissions scenario, annual average temperatures are projected to be -5 ºC for the 2021–2050 period, -2.5 ºC for the 2051–2080 period and -1.3 ºC for the last 30 years of this century.

Average annual precipitation for the 1951–1980 period was 386 mm. Under a high emissions scenario, this is projected to be 10% higher for the 2021–2050 period, 19% higher for the 2051–2080 period and 27% higher for the last 30 years of this century.

These values reflect an arbitrary ~10 km x 6 km grid cell (chosen by the website to represent Resolution Island). The actual grid for the BAF-5 site is selectable using the “Variables Tab” and is designated Brewer Bay, NU. This area may more accurately represent the microclimates at the site caused by local topography. It should be noted that considerable local deviations in precipitation quantities may be possible due to these microclimates. Annual values are used in this study, although monthly or seasonal values are available. 30-year averages and 30-year changes are also available. Figure 2 shows a Google Earth aerial view of the site that illustrates the location of Brewer Bay (image from June 2006).

Figure 2: Resolution Island Site and Brewer Bay

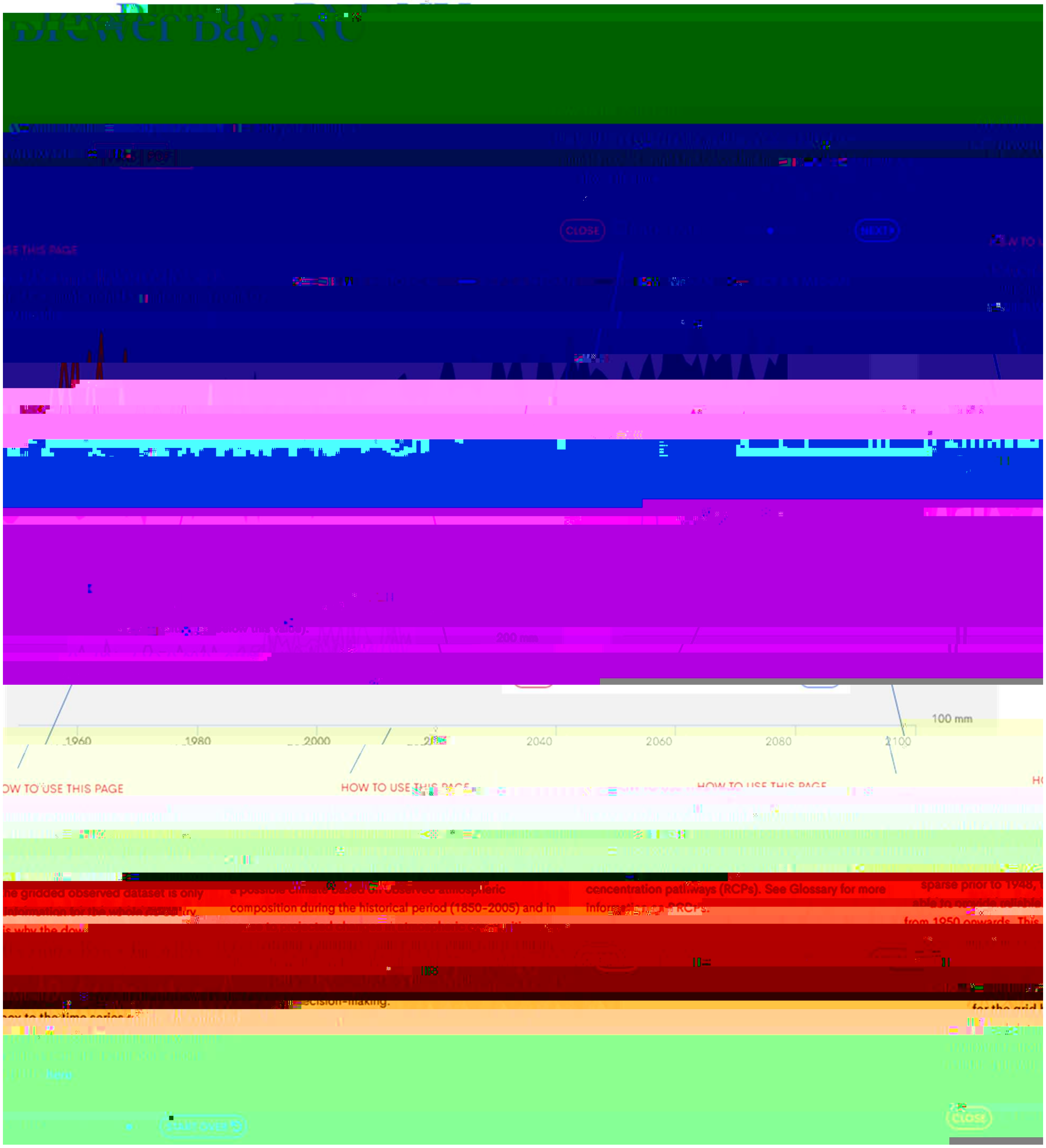

Figure 3: A ClimateData.ca Precipitation Graph

For this report, only definitions for relative precipitation metrics shall be detailed here. Temperature and Other Variables definitions can be found in Appendix C.

Precipitation significantly impacts water availability, agricultural practices, electricity

weather, temperature, precipitation, and agriculture. For each, a range of sub-headings can be selected. These are broadly like the subcategories available through ClimateData.ca. For an overview, the downloadable file entitled “Climate Data: Resolution Island.pdf” is presented in concise format and included in Table 2 below.

4.9 Exported Data in png format

The following figures demonstrate the available data from ClimateData.ca. For these graphs, gridded historical data plots (1950-2013) have been omitted for simplicity. Only figures relating to precipitation are presented here. Figures relating to temperature and other variables can be found in Appendix D.

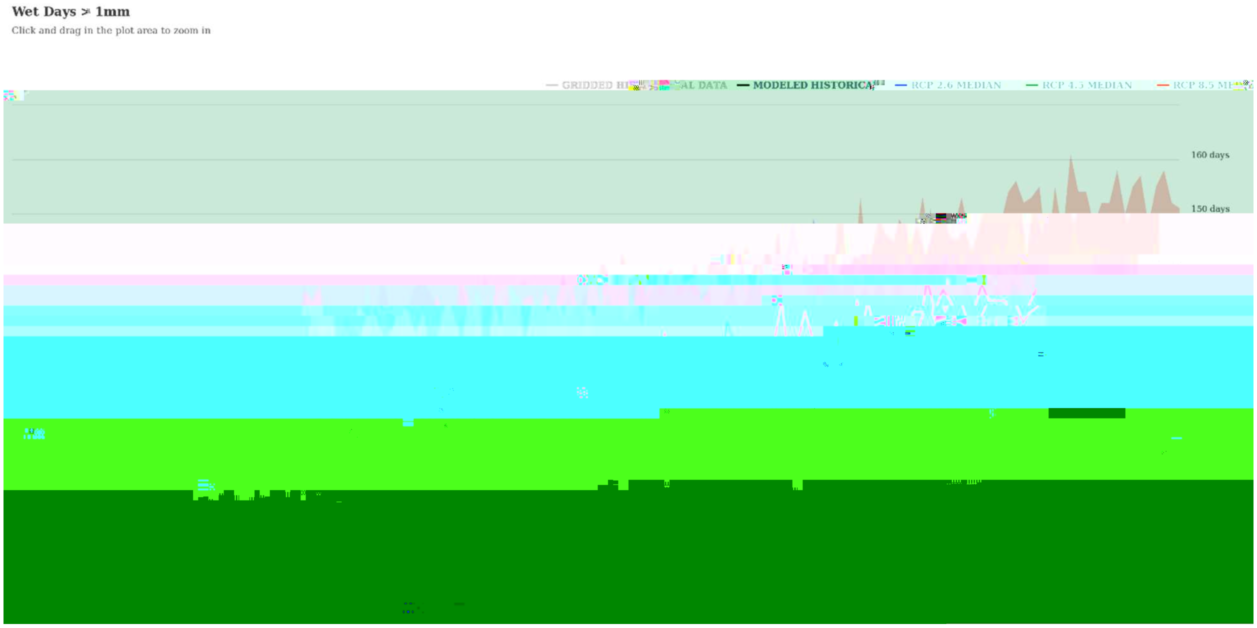

Figure 4: CD Wet days > 1mm MH RCP 2.6 RCP 4.5 RCP 8.5.png

Figure 5: CD Wet days > 10mm MH RCP 2.6 RCP 4.5 RCP 8.5.png

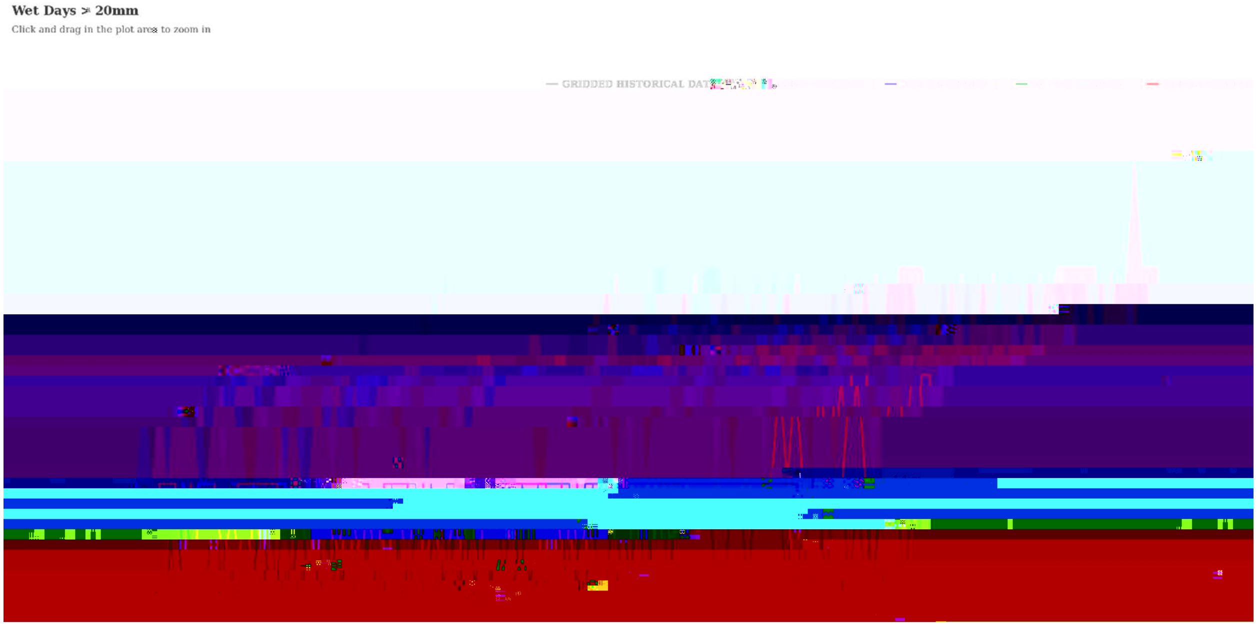

Figure 6: CD Wet days > 20mm MH RCP 2.6 RCP 4.5 RCP 8.5.png

Figure 7: CD 1 Day Total Precipitation MH RCP 2.6 RCP 4.5 RCP 8.5.png

Figure 8: CD Maximum Number of Consecutive Dry Days MH RCP 2.6 RCP 4.5 RCP 8.5.png

Figure 9: CD Number of Periods with 5 or More Consecutive Dry Days MH RCP 2.6 RCP 4.5 RCP 8.5.png

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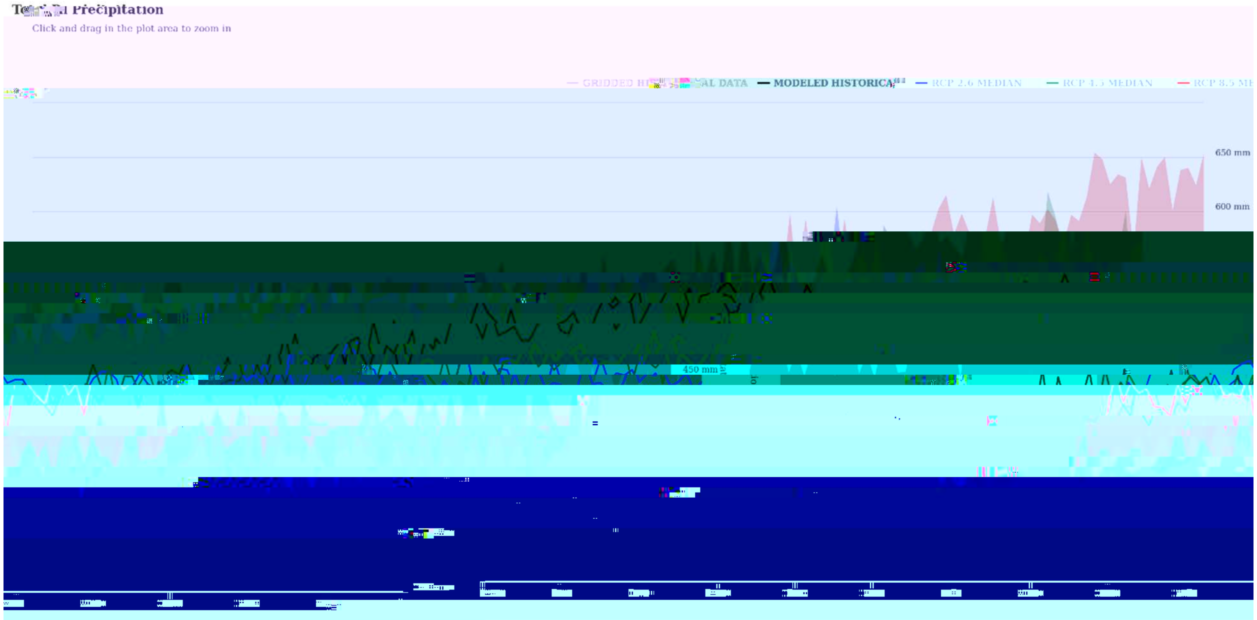


Figure 10: CD Total Precipitation MH RCP 2.6 RCP 4.5 RCP 8.5.png

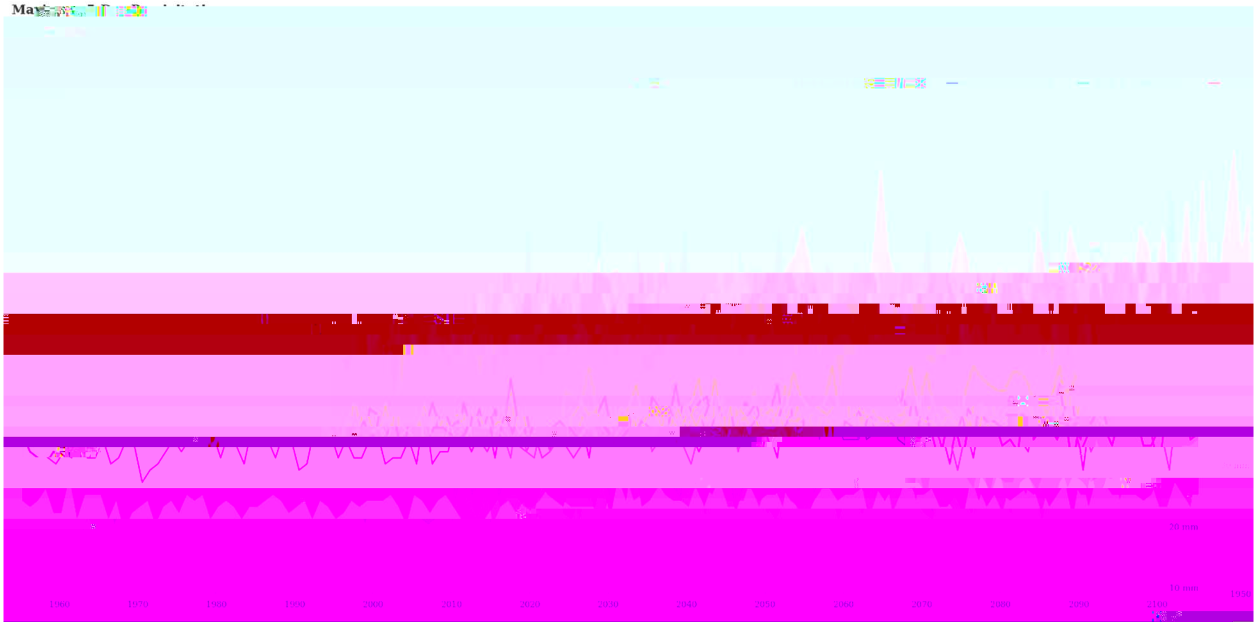


Figure 11: CD Maximum 5-Day Precipitation MH RCP 2.6 RCP 4.5 RCP 8.5.png

5.1.2 One-Day Total Precipitation MH RCP 4.5 (maximum 1-day total precipitation – ClimateAtlas.ca)

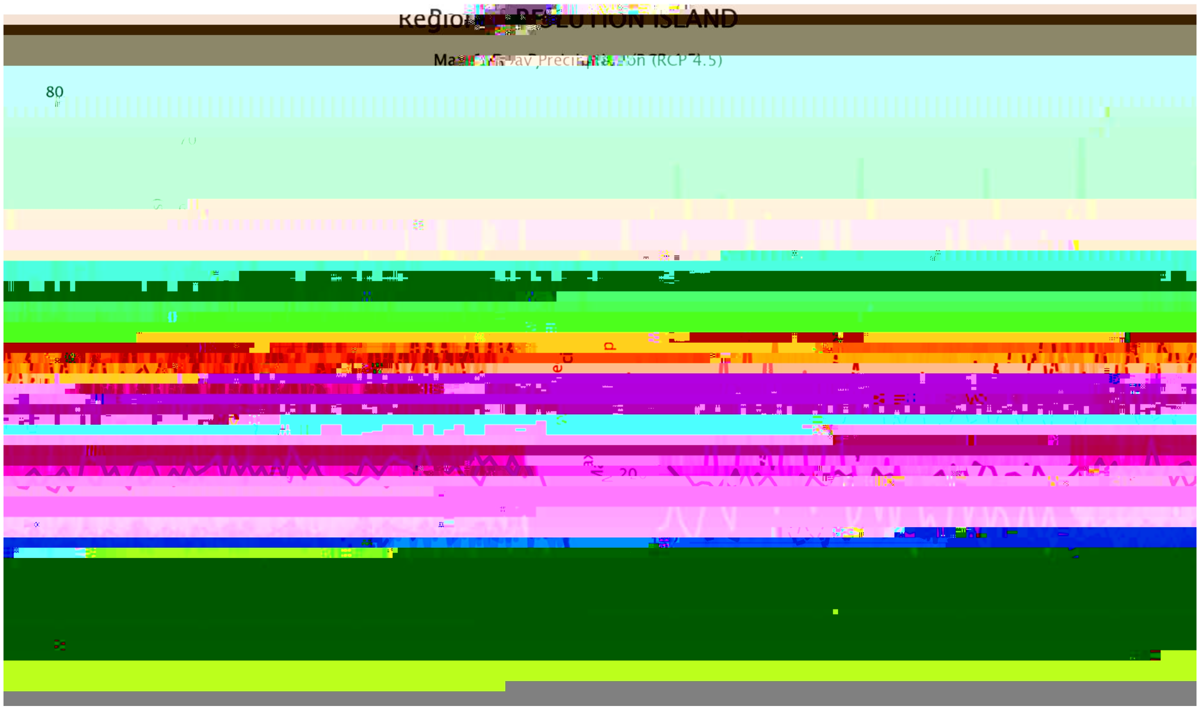


Figure 14: One Day Total Precipitation Maximum (mm) for RCP 4.5

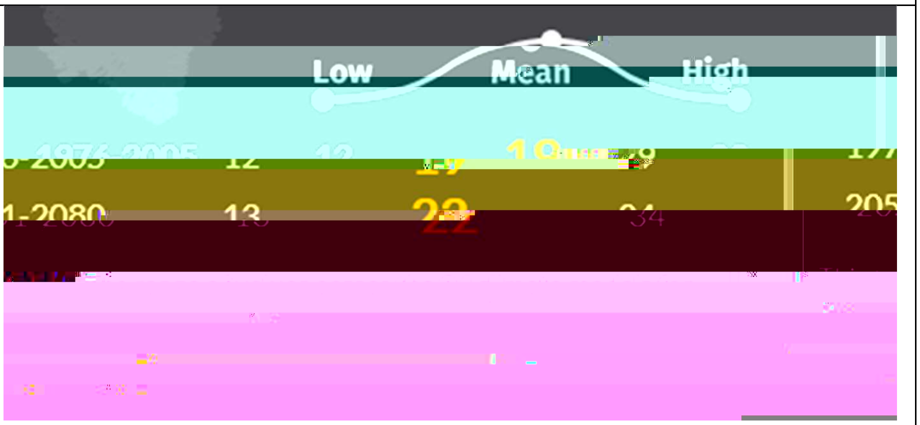
Projected change in mean: 2021-2050	
Projected change in mean: 2051-2080	

Figure 15: Projected Change in One-Day Maximum Precipitation (mm) for RCP 4.5

The 1976–2005 period is used to set the baseline with a mean (annual) precipitation value of 400 mm, taken from the average (referred to as ensemble) value of the multiple climate models used over this data period.

For 2021–2050, RCP 4.5 mean (annual) rainfall is estimated at 433 mm, which is an 8.3 % on the baseline value. Low and high values are set using the 10 percentile and 90 percentile values of 24 separate climate models. The low value for this range is 360 mm and 512 mm is the high value. Similarly, for 2051–2080, RCP 4.5, the mean (annual) rainfall is estimated at 449 mm, which is an 12.3% increase, with a low of 363 mm and high of 540 mm.

A statistical comparison of means for the years 1950–2013 from the historical data set (387 mm) and the modelled ensemble data (397 mm) suggested no significant difference between the datasets (Student’s t test, p = 0.37, confidence level of 95%; i.e. ẹ en w& wpart m m e l n ee

Projected change in mean: 2021-2050	
Projected change in mean: 2051-2080	

Figure 19: Projected Change in Maximum 5-Day Precipitation (mm) for RCP 4.5

For RCP 4.5, the baseline value is set at 32 mm for Maximum 5-day precipitation. For 2021–2050, this goes up 10% to 35 mm and for 2051–2080, an increase of 12% to 35 mm is seen. The change from 10% increase to 12% increase is not observed in the presented data (both values are 35 mm) because of the use of two significant figures.

Certain other precipitation metrics such as Wet days > 20 mm have been omitted from further discussion. Measured occurrences of this metric are low. For example, the 30-year averages for 1951–1980 have a median value = 0, and a range of 0–1, versus a median of 1 (range 1–1) for 2071–2100. Even for the more pessimistic prediction of RCP 8.5, at the maximum extent of the timeline (2100), > 20 mm events are not predicted to increase significantly. Non-precipitation weather events as they relate to temperature or other metrics are beyond the scope of the present report. Frost days, freeze thaw cycles and ice days, however, may well be relevant to degradation pathways in engineered structures and future studies may address these metrics for Resolution Island and/or other sites. . Predictions for freeze thaw cycling at BAF-5 are briefly discussed in section 5.5.2.

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5.2 Generation of Precipitation Data

The ability to produce high quality estimates and measurement for precipitation is essential for accurate climate modelling, and yet quantification remains challenging.

“Most precipitation data sets may be categorized into one of three broad categories: gauge data sets (e.g. CRU TS, GPCC, APHRODITE, PREC/L), satellite-only data sets (e.g., CHOMPS) and merged satellite-gauge products (e.g. GPCP, CMAP, TRMM 3B42)”.

Even with thousands of satellites in the sky, most satellites orbit over a region with a relatively low periodicity, leading to the potential for missed precipitation events. For this reason, observations are often made from multiple satellites that carry scientific equipment such as passive microwave and/or infrared instruments. Infrared sensors are used to estimate temperatures, and microwave data are used to calculate a precipitation value from both scattered and emitted radiation. The scattering signal is particularly useful over land because of significant distortion of the emission signal.

Rain gauge-based data sets themselves can be difficult to use, as extrapolating point data to cover a wide geographical area can lead to large uncertainties. Errors in measurement can occur because of wind and/or evaporation effects. In remote locations, weather stations are few an

methods#toc-0 → data sources and methods→about this data→observed values. In the following paragraphs, the two datasets (Meteoblue Data Download and ERA5 Download) are further compared with ensemble (averaged data) obtained from ClimateAtlas.ca.

5.4.2 Meteoblue Data: Resolution Island

5.4.2.1. Meteoblue Simulated Historic Climate and Weather Data – 30 Years

The minimum and maximum temperatures (for an average day) as well as precipitation amounts for each month are displayed below. The dotted lines show the average hottest day and coldest day for each month. These averages have been compiled for the last 30 years (circa 1991–2021). This simulated historical climate data has a spatial resolution of approximately 30 km. The average annual precipitation (1991–2021) is 553 mm and is broken down as follows: Jan (30 mm); Feb (27 mm); Mar (32 mm); Apr (36 mm); May (46 mm); June (51 mm); July (56 mm); Aug (64 mm); Sep (68 mm); Oct (54 mm); Nov (54 mm); Dec (35 mm). Seasonal values are spring (114 mm), summer (171 mm), fall (176 mm), and winter (92 mm). Note that this total annual precipitation amount of 553 mm is substantially elevated over the measured climate normal value

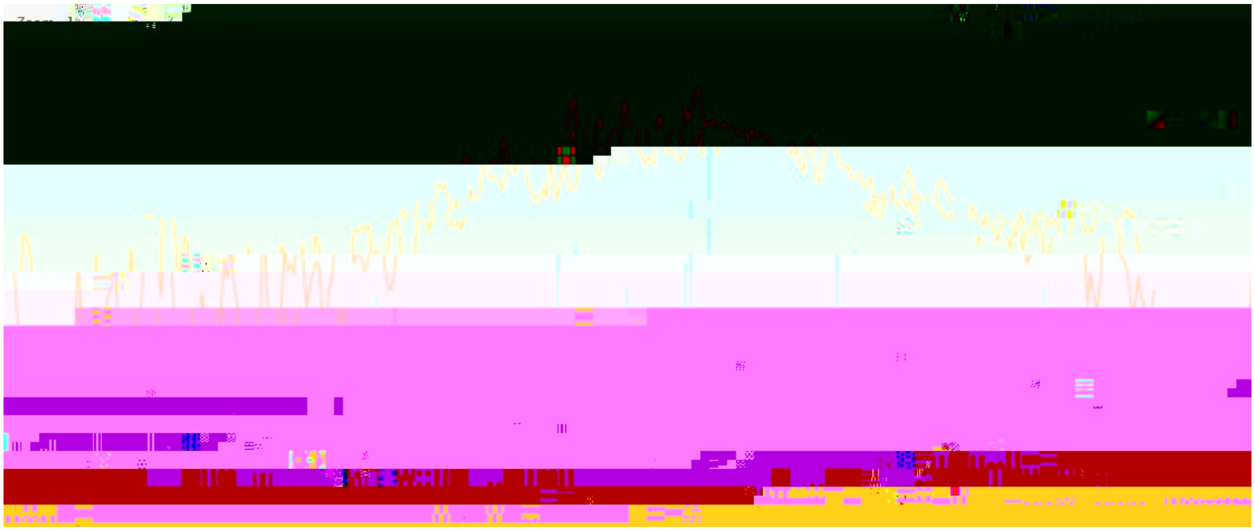


Figure 26: Meteoblue -Precipitation and Temperature 2010 Data Download

Average temperature: - 3.6 C; Total Annual Precipitation: 587 mm

Figure 27: Meteoblue -Precipitation and Temperature 2011 Data Download

Average temperature: - 6.8 C; Total Annual Precipitation: 418 mm

Figure 28: Meteoblue -Precipitation and Temperaturm ẹ rP ¾ ! a nt tiont em mo m

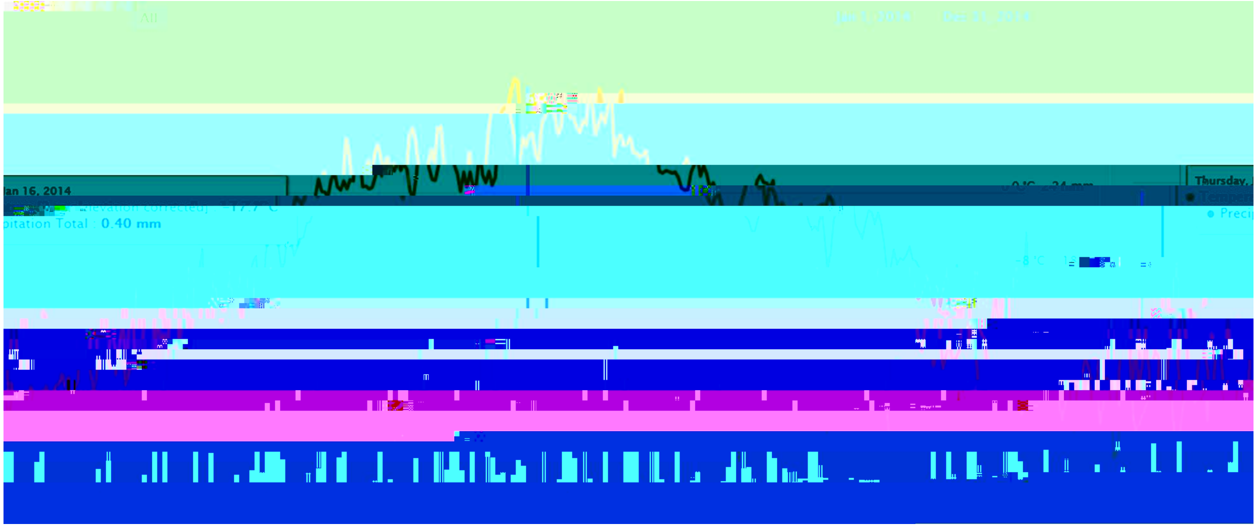


Figure 30: Meteoblue -Precipitation and Temperature 2014 Data Download

Average temperature: -6.8 C; Total Annual Precipitation: 494 mm

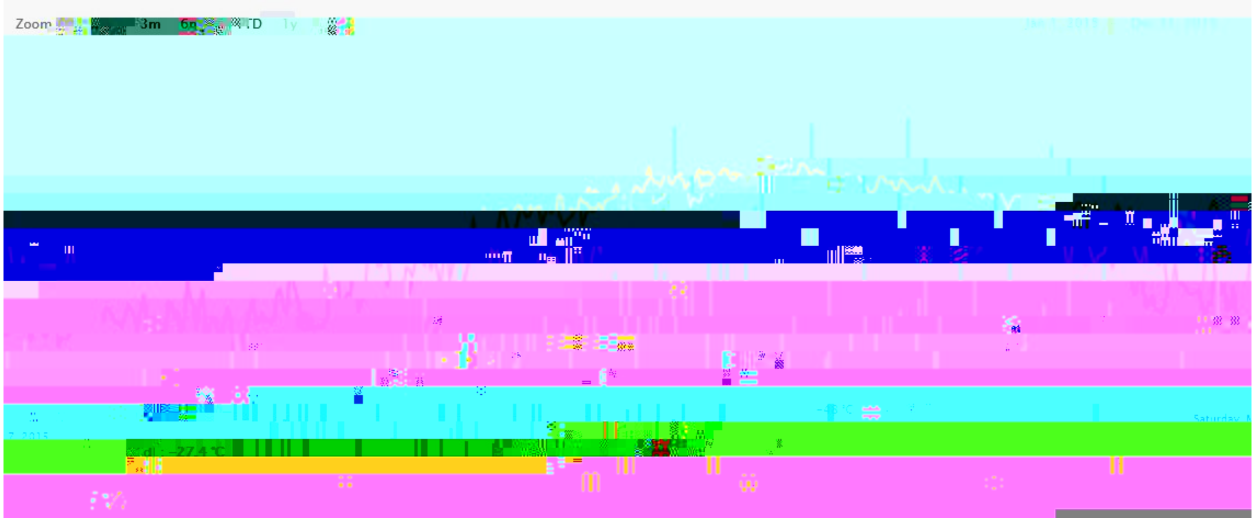


Figure 31: Meteoblue -Precipitation and Temperature 2015 Data Download

Average temperature: -9.3 C; Total Annual Precipitation: 513 mm

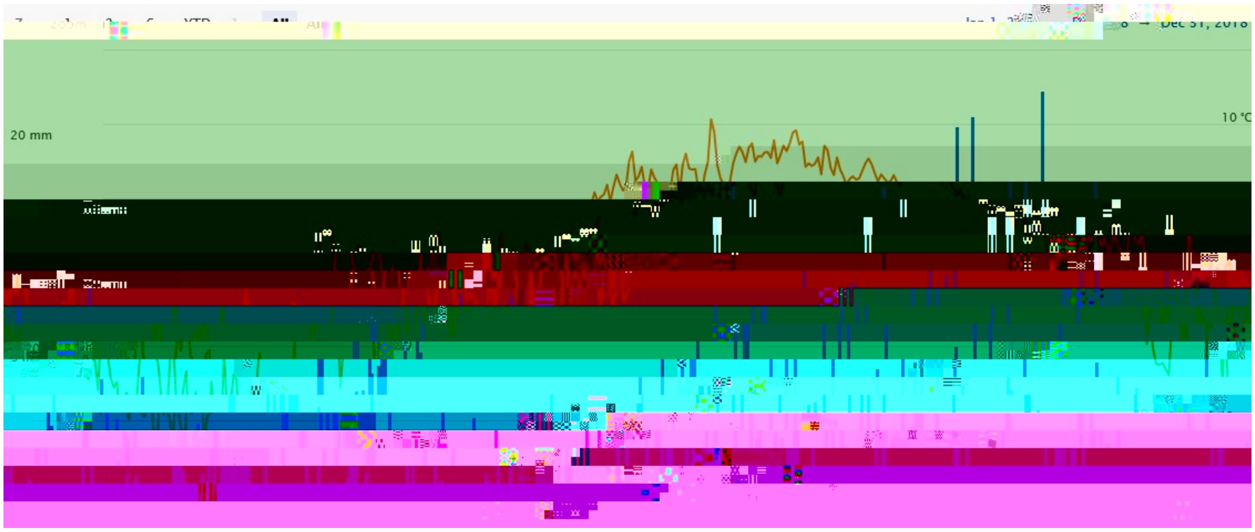


Figure 34: Meteoblue -Precipitation and Temperature 2018 Data Download

Average temperature: -8.1 C; Total Annual Precipitation: 507 mm

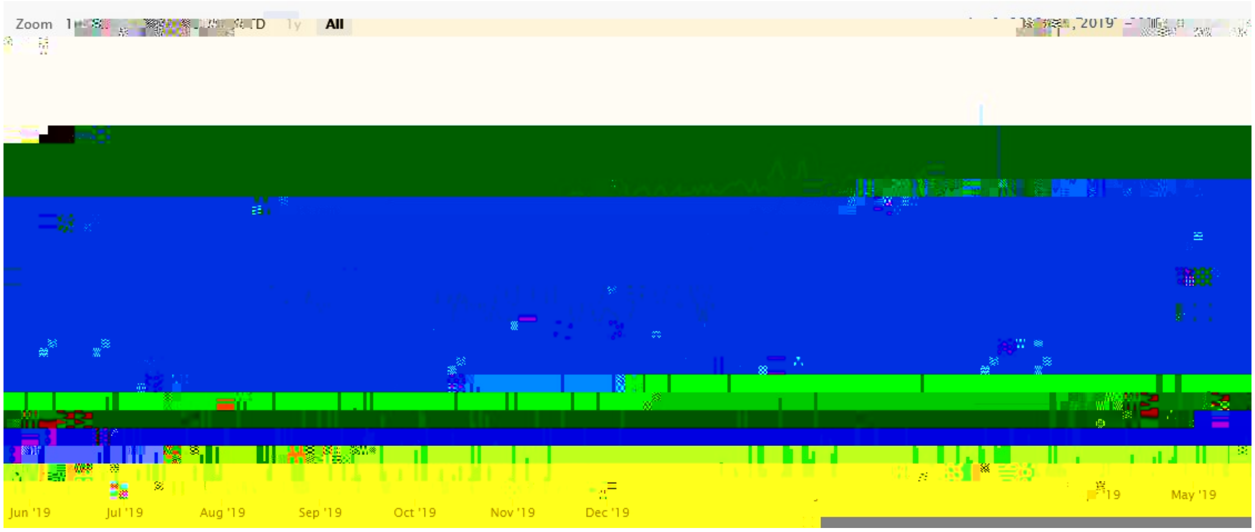


Figure 35: Meteoblue -Precipitation and Temperature 2019 Data Download

Average temperature: -7.1 C; Total Annual Precipitation: 406 mm

5.4.3 Meteoblue Precipitation and Temperature Data 2006 – 2019. ERA5 Download

The figure for the first "ERA5 Download" (Figure 36) allows a direct visual comparison with the equivalent "Data Download" image (Figure 22). For the subsequent years 2007 to 2019 inclusive, only the ERA5 recalculated average temperature and total annual precipitation are presented in the following list. The images and xls data for these years are available on request.

Figure 36: Meteoblue -Precipitation and Temperature 2006 -ERA5 Processed

Average temperature: -6.4

Meteoblue -Precipitation and Temperature 2014 ERA5 Processed

Average temperature: -7.6 C; Total Annual Precipitation: 425 mm

Meteoblue -Precipitation and Temperature 2015 ERA5 Processed

Average temperature: -9.1 C; Total Annual Precipitation: 461 mm

Meteoblue -Precipitation and Temperature 2016 ERA5 Processed

Average temperature: -7.5 C; Total Annual Precipitation: 462 mm

Meteoblue -Precipitation and Temperature 2017 ERA5 Processed

Average temperature: -7.5 C; Total Annual Precipitation: 517 mm

Meteoblue -Precipitation and Temperature 2018 -7.5

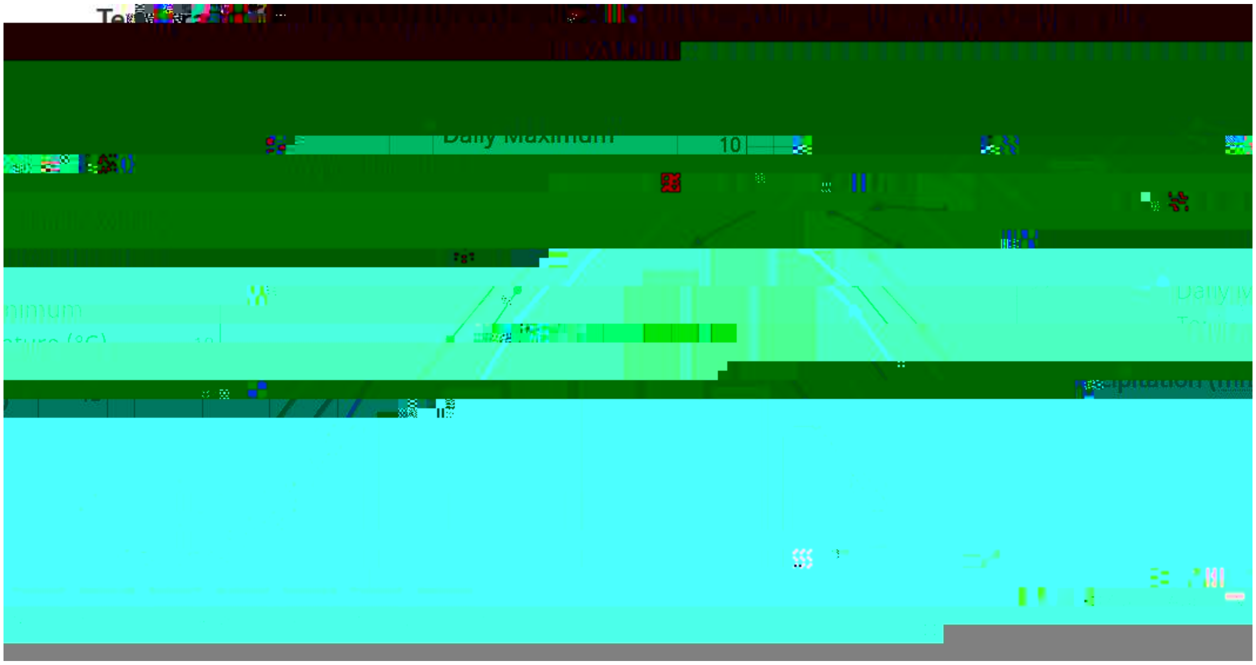


Figure 37: Iqaluit Climate Normal 1981–2010

The average annual precipitation (1981–2010) is 404 mm and is broken down as follows: Jan (19.7 mm); Feb (18.7 mm); Mar (18.7 mm); Apr (27.5 mm); May (29.2 mm); June (33.0 mm); July (51.9 mm); Aug (69.5 mm); Sep (55.2 mm); Oct (33.3 mm); Nov (27.2 mm); Dec (19.9 mm). Seasonal values are spring (75.4 mm), summer (154.4 mm), fall (115.7 mm), and winter (58.3 mm).

Other useful precipitation data is also accessible, including Extreme Daily Precipitation (mm), which is organized by month in a tabulated format.

Gridded historical data is not available for Resolution Island (or any other sites) after 2013. For the duration of the study period relevant for the present work, 2006–2019, the Iqaluit annual precipitation measurements were downloaded (from the Iqaluit Climate weather station) and results are presented in Table 4. Gridded Historical Data (2006–2013), Ensemble Mean Data, Meteoblue (data download) and Meteoblue (ERA5) are also compared. These annual precipitation datasets are compared to soil (movement) metrics, recorded in previous ASU reports. This was carried out to see if a correlation exists between the amount of precipitation received and the quantity of soil transported by runoff. Two monitored features at the site: 1) the Furniture Dump PRB and 2) the Beach S1/S4 PRB were of particular interest.

The use of either MB Data download or MB ERA5 data, while readily available/organized, does not show a good correlation with any of the other data sets.

5.4.5 Resolution Island Historic Precipitation Maximums

The maximum annual rainfall observed at Resolution Island (from historical records-gridded) over the course of a singO Ma ^ m h] l ce] l s7f

Resolution Island climate normals (1941–1970) of 386 mm, (1951–1980) of 404 mm and obtained from ClimateAtlas.ca (1975–2005) of 400 mm closely resemble the most recent values found for Iqaluit (1981–2010) of 403 mm. It is reasonable, therefore, given the inherent uncertainty in precipitation values, to use Iqaluit as a proxy for future measurements related to precipitation events at Resolution Island.

constructed to intercept contaminated soil from the drainage pathway. Since its say ^{T} olre "45a

Table 8: S1/S4 Beach Barrier Soil Quantity vs Precipitation Model-Year Per Year

	Measured	Soil (m)	IS	EM	GH
2006	Y (2.0)	2.0	268	423	192
2007	Y (1.2)	1.2	341	410	197
2008	Y (5.3)	5.3	340	393	428
2009	N	1.15*	208	428	345
2010	Y (2.3)*	1.15*	382	407	405
2011	N	2.0	257	420	380
2012	N	2.0	350	398	386
2013	Y (6.0)**	2.0	327	397	340
2014	N	1.17	619	410	NA
2015	N	1.17	301	396	NA
2016	N	1.17	487	425	NA
2017	N	1.17	359	417	NA
2018	N	1.17	324	408	NA
2019	Y (13)**	1.17	254	398	NA

Figure 40: Change in Volume of Sediment in RI Barriers (2005-2010)

IS and EM precipitation data (2006–2019) and GH data (2006–2013) were investigated to consider potential links to weather phenomenon. GH data showed a peak value in 2008 of 428 mm annual precipitation (with a dataset mean of 334 mm). The EM value of 393 (dataset mean of 398) was not elevated in 2008, nor was the IS measurement of 340 mm (vs a mean of 343 mm).

The ClimateAtlas.ca GH dataset was reviewed for Resolution Island with a focus on the data range 2006–2013 and 2008, for the following additional precipitation metrics: Days with

5.5 Establishment of Baseline Values and Use of Precipitation Data towards Meeting OMS

difference was observed between annual precipitation values (mm) for GH data for Iqaluit (from ClimateAtlas.ca) and the Iqaluit EM, RCP4.5 (from ClimateAtlas.ca) (Student's t-test, n=64).

5.5.1 Setting Action Levels Using EM Iqaluit for a RCP 4.5 Baseline

Given the variability in measurable data and the requirement to use Iqaluit weather station as a proxy for Resolution Island precipitation data, the data used to develop moderate, high, and extreme action levels are somewhat arbitrary. The following is one possible mechanism to set an appropriate response.

Upper prediction levels (UPLs) were calculated using ProUCL5.1 (freeware for statistical computations from USEPA). Confidence levels were selected to represent moderate (90%), high (95%) and extreme (99%) action levels for EM and GH data separately. These levels are displayed in Table 11 using data from 1950 to 2013 (when GH data reporting stopped).

Table 11: Action Levels (Upper Prediction Level, UPL)

Effect Level	GH Iqaluit UPL (mm) 1950–2013	EM Iqaluit UPL (mm) 1950–2013 9 1	1
Moderate			

Table 12: Action Levels (Upper Prediction Level, UPL) – EM Moving Average (2006-2030)

Effect Level	EM Iqaluit UPL (mm) 2006–2030
Moderate	**498**
High	**504**

The Iqaluit Climate weather station operated by ECCC-MSC, Latitude: 63°44'50.000" N, Longitude: 68°32'40.000" W, Elevation 33.5 m, can be used to provide suitable data. To be manageable, this should be downloaded using daily intervals that will provide per month data for download in several formats. Additional weather station data include a Climate Identifier (CI) Number: 2402592, a World Meteorological Organization Identifier (WMO) number: 71321 and a Transport Canada (TC) identifier: XFB.

Table 13: Action > ʼ я able ɜ ݢ w n ` bb) l ʼ p tbgaentble ɜ ݢ

related damage and to prevent further structural degradation, are recommended to be based only on measured data from the Iqaluit weather station. These action levels should be updated every 8-10 years to ensure relevant and current values are used (Appendix F). Current action levels are presented in Table 13, basedue tt ↓ k t eh

GIS Geography. https://gisgeography.com/free-world-climate-data-sources/. Accessed Nov 30, 2021.

Climate Atlas of Canada. Data Sources and Methods. https://climateatlas.ca/data-sources-and-methods. Accessed November 30, 2021.

Van Vuuren DP, Edmonds J, Kainuma M, Riahi K, Thomson A, Hibbard K, Hurtt GC, Kram T, Krey V, Lamarque JF, Masui T. The representative concentration pathways: an overview. Climatic change. 2011 Nov;109(1):5-31. DOI 10.1007/s10584-011-0148-z.

Environment and Climate Change Canada 2021. Climate Data for a Resilient Data. https://ClimateData.ca/ Accessed November 26, 2021.

Pakkala TA, Lahdensivu J, Huuhka P. Freeze-thaw Damage Dependence on Wind-driven Rain of Outdoor Exposed Concrete–A Case Study. Nordic Concrete Research. 2019 Dec;61(2):91-106.

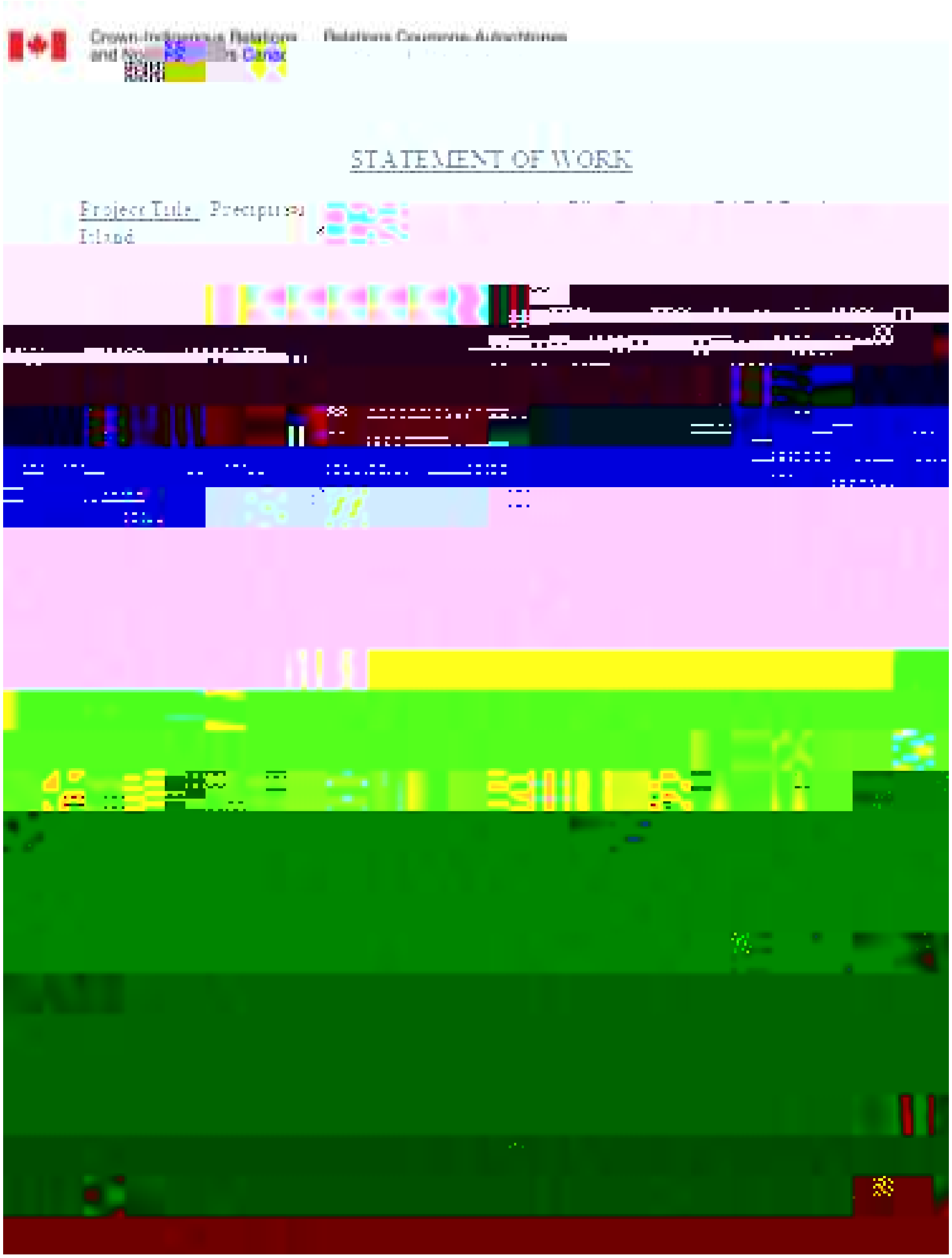
Hart, S., Raymond, K., Williams, C.J. et al. Precipitation impacts on earthen architecture for better implementation of cultural resource management in the US Southwest. Herit Sci 9, 143 (2021). https://doi.org/10.1186/s40494-021-00615-z

Thomson, A.M., Calvin, K.V., Smith, S.J. et al. RCP4.5: a pathway for stabilization of radiative forcing by 2100. Climatic Change 109, 77 (2011). https://doi.org/10.1007/s10584-011-0151-4

. Burn, K.N: Frost Action and foundations. Canadian Building Digest (1976-11). https://doi.org/10.4224/40000696

APPENDIX A: PROPOSAL

RE: Application to undertake a study regarding the project entitled “Precipitation events remote monitoring Pilot Project on BAF-5 Resolution Island” for 2021/2022



Crown-Indigenous Relations and [illegible] Canada   Relations Couronne-Autochtones

STATEMENT OF WORK

Project Title: Precipitation [illegible] Island

Deliverables:

The Contractor shall:

1. Submit [illegible] electronic copy (Microsoft Word) of a Draft #1 Weather-Based Monitor [illegible] Pilot Report to the Departmental Contact on or before September 28th, 2021.
2. Receive the review of Draft #1 Weather-Based Monitoring Pilot Report with comments included by the Depa [illegible] on or before October 12th,
3. Subm [illegible]

[illegible] Draft #2 Weather-Based M [illegible]

APPENDIX B: EXPORTED DATA XLS, PNG AND PDF

File names as follows [illegible]

CD Hottest Day MH RCP 2.6 RCP 4.5 RCP 8.5

CD Mean Temperature MH RCP 2.6 RCP 4.5 RCP 8.5

CD Minimum Temperature MH RCP 2.6 RCP 4.5 RCP 8.5

CD Maximum Temperature MH RCP 2.6 RCP 4.5 RCP 8.5

CD Days with Tmin < -15 C MH RCP 2.6 RCP 4.5 RCP 8.5

CD Days with Tmin < -25 C MH RCP 2.6 RCP 4.5 RCP 8.5

CD Days with Tmax > 25 C MH RCP 2.6 RCP 4.5 RCP 8.5

CD Coldest Day MH RCP 2.6 RCP 4.5 RCP 8.5

CD Last Spring Frost MH RCP 2.6 RCP 4.5 RCP 8.5

CD First Fall Frost MH RCP 2.6 RCP 4.5 RCP 8.5

CD Frost Free Season MH RCP 2.6 RCP 4.5 RCP 8.5

CD Wet days > 1mm MH RCP 2.6 RCP 4.5 RCP 8.5

CD Wet days > 10mm MH RCP 2.6 RCP 4.5 RCP 8.5

CD Wet days > 20mm MH RCP 2.6 RCP 4.5 RCP 8.5

CD 1 Day Total Precipitation MH RCP 2.6 RCP 4.5 RCP 8.5

APPENDIX C: TEMPERATURE AND OTHER VARIABLE DEFINITIONS

“The Hottest Day describes the warmest daytime temperature in the selected time period. In general, the hottest day of the year occurs during the summer months.

High temperatures are important. They determine if plants and animals can thrive, they

“Maximum temperature describes the warmest temperature of the 24-hour day. Typically, but not always, the maximum temperatures occur during the day and so this variable is commonly referred to as the daytime high.

The average highest temperature is an environmental indicator with many applications in agriculture, engineering, health, energy management, recreation, and more.

“The Frost Free Season is the approximate length of the growing season during which there are no freezing temperatures to kill or damage frost-sensitive plants. This index describes the number of days between the Last Spring Frost and the First Fall Frost.

Technical description:

The number of days between the date of the last spring frost and the date of the first fall frost, equivalent to the number of consecutive days during the ‘summer’ without any daily minimum temperatures below 0°C.”

“Relative Sea Level Change is the change in ocean level relative to land. Whereas global sea-level change can be attributed to thermal expansion of water and meltwater from glaciers, ice caps, and ice sheets, relative sea-level change is the combination of the effects from global sea-level change and the vertical motion of the land.

Projected relative sea level change data is available for 2006 and for every decade from 2010-2100, relative to 1986-2005 conditions.”

More details as they relate to the models, and calculations used to predict the effect of RCPs on relative sea level change, can be found on the ClimateData.ca website at https://ClimateData.ca/variable → Relative Sea Level Change (RSLC) → read more. Resolution Island is expected to be strongly impacted, with a RSLC predicted to be in the 100–150 cm range for RCP 8.5, by 2100.

“Frost Days describes the number of days where the coldest temperature of the day is lower than 0°C.

The number of frost days is an indicator of the length and severity of the winter season. A location with many frost days is also likely to have a short growing season since frost is harmful to many plants.

Technical description:

A day when the daily minimum temperature (Tmin) is below 0°C.”

"This is a simple count of the days when the air temperature fluctuates between freezing and non-freezing temperatures on the same day. Freeze-thaw cycles can have major impacts on infrastructure. Water expands when it freezes, so the freezing, melting and re-freezing of water can, over time, cause significant damage to roads, sidewalks, and other outdoor structures.

Technical description

A freeze-thaw cycle occurs when the daily maximum temperature (Tmax) is higher than 0°C and the daily minimum temperature (Tmin) is less than or equal to -1°C."

"Ice Days describe the number of days where the warmest temperature of the day is not above 0°C.

In other words, this index indicates the number of days when temperatures have remained below freezing for the entire 24-hour period. This index is an indicator of the length and severity of the winter season.

Technical description:

A day when the daily maximum temperature (Tmax) is less than 0°C."

The following categories of weather data were not included in this study: standardiz

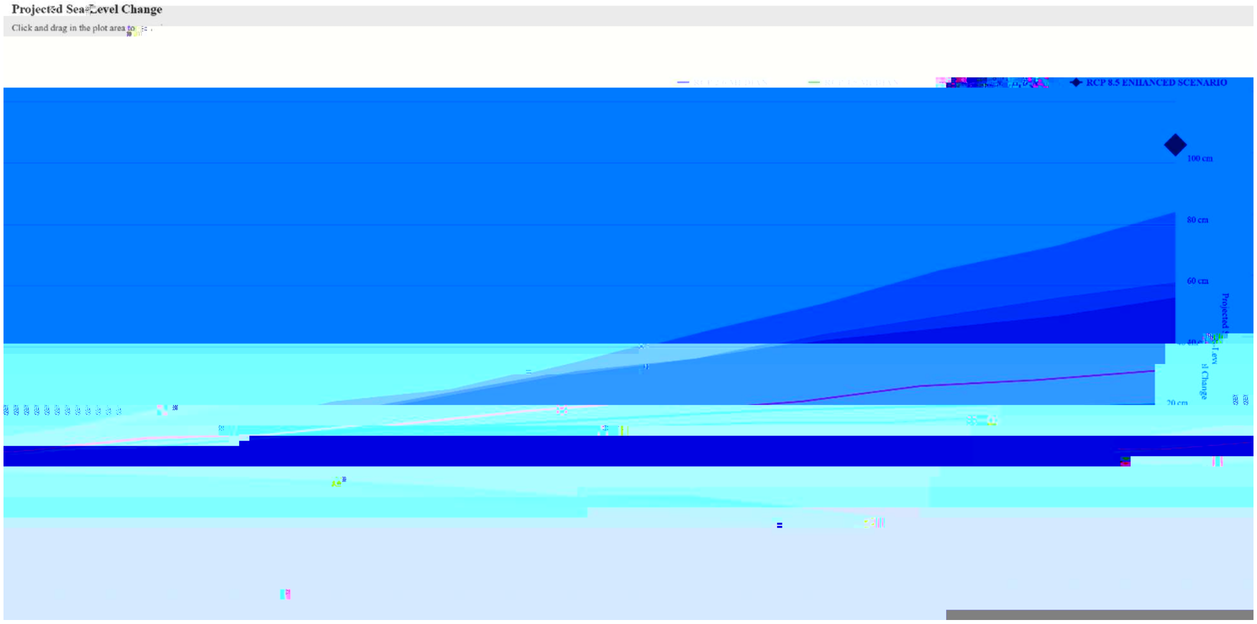
APPENDIX D: TEMPERATURE AND OTHER VARIABLES - FIGURES

CD Days with Tmin <m ’

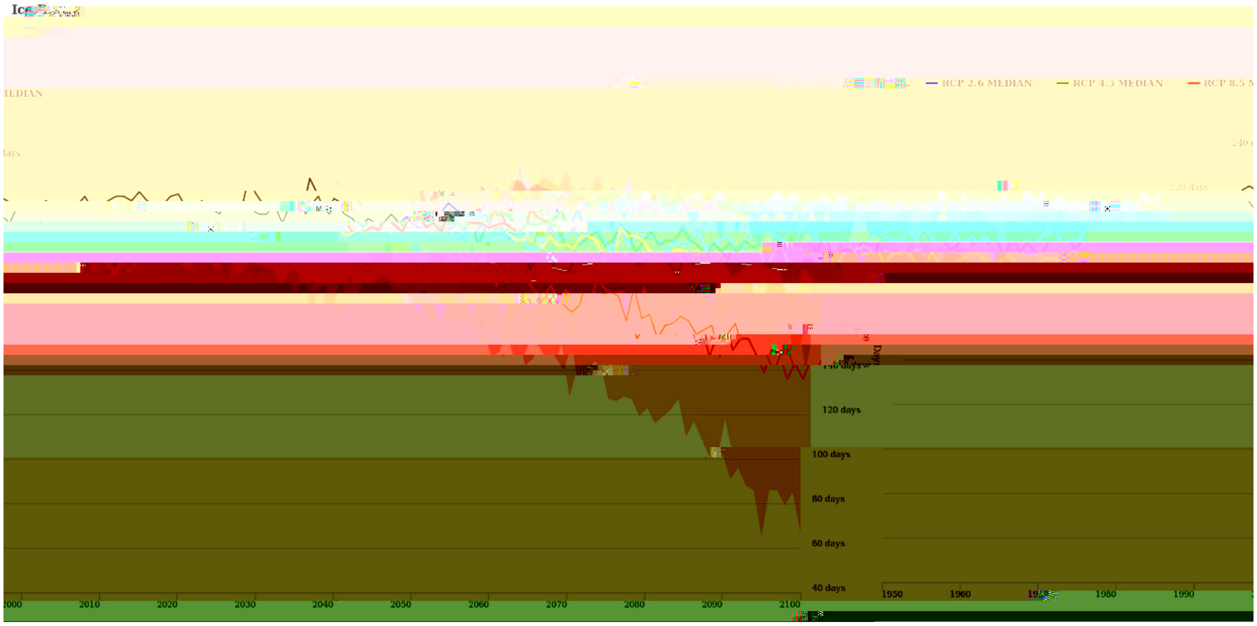
CD Days with Tmax > 25 C MH RCP 2.6 RCP 4.5 RCP 8.5.png

Note: Data was not presented in figure format for “Days with Tmax > 27 C” as there were no

CD Frost Free Season MH RCP 2.6 RCP 4.5 RCP 8.5.png



CD Relative Sea Level Change MH RCP 2.6 RCP 4.5 RCP 8.5.png



CD Ice Days MH RCP 2.6 RCP 4.5 RCP 8.5.png

APPENDIX E: SAMPLE CALCULATION TO DETERMINE ACTION LEVEL PRECIPITATION VALUES (EM MOVING AVERAGES)

Action Levels (Upper Prediction Level, UPL) – EM Moving Average, For use in 2030-2038 (data from 2014-2038)

Action Levels (Upper Prediction Level, UPL) – EM Moving Average (2014-2038)

Effect Level	EM Iqaluit UPL (mm) 2014-2038
Moderate	**512**
High	**519**
Extreme	**535**

9	**Chart data will be presented for YEAR, HISTORICAL, ENSEMBLE etc.**
10	**This data can be copied and pasted to a suitable excel file or exported as CHART DATA. csv format**
11	**Select the relevant EM data range years e.g., 2014-2038.**
12	**Paste this data under the header in ProUCL 5.1 (use the edit/paste heading in ProUCL 5.1)**
13	**Select Upper Limits/BTVs, then all.**
14	**For Available Variables, select and move to Selected Variables, click OK.**
15	**Select Confidence Interval, Type 0.90; Coverage 0.90. This will be repeated for 0.95 and 0.99 to set 3 different action level values). For 0.95 confidence interval, select 0.95 cover.99**

APPENDIX F: PROCEDURE FOR RECALCULATION OF ACTION LEVEL PRECIPITATION VALUES (IS STATION DATA)

Details for Extracting Precipitation Data from The Iqaluit Climate weather station

Weather station data can be obtained through the following link:

https://climate.weather.gc.ca/historical_data/search_historic_data_e.html

The ability to predict whether a site visit is required in the near term (1-2 years), to deal with potential weather-related damage and to prevent further structural degradation, must be based only on measured data. Current action levels were based on total annual precipitation data from the Iqaluit weather station (Table 13).

UPL action levels were last calculated from IS 2006-2019 data and are to be used till 2029. To keep the data set range comparable, early in 2030 data from 2016-2029 should be used to calculate

9	**For Available Variables, select and move to Selected Variables, click OK.**
10	**Select Confidence Interval, Type 0.90; Coverage 0.90. This will be repeated for**