Climate Change Information for Decision Making

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THE PURPOSE OF THIS DOCUMENT

This document summarises key climate indices useful to operational council staff. The climate indices were selected in direct consultation with council personnel and reflect the operational, tactical and strategic climate information needs for decision makers within all of the local councils of southern Tasmania.

This document expands upon previously produced *local profiles* and has been developed to support decision making across Brighton's strategic, operational, service, adaptation and emergency management planning functions.

BACKGROUND

The Climate Change Information for Decision Making - Brighton has been developed using outputs from the *Climate Futures for Tasmania Project* and the *Climate Futures Australasian Projections 2019 data archive*, developed by the University of Tasmania's Climate Futures Programme.

All values are based on the projections generated by the Climate Futures Programme, using previously published results. Descriptive documentation and supporting reports can be found here: http://climatefutures.org.au. This document is to be reviewed and updated when more up-to-date information becomes available, or at 5-yearly intervals. It should be considered in conjunction with Brighton's policies and strategies, alongside technical and industry standards.

Values given are the multi-model mean from an ensemble of six downscaled global climate models based on the *business as usual* high emissions scenario RCP8.5 (the scenario human society is currenty most closely following). Averaging across the ensemble smooths out the inter-annual variability, revealing the forced climate response. For most variables, the range between climate models is not large relative to the percent change projected into the future.

In order to capture the regional variability, the data were separated into *cool* ($< 25^{th}$ percentile), *average* (between the 25^{th} and 75^{th} percentile) or *warm* ($> 75^{th}$ percentile) grid cells, based on average temperature during the baseline period, 1961–1990. These three groups of values were then analysed and presented separately. This provides councils with greater utility when mangaing a diverse landscape (NB: municiaplities with small spatial extents have limited differences captured across the municipality at 10km^2 resolution). It is the responsibility of the user to determine which values may be most appropriate for a given application. For example, if building a road over Vinces Saddle, it would be more useful to apply values from the cooler table, whereas for estimating future high-intensity rainfall within Kingston CBD, values from the warmer table would be more appropriate.

CURRENT CLIMATE AND RECENT TRENDS

All Tasmanian municipalities have a temperate, maritime climate with relatively mild winters at low elevations, transitioning towards warm alpine winters at higher elevations. Long-term average temperatures have risen in the decades since the 1950s at a rate of up to 0.1 °C per decade, with this rate expected to increase from 2020 onwards.

Despite covering small geographic areas all municipalities experience marked rainfall gradients, with average annual rainfall from about 600 mm per year at lower elevations and about 1500 mm per year at higher elevations. There has been a decline in average annual rainfall since the mid 1970s, and this decline has been strongest in autumn and enhanced over higher elevation regions.

EXTREME EVENTS

The changes in climate that are most likely to impact upon the each municipality's infrastructure, roads, the local community and the environment are an increase in intensity of extreme events. Potential impacts by 2100 are as follows (following the *business as usual* high emissions scenario RCP8.5):

- Increased evaporation and longer dry periods coupled with more extreme temperatures are likely to enhance the occurrence and intensity of bushfires.
- The frequency of extremely hot days (> 40°C) is projected to increase. Heat wave frequency is projected to remain stable, but will increase in intensity (warmer days and nights).
- The Annual Exceedance Probability (AEP) is a measure of the rarity of an event. Rainfall AEPs are expressed as the probability that a given rainfall total accumulated over a given duration will be exceeded in any one year. Heavier rainfall events are expected within a warmer climate. High daily runoff events are likely to increase, including those that may lead to erosion or flooding.
- Inundation along all coastal frontage will increase due to sea level rise. This means the coastal indunation AEP values for all probability events will increase in intensity. The current 100-year coastal inundation event may become a 50-year event by 2030, and a 5-year event by 2090.

Table 1: **Brighton local government area: *Cool subregions***
Projected changes in selected climate variables for each 20-year time period from 2001 to 2100 relative to the baseline period 1961–1990. All values are reported following the RCP8.5 emissions scenario. Changes reported relative to the 1961-1990 baseline period.

Climate Variable	1961–1990	2001–2020			2021–2040			2041–2060			2061–2080			2081–2100		
	value	value	change	% change	value	change	% change	value	change	% change	value	change	% change	value	change	% change
Average annual daily mean (°C)	10	10.5	0.5	4.9	11	1	10.2	11.7	1.7	17	12.4	2.4	24.3	13	3	30.5
Average daily maximum temperature (°C)	15	15.6	0.5	3.4	16.2	1.1	7.4	16.9	1.8	12.3	17.7	2.6	17.6	18.3	3.3	21.6
Average daily minimum temperature (°C)	4.9	5.4	0.5	9.4	5.8	0.9	18.7	6.4	1.5	31.4	7.1	2.2	45	7.7	2.8	57.7
Hottest daily temperature of the year (°C)	33.1	33.9	0.8	2.4	34.4	1.3	4	35.3	2.3	6.9	35.8	2.8	8.4	36.3	3.2	9.7
Temperature of warmest days [99^{th} percentile] (°C)	29.7	30.3	0.6	2	30.9	1.2	4	31.8	2.2	7.3	32.8	3.2	10.6	33	3.4	11.3
Temperature of warmest nights [99^{th} percentile] (°C)	13.9	14.5	0.5	3.8	14.8	0.9	6.5	15.3	1.3	9.7	16	2.1	14.8	16.3	2.4	17.4
Temperature of coldest nights [1^{st} percentile] (°C)	-2.9	-2.5	0.4	12.4	-2.2	0.7	23.6	-1.7	1.2	40	-1.1	1.7	60.5	-0.5	2.4	83.7
Average annual frost risk days (<2°C)	88	74	-14	-15.8	65	-23	-26.4	50	-38	-43.4	37	-51	-57.7	27	-61	-68.9
Average annual freeze risk days (<0°C)	36	29	-8	-21	23	-13	-35.8	17	-20	-54.6	11	-26	-70.3	7	-30	-81.2
Average annual summer days (>25°C)	16	18	2	13.2	20	4	27.6	24	8	50	27	11	72.8	30	14	91.3
Average annual hot days (>30°C)	4	5	1	26.5	6	2	56.1	8	4	114.1	10	6	163	11	8	202.6
Average annual extreme heat days (>40°C)	<1	<1	<1	NA	<1	<1	NA	<1	<1	NA	<1	<1	NA	<1	<1	NA
Mean Minimum Asphalt Critical Viscosity	55400	66300	10900	19.7	79400	24000	43.3	100600	45200	81.6	130900	75500	136.3	166100	110700	199.8
Average annual evaporation (mm)	896	908	12	1.3	946	50	5.5	996	100	11.1	1045	149	16.7	1122	226	25.3
Average annual rainfall (mm)	630	614	-16	-2.6	609	-21	-3.4	605	-25	-3.9	602	-28	-4.4	634	5	0.7
Seasonal rainfall - Winter (mm)	185	179	-6	-3.1	172	-13	-7	177	-8	-4.2	182	-3	-1.4	195	10	5.6
Seasonal rainfall - Spring (mm)	157	155	-1	-0.7	147	-10	-6.3	142	-14	-9	144	-13	-8.2	132	-25	-15.8
Seasonal rainfall - Summer (mm)	145	139	-6	-4	156	11	7.7	148	3	1.8	144	-1	-0.6	152	7	4.8
Seasonal rainfall - Autumn (mm)	153	154	1	0.4	148	-5	-3.6	152	-1	-0.8	146	-8	-4.9	164	10	6.8
Annual maximum daily rainfall (mm)	50	49	0	-0.3	62	12	24.5	57	7	15.1	54	5	9.5	64	15	29.5
Rainfall Extreme - 24hr 10% AEP (mm)[a]	117	120	3	2.5	123	6	5.2	127	10	8.7	132	15	12.4	136	18	15.6
Rainfall Extreme - 24hr 5% AEP (mm)[a]	135	138	3	2.5	142	7	5.2	146	12	8.7	152	17	12.4	156	21	15.6
Rainfall Extreme - 24hr 1% AEP (mm)[a]	174	178	4	2.5	183	9	5.2	189	15	8.7	196	22	12.4	201	27	15.6
Rainfall Extreme - 24hr 0.5% AEP (mm)[a]	193	197	5	2.5	203	10	5.2	209	17	8.7	217	24	12.4	223	30	15.6
Rainfall Extreme - 48hr 10% AEP (mm)[a]	149	152	4	2.5	156	8	5.2	161	13	8.7	167	18	12.4	172	23	15.6
Rainfall Extreme - 48hr 5% AEP (mm)[a]	169	174	4	2.5	178	9	5.2	184	15	8.7	190	21	12.4	196	26	15.6
Rainfall Extreme - 48hr 1% AEP (mm)[a]	220	225	6	2.5	231	11	5.2	239	19	8.7	247	27	12.4	254	34	15.6
Rainfall Extreme - 48hr 0.5% AEP (mm)[a]	243	249	6	2.5	256	13	5.2	264	21	8.7	273	30	12.4	281	38	15.6
Average annual cummulative Forest Fire Danger Index	1016	1043	27	2.7	1116	100	9.9	1204	189	18.6	1304	288	28.4	1406	390	38.4
Sea level - 1% AEP with Freeboard (m)[b]	1.77	1.85	0.08	4.5	1.92	0.15	8.5	2	0.23	13	2.24	0.47	26.6	2.6	0.83	46.9

[a] *Based on recommendations from Australian Rainfall and Runoff, Book 1 Scope And Philosophy, Chapter 6 Climate Change Considerations, version last updated 14^{th} May 2019.*

[b] *Based on recommendations from Tasmanian Government Department of Premier and Cabinet, Coast Hazards Report, December 2015.*
For exact details reference (from theList): Sea Level Rise Planning Allowances; or Coastal Risk Hazard Bands.

Table 2: **Brighton local government area:** ***Average subregions***
Projected changes in selected climate variables for each 20-year time period from 2001 to 2100 relative to the baseline period 1961–1990. All values are reported following the RCP8.5 emissions scenario. Changes reported relative to the 1961-1990 baseline period.

Climate Variable	1961–1990	2001–2020			2021–2040			2041–2060			2061–2080			2081–2100		
	value	value	change	% change	value	change	% change	value	change	% change	value	change	% change	value	change	% change
Average annual daily mean (°C)	11.4	11.9	0.5	4.1	12.4	1	8.7	13.1	1.7	14.4	13.8	2.4	20.7	14.4	3	25.9
Average daily maximum temperature (°C)	16.5	17	0.5	2.9	17.5	1	6.3	18.2	1.7	10.4	19	2.5	15	19.5	3	18.5
Average daily minimum temperature (°C)	6.4	6.9	0.5	7.4	7.3	0.9	14.8	8	1.6	24.8	8.6	2.3	35.5	9.3	2.9	45.2
Hottest daily temperature of the year (°C)	35.2	36.1	0.9	2.6	36.6	1.4	4	37.7	2.5	7.2	38.3	3.1	8.8	38.8	3.7	10.4
Temperature of warmest days [99^{th} percentile] (°C)	31	31.6	0.6	2	32.2	1.2	4	33.2	2.3	7.3	34.3	3.3	10.6	34.4	3.5	11.2
Temperature of warmest nights [99^{th} percentile] (°C)	15.4	15.9	0.4	2.7	16.3	0.8	5.3	16.7	1.2	8	17.3	1.9	12.1	17.5	2.1	13.5
Temperature of coldest nights [1^{st} percentile] (°C)	-1.7	-1.3	0.3	19.8	-1	0.7	39.9	-0.5	1.1	68	0.1	1.8	105.3	0.8	2.5	147.3
Average annual frost risk days (<2°C)	52	42	-10	-19.8	34	-18	-34.1	24	-28	-53.5	16	-36	-68.8	10	-41	-79.8
Average annual freeze risk days (<0°C)	17	13	-4	-24.7	10	-7	-42.7	6	-10	-62.1	4	-13	-77.6	2	-14	-86.8
Average annual summer days (>25°C)	19	20	2	9.5	23	4	23.4	26	8	42.3	31	12	65.3	33	15	80.7
Average annual hot days (>30°C)	5	7	1	21.4	8	2	45.3	10	5	88.8	12	7	123	14	9	156.5
Average annual extreme heat days (>40°C)	<1	<1	<1	NA	<1	<1	NA	<1	<1	NA	<1	<1	NA	<1	<1	NA
Mean Minimum Asphalt Critical Viscosity	97300	116900	19600	20.1	140900	43600	44.8	179400	82100	84.4	234700	137400	141.2	297500	200200	205.8
Average annual evaporation (mm)	988	996	8	0.8	1035	47	4.8	1087	99	10	1137	149	15.1	1217	229	23.1
Average annual rainfall (mm)	569	556	-14	-2.4	553	-16	-2.9	550	-19	-3.3	542	-28	-4.9	572	3	0.5
Seasonal rainfall - Winter (mm)	159	151	-8	-5	145	-14	-8.7	151	-8	-4.8	152	-6	-3.9	164	5	3.3
Seasonal rainfall - Spring (mm)	142	141	-1	-1	135	-7	-5	130	-12	-8.4	130	-12	-8.3	117	-25	-17.7
Seasonal rainfall - Summer (mm)	137	134	-3	-2.2	151	14	10.2	141	4	2.9	139	2	1.2	149	12	8.6
Seasonal rainfall - Autumn (mm)	141	144	3	1.8	135	-6	-3.9	141	0	0.3	133	-8	-5.7	151	10	6.8
Annual maximum daily rainfall (mm)	50	49	0	-0.3	62	12	24.5	57	7	15.1	54	5	9.5	64	15	29.5
Rainfall Extreme - 24hr 10% AEP (mm)[a]	117	120	3	2.4	123	6	5.1	127	10	8.5	132	14	12.1	135	18	15.2
Rainfall Extreme - 24hr 5% AEP (mm)[a]	135	138	3	2.4	142	7	5.1	146	11	8.5	151	16	12.1	155	20	15.2
Rainfall Extreme - 24hr 1% AEP (mm)[a]	174	178	4	2.4	183	9	5.1	189	15	8.5	195	21	12.1	201	26	15.2
Rainfall Extreme - 24hr 0.5% AEP (mm)[a]	193	197	5	2.4	203	10	5.1	209	16	8.5	216	23	12.1	222	29	15.2
Rainfall Extreme - 48hr 10% AEP (mm)[a]	149	152	4	2.4	156	8	5.1	161	13	8.5	167	18	12.1	171	23	15.2
Rainfall Extreme - 48hr 5% AEP (mm)[a]	170	174	4	2.4	178	9	5.1	184	14	8.5	190	21	12.1	195	26	15.2
Rainfall Extreme - 48hr 1% AEP (mm)[a]	220	225	5	2.4	231	11	5.1	238	19	8.5	247	27	12.1	253	33	15.2
Rainfall Extreme - 48hr 0.5% AEP (mm)[a]	243	249	6	2.4	256	12	5.1	264	21	8.5	273	30	12.1	280	37	15.2
Average annual cummulative Forest Fire Danger Index	1701	1733	32	1.9	1866	165	9.7	1992	291	17.1	2153	452	26.6	2268	567	33.3
Sea level - 1% AEP with Freeboard (m)[b]	1.77	1.85	0.08	4.5	1.92	0.15	8.5	2	0.23	13	2.24	0.47	26.6	2.6	0.83	46.9

[a] *Based on recommendations from Australian Rainfall and Runoff, Book 1 Scope And Philosophy, Chapter 6 Climate Change Considerations, version last updated* 14^{th} *May 2019.*

[b] *Based on recommendations from Tasmanian Government Department of Premier and Cabinet, Coast Hazards Report, December 2015.*
For exact details reference (from theList): Sea Level Rise Planning Allowances; or Coastal Risk Hazard Bands.

Table 3: **Brighton local government area: *Warm subregions***
Projected changes in selected climate variables for each 20-year time period from 2001 to 2100 relative to the baseline period 1961–1990. All values are reported following the RCP8.5 emissions scenario. Changes reported relative to the 1961-1990 baseline period.

Climate Variable	1961–1990	2001–2020			2021–2040			2041–2060			2061–2080			2081–2100		
	value	value	change	% change	value	change	% change	value	change	% change	value	change	% change	value	change	% change
Average annual daily mean (°C)	11.8	12.2	0.5	4	12.8	1	8.5	13.4	1.7	14.2	14.1	2.4	20.3	14.7	3	25.3
Average daily maximum temperature (°C)	16.9	17.4	0.5	2.8	17.9	1	6.1	18.6	1.7	10.2	19.4	2.5	14.7	20	3.1	18.1
Average daily minimum temperature (°C)	6.6	7.1	0.5	7.2	7.6	1	14.4	8.2	1.6	24.2	8.9	2.3	34.6	9.5	2.9	44
Hottest daily temperature of the year (°C)	35.2	36	0.8	2.4	36.5	1.3	3.8	37.6	2.5	7	38.2	3	8.5	38.7	3.5	10
Temperature of warmest days [99^{th} percentile] (°C)	31.2	31.8	0.6	2.1	32.4	1.2	4	33.5	2.3	7.2	34.5	3.3	10.7	34.7	3.5	11.4
Temperature of warmest nights [99^{th} percentile] (°C)	15.7	16.1	0.4	2.6	16.4	0.8	5.1	16.9	1.2	7.8	17.5	1.8	11.5	17.8	2.1	13.4
Temperature of coldest nights [1^{st} percentile] (°C)	-1.5	-1.2	0.3	19.8	-0.8	0.7	44.5	-0.4	1.2	76.1	0.3	1.8	119.3	1.1	2.6	169.9
Average annual frost risk days (<2°C)	48	38	-10	-20.9	31	-17	-35	22	-27	-55.2	14	-34	-70.4	9	-39	-81
Average annual freeze risk days (<0°C)	15	11	-4	-26.4	9	-7	-44	6	-10	-63.7	3	-12	-78.5	2	-13	-87.5
Average annual summer days (>25°C)	20	22	2	8.2	25	5	22.7	29	8	40.6	33	13	63.6	36	16	78.6
Average annual hot days (>30°C)	6	7	1	18.4	9	3	43.7	11	5	86.7	13	7	119.4	15	9	151.6
Average annual extreme heat days (>40°C)	<1	<1	<1	NA	<1	<1	NA	<1	<1	NA	<1	<1	NA	<1	<1	NA
Mean Minimum Asphalt Critical Viscosity	105900	127400	21500	20.3	153700	47800	45.1	196300	90400	85.4	257400	151500	143.1	326600	220700	208.4
Average annual evaporation (mm)	1027	1036	9	0.8	1077	50	4.8	1132	105	10.2	1186	158	15.4	1268	241	23.4
Average annual rainfall (mm)	513	503	-10	-2	504	-10	-1.9	498	-15	-2.9	488	-26	-5	519	6	1.2
Seasonal rainfall - Winter (mm)	142	136	-6	-4.4	132	-10	-7.2	135	-7	-4.7	137	-5	-3.2	148	6	4.2
Seasonal rainfall - Spring (mm)	128	127	-1	-0.8	123	-5	-3.8	118	-10	-7.5	118	-10	-7.8	106	-22	-16.9
Seasonal rainfall - Summer (mm)	124	122	-2	-1.8	137	13	10.7	128	5	3.7	124	0	0.2	137	13	10.4
Seasonal rainfall - Autumn (mm)	128	130	3	2	123	-4	-3.4	128	0	0.2	119	-8	-6.5	136	8	6.2
Annual maximum daily rainfall (mm)	50	49	0	-0.3	62	12	24.5	57	7	15.1	54	5	9.5	64	15	29.5
Rainfall Extreme - 24hr 10% AEP (mm)[a]	117	120	3	2.4	123	6	5.1	127	10	8.5	132	14	12.2	135	18	15.3
Rainfall Extreme - 24hr 5% AEP (mm)[a]	135	138	3	2.4	142	7	5.1	146	11	8.5	151	16	12.2	155	21	15.3
Rainfall Extreme - 24hr 1% AEP (mm)[a]	174	178	4	2.4	183	9	5.1	189	15	8.5	195	21	12.2	201	27	15.3
Rainfall Extreme - 24hr 0.5% AEP (mm)[a]	193	197	5	2.4	203	10	5.1	209	16	8.5	216	24	12.2	222	29	15.3
Rainfall Extreme - 48hr 10% AEP (mm)[a]	149	152	4	2.4	156	8	5.1	161	13	8.5	167	18	12.2	171	23	15.3
Rainfall Extreme - 48hr 5% AEP (mm)[a]	170	174	4	2.4	178	9	5.1	184	14	8.5	190	21	12.2	195	26	15.3
Rainfall Extreme - 48hr 1% AEP (mm)[a]	220	225	5	2.4	231	11	5.1	239	19	8.5	247	27	12.2	253	34	15.3
Rainfall Extreme - 48hr 0.5% AEP (mm)[a]	243	249	6	2.4	256	12	5.1	264	21	8.5	273	30	12.2	281	37	15.3
Average annual cummulative Forest Fire Danger Index	1823	1849	25	1.4	1992	168	9.2	2134	311	17.1	2310	486	26.7	2432	609	33.4
Sea level - 1% AEP with Freeboard (m)[b]	1.77	1.85	0.08	4.5	1.92	0.15	8.5	2	0.23	13	2.24	0.47	26.6	2.6	0.83	46.9

[a] *Based on recommendations from Australian Rainfall and Runoff, Book 1 Scope And Philosophy, Chapter 6 Climate Change Considerations, version last updated 14^{th} May 2019.*

[b] *Based on recommendations from Tasmanian Government Department of Premier and Cabinet, Coast Hazards Report, December 2015.*
For exact details reference (from theList): Sea Level Rise Planning Allowances; or Coastal Risk Hazard Bands.

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