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Southern Tasmanian COUNCILS AUTHORITY

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 Clarence's strategic, operational, service, adaptation and emergency management planning functions.

BACKGROUND

The Climate Change Information for Decision Making - Clarence 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 Clarence'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: **Clarence 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)	12.4	13.2	0.8	6.3	13.9	1.5	11.9	15	2.6	21.2	16.2	3.8	30.6	17.2	4.9	39.3
Average daily maximum temperature (°C)	16.6	17.5	0.9	5.2	18.3	1.6	9.8	19.6	2.9	17.5	20.9	4.2	25.3	22.1	5.4	32.6
Average daily minimum temperature (°C)	8.1	8.8	0.7	8.7	9.4	1.3	16.4	10.4	2.3	29	11.5	3.4	41.6	12.4	4.3	53.2
Hottest daily temperature of the year (°C)	34.8	35.8	1	2.9	36.8	2	5.7	37.7	2.9	8.2	38.9	4.1	11.9	39.6	4.8	13.8
Temperature of warmest days [99^{th} percentile] (°C)	29.9	31.1	1.2	4	32	2.1	7	33.6	3.7	12.5	35.4	5.5	18.3	36.3	6.4	21.5
Temperature of warmest nights [99^{th} percentile] (°C)	16	16.8	0.8	5.2	17.5	1.5	9.5	18.7	2.7	17.1	19.9	3.9	24.3	20.8	4.8	29.8
Temperature of coldest nights [1^{st} percentile] (°C)	1	1.5	0.5	47.6	2	0.9	92.7	2.6	1.6	155.9	3.5	2.5	246.4	4.5	3.4	336.9
Average annual frost risk days (<2°C)	12	7	-5	-39.9	5	-7	-61.6	2	-9	-80.1	1	-11	-92.6	0	-11	-97.6
Average annual freeze risk days (<0°C)	1	1	0	-33.6	0	-1	-69.5	0	-1	-85.4	0	-1	-95.2	0	-1	-99.3
Average annual summer days (>25°C)	11	14	3	25	17	6	51.1	23	12	107.3	33	21	189.7	43	32	284.1
Average annual hot days (>30°C)	4	6	2	47	7	4	96.1	11	8	200	18	14	360.5	26	22	590.8
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	190000	250900	60900	32.1	324700	134700	70.9	479000	289000	152.1	719200	529200	278.5	1033700	843700	444.1
Average annual evaporation (mm)	1014	1070	56	5.6	1089	75	7.4	1227	213	21	1331	317	31.2	1492	478	47.2
Average annual rainfall (mm)	530	515	-15	-2.8	508	-22	-4.1	503	-28	-5.2	481	-49	-9.3	511	-19	-3.6
Seasonal rainfall - Winter (mm)	151	141	-10	-6.3	137	-14	-9	146	-5	-3.2	145	-6	-3.9	156	5	3.3
Seasonal rainfall - Spring (mm)	128	126	-2	-1.8	120	-8	-6.5	113	-15	-11.6	113	-16	-12.2	103	-26	-20
Seasonal rainfall - Summer (mm)	124	119	-5	-4.3	129	5	4.1	123	-1	-1.2	112	-12	-9.6	124	0	0.1
Seasonal rainfall - Autumn (mm)	135	141	6	4.4	134	-1	-1	132	-3	-2.4	122	-13	-9.8	135	0	0.1
Annual maximum daily rainfall (mm)	57	56	-1	-1.3	70	13	23.5	64	7	12.7	62	5	8.2	71	14	23.9
Rainfall Extreme - 24hr 10% AEP (mm)[a]	130	136	5	4.1	140	10	7.7	148	18	13.7	156	26	19.7	163	33	25.3
Rainfall Extreme - 24hr 5% AEP (mm)[a]	150	156	6	4.1	161	12	7.7	170	20	13.7	179	29	19.7	188	38	25.3
Rainfall Extreme - 24hr 1% AEP (mm)[a]	193	200	8	4.1	207	15	7.7	219	26	13.7	231	38	19.7	241	49	25.3
Rainfall Extreme - 24hr 0.5% AEP (mm)[a]	213	221	9	4.1	229	16	7.7	242	29	13.7	255	42	19.7	267	54	25.3
Rainfall Extreme - 48hr 10% AEP (mm)[a]	166	173	7	4.1	179	13	7.7	189	23	13.7	199	33	19.7	208	42	25.3
Rainfall Extreme - 48hr 5% AEP (mm)[a]	189	196	8	4.1	203	15	7.7	215	26	13.7	226	37	19.7	237	48	25.3
Rainfall Extreme - 48hr 1% AEP (mm)[a]	243	253	10	4.1	262	19	7.7	276	33	13.7	291	48	19.7	305	62	25.3
Rainfall Extreme - 48hr 0.5% AEP (mm)[a]	268	279	11	4.1	289	21	7.7	305	37	13.7	321	53	19.7	336	68	25.3
Average annual cummulative Forest Fire Danger Index	1767	1785	20	1.1	1917	167	8.5	2044	308	15.7	2221	504	25.7	2331	626	31.9
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: **Clarence 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)	12	12.5	0.5	4.4	13.1	1.1	9	13.9	1.8	15.4	14.7	2.7	22.1	15.4	3.3	27.8
Average daily maximum temperature (°C)	16.8	17.3	0.5	3.2	17.9	1.1	6.7	18.7	1.9	11.5	19.6	2.8	16.6	20.3	3.5	20.8
Average daily minimum temperature (°C)	7.2	7.8	0.5	7.2	8.3	1	14.3	9	1.8	24.3	9.8	2.5	34.8	10.4	3.2	44.3
Hottest daily temperature of the year (°C)	36.1	37	0.9	2.6	37.7	1.6	4.5	38.6	2.5	6.9	39.5	3.4	9.5	40.1	4	11.2
Temperature of warmest days [99^{th} percentile] (°C)	30.8	31.6	0.8	2.6	32.3	1.4	4.7	33.5	2.7	8.6	34.8	3.9	12.7	35.2	4.3	14
Temperature of warmest nights [99^{th} percentile] (°C)	16	16.5	0.5	3.2	17	1	6.1	17.7	1.7	10.6	18.7	2.6	16.5	19.3	3.3	20.6
Temperature of coldest nights [1^{st} percentile] (°C)	-0.6	-0.2	0.3	59.4	0.1	0.7	120.5	0.7	1.2	212.8	1.4	1.9	332.1	2.1	2.7	453.8
Average annual frost risk days (<2°C)	31	23	-8	-25.6	18	-13	-41.4	12	-20	-63.1	7	-25	-78.3	4	-27	-87.5
Average annual freeze risk days (<0°C)	7	5	-2	-30	3	-3	-50.7	2	-5	-68.7	1	-6	-84.2	1	-6	-91.4
Average annual summer days (>25°C)	17	19	2	11.3	21	4	26.7	25	8	50.1	30	14	82.2	35	18	110.5
Average annual hot days (>30°C)	5	6	1	24.7	8	3	49.7	10	5	102.8	13	8	154.1	16	11	208.9
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	135100	165700	30600	22.6	202800	67700	50.1	267500	132400	98	361000	225900	167.2	469900	334800	247.8
Average annual evaporation (mm)	1027	1050	23	2.2	1086	59	5.7	1171	144	14.1	1244	217	21.2	1355	328	32
Average annual rainfall (mm)	530	520	-10	-1.8	519	-11	-2.1	512	-18	-3.4	496	-34	-6.4	527	-3	-0.6
Seasonal rainfall - Winter (mm)	141	133	-8	-5.7	129	-13	-9	134	-7	-5.1	134	-7	-5	144	2	1.7
Seasonal rainfall - Spring (mm)	132	131	-2	-1.2	128	-4	-3.2	121	-11	-8.4	121	-12	-8.9	107	-26	-19.3
Seasonal rainfall - Summer (mm)	130	129	-2	-1.2	144	14	10.4	134	4	2.8	128	-2	-1.5	143	13	9.7
Seasonal rainfall - Autumn (mm)	135	140	5	3.8	131	-4	-2.9	135	1	0.4	124	-10	-7.6	141	6	4.5
Annual maximum daily rainfall (mm)	57	56	-1	-1.3	70	13	23.5	64	7	12.7	62	5	8.2	71	14	23.9
Rainfall Extreme - 24hr 10% AEP (mm)[a]	132	136	4	2.7	139	7	5.6	145	13	9.5	150	18	13.7	155	23	17.2
Rainfall Extreme - 24hr 5% AEP (mm)[a]	152	156	4	2.7	160	8	5.6	166	14	9.5	172	21	13.7	178	26	17.2
Rainfall Extreme - 24hr 1% AEP (mm)[a]	195	200	5	2.7	206	11	5.6	214	19	9.5	222	27	13.7	229	34	17.2
Rainfall Extreme - 24hr 0.5% AEP (mm)[a]	216	221	6	2.7	228	12	5.6	236	20	9.5	245	29	13.7	253	37	17.2
Rainfall Extreme - 48hr 10% AEP (mm)[a]	168	173	5	2.7	178	9	5.6	184	16	9.5	191	23	13.7	197	29	17.2
Rainfall Extreme - 48hr 5% AEP (mm)[a]	191	196	5	2.7	202	11	5.6	209	18	9.5	217	26	13.7	224	33	17.2
Rainfall Extreme - 48hr 1% AEP (mm)[a]	246	253	7	2.7	260	14	5.6	270	23	9.5	280	34	13.7	289	42	17.2
Rainfall Extreme - 48hr 0.5% AEP (mm)[a]	272	279	7	2.7	287	15	5.6	298	26	9.5	309	37	13.7	318	47	17.2
Average annual cummulative Forest Fire Danger Index	1964	1984	19	1	2131	167	8.5	2272	308	15.7	2468	504	25.7	2590	625	31.8
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: **Clarence 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)	12.2	12.7	0.5	3.8	13.2	1	7.9	13.9	1.6	13.3	14.6	2.4	19.2	15.2	2.9	24
Average daily maximum temperature (°C)	17	17.5	0.4	2.6	18	1	5.7	18.7	1.7	9.7	19.4	2.4	14.1	20	3	17.4
Average daily minimum temperature (°C)	7.5	7.9	0.5	6.4	8.4	1	12.8	9.1	1.6	21.6	9.8	2.3	30.9	10.4	2.9	39
Hottest daily temperature of the year (°C)	35.2	36	0.8	2.3	36.5	1.3	3.6	37.6	2.4	6.9	38.1	2.9	8.3	38.6	3.4	9.8
Temperature of warmest days [99^{th} percentile] (°C)	30.7	31.4	0.7	2.1	32	1.2	3.9	33	2.3	7.4	34.1	3.3	10.9	34.2	3.5	11.4
Temperature of warmest nights [99^{th} percentile] (°C)	16.3	16.7	0.4	2.8	17.1	0.8	5.1	17.6	1.3	8	18.2	1.9	11.8	18.4	2.2	13.3
Temperature of coldest nights [1^{st} percentile] (°C)	-0.3	0.1	0.3	118.8	0.4	0.7	245.6	0.9	1.2	423.5	1.6	1.9	661.6	2.3	2.6	898.4
Average annual frost risk days (<2°C)	28	21	-7	-25.9	16	-12	-41.7	10	-18	-64.3	6	-22	-79.3	3	-25	-88
Average annual freeze risk days (<0°C)	5	4	-2	-31	3	-3	-50.2	2	-4	-69.6	1	-5	-85.4	0	-5	-91.8
Average annual summer days (>25°C)	17	19	1	8.4	21	4	22.9	25	7	41.9	30	12	69	33	15	87
Average annual hot days (>30°C)	5	6	1	18.3	7	2	42.2	9	4	85.8	11	6	117.7	13	8	147.7
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	146300	176400	30100	20.6	212700	66400	45.4	272600	126300	86.3	358000	211700	144.7	452300	306000	209.2
Average annual evaporation (mm)	1057	1068	11	1.1	1110	53	5	1177	120	11.3	1238	182	17.2	1329	272	25.8
Average annual rainfall (mm)	513	502	-12	-2.3	506	-7	-1.4	499	-14	-2.8	479	-35	-6.7	513	0	0
Seasonal rainfall - Winter (mm)	138	130	-8	-5.7	127	-10	-7.3	131	-6	-4.4	131	-6	-4.4	139	1	0.9
Seasonal rainfall - Spring (mm)	127	125	-2	-1.9	124	-3	-2.4	117	-10	-7.8	116	-11	-8.5	104	-24	-18.6
Seasonal rainfall - Summer (mm)	124	122	-2	-1.6	137	13	10.3	129	5	3.8	121	-3	-2.4	140	16	12.8
Seasonal rainfall - Autumn (mm)	133	137	4	3.2	130	-3	-2.2	133	0	0.3	121	-12	-8.8	138	6	4.2
Annual maximum daily rainfall (mm)	57	56	-1	-1.3	70	13	23.5	64	7	12.7	62	5	8.2	71	14	23.9
Rainfall Extreme - 24hr 10% AEP (mm)[a]	133	136	3	2.4	139	7	4.9	144	11	8.4	149	16	12	153	20	15
Rainfall Extreme - 24hr 5% AEP (mm)[a]	152	156	4	2.4	160	8	4.9	165	13	8.4	171	18	12	175	23	15
Rainfall Extreme - 24hr 1% AEP (mm)[a]	196	200	5	2.4	205	10	4.9	212	16	8.4	219	24	12	225	29	15
Rainfall Extreme - 24hr 0.5% AEP (mm)[a]	216	221	5	2.4	227	11	4.9	234	18	8.4	242	26	12	249	33	15
Rainfall Extreme - 48hr 10% AEP (mm)[a]	169	173	4	2.4	177	8	4.9	183	14	8.4	189	20	12	194	25	15
Rainfall Extreme - 48hr 5% AEP (mm)[a]	192	196	5	2.4	201	9	4.9	208	16	8.4	215	23	12	221	29	15
Rainfall Extreme - 48hr 1% AEP (mm)[a]	247	253	6	2.4	259	12	4.9	268	21	8.4	277	30	12	284	37	15
Rainfall Extreme - 48hr 0.5% AEP (mm)[a]	273	279	6	2.4	286	13	4.9	295	23	8.4	306	33	12	314	41	15
Average annual cummulative Forest Fire Danger Index	1737	1756	19	1.1	1870	133	7.6	2000	262	15.1	2183	446	25.7	2291	553	31.9
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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