## Whaitua Catchments Climate Change parameters (Updated December 2020)

All parameters were extrapolated based on the most recent NIWA regional climate change report (2017) and Climate Change Extremes and Implications report (2019) for the Wellington Region, available from <a href="http://www.gw.govt.nz/climate-change">www.gw.govt.nz/climate-change</a>

## Wellington Region whaitua

As pictured on the map below, the Wellington Region has been split into five whaitua (catchments) with a committee in each making decisions on the future of land and water management in that whaitua.

For more info visit: <u>http://www.gw.govt.nz/whaitua-committees/</u>



**Changes that have already happened (verified by measurements):** As of 2020, our region has already warmed by about 0.8 degrees in total, i.e., since the industrial revolution. Over a third of this warming (about 0.3 degrees) has happened since 1995, which is the reference baseline year representing the middle of the 1986-2005 period against which the IPCC models calculate their projections. This overall warming has been associated with several additional climatic changes, including increases in weather extremes and a significant disruption of weather patterns and displacement of the seasons (e.g. winters starting late). Insurance data confirms a marked increase of weather-related claims in New Zealand over the last decade.

**Predicted changes (estimated by climate models):** At least a third of the warming predicted for mid-century has already happened since the 1995 baseline. If emissions are reduced by half this decade, and further reduced to net negative by mid-century, most of the high-end projections for late century can be avoided (i.e., a total warming capped by 1.5-2.0 degrees).

Climate Change mapping online: https://mapping1.gw.govt.nz/gw/ClimateChange/

Te Awarua-o-Porirua whaitua			
Variable/period	2040	2090	Commentary
Average annual	+0.5C to 1C	+1C to	Maximum warming in autumn and winter, least in spring
Temperature	above the	+2.7C above	
	1995	the 1995	Note reference to 'above the 1995 baseline' versus 'pre-
	baseline	baseline	Industrial: About 0.5C of warming has already happened from
	(+1.0C to	(+1 5C to	1986-2005 model baseline, centered in 1995)
	+1.5.0	+3.2C above	
	above pre-	pre-	Uncertainty range: lower range for significant emissions reduction
	industrial)	industrial)	(Paris agreement targets met), and upper range for high
	,	,	emissions
Average annual	0% to 5%	0% to 10%	There is a large uncertainty in the range of changes due to model
rainfall	increase	increase	differences and emission scenarios. Changes against emission
			scenarios are not necessarily linear. Greater likelihood of
			increases in autumn, winter and spring.
Amount of rain falling	0% to 15%	5% to 25%	There is a large uncertainty in the range of changes due to model
during heavy rainfall	increase	increase	differences and emission scenarios. Changes against emission
days (> 99"			scenarios are not necessarily linear. Greater likelihood of
rainfall equivalent to			increases in autumn, winter and spring.
heavy rainfall days			
seen every year. i.e			
not too extreme)			
Extreme rainfall	6% to 12%	12% to 32%	Although the uncertainty in average rainfall range is high,
magnitude: 6-12 hour	increase	increase	extreme rainfall increases are more certain due to the increased
duration, 100 year			amount of water vapour that the atmosphere can hold as it gets
Average Recurrence			warmer (about 8% increase in saturation vapour per degree of
Interval (normally			warming). The figures for extreme rainfall are given as an average
used as reference for			of different IPCC models used to inform the HIRDS system, which
flooding design,			is the national reference for Flood Protection
referring to very			( <u>https://hirds.niwa.co.nz/</u> ).
extreme, infrequent			
rainiai eventsj			
Sea level rise	0.12 to 0.24	0.69 to 1.75	The projected see level rise for 2000 is based on IRCC ARE plus an
	metres	0.08 (0 1.75	estimated additional contribution from Antarctica, based on
	above the	above the	naners nublished in <i>Nature</i> in 2018. As such the unner range
	1995	1995	appears slightly higher than the RCP8.5 H+ from the MFE Coastal
	baseline	baseline	Guidance (2017). Note the difference between the 1995 baseline
			and pre-industrial, as we have already had about 26cm of sea
	(0.38 to 0.5		level rise prior to 1995.
	metres	(0.94 to 2	More regular storm events in the fragile coastal environment may
	above pre-	metres	also mean faster and more significant coastal retreat. See the link
	muustnai)	above pre-	below for climate change, sea level rise and storm surge maps for
		industrial)	the Region:
			https://manning1.gu/gout.pz/gu/ClimateChange/
			nttps://mappingi.gw.govt.nz/gw/climatechange/

Number of hot days	Up to 10	Up to 30		
(above 25C) per year	days	days		
	increase	increase		
Number of frost	Up to 5	Up to 15		
nights (below 0C) per	days	days		
year	reduction	reduction		
Change in the	1% to 2%	1% to 3%		
intensity of wind	increase	increase		
during windy days				
(>99 <sup>th</sup> percentile of				
daily mean)				
Change in annual	2 to 4 days	2 to 10 days		
number of windy	increase	increase		
days				
Change in annual	Increase	Increase	Measures potential for crop and pasture growth	
growing degree days	between	between		
base 10	200 and	300 and		
	300 GDD	900 GDD		
	units	units		
Change in annual	Increase	Increase	Measures drought intensity	
potential	between 60	between 60		
evapotranspiration	and 100	and 120		
deficit (mm)	mm	mm		
Change in rivers	Decrease	Decrease	Measures water shortage in the catchments	
mean annual low	up to 40%	up to 40%		
flow discharge (IVIAL)	1			
Change in rivers	Increase up	Increase up	Measures flood potential in the catchments	
mean annual flood	to 40%	to 80%		
Changes in number of	F0% to	100% to	These figures are given by IPCC model everages Individual models	
changes in number of	50% to	100% to	These figures are given by IPCC model averages. Individual models	
avtromo forost firo	100%	150% increase	can show much higher increases of up to 700%	
danger	Increase	Increase		
Key environmental	Increased flor	d intensity		
impacts	Increased roo	ou intensity	(some areas to become permanently inundated)	
impacts	Increased erc	sion	r (some areas to become permanently indicated)	
	Reduced soil	fortility		
	Decreased wa	ater quality		
	Groundwater	ouality and av	ailability pressures	
	Salt water int	rusion		
	Ground wate	r intrusion		
	Increased pre	essure on water	r storage	
	Biodiversity lo	osses	-	
	Increased pes	Increased pests such as wasps and rodents		
	Ocean acidifi	cation		
	Decline in fish	n population		
	Increased wil	dfire		
	Increased alle	ergies (e.g. poll	en)	

	Wellington Harbour & Hutt Valley whaitua			
Variable/period	2040	2090	Commentary	
Average annual	+0.5C to	+1C to	Maximum warming in summer and autumn, least in spring and winter	
Temperature	1C above	+2.5C		
	the 1995	above the	Note reference to 'above the 1995 baseline' versus 'pre-industrial':	
	baseline	1995	About 0.5C of warming has already happened from pre-industrial to	
		baseline	the 1995 baseline (1880-1909 compared to the 1986-2005 model	
	(+1.0C to		baseline, centered in 1995).	
	+1.5 C	(+1.5C to		
	above	+3.0C	Uncertainty range: lower range for significant emissions reduction	
	pre-	above	(Paris agreement targets met), and upper range for high emissions	
	industrial)	pre-		
		industrial)		
Average annual	5%	5%	There is a large uncertainty in the range of changes due to model	
rainfall	decrease	decrease	differences and emission scenarios. Changes against emission	
	to 10%	to 10%	scenarios are not necessarily linear. Greater likelihood of increases in	
	increase	increase	autumn, winter and spring.	
Amount of rain	5% to 15%	5% to 30%	There is a large uncertainty in the range of changes due to model	
falling during heavy	increase	increase	differences and emission scenarios. Changes against emission	
rainfall days (> 99"			scenarios are not necessarily linear. Greater likelihood of increases in	
percentile of daily			autumn, winter and spring.	
rainfail, equivalent				
to neavy rainfail				
days seen every				
year, i.e., not too				
Extreme rainfall	$6\% \pm 0.12\%$	1.20/ +0	Although the uncertainty in average rainfall range is high extreme	
magnitude: 6-12		30%	rainfall increases are more certain due to the increased amount of	
hour duration 100	increase	increase	water vanour that the atmosphere can hold as it gets warmer (about	
vear Average		mereuse	8% increase in saturation vanour per degree of warming) The figures	
Recurrence Interval			for extreme rainfall are given as an average of different IPCC models	
(normally used as			used to inform the HIRDS system, which is the national reference for	
reference for			Elood Protection (https://hirds.niwa.co.nz/)	
flooding design.				
referring to verv				
extreme.				
infrequent rainfall				
events)				
Sea level rise	0.12 to	0.001		
	0.24	0.68 to	The projected sea level rise for 2090 is based on IPCC AR5 plus an	
	metres	1.75	estimated additional contribution from Antarctica, based on papers	
	above the	metres	published in <i>Nature</i> in 2018. As such, the upper range appears slightly	
	1995	above the	higher than the RCP8.5 H+ from the MFE Coastal Guidance (2017).	
	baseline	1995	Note the difference between the 1995 baseline and pre-industrial, as	
		baseline	we have already had about 26cm of sea level rise prior to 1995.	
	(0.38 to		More regular storm events in the fragile coastal environment may also	
	0.5	(0.94 to 2	mean faster and more significant coastal retreat. See the link below	
	metres	metres	for climate change, sea level rise and storm surge maps for the Region:	
	above	ahove	https://mapping1.gw.govt.pz/gw/ClimateChange/	
	pre-	nre-	https://mappingi.gw.govi.nz/gw/climateendlige/	
	industrial)	industrial)		
		maastiaij		

Number of hot	Up to 10	Up to 40				
days (above 25C)	days	days				
per year	increase	increase				
Number of frost	Up to 5	Up to 10				
nights (below 0C)	days	days				
per year	reduction	reduction				
Change in the	1% to 2%	1% to 4%				
intensity of wind	increase	increase				
during windy days						
(>99 <sup>th</sup> percentile of						
daily mean)						
Change in annual	2 to 6	2 to 12				
number of windy	days	days				
days	increase	increase				
Change in annual	Increase	Increase	Measures potential for crop and pasture growth			
growing degree	between	between				
days base 10	0 and 300	200 and				
	GDD units	800 GDD				
		units				
Change in annual	Increase	Increase	Measures drought intensity			
potential	between	between				
evapotranspiration	40 and	40 and				
deficit (mm)	100 mm	140 mm				
Change in rivers	Decrease	Decrease	Measures water shortage in the catchments			
mean annual low	up to 40%	up to 40%				
flow discharge						
(MAL)						
Change in rivers	Increase	Increase	Measures flood potential in the catchments			
mean annual flood	up to 40%	up to				
discharge (MAF)		100%				
Changes in number	50% to	100% to	These figures are given by IPCC model averages. Individual models can			
of days of very high	100%	150%	show much higher increases of up to 700%			
and extreme forest	increase	increase				
fire danger						
Key environmental	Increased fl	ood intensity				
impacts	Increased co	oastal inunda	tion (some areas to become permanently inundated)			
	Increased e	rosion				
	Reduced so	il fertility				
	Decreased v	water quality				
	Groundwat	er quality and	availability pressures			
	Saltwater in	trusion				
	Ground wat	er intrusion				
	Increased p	ressure on wa	ater storage			
	Biodiversity	losses				
	Increased p	ests such as v	wasps and rodents			
	Ocean acidi	fication				
	Decline in fi	Decline in fish population				
	Increased w	Increased wildfire				
	Increased a	Increased allergies (e.g. pollen)				

Kāpiti Coast whaitua				
Variable/period	2040	2090	Commentary	
Average annual	+0.5C to 1C	+1C to	Maximum warming in autumn and winter, least in spring	
Temperature	above the	+2.7C above		
	1995	the 1995	Note reference to 'above the 1995 baseline' versus 'pre-	
	baseline	baseline	industrial': About 0.5C of warming has already happened from	
			pre-industrial to the 1995 baseline (1880-1909 compared to the	
	(+1.0C to	(+1.5C to	1986-2005 model baseline, centered in 1995).	
	+1.5 C	+3.2C above		
	above pre-	pre-	Uncertainty range: lower range for significant emissions	
	industrial)	industrial)	reduction (Paris agreement targets met), and upper range for	
			high emissions	
Average annual	0% to 5%	0% to 10%	There is a large uncertainty in the range of changes due to model	
rainfall	increase	increase	differences and emission scenarios. Changes against emission	
			scenarios are not necessarily linear. Greater likelihood of	
			increases in autumn, winter and spring.	
Amount of rain falling	0% to 10%	0% to 15%	There is a large uncertainty in the range of changes due to model	
during heavy rainfall	increase	increase	differences and emission scenarios. Changes against emission	
days (> 99"			scenarios are not necessarily linear. Greater likelihood of	
percentile of daily			increases in autumn, winter and spring.	
rainfail, equivalent to				
neavy rainfail days				
seen every year, i.e.,				
Tot too extreme)	$60/ \pm 0.120/$	120/ to 220/	Although the uncertainty in average rainfall range is high	
magnituda: 6 12 hour	6% t0 12%	12% t0 52%	Although the uncertainty in average rainfall range is high,	
duration 100 year	Increase	Increase	amount of water vaneur that the atmosphere can hold as it gets	
Average Recurrence			warmer (about 8% increase in saturation vanour per degree of	
Interval (normally			warming) The figures for extreme rainfall are given as an	
used as reference for			average of different IPCC models used to inform the HIRDS	
flooding design			system which is the national reference for Flood Protection	
referring to verv			(https://highs.niwa.co.nz/)	
extreme, infrequent			( <u>netps://mas.niwa.co.nz/</u> ).	
rainfall events)				
Sea level rise	0.12 to 0.24	0.69 to 1.75	The projected cap level rice for 2000 is based on IRCC ARE plus	
	metres	0.08 (0 1.75	The projected sed level rise for 2090 is based on IPCC ARS plus	
	above the	above the	an estimated additional contribution from Antarctica, based on	
	1995	1005	papers published in <i>Nature</i> in 2016. As such, the upper range	
	baseline	haseline	Guidance (2017) Note the difference between the 1995 baseline	
		basenne	and pre-industrial as we have already had about 26cm of sea	
	(0.38 to 0.5		level rise prior to 1995	
	metres	(0.94 to 2		
	above pre-	metres	More regular storm events in the tragile coastal environment	
	industrial)	above pre-	may also mean faster and more significant coastal retreat. See	
		industrial)	the link below for climate change, sea level rise and storm surge	
			maps for the Region:	
			https://mapping1.gw.govt.nz/gw/ClimateChange/	
Number of hot days	Between 5	Between 5		
(above 25C) per year	and 10 days	and 50 days		
	increase	increase		
Number of frost	Up to 5	Up to 15		
nights (below 0C) per	days	days		
year	reduction	reduction		

Change in the	Up to 2%	Up to 3%		
intensity of wind	increase	increase		
during windy days				
(>99 <sup>th</sup> percentile of				
daily mean)				
Change in annual	Up to 4	Up to 6		
number of windv	davs	davs		
days	increase	increase		
Change in annual	Increase	Increase	Measures potential for crop and pasture growth	
growing degree days	between 0	between		
base 10	and 300	200 and		
	GDD units	900 GDD		
		units		
		units		
Change in annual	Increase	Increase	Measures drought intensity	
potential	between 40	between 40		
evapotranspiration	and 80 mm	and 100		
deficit (mm)		mm		
Change in rivers	Decrease	Decrease	Measures water shortage in the catchments	
mean annual low	up to 40%	up to 40%		
flow discharge (MAL)	-	-		
Change in rivers	Between	Increase up	Measures flood potential in the catchments	
mean annual flood	20%	to 60%		
discharge (MAF)	decrease			
	and 60%			
	increase			
	depending			
	on			
	catchment			
Changes in number of	50% to	100% to	These figures are given by IPCC model averages. Individual	
days of very high and	100%	150%	models can show much higher increases of up to 700%	
extreme forest fire	increase	increase		
danger				
Key environmental	Increased floo	od intensity		
impacts	Increased coa	, astal inundatior	n (some areas to become permanently inundated)	
	Increased erc	sion		
	Reduced soil	fertility		
	Decreased wa	, ater quality		
	Groundwater	quality and av	ailability pressures	
	Saltwater intr	rusion		
	Ground wate	r intrusion		
	Increased pre	essure on water	r storage	
	Biodiversity losses			
	, Increased per	Increased pests such as wasps and rodents		
	Ocean acidifi	Ocean acidification		
	Decline in fish	n population		
	Increased wil	Increased wildfire		
	Increased alle	ergies (e.g. poll	en)	

		Rua	māhanga whaitua
Variable/period	2040	2090	Commentary
Average annual	+0.7C to 1C	+1.2C to	Maximum warming in autumn and summer, least in winter
Temperature	above the	+3C above	
	1995	the 1995	Note reference to 'above the 1995 baseline' versus 'pre-
	baseline	baseline	industrial': About 0.5C of warming has already happened from
	(+1.20 to	(+1.7C to	pre-industrial to the 1995 baseline (1880-1909 compared to the
	+1.50	+3 5C above	
	above pre-	pre-	Uncertainty range: lower range for significant emissions
	industrial)	industrial)	reduction (Paris agreement targets met), and upper range for
	,	,	high emissions
Average annual	5%	0% to 10%	There is a large uncertainty in the range of changes due to model
rainfall	decrease to	decrease	differences and emission scenarios. Changes against emission
	5% increase		scenarios are not necessarily linear. Greater likelihood of
			decreases in summer.
Amount of rain falling	$00/ \pm 0.100/$	0% to 20%	There is a large uncertainty in the range of changes due to model
during beavy rainfall			differences and emission scenarios. Changes against emission
days (> 99 <sup>th</sup>	merease	merease	scenarios are not necessarily linear. Greater likelihood of
percentile of daily			increases in autumn, winter and spring.
rainfall, equivalent to			, , , , , , , , , , , , , , , , , , , ,
heavy rainfall days			
seen every year, i.e.,			
not too extreme)			
Extreme rainfall	8% to 12%	14% to 36%	Although the uncertainty in average rainfall range is high,
magnitude: 6-12 hour	increase	increase	extreme rainfall increases are more certain due to the increased
duration, 100 year			amount of water vapour that the atmosphere can hold as it gets
Average Recurrence			warming) The figures for extreme rainfall are given as an
used as reference for			average of different IPCC models used to inform the HIRDS
flooding design.			system, which is the national reference for Flood Protection
referring to very			(https://hirds.niwa.co.nz/).
extreme, infrequent			
rainfall events)			
Can laval vian	0.12 += 0.24		
Sea level rise	0.12 to 0.24	0.68 to 1.75	The projected sea level rise for 2090 is based on IPCC AR5 plus
	above the	metres	an estimated additional contribution from Antarctica, based on
	1995	above the	papers published in <i>Nature</i> in 2018. As such, the upper range
	baseline	1995	appears slightly higher than the RCP8.5 H+ from the MFE Coastal
	2000	baseline	Guidance (2017). Note the difference between the 1995 baseline
	(0.38 to 0.5		and pre-industrial, as we have already had about 26cm of sea
	metres	(0.94 to 2	
	above pre-	metres	More regular storm events in the fragile coastal environment
	industrial)	above pre-	may also mean faster and more significant coastal retreat. See
		industrial)	the link below for climate change, sea level rise and storm surge
			maps for the Region:
			https://mapping1.gw.govt.nz/gw/ClimateChange/
Number of hot days	Up to 30	Up to 80	
(above 25C) per year	aays	days	
	increase	increase	

Number of frost	Up to 15	Up to 40			
nights (below 0C) per	days	days			
year	reduction	reduction			
Change in the	Up to 3%	1% to 4%			
intensity of wind	increase	increase			
during windy days					
(>99 <sup>th</sup> percentile of					
daily mean)					
Change in annual	Up to 4	Up to 12			
number of windy	davs	davs			
davs	increase	increase			
, Change in annual	Increase	Increase	Measures potential for crop and pasture growth		
growing degree days	between 0	between			
base 10	and 300	200 and			
	GDD units	1000 GDD			
	GDD units	units			
		units			
Change in annual	Increase	Increase	Measures drought intensity		
potential	between 20	between 0			
evapotranspiration	and 120	and 180			
deficit (mm)	mm	mm			
Change in rivers	Decrease	Decrease	Measures water shortage in the catchments		
mean annual low	up to 60%	up to 80%			
flow discharge (MAL)	-	-			
Change in rivers	Between	Between	Measures flood potential in the catchments		
mean annual flood	20%	20%			
discharge (MAF)	decrease	decrease			
	and 40%	and 60%			
	increase	increase			
	depending	depending			
	on	on			
	catchment	catchment			
Changes in number of	100% to	100% to	These figures are given by IPCC model averages. Individual		
days of very high and	150%	150%	models can show much higher increases of up to 700%		
extreme forest fire	increase	increase			
danger					
Key environmental	Increased flo	od intensity			
impacts	Increased coa	astal inundation	n (some areas to become permanently inundated)		
	Increased erc	osion			
	Reduced soil	fertility			
	Decreased wa	ater quality			
	Groundwater	<sup>.</sup> quality and av	ailability pressures		
	Saltwater int	rusion			
	Increased in o	drought freque	ncy and intensity		
	Increased pre	Increased pressure on water storage			
	Biodiversity l	osses			
	Increased per	sts such as was	ps and rodents		
	High potentia	High potential for fruit fly establishment			
	Ocean acidifi	cation			
	Decline in fish	Decline in fish population			
	Increased wil	dfire			
	Increased alle	ergies (e.g. poll	en)		

		Waira	rapa Coast whaitua
Variable/period	2040	2090	Commentary
Variable/period Average annual Temperature Average annual rainfall	2040 +0.5C to 1C above the 1995 baseline (+1.0C to +1.5 C above pre- industrial) 5% decrease to 5% increase	2090 +1C to +3C above the 1995 baseline (+1.5C to +3.5C above pre- industrial) 10% decrease to 5% increase	Commentary Maximum warming in autumn and summer, least in spring Note reference to 'above the 1995 baseline' versus 'pre- industrial': About 0.5C of warming has already happened from pre-industrial to the 1995 baseline (1880-1909 compared to the 1986-2005 model baseline, centered in 1995). Uncertainty range: lower range for significant emissions reduction (Paris agreement targets met), and upper range for high emissions There is a large uncertainty in the range of changes due to model differences and emission scenarios. Changes against emission scenarios are not necessarily linear. Greater likelihood of decreases in summer.
Amount of rain falling during heavy rainfall days (> 99 <sup>th</sup> percentile of daily rainfall, equivalent to heavy rainfall days seen every year, i.e., not too extreme)	0% to 15% increase	0% to 30% increase	There is a large uncertainty in the range of changes due to model differences and emission scenarios. Changes against emission scenarios are not necessarily linear. Greater likelihood of increases in autumn, winter and spring.
Extreme rainfall magnitude: 6-12 hour duration, 100 year Average Recurrence Interval (normally used as reference for flooding design, referring to very extreme, infrequent rainfall events)	6% to 12% increase	12% to 36% increase	Although the uncertainty in average rainfall range is high, extreme rainfall increases are more certain due to the increased amount of water vapour that the atmosphere can hold as it gets warmer (about 8% increase in saturation vapour per degree of warming). The figures for extreme rainfall are given as an average of different IPCC models used to inform the HIRDS system, which is the national reference for Flood Protection (https://hirds.niwa.co.nz/).
Sea level rise	0.12 to 0.24 metres above the 1995 baseline (0.38 to 0.5 metres above pre- industrial)	0.68 to 1.75 metres above the 1995 baseline (0.94 to 2 metres above pre- industrial)	The projected sea level rise for 2090 is based on IPCC AR5 plus an estimated additional contribution from Antarctica, based on papers published in <i>Nature</i> in 2018. As such, the upper range appears slightly higher than the RCP8.5 H+ from the MFE Coastal Guidance (2017). Note the difference between the 1995 baseline and pre-industrial, as we have already had about 26cm of sea level rise prior to 1995. More regular storm events in the fragile coastal environment may also mean faster and more significant coastal retreat. See the link below for climate change, sea level rise and storm surge maps for the Region: https://mapping1.gw.govt.nz/gw/ClimateChange/
Number of hot days (above 25C) per year	Between 5 and 30 days increase	Between 15 and 60 days increase	

Number of frost	Up to 5	Up to 15		
nights (below 0C) per	days	days		
year	reduction	reduction		
Change in the	Up to 3%	1% to 4%		
intensity of wind	increase	increase		
during windy days				
(>99 <sup>th</sup> percentile of				
daily mean)				
Change in annual	Up to 6	Up to 10		
number of windy	days	days		
days	increase	increase		
Change in annual	Increase	Increase	Measures potential for crop and pasture growth	
growing degree days	between 0	between		
base 10	and 300	200 and		
	GDD units	900 GDD		
		units		
Change in annual	Increase	Increase	Measures drought intensity	
potential	between 40	between 40		
evapotranspiration	and 120	and 160		
deficit (mm)	mm	mm		
Change in rivers	Decrease	Decrease	Measures water shortage in the catchments	
mean annual low	up to 60%	up to 80%		
flow discharge (MAL)				
Change in rivers	Between	Between	Measures flood potential in the catchments	
mean annual flood	20%	20%		
discharge (MAF)	decrease	decrease		
	and 20%	and 60%		
	increase	increase		
	depending	depending		
	on	on		
	catchment	catchment		
Changes in number of	100% to	100% to	These figures are given by IPCC model averages. Individual	
days of very high and	150%	150%	models can show much higher increases of up to 700%	
extreme forest fire	increase	increase		
danger				
Key environmental	Increased flo	od intensity		
impacts	Increased coa	astal inundation	n (some areas to become permanently inundated)	
	Increased erc	osion		
	Reduced soil	fertility		
	Decreased wa	ater quality		
	Ground wate	r quality and av	vailability pressures	
	Saltwater int	rusion		
	Increase in di	rought frequen	cy and intensity	
	Increased pre	essure on wate	r storage	
	Biodiversity l	osses		
	Increased pe	sts such as was	ps and rodents	
	High potentia	al for fruit fly es	tablishment	
	Ocean acidifi	cation		
	Decline in fish	Decline in fish population		
	Increased wil	dtire		
	Increased alle	ergies (e.g. poll	en)	

## Note on uncertainty range:

The six climate models used by NIWA and the regional downscaling approach used to obtain finer detail for this report are widely recognised as the best available in New Zealand.

There is always a source of uncertainty associated with any climate projections. There are uncertainties related to the modelling component (e.g. model physics, resolution), uncertainties related to the actual emissions, climate feedback mechanisms (e.g. methane from permafrost melting, sea ice variations), and unforeseen events such as volcanic eruptions, just to mention a few. There are also uncertainties related to the urban heat island and topographical effects characterising the spatial variability within each area, and the exact definition of the baseline period.

The commentary section on the tables above provides more details on the specific range for each climate variable. The overall range provided for each variable can be interpreted as the spatial variability within each region between a high emissions future and a significant emissions reduction, roughly meeting the Paris agreement goal of limiting global warming within two degrees above pre-industrial (the IPCC RCP 4.5 scenario being an approximate example).

In short, we have the following.

**For temperature**: lower end of the range increases for the significant emissions reduction, higher increases for higher emissions. Full range also represents the spatial variability across each whaitua region.

**For rainfall**: A range of decreases and increases is presented, mostly representing the likely spatial variability within the region. In general, for heavy and extreme rainfall there is greater certainty of increases for higher emissions.

**For hot days, dry spells and drought indicators**: the range mostly represents that we are confident of increased outputs for higher emission scenarios.

The whaitua tables are current as of the date of publication, and will be continuously updated when improved modelling, or additional information, become available.