Report Summary

Northland climate change projections and impacts

Impacts of climate change for Northland

- Summer is likely to warm the most out of all seasons.
- Annual temperature increases of up to 1.1°C by 2040 and up to 3.1°C by 2090.
- Reduction in spring rainfall of up to 20% for eastern areas by 2090.
- Increased risk of drought.
- Some areas may experience 90 more hot days per year by 2090.

Implications of climate change

- Warmer temperatures may allow different crops to be grown.
- More droughts may limit pasture production.
- More heat-tolerant pests may impact Northland's primary industries.
- Reductions in river flow and rainfall, as well as sea-level rise, may reduce groundwater storage.

Northland climate change overview

Northland is likely to warm significantly into the future to a more subtropical climate. Rainfall may decrease for some seasons with a higher risk of drought.

- Annual hot days (>25°C) may increase from 25 days now to 99 days by 2090, for Northland as a whole.
- Frosts may decline from one frost every two years at present to one frost every 10 years by 2090 (all of Northland).
- Rainfall changes are small by 2040, with up to 10% less rainfall for some areas in spring.
- By 2090, more significant spring rainfall reductions and autumn/summer increases.
- Rare, large extreme rainfall events are likely to increase in intensity due to more moisture being held in a warmer atmosphere, but the future impact of ex-tropical cyclones is uncertain.
- Increase in drought risk is highest for east and west coasts and southern inland areas.
- Whangarei has experienced ~2.2 mm/yr of sea-level rise since the 1900s.

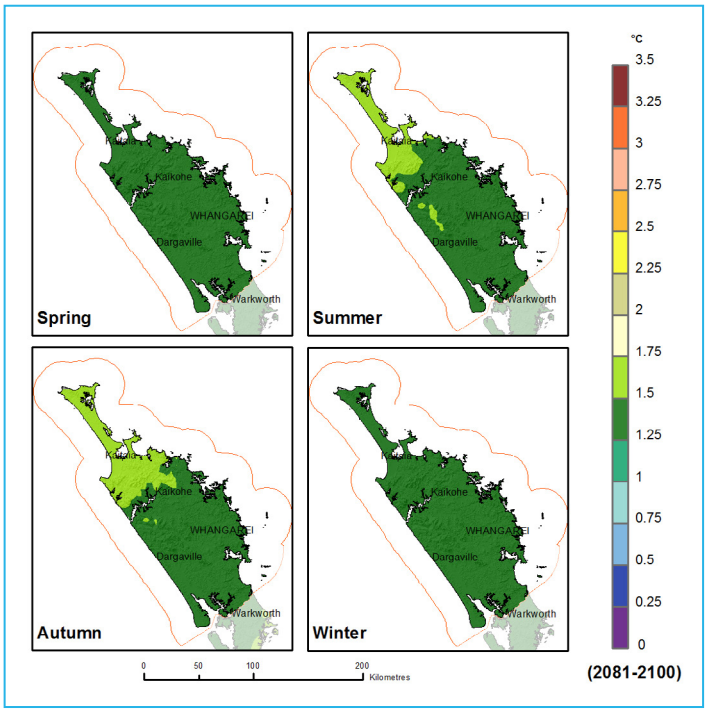
Global and New Zealand climate change

- The climate system is warming and most of the recent temperature increases are due to human greenhouse gas emissions[1].
- New Zealand warmed by about 0.09°C per decade since 1909, with more heat waves, fewer frosts, more rain in the south and west of New Zealand, less rain in the north and east of the North and South Islands, and a rise in sea level since 1900 of about 1.7 mm/yr[2].
- Global sea-level rise will likely be between 0.28 m and 0.98 m by 2100, compared with present.
- Changes to extreme events are likely (e.g., ex-tropical cyclones, drought, floods) with consequent economic losses.
- The Intergovernmental Panel on Climate Change (IPCC) produces global climate change reports. Climate model data from the Fifth Assessment Report was used here.
- The IPCC uses scenarios (Representative Concentration Pathways, or RCPs) to provide climate change projections which cover different socio-political and environmental futures.
- RCP 2.6 is the 'best case' scenario. RCP 4.5 and 6.0 are mid-range scenarios, and RCP 8.5 is the 'worst case' scenario.

Temperature changes

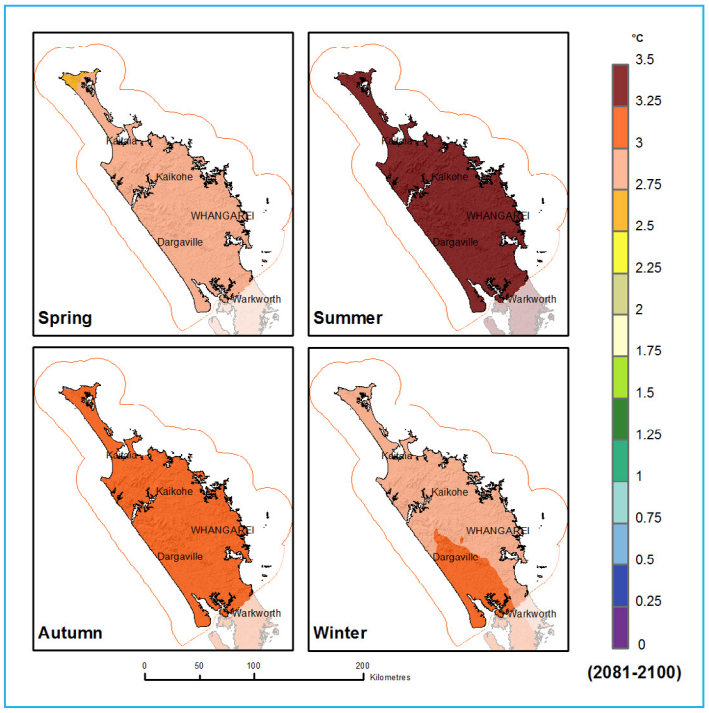
The maps below show the projected mean seasonal temperature for 2040 and 2090 for Northland, compared to the seasonal average for 1986–2005, for RCP 8.5, the 'worst case' climate change scenario.

2040

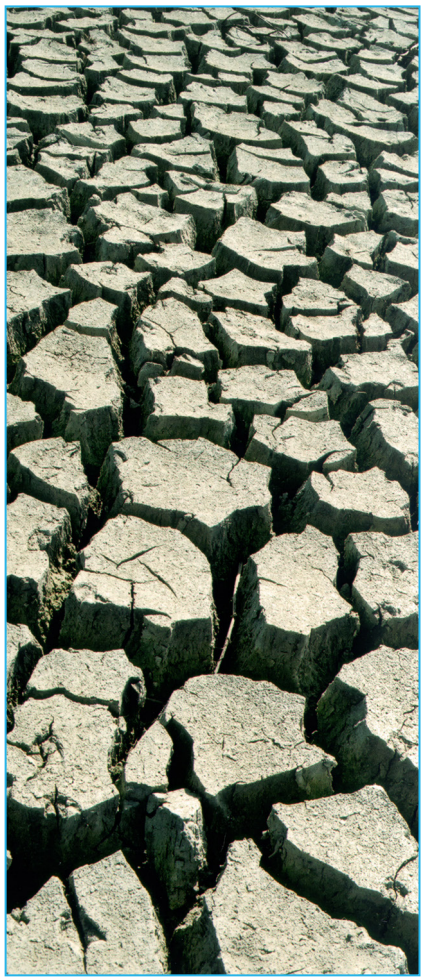


By 2040, Northland is projected to warm by up to 1.25°C in all seasons except spring, where up to 1°C of warming is projected.

2090



By 2090, significant warming is projected for summer, with over 3.25°C of warming projected across Northland.



Ranges of uncertainty in temperature projections

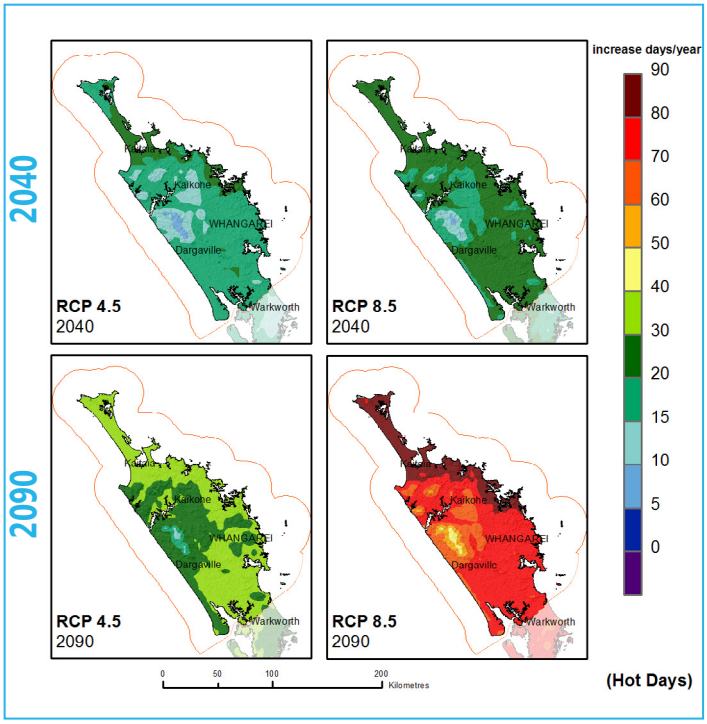
The table below shows projected changes in seasonal and annual mean temperature for Northland for 2040 and 2090, for two climate change scenarios – the 'worst case' scenario (RCP 8.5) and a mid-range scenario (RCP 4.5). Changes are relative to the baseline period, 1986–2005.

The number outside the brackets is the average of all climate models used to calculate the projections, and the bracketed numbers give the range (5th and 95th percentile) of all model results.

There is a range of uncertainty in the model results for each projection. For example, the average summer temperature under RCP 8.5 is likely to increase by 1.1°C by 2040, but estimates of summer temperatures range from 0.5°C to 1.6°C.

Change in temperature	Climate change scenario	Summer	Autumn	Winter	Spring	Annual
2040	RCP 8.5	1.1 (0.5, 1.6)	1.1 (0.7, 1.5)	1.1 (0.6, 1.4)	1.0 (0.5, 1.3)	1.1 (0.7, 1.4)
	RCP 4.5	1.0 (0.4, 1.5)	0.9 (0.4, 1.4)	0.9 (0.5, 1.2)	0.8 (0.4, 1.1)	0.9 (0.5, 1.2)
2090	RCP 8.5	3.3 (2.4, 5.0)	3.2 (2.2, 4.3)	3.0 (2.3, 3.8)	2.8 (2.1, 3.6)	3.1 (2.4, 4.1)
	RCP 4.5	1.5 (0.9, 2.5)	1.5 (0.9, 2.1)	1.4 (0.8, 1.9)	1.3 (0.8, 1.8)	1.4 (0.9, 2.0)

Changes to hot days



By 2040, 20-30 more hot days (>25°C) per year are expected for most of Northland for both scenarios (mid range RCP 4.5 and 'worst case' RCP 8.5).

By 2090, up to 40 more hot days are projected for lowland parts of Northland under the mid-range RCP 4.5 scenario. Under the 'worst case' RCP 8.5 scenario, up to 90 more hot days are projected for northern and eastern coastal areas, with 80 more hot days likely for most of the rest of Northland.

How to manage uncertainty in climate projections

There is always some uncertainty in climate projections because the rate of climate change will depend on future global emissions of greenhouse gases, which in turn depend on social, economic and environmental policies and development. Incomplete scientific knowledge about some of the processes governing the climate, and natural year-to-year variability, also contributes to uncertainty in projections for the future.

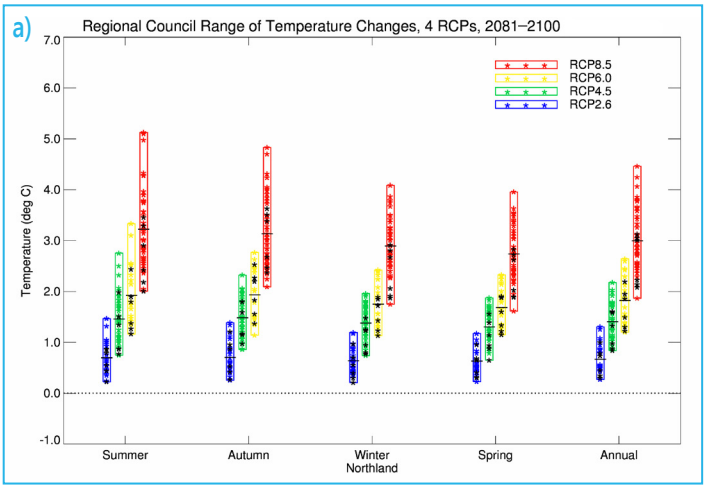
The graphs (right) show the range of projections for temperature (a) and rainfall (b) for Northland and Whangarei, respectively, for 2090.

There is a large range of possible outcomes, shown by the length of the bars and inset stars (which show individual model results). All temperature projections are above 0°C, indicating that all models under all scenarios project warming. The direction of change is much less certain for rainfall, with all bars crossing 0% change and some scenarios having very different model projections.

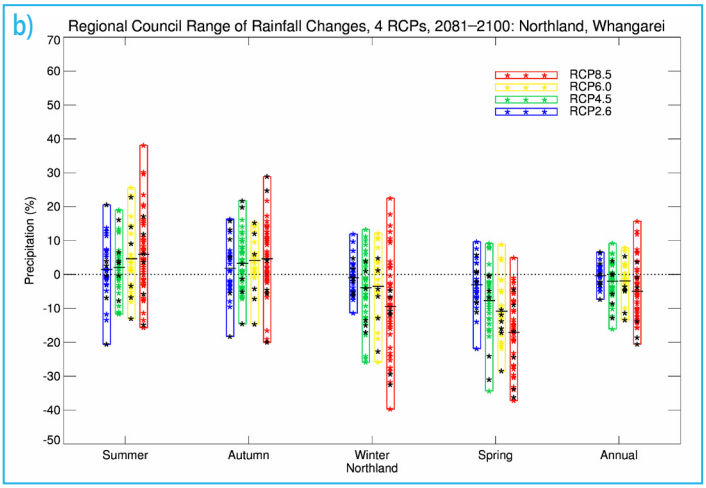
Councils can undertake scenario analysis to assess the likely effects of climate change. The scenarios that span the likely range of future conditions may be used in conjunction with expert knowledge and models of the sensitivity of natural or managed systems to climate to understand a range of possible climate impacts on selected council activities and services. See Reference 3 for more details.

Range of model outcomes for temperature (a) and rainfall (b) for 2090

a)



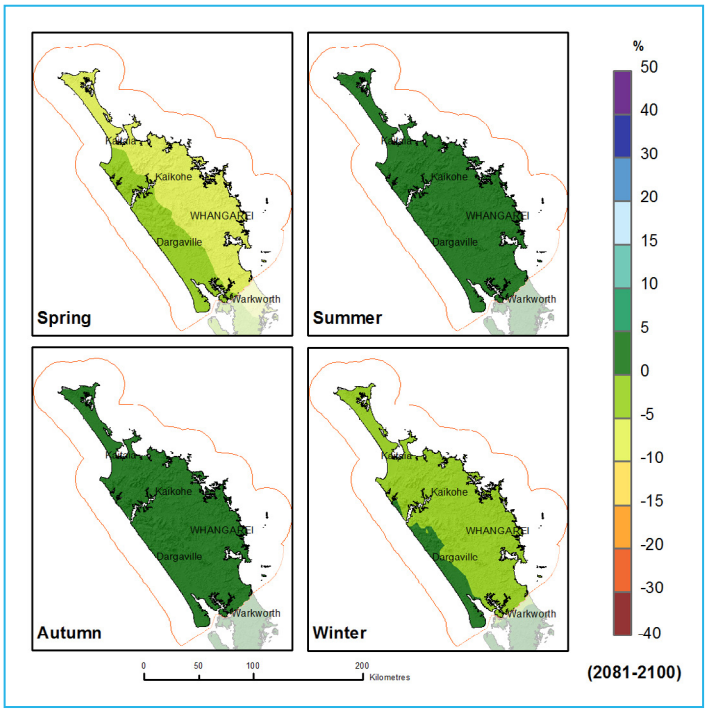
b)



Rainfall changes

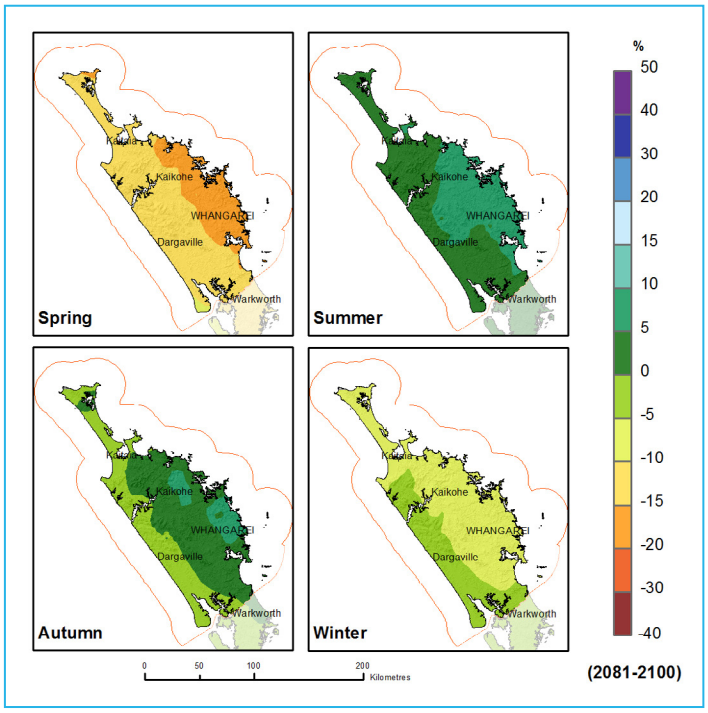
The maps below show the projected seasonal rainfall change for 2040 and 2090, compared to the seasonal average for 1986–2005, for RCP 8.5, the 'worst case' climate change scenario.

2040



By 2040, spring rainfall for most of Northland is projected to decrease by 5-10%. For western areas, a small decrease in rainfall is projected. For the remaining seasons, projected change is less than ±5%.

2090



By 2090, spring rainfall is projected to decrease by up to 20% in eastern Northland. In autumn and summer, eastern areas are projected to experience increases of 5-10%. In winter, decreases of 5-10% are likely for most of the region outside western areas.

Ranges of uncertainty in rainfall projections

The table below shows projected changes in seasonal and annual rainfall (in %) for Whangarei for 2040 and 2090, for two climate change scenarios – the 'worst case' scenario (RCP 8.5) and a mid-range scenario (RCP 4.5). Changes are relative to the baseline period, 1986–2005. The number outside the brackets is the average of all climate models used to calculate the projections, and the bracketed numbers give the range (5th and 95th percentile) of all model results. Rainfall projections have large uncertainties. For example, average spring rainfall under RCP 8.5 is likely to decrease by 7% by 2040, but estimates range from -16% to +5%. For 2090, spring rainfall is likely to decrease by 17%, but estimates range from -38% to -2%.

Change in rainfall %	Climate change scenario	Summer	Autumn	Winter	Spring	Annual
2040	RCP 8.5	1 (-8, 10)	2 (-7, 13)	-2 (-15, 10)	-7 (-16, 5)	-2 (-8, 5)
	RCP 4.5	3 (-12, 13)	3 (-9, 17)	-2 (-15, 9)	-4 (-18, 10)	-1 (-7, 6)
2090	RCP 8.5	6 (-11, 30)	5 (-7, 16)	-9 (-28, 14)	-17 (-38, -2)	-4 (-15, 12)
	RCP 4.5	2 (-11, 19)	3 (-7, 16)	-3 (-25, 11)	-7 (-18, 8)	-2 (-12, 6)

Short return period extreme rainfalls (e.g., annual recurrence interval ~1 year) may decrease in Northland due to reductions in mean annual rainfall. Rare larger extreme rainfall events are likely to increase in intensity due to more moisture being held in a warmer atmosphere. Tropical cyclones are likely to increase in intensity and have higher rain rates but their frequency is projected to stay the same or decline, and it is uncertain how they will affect New Zealand.

Flow changes: Wairoa River

- River flow projections are highly uncertain – there is a large range of model results for all flow variables.
- Flow projections for the Wairoa River are provided as guidance only, and the model used is uncalibrated with no bias correction.
- Results are variable between model runs because the models are highly sensitive to rainfall – where rain falls in the catchment can drastically change the flow projection.
- Mean annual flow: general decrease in mean annual flow, consistent with decreases in precipitation; 11% decrease under 'worst case' scenario at 2090.
- Mean annual flood: the average of the maximum flood discharges experienced. Variable responses projected between scenarios. 'Worst case' scenario projects decrease of mean annual flood at 2040 of 3% and increase at 2090 of 22%. This increase in MAF agrees with the likely increasing intensity of rare, large extreme rainfall events
- Mean annual low flow: the flow that is exceeded 90% of the time. Reductions at 2040 and 2090 under most scenarios, with a decrease of 24% for 'worst case' scenario at 2090.
- Average seasonal flow: general decreases for summer, winter and spring, with summer showing the largest decreases. Small increases in autumn flow.

Climate change implications and opportunities

- Hayward kiwifruit production may decline due to a lack of winter chilling.
- Warming may allow more subtropical and tropical crop species to be grown, such as rice and soybeans. However, crops like rice which have a high water requirement may be limited by water availability.
- Crops may be sown earlier in the growing season and will reach maturity faster due to higher temperatures.
- Pinus radiata is likely to perform better in a warmer Northland than it currently does due to increased carbon dioxide.
- Kikuyu grass is likely to become the most prevalent forage grass as it is more efficient under higher temperatures and drier conditions.
- Pasture production will generally increase, especially in winter, due to higher temperatures, more carbon dioxide in the atmosphere, and a longer growing season. However, more drought in summer may counteract this extra growth.
- 'Sleeper' pests currently in New Zealand may affect primary industries due to change in host-pest relationships (e.g., increase in different pasture grass species, more heat-tolerant pests favoured).
- Cattle may be susceptible to increased heat stress.
- Days of very high and extreme forest fire danger are projected to increase by 40–50% by 2100.
- Ocean acidification may impact the early developmental stages of shellfish in wild fisheries and aquaculture (e.g., paua and oysters).
- Oyster herpesvirus outbreaks are exacerbated in warmer waters, and there are concerns about paua stress in warmer water.
- Strengthening East Auckland Current may bring more warm-water species to Northland which may impact on wild fisheries.
- Less groundwater recharge (a flow-on effect from less precipitation) will impact aquifer storage.
- As sea level rises, coastal groundwater levels may increase. This would not mean an increase in groundwater yield, but a reduction in groundwater flow velocities. How far this effect extends from the coast depends on aquifer properties, flow velocities, and the amount of sea-level rise.
- Due to sea-level rise, salinisation of coastal aquifers around Taipa, Ngunguru and Russell may increase.

Future research directions and gaps in Northland's knowledge

The level of uncertainty in Northland's climate change projections may decrease if some of the gaps in knowledge concerning the impacts and implications of climate change were addressed:

- Calculation of a homogenised temperature series for Northland would improve understanding of how Northland's climate has changed in the past.
- Understanding how frequently ex-tropical cyclones affect Northland and the impact that they have could be useful for hazard planning.
- Northland is a coastal region, so understanding the influence of climate-induced coastal hazard drivers like sea-level rise, storm surge and waves, as well as future changes in high tide exceedances, would inform coastal planning.
- The river flow projections to date are only for a single river in Northland (Wairoa) and are uncalibrated. A calibrated model for more rivers in the region would provide more robust flow projections.
- Aquifers are likely to be affected by changes to rainfall and river flows, as well as irrigation/abstraction demand, so groundwater modelling exercises for Northland would improve understanding of potential aquifer changes.

References

1. Intergovernmental Panel on Climate Change Fifth Assessment Report (2013). Available from https://www.ipcc.ch/report/ar5/
2. Climate change projections for New Zealand (2016). Available from http://www.mfe.govt.nz/node/21990
3. Climate change effects and impacts assessment: A guidance manual for local government in New Zealand. Available from: http://www.mfe.govt.nz/publications/climate-change/climate-change-effects-and-impacts-assessment-guidance-manual-local-6

NRC report

This report was written by NIWA for Northland Regional Council, and should be referenced as follows:

Pearce, P.R. (2017) Northland Climate Change Projections and Impacts. *NIWA Client Report* for Northland Regional Council, 2017027AK.

Future climate

More detailed information about Northland's future climate can be found in the following report: Climate change projections and implications for Northland (2016). Available from: http://www.nrc.govt.nz/Environment/Air/Issues/Climate-change/

For more information

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NORTHLAND REGIONAL COUNCIL

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