# Initial Assessment of a New Coral Bleaching Event at Tongareva Atoll in the Northern Cook Islands

**Dr Michael White**

**Hakono Hararanga Incorporated**

**January 2019**

# Foreword

In the first half of 2016 Tongareva suffered a devastating coral bleaching event that was caused by the longest *El Niño* on record (April 2015 to May 2016). The author found the first bleaching on 21st December 2015 near Tokerau motu in the northwest lagoon. In the following weeks our surveys revealed that the entire 77 km outer reef had bleached, as had every coral head (*toka*) in the 233 $km^2$ lagoon. Even worse was that 95% of **pasua** (*Tridacna maxima* small giant clam) had died too; these are an important food resource and permanently protected under *rahui* (traditional management that closes or opens the harvest). In both cases, corals and clams, this was a thermal response to elevated seawater temperatures: and a direct consequence of climate change. This was published in The Marine Biologist (White 2016) ~ which is important because remote places rarely get mentioned in main-stream science, unlike the Great Barrier Reef which is often in the news. For several weeks the lagoon temperature reached 38ºC and the nearshore ocean surface temperature was 33-34ºC. Our atoll is the worst affected by climate change in Kuki Airani. Other consequences were: substantial forest loss, fish species leaving for cooler waters, followed by the seabirds which prey on them, and plants having difficulty pollinating and setting fruit. As trees fell down the soil dried out and then eroded. All-in-all a cascade effect that had a severe environmental impact.

Over the following months seabirds returned to nest, but trees continued to struggle and arboreal habitats were degraded. *La Niña* moved into place and corals recovered. It was only in mid-2018 that *pasua* were seen again: range is greatly reduced from the tens of thousands that existed before. The outer reef and toka appeared to return to their pristine condition.

Then on Boxing Day 2018 the author discovered coral bleaching on the southwestern reef top: those corals had been in visibly good condition 13 days earlier. The rest of this manuscript details the first surveys around the atoll. Rapid coral health assessments were done to understand the impact extent, and measure water temperature. Every site checked was in the early stages of bleaching: some coral species show resilience, but it seems likely we are heading for another ecosystem tragedy. Human activities directly cause climate change and global warming. Science is crystal clear, and domestic and international law requires us to adhere to the 2015 Paris Agreement on Climate Change.

I'd like to mention that *Hakono Hararanga Incorporated* (Tongareva's Community Environmental Society) currently has a Global Environment Facility Small Grant Programme in place: concerning biodiversity conservation, climate change, community education and managing oceanic plastics. So thanks to Teuru Tiraa Passfield as the SGP co-ordinator. I'd also like to thank *Honu Kuki Airani* for keeping the honu research rolling along through the years. Finally, deepest thanks to Chairman Ru Taime; Secretary Mereani Taime; Trustees Hina Taime and Taimana Matara; our lawyer Wilkie Rasmussen; and Project Planning Officer Vainetini Joseph. Kia Orana e Kia Manuia!

**Dr Michael White**

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Fellow of the The Marine Biological Association

Member of IUCN Species Survival Commission:
Marine Turtle Specialist Group

***21st January 2019 at Omoka, Tongareva Atoll***

**The present study contributes to Hakono Hararanga's GEF SGP Project:**

**Conserving Biodiversity of Tongareva Atoll through Training, Revegetation, & Waste Management**

[GEF-SGP # CI/SGP/OP5/Y5/CORE/CB/17/04 - HAKONO HARARANGA INCORPORATED]

**and in particular to Specific Objective 5.2: Biological surveys, endangered species, threats and impacts ~ with a focus on Ecosystem Integrity.**

**Also to SDG 14 'Life below water'**

**And to Honu Kuki Airani's ongoing research and conservation efforts**

[Research Permit 21/2015]

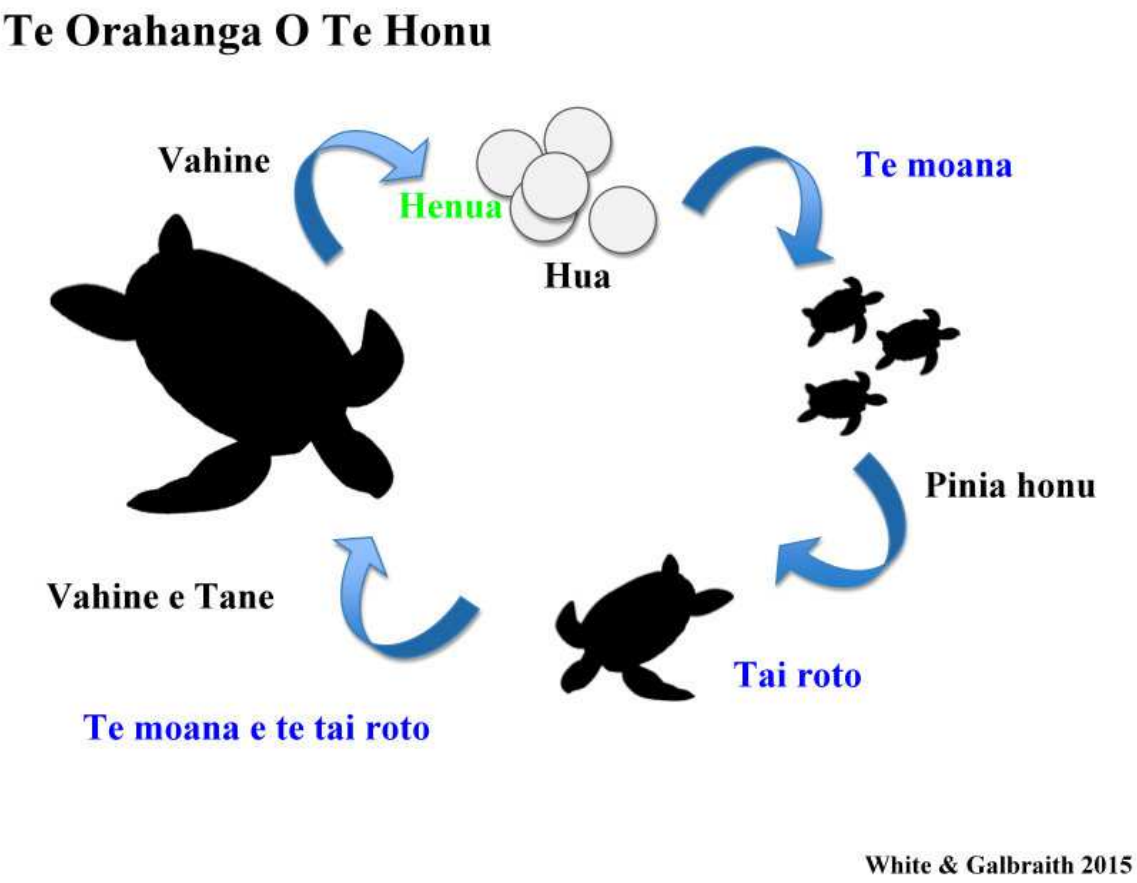
Empowered lives.
Resilient nations.

the POWER of humanity

# An unfolding coral bleaching event at Tongareva Atoll (January 2019)

## Introduction

Tongareva [09º South; 158º West] is the largest and most remote atoll in *Kuki Airani* (the Cook Islands). It is the country's most important maritime ecosystem and has substantial nesting seabird populations, and is by far the most important *honu* (sea turtle) habitat in the central South Pacific. It has year-round juvenile honu development, regular mating at Omoka wharf and Taruia Passage, and year-round nesting by endangered green turtles (*Chelonia mydas*); critically-endangered hawksbill (*Eretmochelys imbricata*) juveniles are present, although increasingly rare (White *in prep*).




## A Subsistence Way-of-life

Tongareva's small human population (about 200 people) is deeply religious and leads a mainly subsistence way-of-life gathering resources directly from nature. Food is coconuts, fish, shellfish and more rarely birds; occasionally cargo is shipped from Hawai'i or Rarotonga. By June of 2015 New Zealand Aid had converted the entire Northern Group atolls to solar-power (photo below). *Uira Natura ko i Tokerau* ended the need to import fuel from Auckland for power generation.

People are an integral part of the ecosystem and stand or fall depending on how well we look after it

**Tongareva is also the island worst affected nationally** by anthropogenic climate change impacts. Tree loss is a real problem, ocean acidification is a great threat (Johnson et al 2016), ocean warming pushes corals and clams towards extinction; birds and fish leave.

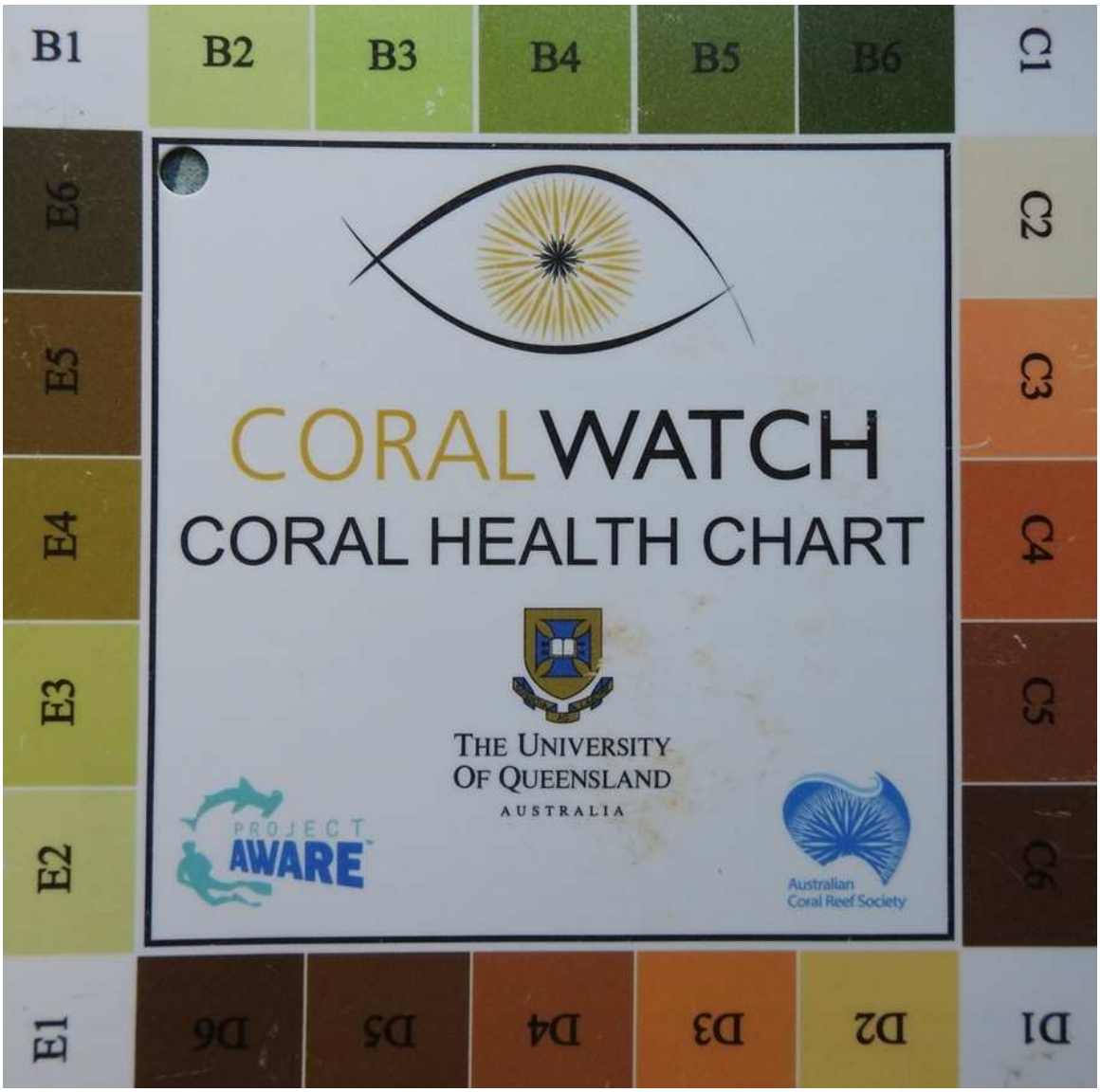
**Above: *Uira Natura* at Omoka; below: Tree-loss at Tongareva.**

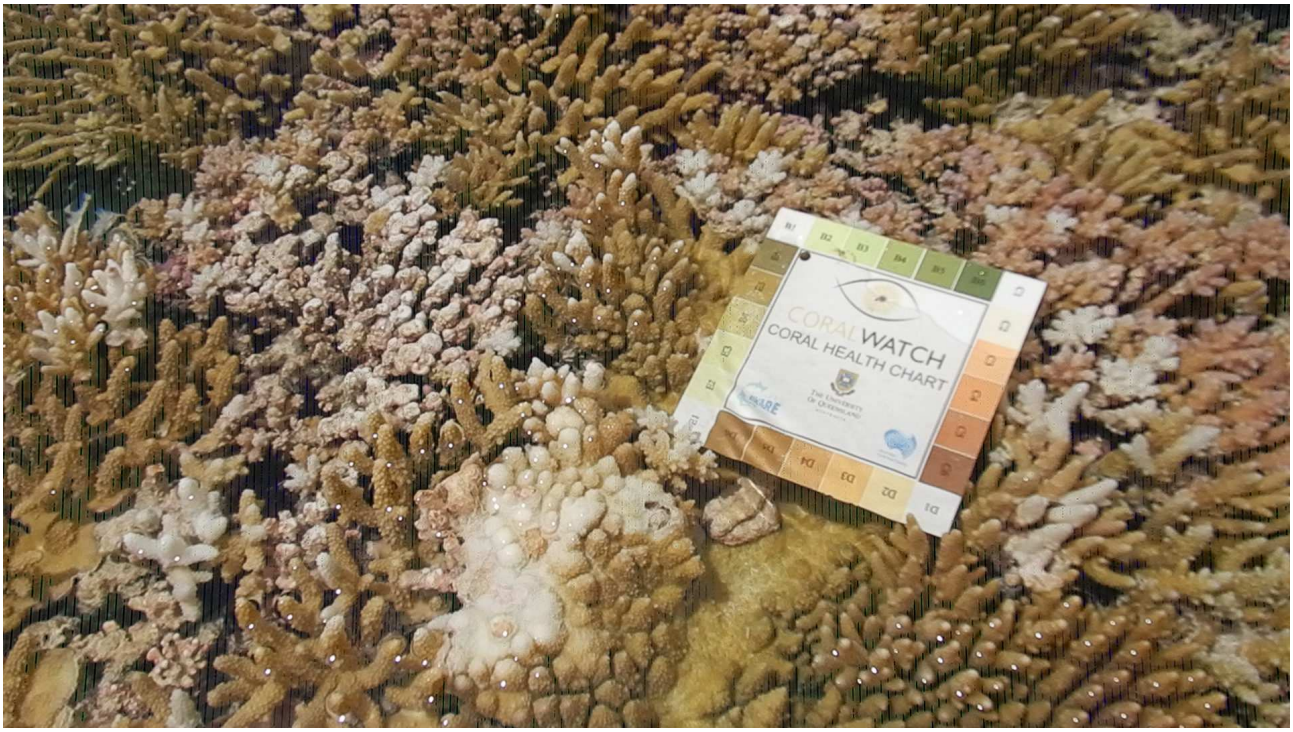
**The Immediate Problem**

***** During the final honu surveys of 2018 Dr White found **bleached** branching corals on the reef top at Mangarongaro's southwestern shore. These had all been in visibly good condition 13 days earlier. A possible cause is increased **ultraviolet radiation** as the SST (sea surface temperature) was normal (30-32ºC). This is now being investigated ~ January 2019. Another tragedy may be unfolding for our most important maritime ecosystem!

In Hakono Hararanga's GEF-SGP monthly reports (from February 2018) we noted corals seemed to be in excellent condition and appeared to have recovered from the severe bleaching event during the 2015-2016 ENSO event (White 2016; Rongo 2016). In December 2018 Dr White looked at many *toka* (lagoon coral heads) **and found no signs of bleaching.**

**The first impact** was discovered on the reef top of the southwestern reef (26th December 2018). Site **BLV1** had been OK on 13th December, so bleaching occurred within two weeks. An immediate health check was done: **CoralWatch** colour chart and data uploaded to University of Queensland. Www.coralwatch.org





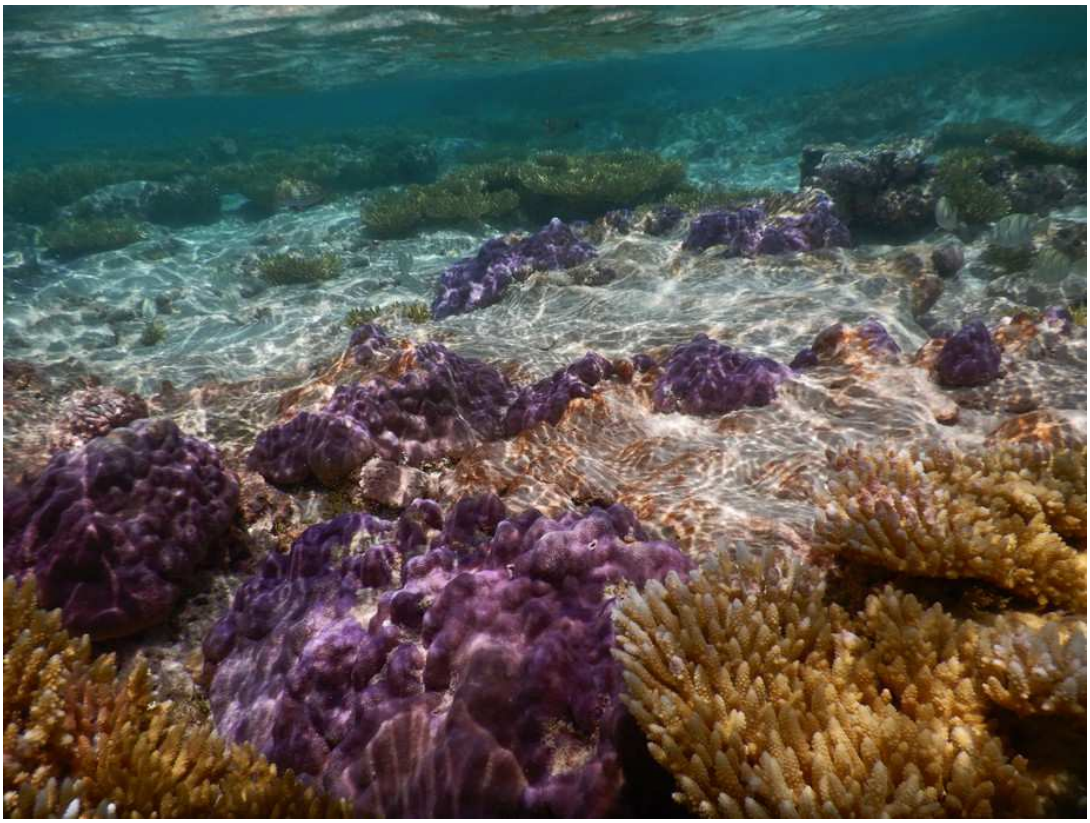

BLV1 [09º 04.220 South; 157º 58.575 West] branching corals bleached 26th December 2018; OK on 13th December. It was noted that the reef was unusually quiet that day, normally waves would be breaking over the reef. Numerous coral clusters were exposed at low water (neap tides).

**Reef top branching corals *(acropora type)* are bleaching: rapid surveys were conducted over three days to determine immediate extent and distribution of bleaching. Some coral species are more susceptible than others *i.e. there can be resilience*.**

**Survey BLV1: widespread bleaching of branched corals on reef-top, exposed at low water. Some coral species show resilience for now.**

## Mahera: two surveys on 28th December 2018

**BLV2** [09º 03.022 South; 157º 59.325 West]: Te Toto ~ acropora corals starting to bleach, boulder type (porites) OK. SST 30ºC



**BLV3** [09º 02.854 South; 157º 59.384 West]: plate & boulder mostly OK ~ no branching corals. SST 30ºC

**Likewise at Akasusa on 31st December2018**

**BLV4** [09º 03.663 South; 157º 58.917 West]: acropora corals starting to bleach, porites OK. SST 30ºC

**BLV5** [09º 03.241 South; 157º 59.227 West]: plate & boulder OK, a few acropora starting to bleach SST 30ºC

**Akasusa was the best of the three locations, possibly red coralline algae by Ava 4 is degrading.**

**Right-hand passage: red coralline algae nearest ocean looks paler.**

**A broken-off coral fragment found on the reef top was partially bleached: a good training aid for the Coral Watch Health card (photos below).** ***Note. Corals lose brightness out of water.***


**Widening the investigation the next two surveys were in the northwest of the atoll at Molokai; plus one on the north shore of Tokerau (8th January 2019)**

**BLV6** [08º 56.423 South; 158º 02.929 West] SST 32ºC

**BLV7** [08º 56.267 South; 158º 02.979 West] SST 32ºC

Both Molokai sites were similar with acropora bleaching in progress.

**BLV8** [08º 55.565 South; 158º 01.369 West] SST 32ºC. North shore is rockier, but with acropora bleaching similar to Molokai above.

**Two more surveys on the southwestern reef; plus one on the southern shore (9th January 2019)**

**BLV9** [09º 04.771 South; 157º 58.235 West] SST 31ºC ~ mainly good plates & boulders

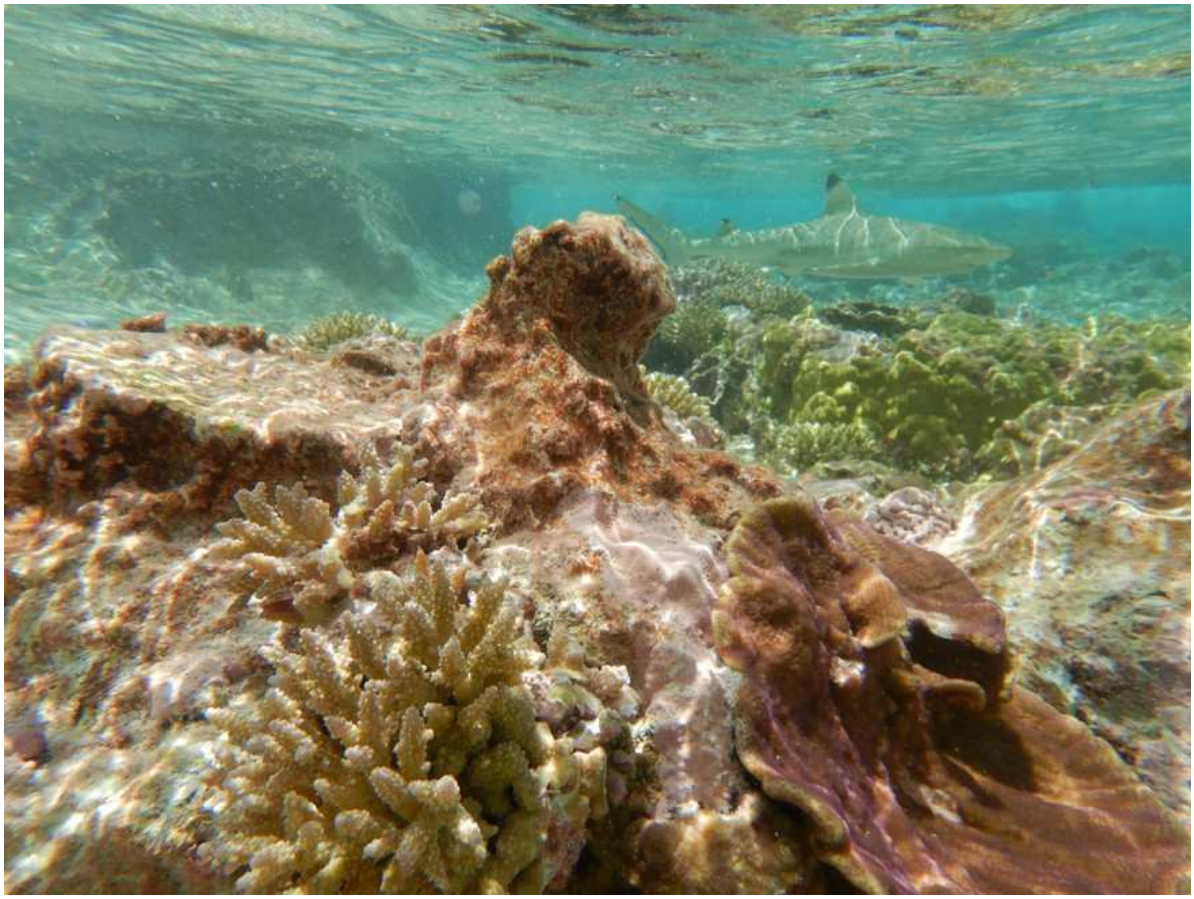
**BLV10** [09º 04.093 South; 157º 58.650 West] SST 31ºC ~ mainly good plates & boulders

**BLV11** [09º 03.053 South; 157º 49.197 West] SST 32ºC. Much rockier and corals sparser, maybe gets considerable wave action at times. Acropora bleaching; and possibly red coralline algae.

**This site was more dangerous to survey ~ also several sharks on reef-top.**

An attempt was made to assess the **eastern (windward) reef** on 15th January 2019 but it was too dangerous. A coral fragment suggested that bleaching was occurring there too. SST was **28ºC**: the coolest of any site, but the ocean is deep with a steep drop-off.

**BLV12** [09º 03.548 South; 157º 59.004 West] was at Akasusa (11th January 2019). This is a nice site for Coral Watch in-water training: a variety of species and there was some resilience. SST 30ºC



**Two surveys were done near the runway (Moana Nui) on 12th January.** This was the most degraded site so far with all three coral types bleaching, and has a higher sediment load. Absence of trees along the shoreline might worsen the localised overheating effect.

**BLV13** [09º 01.001 South; 158º 01.927 West] SST 32ºC

**BLV14** [09º 00.390 South; 158º 02.253 West] SST 32ºC

**Three surveys along the Mahera section (16th January):** found the first plate corals bleaching in the south and one boulder coral whitening.

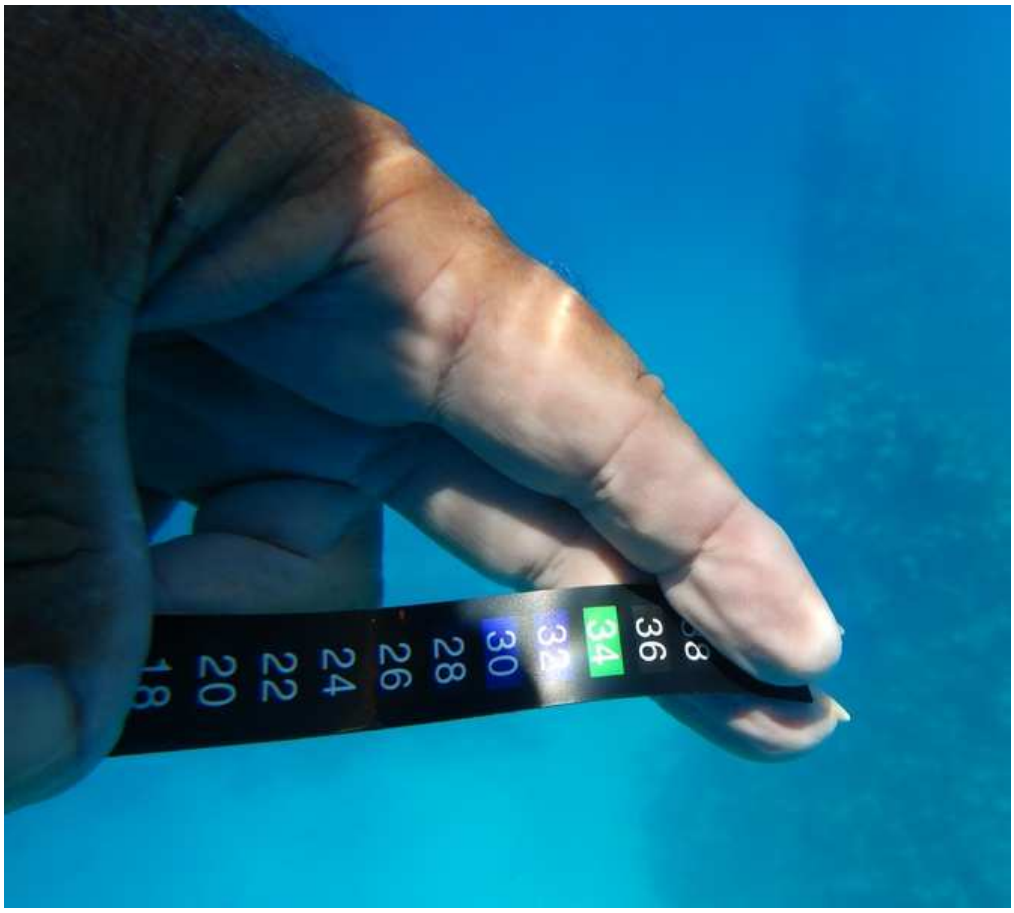
**BLV15** [09º 03.003 South; 157º 59.339 West] SST 31ºC

**BLV16** [09º 02.757 South; 157º 59.423 West] SST 31ºC

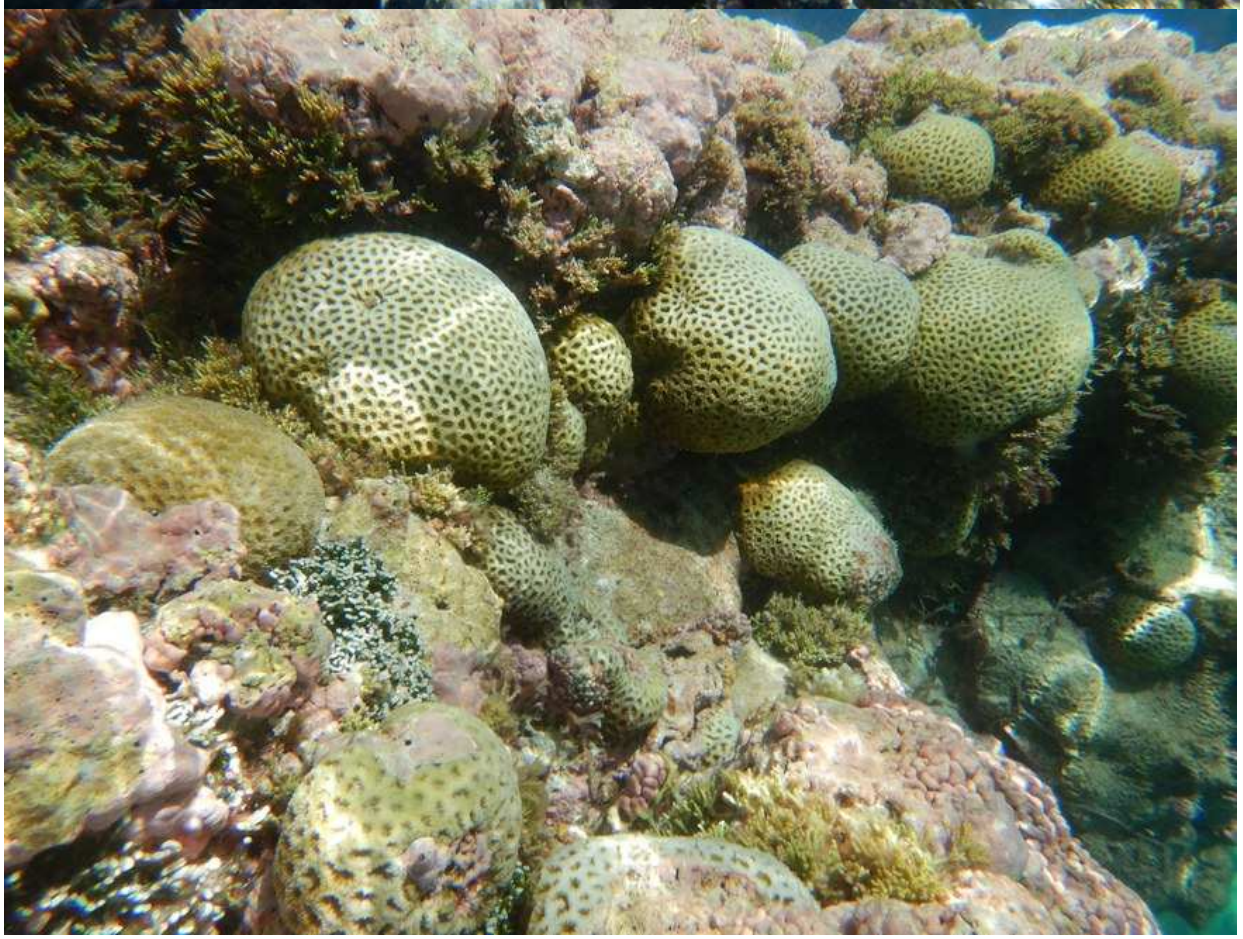
**BLV17** [09º 02.537 South; 157º 59.517 West] SST 30ºC

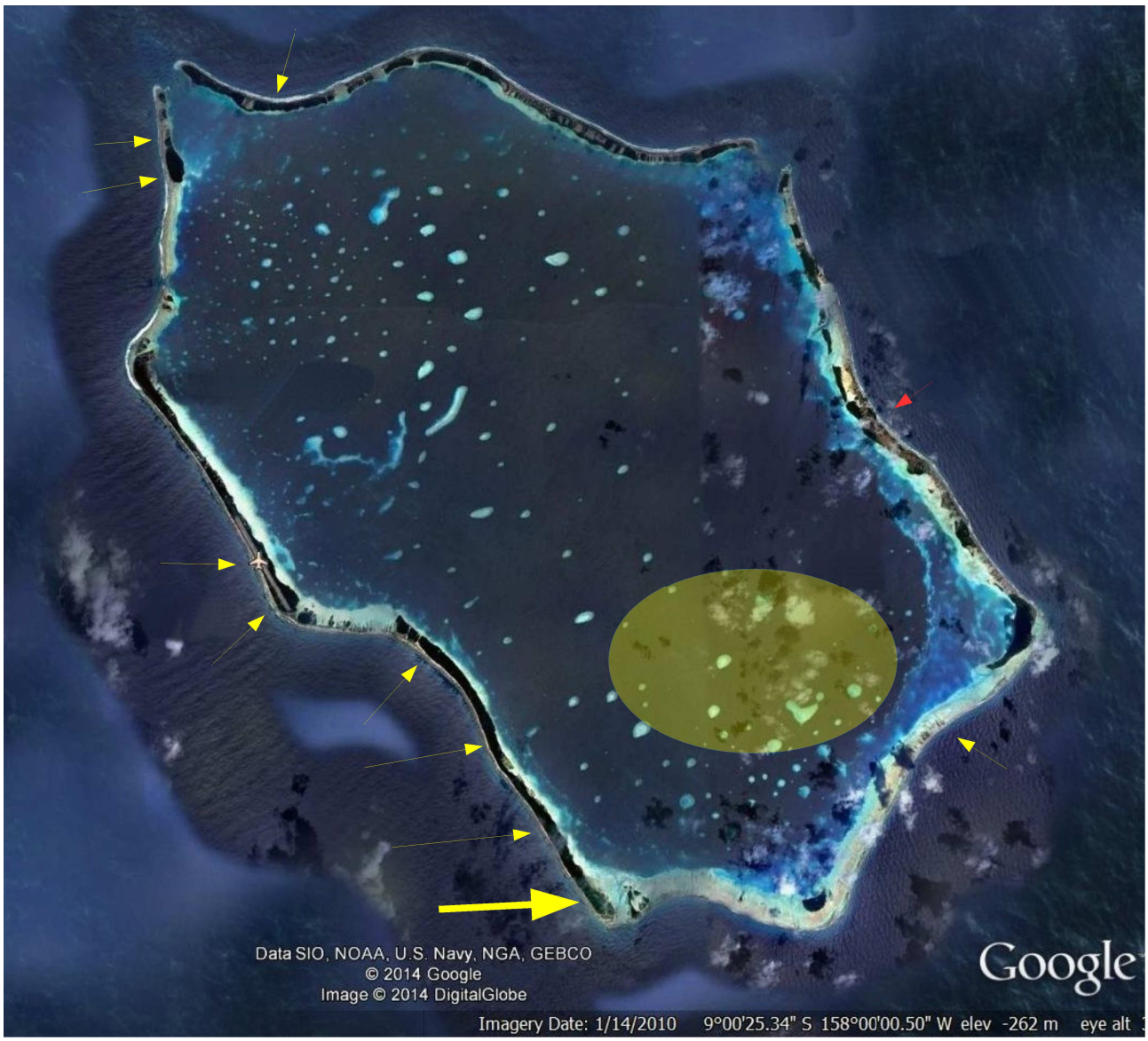
**During a rapid survey in the southern lagoon (9th January 2019)** six toka were waymarked but not health-checked due to time constraints. These all had a mixture of deeper bleached porites type corals and pristine corals near the surface. These will be monitored to see if bleaching is worsening or easing. SST was 34ºC

**BTV1** [09º 04.484 South; 157º 57.395 West]
**BTV2** [09º 04.461 South; 157º 57.313 West]
**BTV3** [09º 04.528 South; 157º 57.175 West]
**BTV4** [09º 04.486 South; 157º 59.716 West]
**BTV5** [09º 04.461 South; 157º 56.461 West]
**BTV6** [09º 03.458 South; 157º 54.882 West]




**Southern lagoon seawater temperature on 9th January 2019 was 34ºC**






**Tongareva Atoll (Google Earth). Yellow arrows indicate survey sites with CoralWatch health checks. Red arrow was too rough, but SST was 28ºC ~ the coolest of any site. Yellow ellipse shows where *toka* were waymarked for future surveys. Initial impact site is bottom left arrow.**

**As time and weather allow we will continue surveys throughout the lagoon and on as much of the outer reef as is safe to investigate.**

## Synthesis

**Bleaching events** tend to be associated with elevated seawater temperatures. Corals have symbiotic dinoflagellates (genus *Symbiodinium*) living in the dermis (skin). These tiny algae photosynthesise, producing high-energy sugars for the coral host: about 90% of energy needs, and giving corals their colour. When seawater temperatures rise the dinoflagellates go into over-drive and produce so much energy that the coral host cannot cope with it. So their thermal response is to expel the algae, which leaves the *bleached* carbonate skeleton. Their only remaining option is filter-feeding, but this is too little to meet the corals' needs (and not enough dermal cells to process food) and death follows.

At the initial observation site (BLV1) Dr White noted the seawater temperature was normal (30ºC), as it had been for most of 2018: i.e. there is no *El Niño* influence. The most likely cause, therefore, is higher irradiance and especially ultraviolet light *(*ozone!*). During the CoralWatch assessment the tide was falling and some branching corals became exposed. The moon (*marama*) was almost at 3rd Quarter so tidal range was neaps, rather than springs; which was also the case two weeks earlier when corals were OK. One further thought is that the reef was very quiet during the 26th December survey: normally wave action would be much greater and corals submerged or overwashed (as on 28th December). Quite why the corals were exposed remains unclear for the moment [*Blue-sky thinking* considered the Krakatau volcanic eruption and tsunami at Sunda, or perhaps another near the Phillipines, moving the ocean. A recent solar wind event affected the ionising layer and perhaps u/v levels].

NOTE: stratospheric *ozone layer is degraded by greenhouse gases, especially emissions containing bromines or chlorines: increased levels of ultraviolet radiation then penetrate the atmosphere.

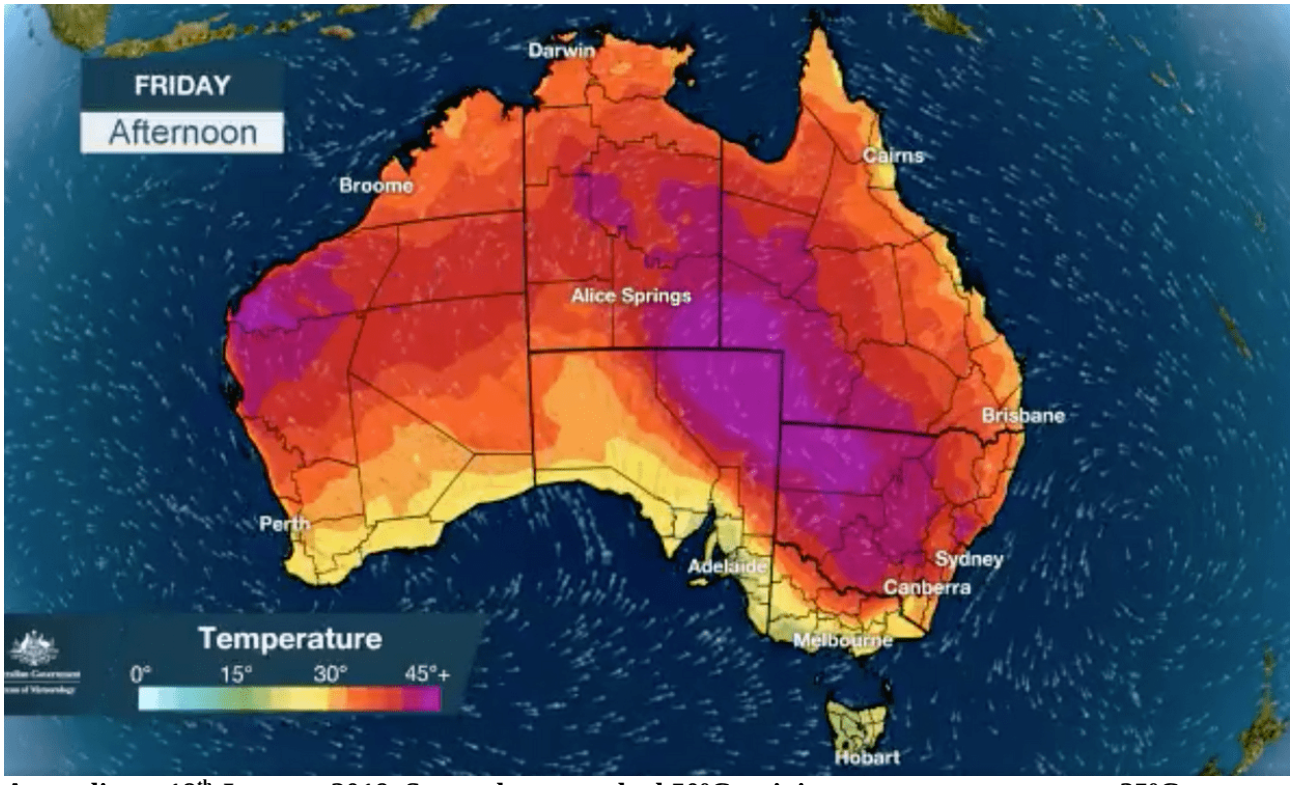
Whatever caused the lower water level several reef top corals were exposed and the same impact resulted: **symbionts ejected.** Dr Teina Rongo wrote previously (Rongo 2016) that different clades of Symbiodinium had differing thermal tolerances, which perhaps explains why during the 2016 event Dr White and Ru Taime had found deeper corals bleached and the shallower ones less so. White (2016) suggested that corals deeper in the lagoon might experience a temperature range of, say, 23-26ºC, whilst those nearer the surface perhaps 28-32ºC: in both cases 38ºC was far above the level needed to kill them; but the relative effect would be worst on deeper species.

Our rapid assessments on the toka found that deeper corals had bleached, including porites type that had been OK on the outer reef, while some nearer the surface still appeared in good condition. This suggests that hotter seawater might have been implicated in the lagoon, even if it hadn't been on the leeward reef. Keeping an open mind the author suggests that both increased solar irradiance and a plume of warmer water traversing Tongareva could be implicated: separately or in combination. We did find *pockets* of hotter water during lagoon snorkelling surveys in January 2019, indicating that higher temperatures were not uniform, and explaining why bleaching so far has been patchy; unlike the 2016 event where bleaching was ubiquitous and the entire water column had heated up.

As before, the impact is occurring quickly. In the three weeks of surveys **every site has early-stage bleaching in progress.** On the leeward reef branching corals (acropora type) were initially most affected and boulders (porites type) and plate corals (montipora type) less so; but now all types of corals are showing signs of impact. Adjacent sites may experience different water flow patterns: a combination of wind & wave direction and ocean depth. Some sites only had boulder and plate type corals, others were dominated by branching corals. This pattern is reinforced by spawning events and regrowth of broken polyps. Temperatures in the lagoon were higher than the nearshore SST.

## Prognosis

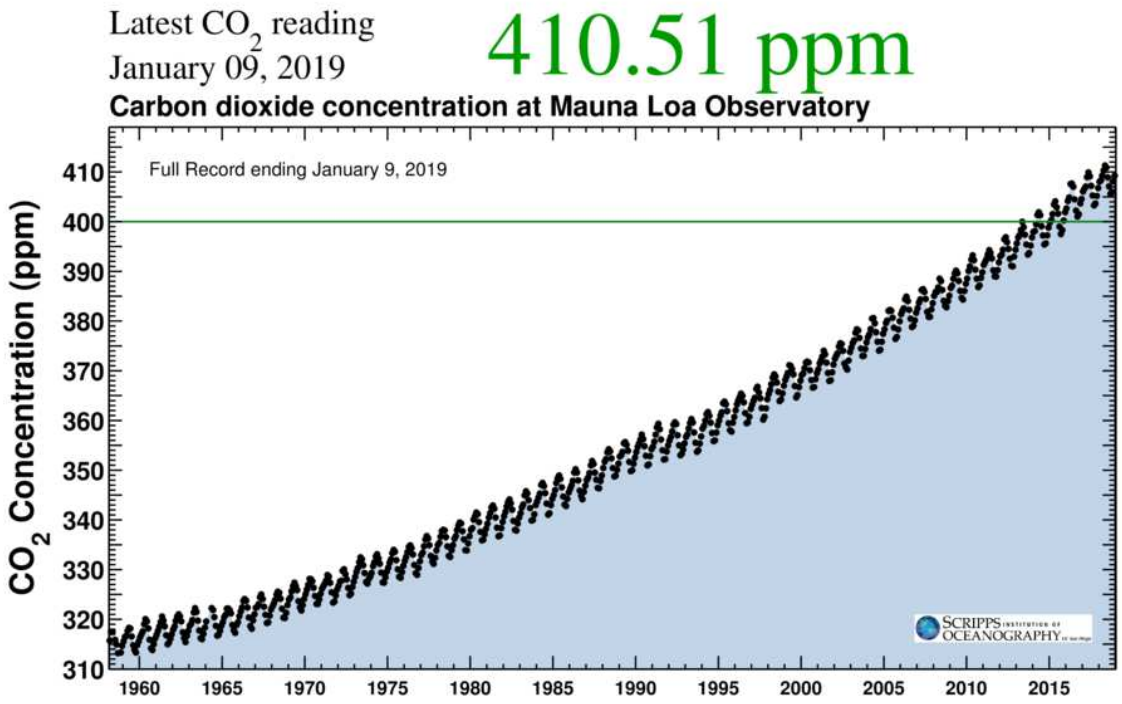
For most of 2018 ocean surface temperatures were normal (30-32ºC). The early part of the year had a *La Niña* in place, then a hiatus, and now heading towards an *El Niño*. Daytime temperatures were high and that heat energy was stored in the deeper ocean beneath a thermocline: this will re-emerge as ENSO flips into the positive phase. State of the Climate report from *WMO* World Meteorological Organisation shows global temperatures rising: continuing the trend of 2015-2017, with 2018 being the cooler of the four years: because of the *La Niña* initially. The world is warming up!




**Australia on 18th January 2019. Some places touched 50ºC; minimum temperatures were 35ºC.**

Tongareva's pristine coral reefs are **at high risk** of a severe impact because bleaching is occurring without an *El Niño* influence.

**Global greenhouse gas emissions continue to rise.** $CO_2$ increased by 3% in 2018, the second year in a row. **Countries should be decreasing their emissions** ~ as they all agreed to at Paris in 2015. Kuki Airani pledged to decrease its emissions 81% by 2030. We see little sign of progress so far.

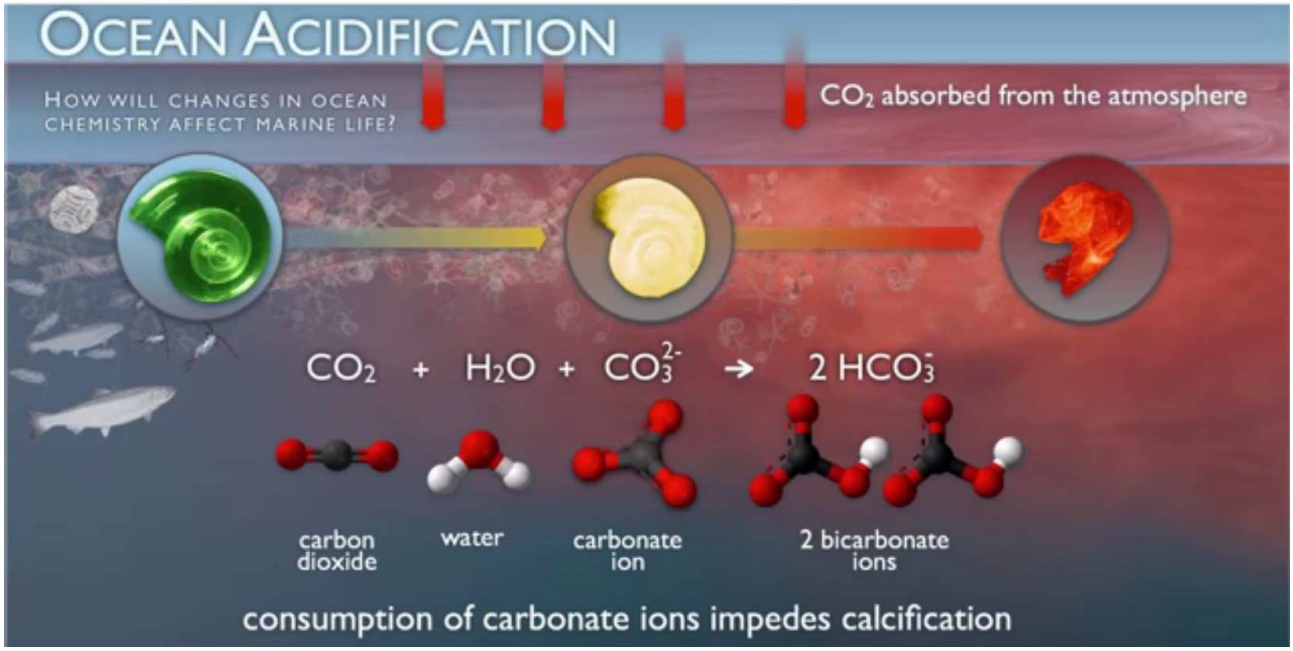



## What can be done?

Probably very little! Humanity seems disinclined to change its polluting behaviour. The reason for inaction appears to be economic. Countries fear to change as they imagine financial difficulties. The environmentally destructive patterns therefore continue: **at whatever cost!** (Open source image below) UN Secretary General Antonio Guterres says the world must reduce its fossil fuel use 25% by 2020 or we are unlikely to achieve the Paris Agreement goals. That is next year!

## Meanwhile at Tongareva …

*Our Lagoon is Our Life*. Imagine how we feel as we watch our atoll's pristine ecosystem collapsing because of problems being caused by the far-away world? This is our food supply. Our homeland is made of coral and that is at risk of dissolving or being unable to rebuild itself.




Although we contribute little to global warming **Hakono Hararanga** decided that we would lead by example and set a sustainable path for others to follow. The first thing we did was calculate our **carbon footprint** so we knew exactly how much $CO_2$ we produce, then we could figure ways to reduce our pollution impact.

### Carbon Emissions

At Tongareva we use the following **Emissions Factors** to calculate our impact (*carbon footprint*):

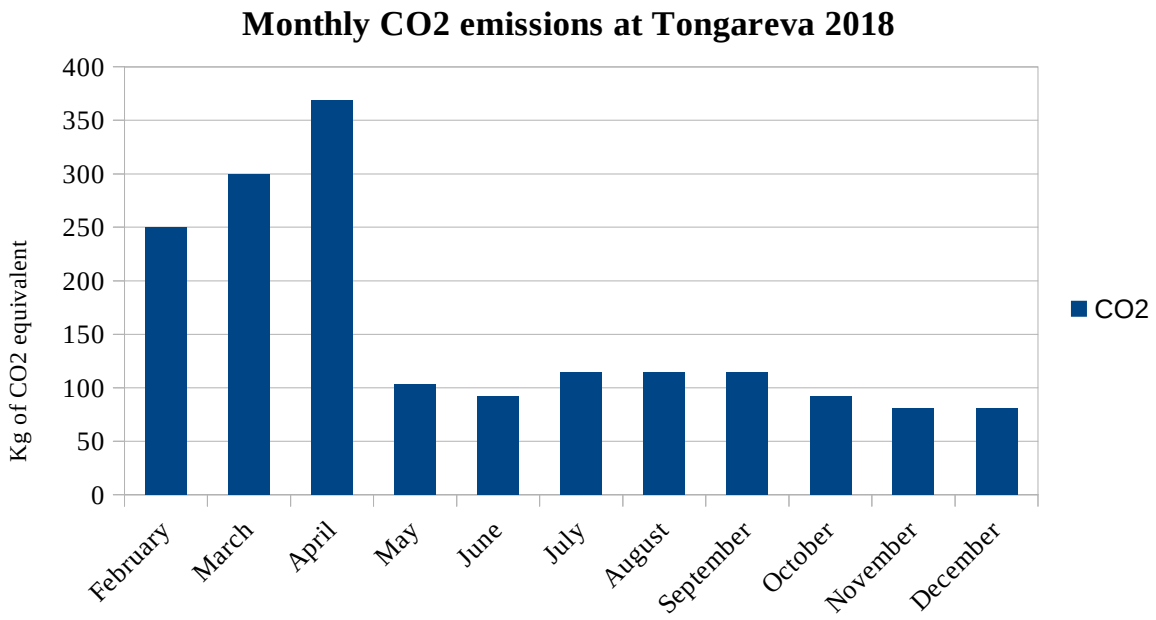
**1 litre jetfuel produces 3.5 kg $CO_2$**
**1 litre diesel produces 2.7 kg $CO_2$**
**1 litre 2-stroke-mixed produces 2.5 kg $CO_2$**
**1 litre petrol produces 2.3 kg $CO_2$**
**1 kg of cooking gas (LPG) produces 1.5 kg $CO_2$**

**The Carbon Footprint is the amount of fuel used × the Emissions Factor**

***Deep Decarbonisation*** requires that we reduce the carbon impact. Three approaches for this are:

1. Use fuel more efficiently
2. Switch to less-polluting fuels
3. Remove $CO_2$ from the atmosphere and ocean

**Fuel efficiency:** can be achieved by planning journeys better: get as many things done as possible in a single trip, walk if somewhere is nearby. Keep machines well maintained. Hakono Hararanga changed to a 4-stroke outboard motor, which reduced fuel use by **60%** ~ and no oil in fuel supply.




**Graph of $CO_2$ emissions (*kg*) during our GEF SGP project so far. We used a 2-stroke outboard February & March, then a 4-stroke from May. April had two community picnic planting days (34 students total).**

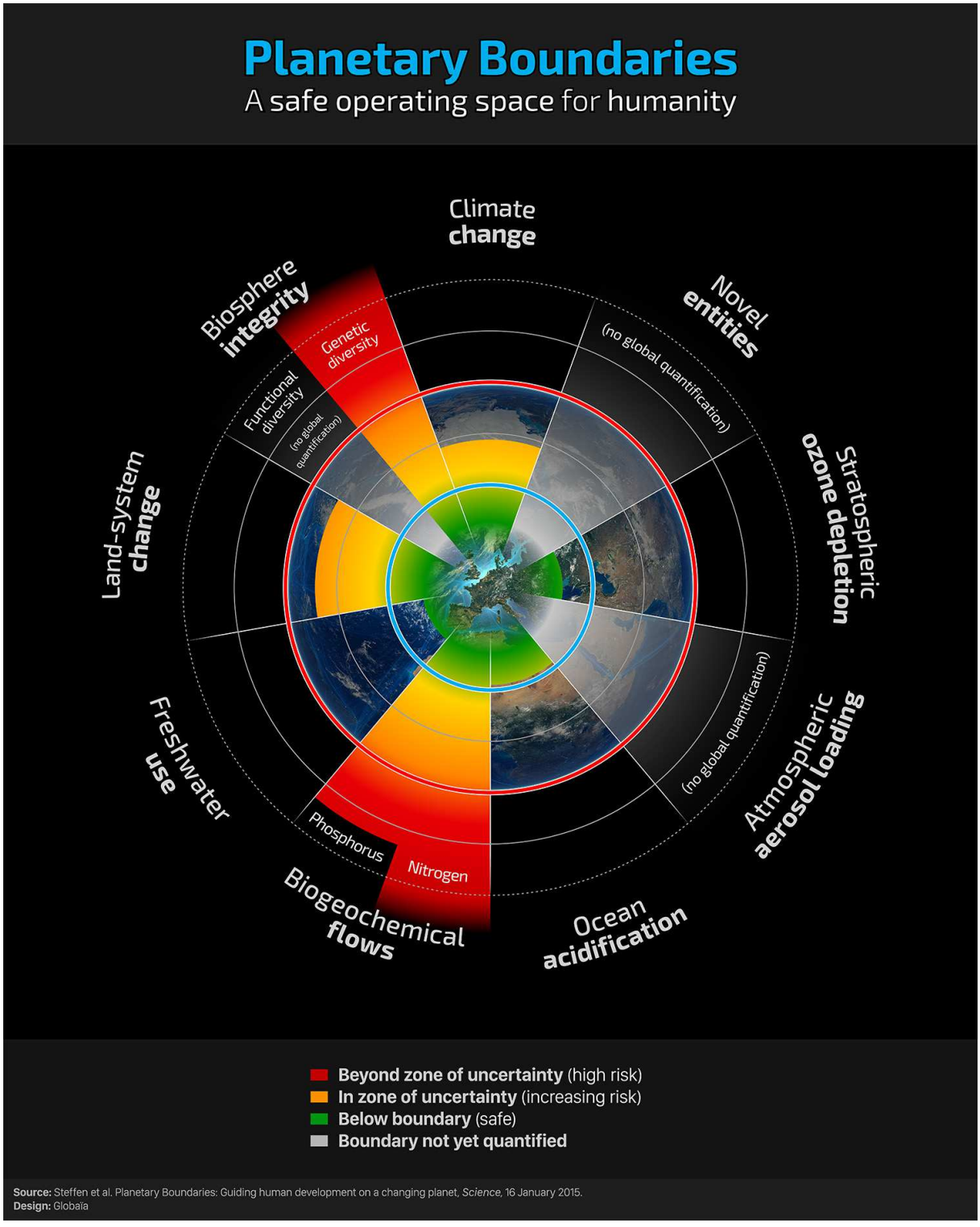
**Fuel-switching:** changing from diesel to a petrol vehicle reduces emissions; LPG is even better. An option is to use *biofuels* (ethanol type made from plants): these can reduce total emissions impact as plants *fix* carbon during their growth phase [It is important to select sustainably-sourced fuels that are not competing with food production]. At Tongareva we got a solar-powered outboard motor and a Storm Rides Electric-scooter: zero-carbon and low-noise too. *Ra umu* & power tools too.


RYOBI
BRUSHLESS
RYOBI
18V
18.0V
90Wh Li-ion (5.0Ah)

**Removing $CO_2$:** Trees convert $CO_2$ into sugars for energy and cell growth using photosynthesis. At Tongareva, Hakono Hararanga has planted over 3000 trees during the last year: further reducing our carbon footprint. *Carbon Capture technology and Sequestration can work in the industrial world.*

## Community Education

Hakono Hararanga continues teaching about climate change and living sustainably. Eco-safe.




**The Planetary Boundaries from the Stockholm Resilience Centre is a useful tool.**


The UN Sustainable Development Goals (SDGs): **Transforming our world: Agenda 2030** is another very practical approach. Hakono Hararanga works with several Goals and various Targets.

## Corals

We will teach CoralWatch methodology to interested islanders, including Hapii Omoka fieldwork. Even if we cannot stop bleaching we can provide robust data, ongoing imagery, and time-lines. This will show the extent of damage and any cascade effect. We will identify any resilient species too.

Our final initiative is to grow new corals with a *microfragmentation* method and we then replenish degraded reefs whenever environmental parameters make it safe to do so.

***

## In Conclusion

The present report is mainly to raise awareness of a severe impending environmental problem. The author will include updates in his upcoming 3-year research report and in monthly GEF SGP reports and will then revisit this document once a clearer story has emerged. Surveys are ongoing.

The world needs to wake up and stop polluting our planet. Reducing $CO_2$ emissions is very easy ~ it just requires intent.

**We leave you with the following message:**

**Plant trees, Save fuel, Stay cool**

**Kia Manuia!**

**Literature Cited**

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White M (*in prep* 2019) Biodiversity and the Challenge of the Anthropocene Era.

Helpful website for ozone etc.
https://ozonewatch.gsfc.nasa.gov/facts/SH.html