# Geyser activity at Geyser Flat, Te Puia, Rotorua: Insights from the second geyser monitoring deployment

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## ABSTRACT

The Rotorua Geothermal System (RGS) covers an area of ~15 km$^2$, with about 1,500 geothermal surface features mapped to date. Geothermal features, including geysers, are a key driver for tourism in Rotorua, and hold significant cultural, economic, and environmental value. Thermal activity in the RGS was in severe decline from the 1960s through to the mid-1980s due to overexploitation. A state of the environment monitoring programme was instated in early 1980s to collect data on the state of the system. However, data on the state of the geysers was ad hoc and not suitable for quantifying the geyser's state of health. A temperature sensor-based monitoring system was developed at Te Tohu and Pohutu geysers and Te Horu pool in 2022 to record temperature spikes from erupted fluids and translate this data into a record of eruptive activity that could be compared to historic periods. The trial was a success, and a second monitoring deployment was undertaken in 2024. This deployment redeployed redundant sensors from Te Tohu and Pohutu to the nearby Mahanga and Waikorohihi geysers, which had recently started erupting again, and added a submerged sensor at 3 m depth in Te Horu pool to investigate basal inflows.

Analysis of data from these deployments confirmed the resumption of activity at Mahanga and Waikorohihi, after two decades of dormancy, and showed that recent geysering at Te Tohu and Pohutu geysers to be amongst the most active on record. The submerged sensor at Te Horu pool provided evidence of a connection to Pohutu-Te Tohu, and confirmed that Te Horu is an active feature in its own right.

The geyser monitoring programme is now integrated to the State of Environment programme for Rotorua, ensuring regular data on the state of geysering activity here is available to inform the future management of the RGS.

## 1. INTRODUCTION

### 1.1 Background

The Rotorua Geothermal System (RGS) covers an area of ~15 km$^2$ and has outstanding surface expression, with about 1,500 geothermal surface features mapped to date (Figure 1). Geothermal features, including geysers, are a key driver for tourism in Rotorua, and hold significant cultural, economic, and environmental value.

Thermal activity in Rotorua was in severe decline from the 1960s through to the mid-1980s due to overuse and wasteful practices, having a significant adverse impact on most geysers and several hot springs (Gordon *et al*., 2005; Cody & Lumb, 1992), and consequently impacting all those community values (Conroy & Te Ahi Kaa Roopu, 2022; BOPRC, 2024).

A Geothermal Taskforce was initiated in the mid-1980s to assess the causes of the decline in geothermal activity and develop remediation actions (Drew *et al*., 1985). Remedial actions included requirements to close most production wells within a 1.5 km radius of the Pohutu Geyser (the 1.5 km Mass Abstraction Exclusion Zone; EBOP, 1999), and the introduction of economic and regulatory instruments / tools to minimise heat and mass (geothermal water) waste at the user end (i.e. through reinjection and increased productive efficiency; O'Shaughnessy, 2000). Activity at most surface features in the RGS has been recovering since, though the recovery in the south of the RGS has been lagging relative to the north (Scott *et al*. 2021).

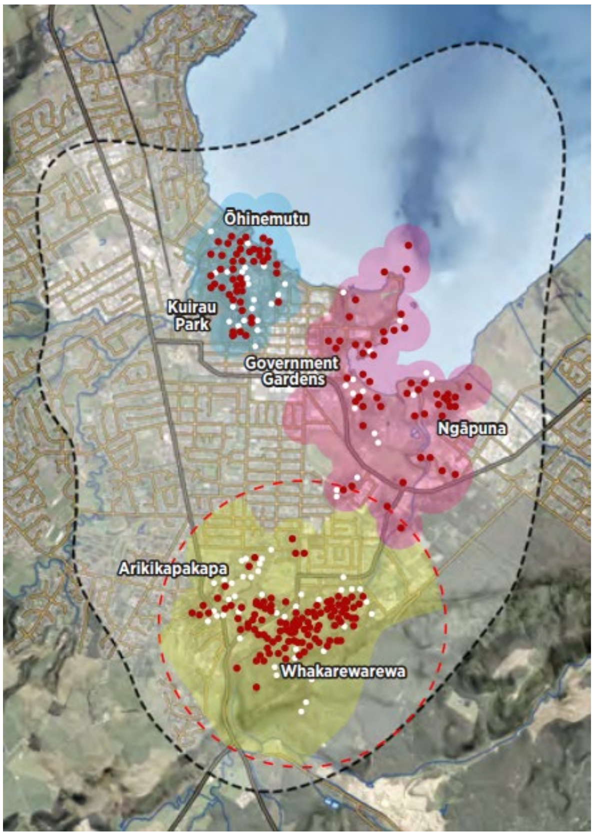


**Figure 1: The Rotorua Geothermal System (black dashed line), showing geothermal surface features (red dots=significant features, white dots=other features). Shaded areas show the Kuirau Park (blue), Ngāpuna (pink), and Whakarewarewa (yellow) management areas. Pohutu, and the other geysers in this study, are located at**

**Geyser Flat in the Whakarewarewa valley, and form the centre of the 1.5 km radius Mass Abstraction Exclusion Zone (red dashed line). Figure from BOPRC, 2024.**

### 1.2 Surface feature monitoring

The Bay of Plenty Regional Council (BOPRC) manages the Rotorua Geothermal System (RGS) under the RMA (various sections), the Rotorua Geothermal Regional Plan (RGRP; EBOP, 1999), and the recently adopted Rotorua System Management Plan - Ngā Wai Ariki o Rotorua (BOPRC, 2024). BOPRC also holds functions under the RMA to report on the state of environment (SOE). SOE reporting is key to understand the state and trend of the natural systems, to inform policies and plans, and to provide information on whether the natural environment is meeting the vision and aspirations of the communities.

A geothermal surface feature monitoring programme (GSFMP) has been underway in Rotorua following the recommendations of the Taskforce in the mid-1980s. The monitoring programme includes visiting 38 selected geothermal surface features on a regular basis (currently bi-monthly) to gather qualitative and quantitative data (BOPRC guideline 2012/03, Scott 2012), including the geysers at Te Puia reported here. However, the data collected as part of this programme are not suitable as an indicator of the geyser's state, or to quantitatively compare their current level of activity to historic periods (Pearson-Grant *et al.* 2015). A dedicated temperature sensor-based monitoring system was developed in 2022 based on insights from earlier trials to collect relevant data of adequate accuracy, consistency and interpretability for environmental monitoring and reporting purposes.

### 1.3 Geyser monitoring

#### 1.3.1 Deployment 1

A geyser monitoring trial was carried out in 2022 focusing on the key geysers in Te Puia, Pohutu and Te Tohu (also known as Prince of Wales Feathers), and Te Horu pool. This trial tested a monitoring system that would enable quantitative data on these geysers state to be acquired, so their activity levels could be recorded over time, and compared to historic levels. Specifically, the trial set out to record:

1. The length of each eruption (minutes per cycle)
2. The frequency of eruptions (number of cycles per day)
3. The percentage of time erupting per day (% per day).

The monitoring system utilised six T16 thermocouple temperature sensors, connected to a CRX1000x datalogger housed in a rugged pelican case away from the geyser vents. Three sensors were positioned near the vent of Te Tohu geyser, and two near the vent of Pohutu geyser on the assumption that water ejected from the geysers during an eruption would have elevated temperatures relative to periods of quiescence. The final sensor was deployed at the outflow of Te Horu pool.

A threshold-based algorithm was developed (with guidance from observational data) to translate this temperature into a record of eruptive activity based on the three indicators outlined above.

The trial encountered some issues, but was ultimately a success, and ~12 weeks of eruptive activity was recorded between October 2022 and July 2023 (Keats *et al.*, 2023a, Keats *et al.*, 2023b).

#### 1.3.2 Deployment 2

The monitoring network was deployed again on the 3-4th April 2024, with a temperature sensor deployed again near the vents of Te Tohu and Pohutu geysers, and at the outflow of Te Horu pool. Sensors were also deployed at 3 m depth in Te Horu pool to investigate basal inflows to this feature, and in the flooding pools around Waikorohihi and Mahanga geysers, where activity had been observed in 2023 during site visits for the GSFMP (pers. comm. with various guides/Te Puia staff; Brakenrig *et al*., 2024).

The Te Tohu sensor was moved to a suboptimal position on the 5th of April, but was moved back to the correct position on the 24th of April. The monitoring network otherwise operated without issue, and ~9 weeks of data was collected before being removed on the 10th of June 2024 (Reeves *et al*., 2024).


**Figure 2: Aerial image of Geyser Flat, showing the layout of the temperature sensor network for Deployment 2. Yellow circles mark the sensor locations, black lines the connecting wires, and the orange rectangle the pelican case containing the datalogger and batteries.**

## 2. DATA AND ANALYSIS

### 2.1 Data

#### 2.1.1 Temperature data

Temperature data for the six thermocouples was recorded with their associated timestamps in TOA5 format text files, with temperature values sampled every 5 seconds, and a datapoint logged every 30s as the mean of the previous six samples.

#### 2.1.2 Observational data

Visual observations of eruptive activity at the monitored geysers were manually logged during both deployments to record the start, end, and the type of eruptive activity at each geyser vent.

At Te Tohu and Pohutu the logged activity types included:

- "pre-play" – referring to the start of an eruptive period where small amounts of fluid are sporadically ejected.
- "eruption" – where greater volumes of fluid are persistently ejected.
- "full-column eruption" – the most active phase of an eruption at Pohutu, where fluids are ejected several metres into the air in a steady stream.

During Deployment 1 observational datasets for these geysers were recorded on the 7th, 9th and 10th of October 2022, and the 29th of June 2023. During deployment 2 an observational dataset was recorded on the 18th of April 2024.

At Mahanga and Waikorohihi the nature of eruptions is slightly different, and the types of recorded activity were: “small splashing”, “large splashing”, and “erupting”.

Observational data was recorded at both geysers on the 8th of April 2024, and a second dataset recorded at Mahanga on the 15th of April 2024.

### 2.2 Geyser eruption algorithm

A threshold-based eruption algorithm was developed for each geyser to translate the temperature data into a record of eruptive activity.

To determine whether a geyser is transitioning from an inactive to an active (i.e., eruptive) state based on the temperature data, we consider two aspects of the data: 1) The recorded temperature ($T$, in °C), and 2) the change in temperature relative to the previous reading ($\Delta T$, in °C).

If both $T$ rises above a threshold value, and $\Delta T$ is also positive and above a threshold value, an eruption is likely to have started. Conversely, if $T$ falls below a threshold value, and $\Delta T$ is also negative and below a threshold value, the eruption is likely to have ended (Figure 3). The thresholds for each sensor were set to be between the background and eruptive temperatures, and were determined through trial and error by comparing the performance of the algorithm during the observational periods to observed eruptive activity.

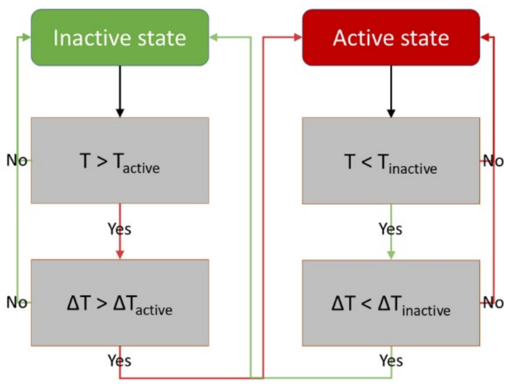


**Figure 3: Flowchart showing the logical framework of the geyser eruption algorithm.**

This framework was used to develop eruption algorithms for Te Tohu and Pohutu geysers during Deployment 1 (Keats *et al.*, 2023b), and these algorithms were used again for Deployment 2. The framework was also applied to develop eruption algorithms at Mahanga and Waikorohihi geysers.

The duration of eruptions at Mahanga were observed to be very short, often lasting less than a minute. This meant aliasing became an issue in analysing the data acquired here, as the eruption frequency was often less than the Nyquist frequency (2 x sampling frequency = 60 s), and the results from our algorithm should be treated with caution.

At Waikorohihi this framework worked very well, with temperature spiking from 25 to 80°C during observed eruptions and remaining there for the duration of the eruption. The algorithm developed for this site utilised an asymmetric temperature threshold, with a single measurement above 45°C and an associated $\Delta T$ greater than 5°C required to switch from an inactive to active state. A single reading below 55°C and an associated $\Delta T$ of less than -5°C was required to switch back to an inactive state.

## 3. RESULTS

The monitoring results from Deployment 2 showed that temperature ranges and eruptive patterns at the features monitored during Deployment 1 remained generally unchanged.

For Te Tohu the recorded temperatures ranged from 40-85°C, with eruptive activity continuing to lead activity at Pohutu. For Pohutu the temperatures ranged from 20-75°C, with eruptions following Te Tohu’s lead. The Te Horu pool sensor again recorded temperature spikes when Pohutu was in eruption, as erupted fluids flowed into the pool, causing it to overflow.

### 3.1 Algorithm performance

#### 3.1.1 Te Tohu (Prince of Wales Feathers)

During Deployment 2 the sensor at Te Tohu was initially positioned in a different place compared to Deployment 1, and the recorded temperatures were slightly lower during this period, ranging from 30-75°C. Once it was re-positioned correctly the temperature range increased to 40-90°C, similar to Deployment 1.

The observational data was acquired on the 18th of April, while the sensor was incorrectly positioned. Despite this the algorithm appeared to still work well (Figure 4), though data from this period was not included in subsequent analysis as a precaution.

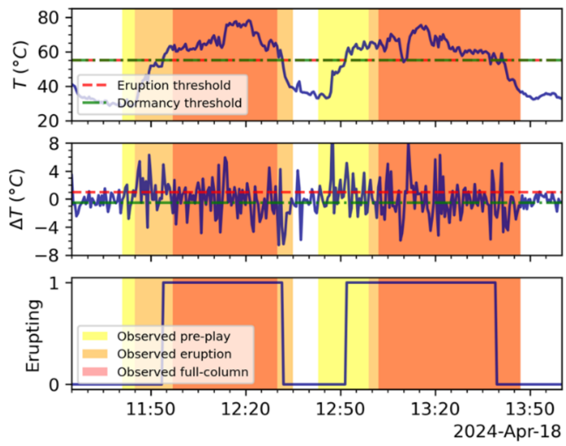


**Figure 4: Temperature ($T$), change in temperature ($\Delta T$), and the algorithmically assessed eruptive state at Te Tohu geyser during the observational period on 18 April 2024. The sensor was positioned incorrectly during this observational period, but the algorithm still performed well. The eruption and dormancy T thresholds are identical and therefore plot on top of each other in this figure.**

#### 3.1.2 Pohutu

The temperature data recorded at Pohutu during Deployment 2 showed temperatures ranged from 20-75°C, similar to Deployment 1. An anomalous period of low temperatures was recorded from the 8-13th of April, and a downwards drift in mean temperatures was noted from the 6th of June.

An analysis of the data during the observational period on the 18th April showed the algorithm for this sensor continued to work well (Figure 5).

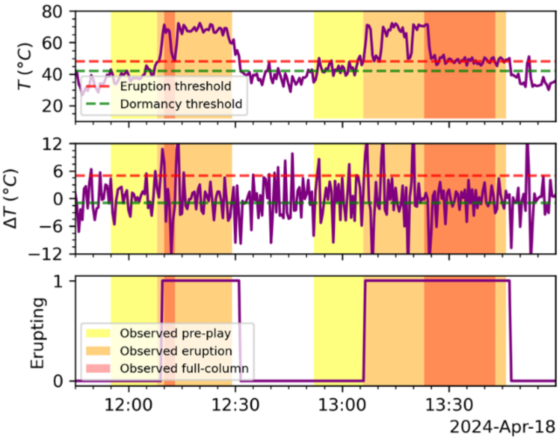


**Figure 5: Temperature (*T*), change in temperature (Δ*T*), and the algorithmically assessed eruptive state at Pohutu geyser during the observational period on 18 April 2024.**

### 3.1.3 Mahanga

The temperatures recorded at Mahanga were variable, ranging from 15-85°C, with a mean of 30°C, for the first few weeks of the deployment before narrowing to 10-45°C for the remainder of the deployment, with a mean of 20°C.

Developing an algorithm for this sensor was difficult due to the variable background temperatures. A 30-minute moving average temperature threshold was used as a threshold as a result, with a single reading 7°C above this value required to switch from an inactive to active state, and three consecutive readings less than 1°C above it to switch back to inactive.

Due to the aliasing issue here the algorithm struggled to capture the nature of eruptive activity at Mahanga. While eruptive periods were generally captured by the algorithm, it did a poor job of flagging individual eruptions (Figure 6). This means that while the percentage of each day spent in eruption should be a rough approximation of true activity, the eruption length and eruption frequency calculated from this algorithm will not be good reflection of true activity at this geyser.

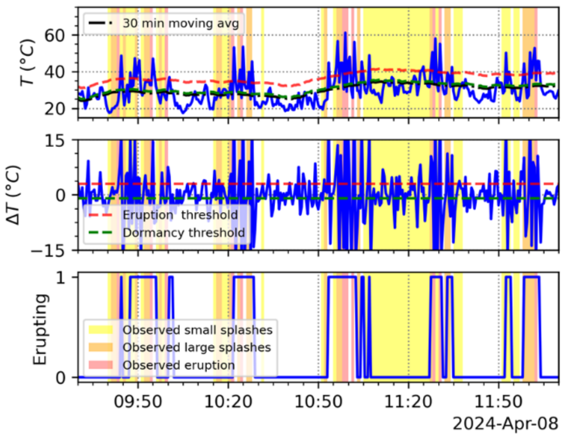


**Figure 6: Temperature (*T*), change in temperature (Δ*T*), and the algorithmically assessed eruptive state at Mahanga geyser during the observational period on 8 April 2024.**

### 3.1.4 Waikorohihi

The temperature data recorded at Waikorohihi showed some minor variation. The range of temperatures recorded remained relatively consistent, at 15-90°C, with a mean of 40°C. However mean temperatures increased by 15°C from the 8-14th of April, and a drifted downwards by 5°C from then until the 21st of May. Anomalous drops in temperature were then observed from the 21-23rd May and from the 26 May to the 8th of June, with the recorded temperature range narrowing to 15-30°C, and the mean dropping to 20°C.

The algorithm developed for this sensor required a single measurement over 45°C, with a Δ*T* great than 5°C, to switch from an inactive to active state, and a single measurement below 55°C, with a Δ*T* less than -5°C to switch back to inactive.

This algorithm performed very well, with an analysis of the data acquired during the observational period on the 8th of April showing that eruptions manifested themselves very clearly in the temperature data (Figure 7).

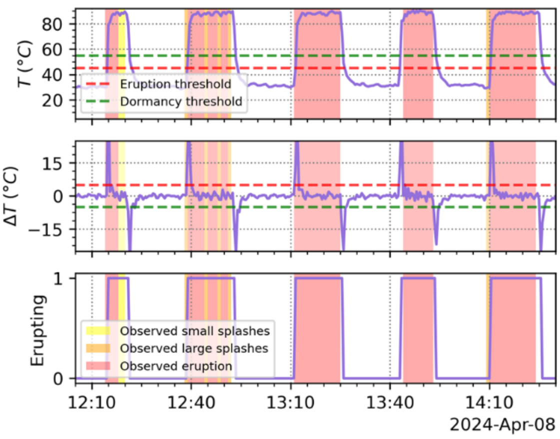


**Figure 7: Temperature (*T*), change in temperature (Δ*T*), and the algorithmically assessed eruptive state at Pohutu geyser during the observational period on 8 April 2024.**

### 3.2 Te Horu pool

Two sensors were deployed at Te Horu Pool during Deployment 2, an overflow sensor at the outflow of the pool (in the same place as during Deployment 1), and a submerged sensor at 3 m depth.

Temperatures recorded on the submerged sensor remained generally stable throughout the deployment, oscillating in the range 60-66°C, except for some anomalous temperature drops from the 8-13 April, and on the 6th and 8-10th of June. The temperatures recorded on the overflow sensor were much more variable, ranging from 20-70°C. Anomalous temperature drops were recorded on the same dates as the submerged sensor. The higher temperatures recorded on the overflow sensor are likely a result of Pohutu eruptions, which regularly reach 75°C.

The presence of basal inflows was investigated by analysing the data recorded by the Te Horu and Pohutu sensors, including during observed eruptions on the 18th April (Figure 8). This showed the temperature oscillations on the submerged sensor were on longer time scale to Pohutu eruptions. Eruptions at Pohutu (particularly full column eruptions) were almost always accompanied by a sharp change in temperature on the submerged sensor (usually a decrease), and/or a change in the temperature trend.



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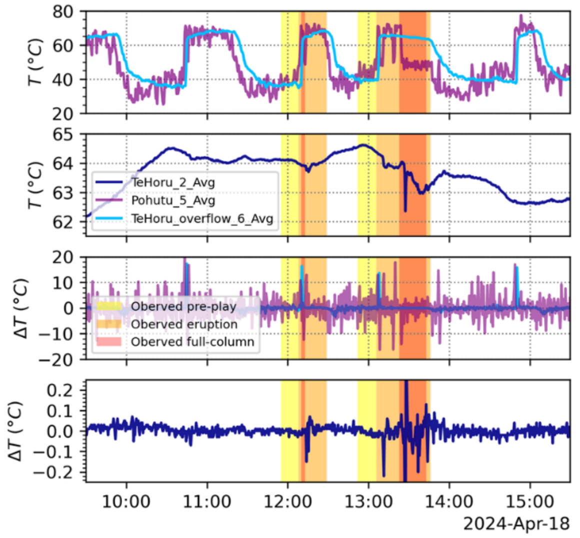


**Figure 8: Te Horu pool submerged sensor record (TeHoru_2_Avg, dark blue) compared with the overflow sensor (TeHoru_overflow_6_Avg, light blue) and Pohutu (Pohutu_5_Avg, purple) during the observational period on 18 April 2024.**

### 3.3 Eruption statistics

Daily eruption statistics, derived from the outputs of the eruption algorithms at each geyser sensor, are shown for Te Tohu and Pohutu in Figure 9, and for Mahanga and Waikorohihi in Figure 10.

At Te Tohu the number of eruptions per day remained consistent, at around 20, for most of the deployment but dropped off notably from late May. The mean eruption duration also remained consistent, at around 55 minutes, but increased notably from late May. The percentage of day in eruption also remained consistent for most of the deployment, at around 70% of the day, but this again changed notably from the end of May, with an initial increase in activity followed by a dramatic drop off towards the end of the deployment.

At Pohutu a similar pattern was evident. The number of eruptions per day counts remained constant, at around 20, for most of the deployment but became more erratic and decreased from the end of May. Eruption durations remained consistent, at around 26 minutes, for most of the deployment, but gradually dropped off from the end of May. The percentage of the day in eruption hovered around 36% of the day for most of the deployment, and dropped down to zero towards the end of the deployment.

At Mahanga the eruption count was very erratic, likely due to the aliasing issues, ranging from 6 to 130 eruptions per day. The mean eruption duration remained consistently low, with a mean of 2 minutes, though the aliasing issues will likely impact this metric too. The percent of the day in eruption, expected to be the most reliable statistic computed at this sensor, was variable, initially remaining consistent at around 25% of the day until the 25th of May before decreasing and becoming more erratic for the remainder of the deployment.

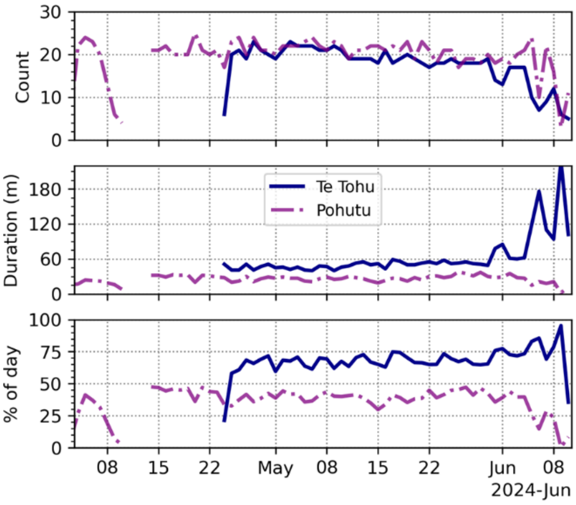


**Figure 9: Eruption statistics at Te Tohu and Pohutu geysers, derived from temperature data and eruption algorithms during Deployment 2. "Count" refers to the number of eruptions per day, "duration" the mean daily eruption duration (in minutes), and "% of day" the percentage of the day spent in an eruptive state.**

At Waikorohihi the number of eruptions per day remained around 40 for most of the deployment, though there was an anomalous period from 26 May to 6 June where this dropped down to close to zero. The mean eruption duration was more variable, with 15-minute mean eruption duration periods recorded around the start and end of the deployment, but this dropped to around 7 minutes in the intervening period. The percent of the day in eruption remained close to 25% for most of the deployment, aside from a period of increased activity from the 8-15 April, and reduced activity during the anomalous period between the 26 May and 6 June.

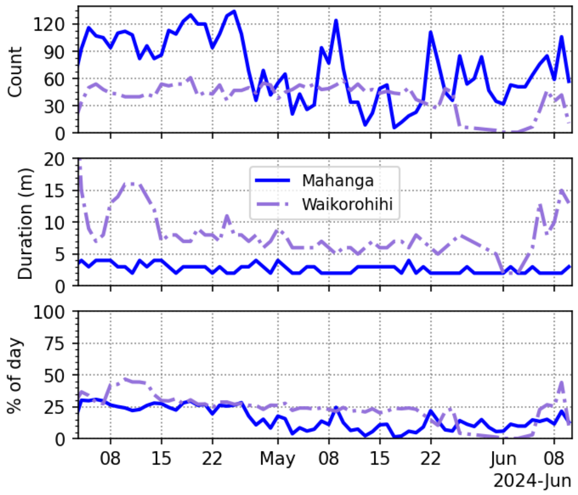


**Figure 10: Eruption statistics at Mahanga and Waikoroghihi geysers, derived from temperature data and eruption algorithms during Deployment 2. "Count" refers to the number of eruptions per day, "duration" the mean daily eruption duration (in minutes), and "% of day" the percentage of the day spent in an eruptive state.**

## 4. DISCUSSION

The eruption framework, and the algorithms developed for Te Tohu and Pohutu geysers (Keats *et al*., 2023b), have proven to be robust, and continued to work well throughout Deployment 2. The framework was successfully extended to develop an algorithm for Waikorohihi geyser. The extension of this framework to develop an algorithm for Mahanga proved to be challenging however (mostly due to the aliasing issues), yielding only limited useful results.

With two recent eruption datasets now available, it is possible now to start to more reliably define the current state of the geysers in Te Puia and, over time, monitor and report on changes and compare current and recent activity to historical records.

### 4.1 Te Tohu geyser

Eruptive activity from Te Tohu was first documented after the 1886 Tarawera Rift eruption. This geyser is known as “the indicator” as it always commences activity before Pohutu.

The results show minor changes in eruptive patterns between Deployment 1 (2022-2023) and Deployment 2 (2024). The mean daily eruption count increased slightly, from 17-18 to around 20, the mean eruption duration remained around 55 minutes (excluding the anomalous period at the end of Deployment 2), and the percent of day in eruption increased slightly, from 64 to 68%.

Historical records show Te Tohu erupted 25–35% of the day during the 1950–1970s. From 1992, it began erupting almost continuously, with 95% of the day spend in eruption (Scott *et al*. 2005). Since 2001, it has developed a cyclic eruptive pattern, like Pohutu, with active periods interspersed with periods of dormancy (Gordon *et al*., 2001). The percentage of the day spent in eruption during recent monitoring is around 64–68%, placing recent activity between the exploited 1950–1970s period and the recovering, highly active 1990s.

### 4.2 Pohutu geyser

Records of activity at Pohutu geyser go back to the 1800s. Activity before the 1886 Tarawera eruption was reportedly very infrequent, and slightly increased afterwards (Cody and Lumb 1992). From the 1900–1940 period, it was active around 5–8% of the day with long periods of inactivity commonly observed. By the 1970s, activity increased to around 30% of the day. From the 1970s a shift in its eruptive pattern was noted, with eruptions becoming shorter and more frequent, and full-column activity becoming rare until many years after the bore closure programme was instigated in 1986.

From March 2000 to April 2001, it played continuously, and since then has settled into its current pattern of longer and more frequent full-column eruptions and dormant periods in-between (Gordon *et al.*, 2001). Over Deployments 1 and 2 (2022-2024) it erupted for 36–45% of the day, which indicates that Pohutu is now active for more of the day than in any previously recorded period.

Eruption durations at Pohutu for periods dating back to 1900 are presented in Cody and Lumb (1992) and reproduced in Figure 11. They show that while early activity (1900–1920s) may have been infrequent, they often lasted over an hour, longer than in any subsequent recorded period. A consistent distribution of eruption durations then developed, with most lasting 15–30 minutes, and very few less than five minutes. From 1982 onwards, this pattern changed with short eruptions (0–10 minutes) becoming most common and a secondary group lasting around 20 minutes. Eruption durations obtained during recent (2022-2024) monitoring (Figure 12) show that eruptions now generally last for longer than in any periods since the 1920s, with the most common duration being 40–50 minutes (Deployment 1) and 20–40 minutes (Deployment 2). Short eruptions (<10 minutes) are still not uncommon though, highlighting the importance of long periods of continuous monitoring for robust results.

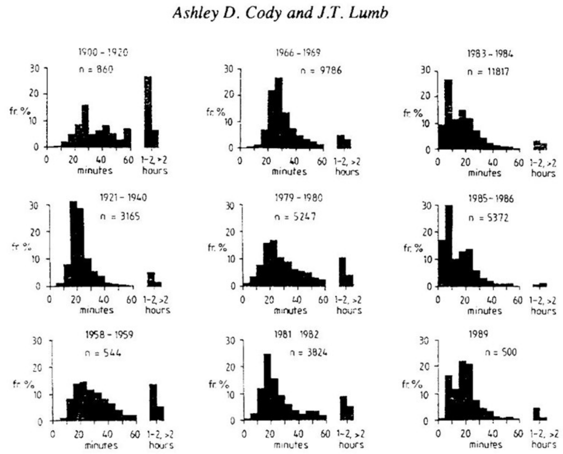


**Figure 11: Histograms of historical eruption durations at Pohutu. Histogram time periods and number of eruptions (n) are indicated above each graph. From Cody and Lumb (1992).**

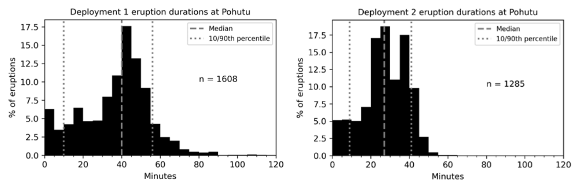


**Figure 12: Histograms of eruption durations at Pohutu during Deployment 1 (2022-2023) and Deployment 2 (2024).**

### 4.3 Mahanga geyser

Mahanga Geyser (also known as Boxing Glove Geyser) has records dating back to 1961 (Lloyd 1975). During the 1980s, eruptions occurred for 20–23% of the day, with eruptions of 13–20 seconds duration every 60–80 seconds. Eruptions were reportedly shorter and less frequent when Pohutu and Waikorohihi were in eruption (Scott *et al*. 2005). Around 800 eruptions per day were recorded during the 1990s, but from 1999 to 2001, eruptions gradually became less frequent and, with exception of a couple of eruptions in late March 2002, the geyser became inactive (Gordon *et al.* 2005). Regular activity was reported by Te Puia guides/staff and noted during routine monitoring in 2023 (Brakenrig *et al*. 2024).

This geyser was incorporated into the monitoring system during Deployment 2 (Reeves *et al*., 2024). The aliasing issue (Section 2) means that values obtained for the number of eruptions per day and eruption duration during this deployment are likely not reliable. The values obtained for the percentage of the day in eruption are likely more reliable. While this was around 25% during the first ~3 weeks, the mean for the whole deployment was 16%, indicating activity levels are likely lower than in the 20-23% estimated for the 1980s (Scott *et al*., 2005).

### 4.4 Waikorohihi geyser

Waikorohihi has records of activity dating back to the 1880s, with large eruptions up to 13 minutes long recorded. It was previously considered to be an interconnected feature with Pohutu and Te Tohu (Cody and Lumb 1992). During the 1960s and 1970s, it erupted 12–20 times per day, with eruptions lasting 25–45 minutes. During the 1980s, it erupted 12–15 times per day, with 55–65% of the day spent in eruption. Its behaviour changed from 1986, following the bore closure program, with long periods of dormancy (20–36 hours) becoming common (Cody and Lumb 1992). Eruptive activity decreased during the 1990s, with eruptions becoming shorter and less common, though there were periods of heightened activity as well, with 150 eruptions per day being recorded on several occasions (Gordon *et al*., 2005).

No eruptions were observed at Waikorohihi while Pohutu was in continuous eruption from March 2000 until April 2001, and eruptions have since become rare (Gordon *et al*., 2005). Like for Mahanga, regular activity was reported by Te Puia guides/staff and noted during routine monitoring in 2023 (Brakenrig *et al*. 2024), and it was incorporated as a monitored feature during Deployment 2 (Reeves *et al*. 2024).

Analysis of this data shows that it has become a consistently active geyser again, with a mean of 42 eruptions per day recorded. This is higher than in any period previously recorded, except for some sporadic eruptions in the 1990s. Eruptions currently tend to be shorter than what was historically reported, with a median eruption duration of 6 minutes, though there is wide variability and long eruptions are not uncommon. The percentage of the day spent erupting, at 25%, is notably lower than the 55-65% reported during the early 1980's however (Scott *et al*., 2005).

### 4.5 Te Horu Pool

Various states of activity have been recorded at Te Horu pool, including geysering up until 1972 (Scott *et al*., 2005). The 'plumbing' of this feature is considered interconnected with Pohutu-Te Tohu (Cody and Lumb, 1992). Overflows have a strong correlation with eruptive activity at Pohutu, however it was also historically assumed that basal inflows played a role due to this connection.

Analysis of the data acquired on the submerged sensor, showed that sharp changes in temperature and/or changes in trend are common during Pohutu eruptions. This confirms the connection to Pohutu-Te Tohu, and supports the assumption that basal inflows are present at this feature, confirming that this feature is not just passively discharging erupted water from Pohutu that falls back into Te Horu.

## 5. CONCLUSIONS

Geysering activity at Geyser Flat, Whakarewarewa, is recovering strongly, with records of activity at Te Tohu and Pohutu obtained during monitoring Deployments 1 and 2 (2022-2024) showing that current activity levels are amongst the highest in their recorded history.

Activity is also confirmed to have resumed at Mahanga and Waikorohihi geysers, after two decades of dormancy. While aliasing issues limited the analysis at Mahanga, in general activity at these geysers was lower than historical records, suggesting further increases in activity levels may occur in the future.

The analysis also confirms the presence of basal inflows at Te Horu pool, providing evidence of a connection to Pohutu-Te Tohu that had long been assumed to exist and confirming that this feature is not just passively discharging erupted water from Pohutu but is an active feature in its own right.

The geyser monitoring programme is now integrated to the regular State of Environment programme for Rotorua, ensuring regular data on the state of geysering activity here is available to inform the future management of the RGS, and that the programme stays relevant under the current production settings, pressures and anticipated changes. These findings help to inform the analysis of the effectiveness of the current policies and support the evidence-base for the review of the Rotorua Geothermal Regional Plan (BOPRC Plan Change 11, currently at drafting stage).

A geyser system coming back to life due to effective environmental management is a rare thing, and these authors are not sure that a precedent for such a feat exists anywhere in the world. These results are testament to the commitment, sacrifice, dedication, and long-term vision of everyone who made it happen over the last 40 years.


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