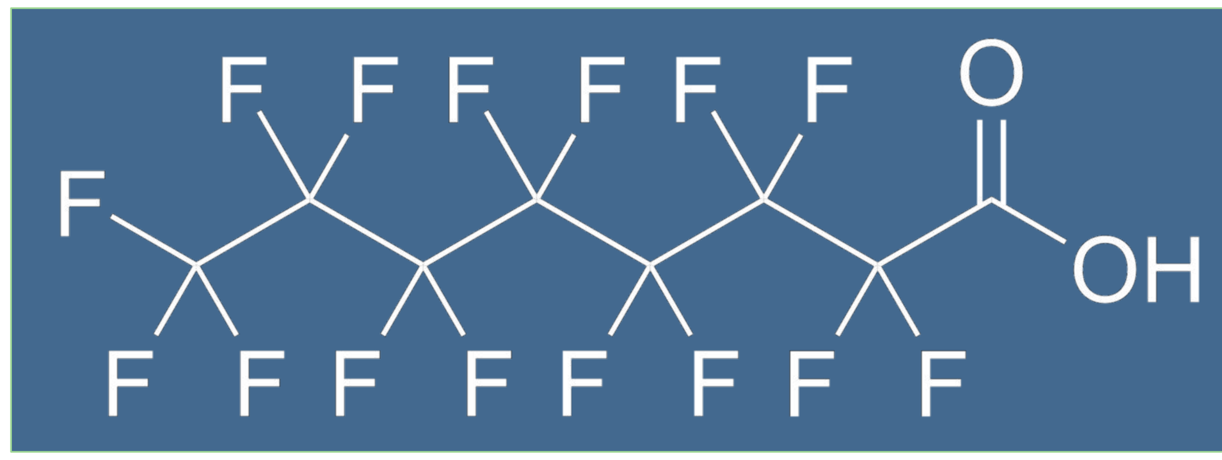
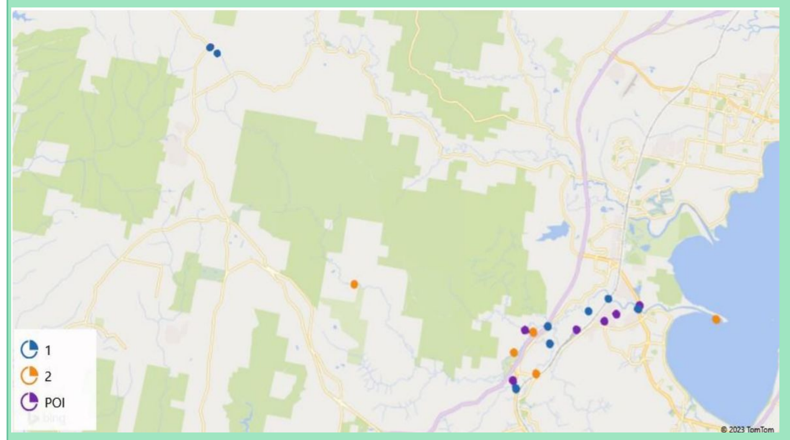


Does the concentration of PFAS vary at different distances from possible points of origin?

Abstract

The ramifications of per- and poly-fluoroalkyl substances (PFAS) use are an increasingly relevant concern to society where the effects appear to be worse than previously thought. Recent developments show that PFAS contamination is at the forefront of many communities' lives, with government assistance and remediation appearing to be symbolic gestures. This poster explores if there is a difference in PFAS levels across two zones. It was hypothesised that the concentration of PFAS would be higher in Zone 1 (less than 1.5km from a possible origin source) than Zone 2. Samples were collected from the Ourimbah catchment and analysed at Envirolab Sydney for a range of PFAS including perfluorooctanesulfonic acid (PFOS). Although no statistical significance was discovered between test sites and possible origin sources, valuable inferences can be made that can be used as a tool to undertake further research into PFAS.

Figure 1
Map of Test Sites and Possible Origin Sources



Blue indicates those locations in Zone One, orange indicates those in Zone Two, and purple indicates points of interest (POI) that PFAS may originate. (Ourimbah Creek Catchment)

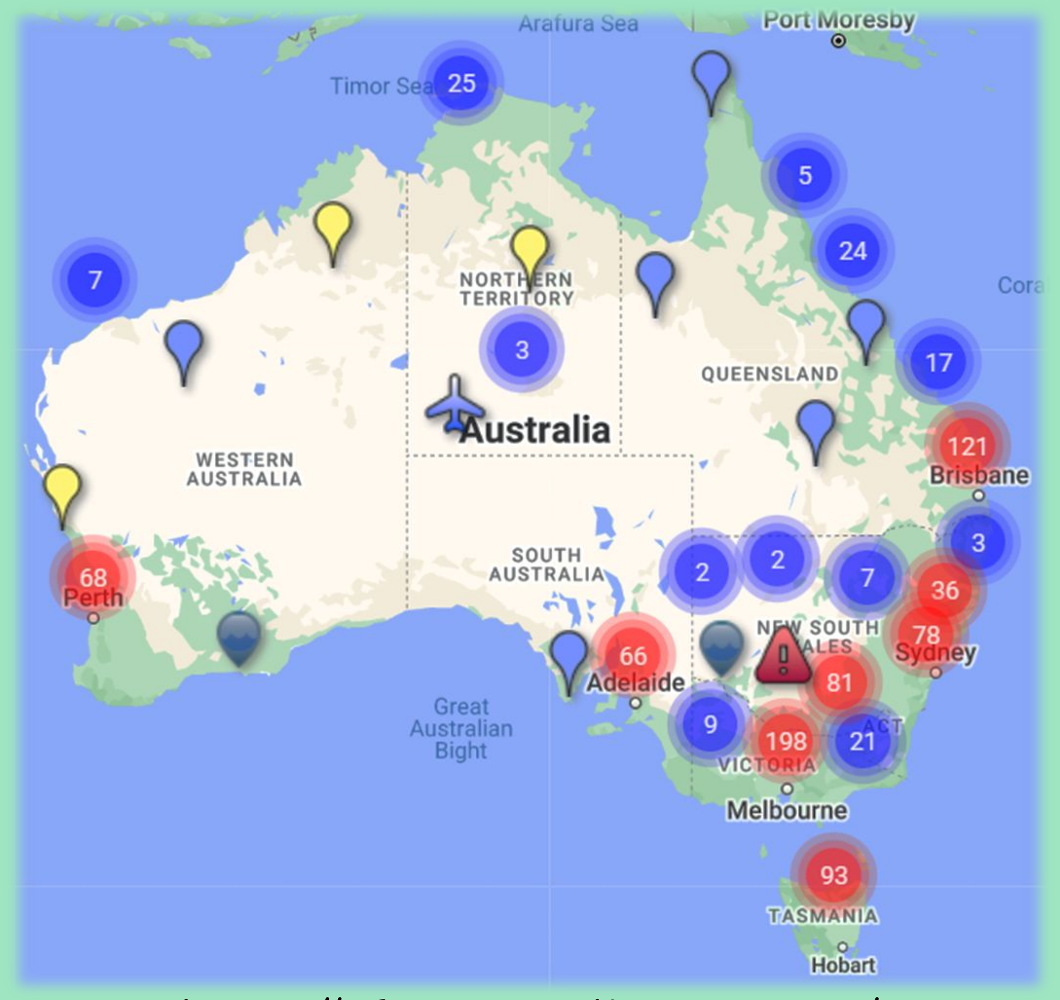
Background Information

PFAS are an emerging class of chemicals that contain over 4000 different compounds. They were invented for their heat-resistant properties in the 1930s and have been widely used since the 1950s. These compounds were highly prevalent in aqueous film forming foams (AFFFs) and were used in common household products such as non-stick pans. Recent developments suggest that PFAS is linked to reproductive, developmental, and immunological effects in both humans and animals (Department of Health, 2020). This has prompted the introduction of regulation such as the Protection of the Environment Operations (General) Amendment (PFAS Firefighting Foam) Regulation 2021 which bans the use of PFAS in firefighting foam unless used by a relevant authority in special circumstances.

PFAS' persistence in the environment is attributed to its unique chemical properties such as its strong carbon-fluorine bonds, and hence low reactivity. Sources of PFAS pollution include fire stations, factories, airports, and military bases. Figure 2 shows the extent to which PFAS has contaminated Australia, with one such example being the Williamtown RAAF base. Here, a defense representative indicated that significant remediation is being undertaken, such as PFAS removal at wastewater treatment plants, the excavation of affected sites, and continual monitoring of contaminated areas. Due to the Ourimbah Catchment containing a number of possible origin sources, the level of PFAS contamination should be investigated in order to determine its level of contamination, and whether remedial actions are required.

Figure 2
Australian PFAS Chemicals Map

Showing the severity of contamination throughout the country.



https://pfas.australianmap.net/

Hypothesis

Alternate hypothesis: The concentration of PFAS is different in Zone One compared to Zone Two

Null hypothesis: The concentration of PFAS is not different in Zone One compared to Zone Two.

Method

Testing of Both Sediment and Water Samples

- Samples were collected using a judgmental method in 100 mL polypropylene containers (Figure 1)
- Samples were measured in the laboratory (2.5mL for Water / 5g for Sediment)
- Added basic methanol solution (2.5mL for Water / 10mL for Sediment)
- Combined in a vortex mixer (30 seconds)
- Sonicated (15 minutes) for water only; Tumbled end over end (1 hour) for sediment only
- Centrifuged (3 minutes at 5000 rpm)
- Added 10 mL of neat acetic acid to reduce pH
- Filtered in a 0.2µm polypropylene syringe into 2mL vials
- Soil and water sample extracts were analysed for a range of PFAS using liquid chromatography-tandem mass spectrometry
- A t-test was conducted on the sediment samples.

Results

PFOS and its isomers were the only compound with detectable concentrations (Table 1). A graph of the mean concentration of PFOS within the two zone locations shows that the concentration was higher in Zone 1, although the error bars do crossover (Figure 3). A t-test was conducted and showed that $t(8)=0.999$ and $p=0.347$. For those concentrations of less than 0.1µg/kg, the statistical analysis assumed a concentration of 0.05µg/kg (Table 2).

Table 1: Sediment

Sample Location	PFOS (µg/kg)
Zone 1 (< 1.5km from POI)	
M1 Bridge	< 0.1
Lees Bridge	< 0.1
Hereford/Chittaway	0.4
Orchard Road	< 0.1
Dog Trap Gully	0.1
Finns Road	0.2
Kulnura RFS	0.1
Bridge Road	1.8
Zone 2 (> 1.5km from POI)	
Palmdale Bridge	< 0.1
Canada Drop Down Creek	0.1
Footts Road	< 0.1
Howes Road	0.4
Palmgrove	< 0.1
Ourimbah Creek Entrance	< 0.1

Figure 3: Mean concentration of PFAS within zone locations.

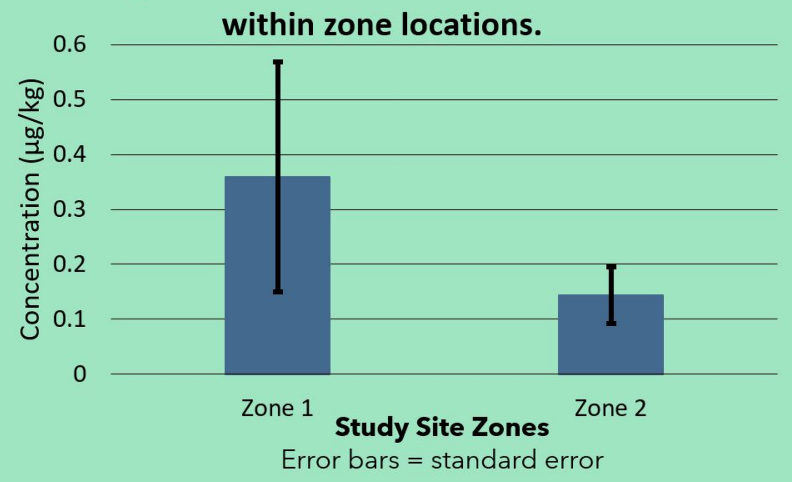


Table 2:	Zone 1	Zone 2
Mean	0.359	0.143
Standard Deviation	0.592	0.126
Standard Error	0.209	0.051
Study Sites	8	6
df	8	
t Stat	0.999	
P(T<=t) two-tail	0.347	
t Critical two-tail	2.306	

Analysis

PFAS' persistence and general spread is of concern to key stakeholders such as residents and the environment. A t-test was used to show whether there was a significant difference between the concentration of PFAS within different zone locations. The results showed that $t(8)=0.999$ and $p=0.347$, meaning that there is no statistical significance between the concentration of PFAS at different zone locations ($p>0.05$). As such, the null hypothesis could not be rejected. Despite no statistical significance, scientific significance was observed. The t-test suggests that the concentration is largely independent of its origin source, leading to social and environmental concerns. These same trends correlate with observations made by Barlow et al, (2019) of PFAS' tendency to travel due to various factors, such as solubility.

Since 2021, PFAS contamination has been an increasingly prevalent social concern. This is evident through government payouts, with $132.7 million being payed to 30 000 complainants in May, 2023 (ABC, 2023). This represents the imperative to become PFAS free. In spite of this, the t-test results imply that monetary compensation alone will not suffice to fully restore those affected, emphasising the need for ongoing monitoring and health effect control.

PFAS testing is extremely expensive, with costs of approximately $250 per sample. As such, the judgemental sampling method used was a limitation. Ideally, a systematic method would have been used so as to analyse samples from the entirety of the creek. This could allow for more accurate results to be obtained, therefore improving the strength of inferences made.

Conclusion

This study aimed to determine if the concentration of PFAS was different at varying distances from possible points of origin, particularly within the Ourimbah catchment. Samples were collected at varying points throughout the catchment, with consideration of factors such as likelihood of contamination affecting the chosen sites. The investigation found that there was little evidence for differing concentrations, as the results indicated that there was no statistical significance between the variables. As such, the null hypothesis could not be rejected. This highlights the dangers of PFAS in contaminating the environment, where the distance from the point of origin is not a strong influence on its concentration. Future research into bioaccumulation, a half-life, and points of origin should be considered as they are imperative to further understanding PFAS and its potentially detrimental effects on the environment, animals, and people.

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