ANALYSING THE IMPACT OF MINING ON CHLOROPHYLL LEVELS

Introduction

Environmental monitoring is an essential aspect of modern mining operations, as mining activities can have critical impacts on the surrounding ecosystem. In this report, we analyse the bimonthly chlorophyll measurements of *Imaginaria Flora* provided by a mining company to determine whether their mining activity has had any effect on the health of the plants surrounding their mine site.

Methodology

The data contains chlorophyll levels of 46 plants found within 50m of the site and 93 plants further than 50m. These levels were measured every two months from November 2016 to November 2022, with mining commencing in June 2017.

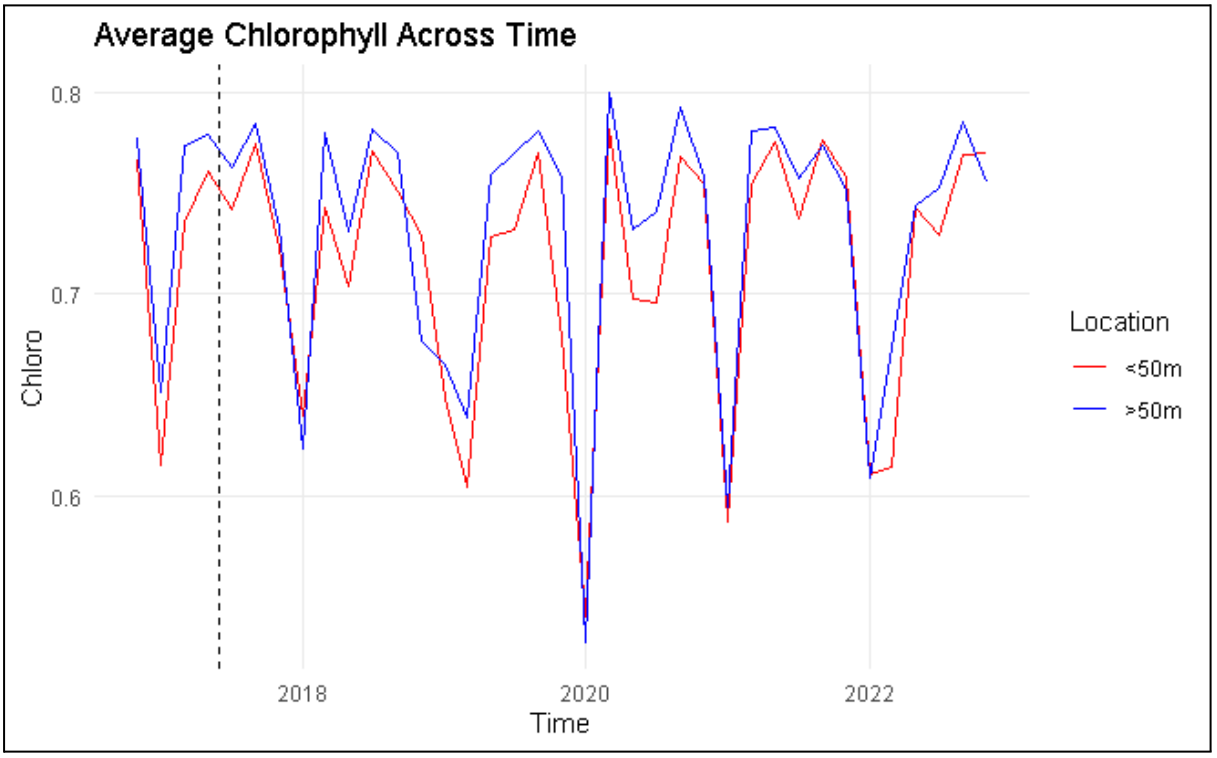
Initial inspection of the dataset shows the hallmark oscillations typical of time series pattern, fluctuating chlorophyll levels around the 0.7 mark. These data characteristics suggest that the data might be better suited for a time series analysis, rather than a conventional linear approach.

Reverse forecasting of the time series was then conducted considering the shorter pre-mining period. This involves using the data after mining intervention to predict chlorophyll levels before intervention. The difference between the forecasted and actual values will then be analysed to gauge the impact of the mining activity.

Forecasting was done using the commonly used ARIMA model that assumes the levels are stationary over time. Specifically, the auto.arima() library in R was utilised to automate the model selection process. Finally, Ljung-Box test was performed to check whether the residuals from the ARIMA models were white noise.

Results

1. Exploratory Analysis



Our initial exploration of the average lines reveals time series patterns, with most values oscillating around 0.7, marked by periodic declines at the start of each new year. Notably, January 2020 had the lowest average, 0.5, deviating by 0.1 from other years.

Both time series for near and far plants exhibit similar, seasonality-driven shapes without distinct trends or changing variance. Additionally, a comparison of line patterns before and after mining (dotted line) activities shows no discernible difference, suggesting that mining has had minimal impact on the overall chlorophyll time series shape.

2. Forecasting Errors

Plants	May 2017	March 2017	January 2017	November 2016
Near (<50m)	0.0613	0.0505	0.1000	0.0610
Distant (>50m)	0.0528	0.0630	0.0982	0.0570

We found that the auto.arima() models produced accurate backcast predictions, with the observed values falling within the 80% prediction interval. In detail, the average prediction error (RMSE) for nearby plants was 0.0682 and for distant plants was 0.0677. These fairly low differences further indicate that mining does not significantly affect the plants' chlorophyll levels, neither near nor far.

Model diagnostics using Ljung-Box test also yielded positive results, with almost all the ARIMA models producing white-noise residuals except for one. This shows that the models are an adequate fit for the data.

However, there is an evident rise in error in the January 2017 prediction. This specific juncture marks the occurrence of the early-year decline as established from our previous analysis. A deeper dive into the forecasting results reveals that the auto.arima() models tend to produce constant outcomes from the second forecasting point onward.

This implies that either the models have overfit, or the time series lack a strong enough temporal pattern, or a combination of both. This absence of a robust pattern can be seen in the average line graph, which, while exhibiting seasonal declines, lacks a discernible pattern leading up to and following these declines. A more expansive dataset is needed to address these issues.

Conclusion

Our analysis of the bimonthly chlorophyll measurements has not revealed any discernible impact of the mining activity on the health of *Imaginaria Flora* in the area. These findings suggest that the mining company's environmental management practices are effective in minimising their impact on the surrounding ecosystem.

However, we recognize that this conclusion is contingent on our limited dataset and on the assumption that the effect of mining on the ecosystem is consistent, which may not be the case for different mining activities or in the long term. Future studies should consider including other contributing factors such as the type of mining activity, soil quality, and weather conditions to gain a more comprehensive understanding of the impact of mining on the health of plants.