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ANALYZING THE MULTIFACETED FACTORS INFLUENCING GLOBAL MICROPLASTIC EMISSIONS: A REGRESSION STUDY

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Introduction

Microplastics, tiny plastic particles smaller than 5 millimeters, pose a pressing environmental challenge (United States Environmental Protection Agency, 2023). Recent studies, such as the one revealing microplastics in the human heart (Badgamia, 2023), emphasize the gravity of this issue. A study in the Physics of Fluids journal also quantified than on average, we inhale up to 16.2 microplastic particles per hour, equivalent to a credit card's size in just a week (Badgamia, 2023). The ubiquity of microplastics calls for comprehensive research on their sources and impact. The research endeavors to investigate the influence of annual global plastic waste recycling and variations in average global temperature anomalies on microplastic emissions in surface waters. It seeks to ascertain whether statistically significant relationships exist between microplastic emissions and global plastic waste recycling, as well as changes in average global temperature anomalies. The primary objectives are to comprehensively assess the impact of these two variables and to quantitatively evaluate the relationships between microplastic emissions and the selected independent variables using rigorous regression analysis.

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Methodology

This research employs **multiple linear regression** (OLS method) to explore connections among key variables: global plastic waste recycling (PWR), average global temperature anomalies (ATEMP), and microplastic concentrations in ocean waters (M). It hypothesizes that increased recycling reduces microplastic emissions, while rising global temperatures contribute to higher microplastic levels due to climate change factors. Data from 1988 to 2015, sourced from OurWorldInData, undergoes preprocessing, including cleaning, addressing serial correlation, multicollinearity, and heteroskedasticity. Residual distribution is tested for normality, and transformations are applied when needed. The regression analysis employs logged variables for enhanced robustness and interpretability.

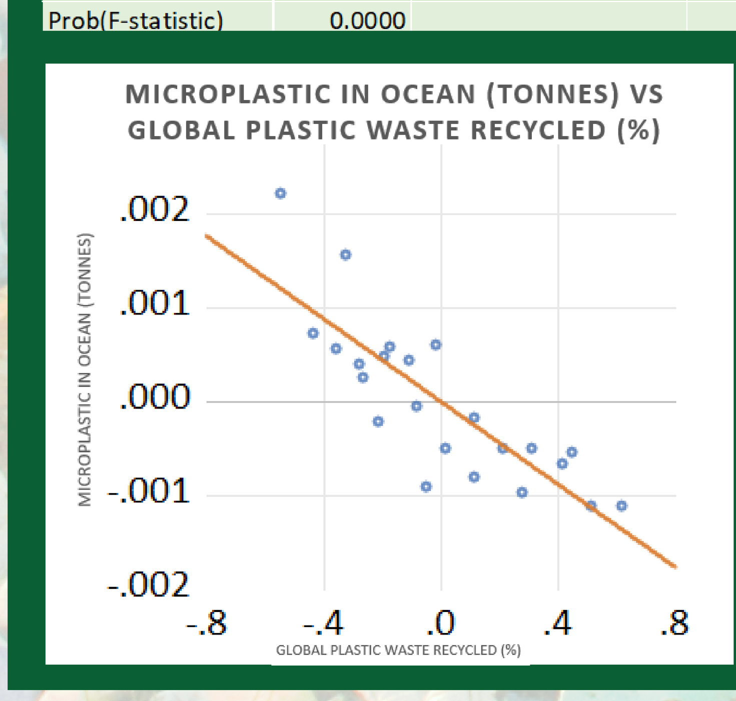
Model Specification

An econometric model was employed to investigate connections between the key factors. This model, expressed as " $LM_t = \beta_0 - \beta_1 LPWR_t + \beta LATEMP_t + \varepsilon_t$ " helps us understand how global plastic recycling (PWR) and changing global temperatures (ATEMP) affect microplastic levels. Past studies (Gabisa et al., 2023; Kakar et al., 2023) highlight recycling's potential to reduce microplastic emissions and the impact of climate change on plastic persistence, suggesting a significant relationship between global temperature and microplastics. To ensure the reliability of this regression analysis, stationarity tests were conducted on each of the key variables. Augmented Dickey-Fuller (ADF) unit root tests was utilized with various model configurations with and without constants and trends.

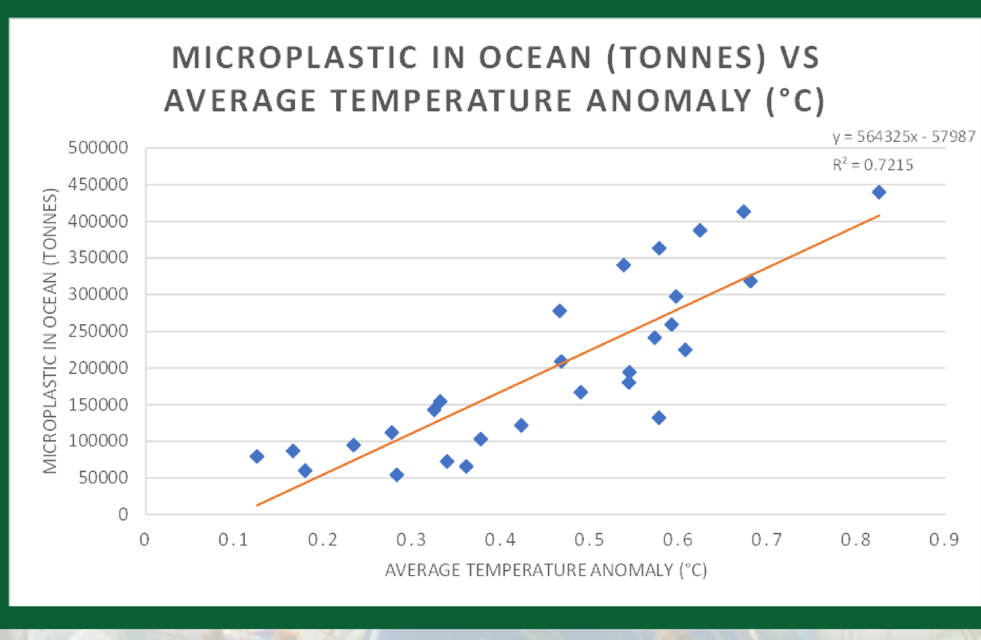
Analysis

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LPWR2I	-0.00223	0.000363	-6.150722	0.0000
LATEMP	7.97E-05	0.000433	0.184175	0.8558
C	0.162677	0.01739	9.354686	0.0000
LM(-1)	0.986492	0.00051	1936.009	0.0000
R-squared	0.999999	Mean dependent var		12.07578
Adjusted R-squared	0.999999	S.D. dependent var		0.515648
S.E. of regression	0.000513	Akaike info criterion		-12.15415
Sum squared resid	5.01E-06	Schwarz criterion		-11.95667
Log likelihood	143.7727	Hannan-Quinn criter.		-12.10449
F-statistic	7396847	Durbin-Watson stat		1.421926
Prob(F-statistic)	0.0000			

- LPWR2I (Logged and Interpolated Global Plastic Waste Recycled): The coefficient of -0.002230 (SE=0.000363) with a p-value of 0.0000 indicates a highly significant and negative relationship between global plastic waste recycling and microplastic concentrations. In simpler terms, as recycling increases, microplastic levels decrease (t-statistic = -6.15, p-value < 0.05, 95% confidence interval).
- LATEMP (Logged Average Global Temperature Anomalies): The coefficient of 7.97E-05 (SE=0.000433) and p-value of 0.8588 suggests a less significant and positive relationship between average global temperature anomalies with microplastic concentrations.
- Constant (C): The constant term has a coefficient of 0.162677 (SE=0.017390), representing the baseline microplastic concentration.
- Model Fit: The model exhibits an excellent fit (adjusted R-squared = 0.999999), explaining almost all variation in microplastic concentrations.
- The Durbin-Watson statistic is 1.421926, indicating that there is no significant serial correlation present in the model's residuals.



- This scatterplot shows the connection between microplastic concentrations and global plastic waste recycling efforts.
- The negative slope of the scatterplot line signifies a clear relationship: as global plastic recycling increases, microplastic concentrations in ocean waters tend to decrease.
- This confirms the intuitive assumption that effective recycling can significantly reduce microplastic pollution.



- This scatterplot shows the relationship between microplastic levels in ocean waters and global temperature anomalies over time.
- As global temperatures rise, there is an increase in microplastic concentrations in surface ocean waters.
- The positive slope of the scatterplot line indicates that as temperatures increase, so do microplastic levels.

Conclusion

It is evident from this study that increased recycling is a robust strategy for curbing microplastic pollution. The findings affirm the established influence of global temperature anomalies on microplastics, emphasizing the importance of climate change mitigation in the fight against microplastic pollution. However, it is crucial to acknowledge the study's limitations. Data availability challenges, especially for 'Global Plastic Waste Recycled,' necessitated interpolation, introducing minor uncertainties. The macro-level focus of this study may overlook local variations and specific pollution drivers. Overfitting is a potential concern, necessitating caution in applying the model to situations marked by significant changes. Additionally, it is worth noting that this model adheres to the seven classical assumptions required for Ordinary Least Squares (OLS) estimators to be considered the best available. Lastly, **correlation does not imply causation**, and unaccounted variables may contribute to microplastic emissions. These findings bolster the case for policy initiatives and global efforts to enhance recycling and combat climate change.

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