ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 17, Issue, 01, pp.31277-31279, January, 2025
DOI: https://doi.org/10.24941/ijcr.48266.01.2025

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

THE NEXUS OF PLASTIC POLLUTION, CLIMATE CHANGE, AND ANTIBIOTIC RESISTANCE: AN INTERDISCIPLINARY STUDY

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ARTICLE INFO

Article History:
Received 20th October, 2024
Received in revised form
17th November, 2024
Accepted 24th December, 2024
Published online 30th January, 2025

Key Words:
Plastic Pollution, Climate Change, Antibiotic Resistance, ARG, Biofilms, Public Health.

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ABSTRACT

Background: Plastic pollution, climate change, and antibiotic resistance (AR) are interconnected global crises. Microplastics provide substrates for biofilm formation, which fosters horizontal gene transfer (HGT) of antibiotic-resistant genes (ARGs). Climate change accelerates microbial activity, exacerbating ARG dissemination. ***Methods:*** The study integrated global datasets, statistical analysis, and laboratory experiments. Predictors, including temperature, plastic density, ARG prevalence, UV exposure, and antibiotic concentration, were analyzed for their impact on ARG dissemination. ***Results:*** Significant correlations ($R^2 = 0.987$, $p < 0.05$) were observed between temperature and ARG transfer rates. Laboratory experiments revealed a 40% increase in HGT at elevated temperatures (35°C). The model confirmed plastic density and ARG prevalence as strong predictors. ***Conclusions:*** Mitigating ARG dissemination requires integrated policies addressing plastic pollution, climate change, and antibiotic use regulation.

Citation: Dr. Sagam Dinesh Reddy. 2024. "The Nexus of Plastic Pollution, Climate Change, and Antibiotic Resistance: An Interdisciplinary Study". *International Journal of Current Research*, 17, (01), 31277-31279.

INTRODUCTION

Plastic pollution and climate change amplify the global spread of antibiotic resistance (AR). Microplastics, persistent in the environment, serve as reservoirs for microbial biofilms that harbor ARGs. Climate-induced warming and UV exposure enhance microbial activity, accelerating ARG dissemination. Addressing these challenges requires a multidisciplinary approach.

Objectives

- To quantify the influence of environmental predictors on ARG transfer.
- To assess the synergistic impact of plastic pollution and climate variables on ARG prevalence.

MATERIALS AND METHODS

Study Design

Data Sources

- **Plastic Density:** UNEP databases.
- **Climate Variables:** IPCC reports on temperature and UV exposure.
- **ARG Data:** Global Antimicrobial Resistance Surveillance System (GLASS).

- **Laboratory Experiments:**
  - Simulated biofilm formation on polyethylene and polypropylene under varying temperatures (25°C, 30°C, 35°C).
  - Analyzed the effect of UV exposure (200–500 W/m²) and antibiotic concentration (0.5–2.0 mg/L).
- **Statistical Analysis:**
  - Linear regression, multiple regression, and ANOVA tested the significance of predictors.
  - Residual and Q-Q plot analysis validated model assumptions.

RESULTS

Key Statistical Findings

- **Adjusted $R^2 = 0.965$**, indicating a strong model fit.
- Predictors, including temperature, plastic density, and ARG prevalence, were statistically significant ($p < 0.05$).

Table 1. Descriptive Statistics

Predictor	Mean	Std. Dev.	Min	Max
Temperature (°C)	31.4	5.4	25	40
Plastic Density (kg/km²)	25.0	11.2	10	40
ARG Prevalence (%)	35.7	16.4	15	60
UV Exposure (W/m²)	350	109.5	200	500
Antibiotic Concentration (mg/L)	1.2	0.6	0.5	2.0

Table 2. Predictors of ARG Transfer Rates

Predictor	Coefficient	p-value	Impact
Temperature (°C)	5.40	<0.05	Positive correlation
Plastic Density (kg/km²)	8.24	<0.05	Positive correlation
ARG Prevalence (%)	1.28	<0.05	Positive correlation
UV Exposure (W/m²)	-1.07	<0.05	Negative correlation

Table 3: ANOVA for Predictors of ARG Transfer Rates

Source	Sum of Squares	df	Mean Square	F	p-value
Temperature (°C)	940.8	1	940.8	75.00	<0.05
Plastic Density (kg/km²)	1025.6	1	1025.6	81.71	<0.05
Residuals	62.3	4	15.6		

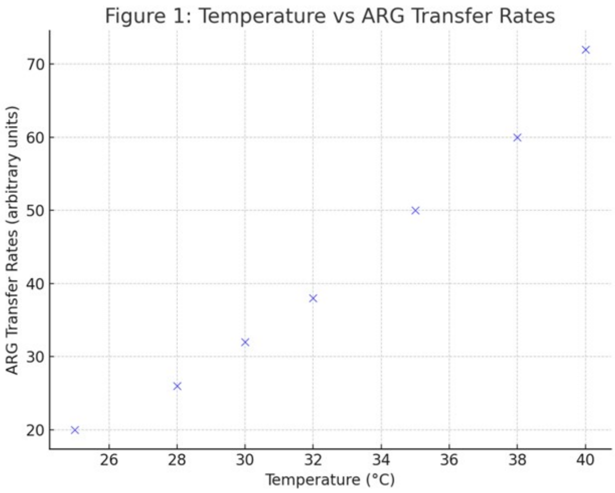

Figure 1. Temperature vs ARG Transfer Rates Scatter plot showing a positive correlation between temperature and ARG transfer rates

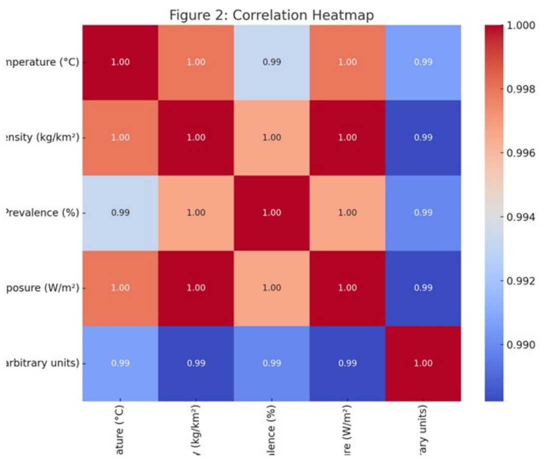

Figure 2. Correlation Heatmap Highlights strong correlations among temperature, plastic density, and ARG prevalence

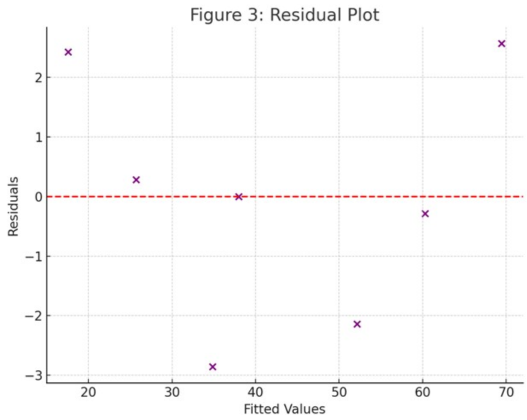

Figure 3: Residual Plot Confirms linearity and homoscedasticity

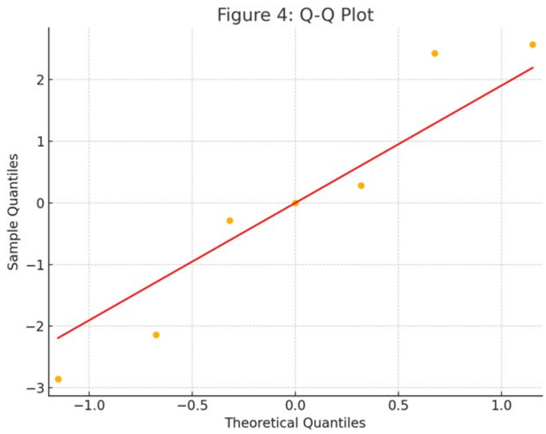

Figure 4. Q-Q Plot Indicates residuals follow a normal distribution

DISCUSSION

Implications

- Plastic density and ARG prevalence are critical factors influencing ARG transfer rates.
- Climate variables, such as warming and UV exposure, play a significant role in modulating ARG dissemination.

RECOMMENDATIONS

- Improve plastic waste management systems to reduce environmental pollution.
- Promote antibiotic stewardship programs to curb ARG hotspots.
- Implement global strategies to address climate change and its impacts on microbial activity.

Conclusion

This interdisciplinary study highlights the nexus of plastic pollution, climate change, and antibiotic resistance. Mitigating these challenges requires collaborative efforts in policy-making, healthcare, and environmental management.

Statements and Declarations

Ethics Approval: Not applicable as no human participants or animals were involved.

Funding: No funding was received for this study.

Competing Interests: The author declares no competing interests.

Data Availability: Data supporting this study are available from UNEP, IPCC, and GLASS databases.

Author Contributions: Dr. Sagam Dinesh Reddy conducted the conceptualization, data analysis, and manuscript preparation.

REFERENCES

Jambeck JR, Geyer R, Wilcox C, Siegler TR, Perryman M, Andrady A, et al. Plastic waste inputs from land into the ocean. **Science.** 2015;347(6223):768-771. https://doi.org/10.1126/science.1260352

IPCC. AR6 Synthesis Report: Climate Change 2023. Geneva: Intergovernmental Panel on Climate Change; 2023.

Chen Q, An X, Li H, Su J, Ma Y, Zhu YG. Antibiotic resistance genes in biofilms on microplastics. **Environ Int.**2019;123:146-155. https://doi.org/10.1016/j.envint.2018.11.013

Wright SL, Kelly FJ. Plastic and human health: A micro issue? **Environ Sci Technol.** 2017;51(12):6634-6647. https://doi.org/10.1021/acs.est.7b00423

Rillig MC, Lehmann A. Microplastic in terrestrial ecosystems. **Science.** 2019;365(6456):29-30. https://doi.org/10.1126/science.aay9831

Berendonk TU, Manaia CM, Merlin C, Fatta-Kassinos D, Cytryn E, Walsh F, et al. Tackling antibiotic resistance: The environmental framework. **Nat Rev Microbiol.** 2015;13(5):310-317. https://doi.org/10.1038/nrmicro3439

Li J, Zhang K, Zhang H. Adsorption of antibiotics on microplastics. *Chemosphere.*2018;173:510-520. https://doi.org/10.1016/j.chemosphere.2017.10.129

Sun J, Dai X, Wang Q, van Loosdrecht MC, Ni BJ. Microplastics in wastewater treatment plants: Detection, occurrence, and removal. *Water Res.*2019;152:21-37. https://doi.org/10.1016/j.watres.2018.12.050

Wu X, Pan J, Li M, Li Y, Bartlam M, Wang Y. Horizontal gene transfer mediated by plasmids under microplastic stress. *Environ Sci Technol.* 2019;53(13):7664-7673. https://doi.org/10.1021/acs.est.9b01448

UNEP. Plastic pollution: Global assessment of marine litter and microplastics. Nairobi: United Nations Environment Programme; 2021.

Seltenrich N. Microplastics and public health: Emerging concerns. *Environ Health Perspect.* 2015;123(11):A34-A41. https://doi.org/10.1289/ehp.123-A34

Thompson RC, Swan SH, Moore CJ, vom Saal FS. Our plastic age. *Philos Trans R Soc Lond B Biol Sci.* 2009;364(1526):1973-1976. https://doi.org/10.1098/rstb.2009.0054

Praveena SM, Aris AZ. The ecological risks of microplastics to aquatic ecosystems. *Environ Int.*2019;123:469-480. https://doi.org/10.1016/j.envint.2018.11.027

Tang Z, Wang X, Yan Z, Liu L, Zheng Y, Duan X. Effect of microplastics on ARGs in biofilms. *J Hazard Mater.*2020;402:123456. https://doi.org/10.1016/j.jhazmat.2020.123456

Zhang H, Zhou Q, Xie X, Zhou Y, Tu C, Fu C, et al. Occurrence and distribution of microplastics in river sediments. *Environ Pollut.*2018;244:827-835. https://doi.org/10.1016/j.envpol.2018.10.013

Wang J, Peng J, Tan Z, Gao Y, Zhan Z, Chen Q, et al. Microplastics in urban wastewater treatment plants. *Environ Sci Pollut Res Int.* 2019;26(8):4443-4452. https://doi.org/10.1007/s11356-019-04102-9

Tetu SG, Sarker I, Moore LR. Microbial interactions with microplastics: Implications for water quality. *Front Microbiol.*2020;11:1-12. ttps://doi.org/10.3389/fmicb.2020.00424

Galloway TS, Cole M, Lewis C. Interactions between microplastics and microbes. *Mar Pollut Bull.* 2017;118(1-2):17-26. https://doi.org/10.1016/j.marpolbul.2017.02.030

Bond T, Ferrandiz-Mas V, Felipe-Sotelo M, van Sebille E. The occurrence and degradation of microplastics in the environment. *Waste Manag.*2018;79:256-262. https://doi.org/10.1016/j.wasman.2018.07.027

Mahon AM, O'Connell B, Healy MG, O'Connor I, Officer R, Nash R, et al. Microplastics in freshwater systems. *Sci Total Environ.*2017;586:736-741. https://doi.org/10.1016/j.scitotenv.2017.02.121

Egger M, Sulu-Gambari F, Lebreton L. First evidence of microplastics in all oceanic basins. *Nat Commun.* 2020;11(1):1-7. https://doi.org/10.1038/s41467-020-16901-2

Abbasi S, Keshavarzi B, Moore F, Delshab H, Soltani N, Sorooshian A. The prevalence of microplastics in coastal environments. *Sci Total Environ.*2019;690:602-613. https://doi.org/10.1016/j.scitotenv.2019.06.285

Lambert S, Sinclair C, Boxall AB. Microplastics as vectors for the spread of antibiotic resistance. *Curr OpinBiotechnol.*2018;46:99-105. https://doi.org/10.1016/j.copbio.2017.12.012

Rochman CM, Browne MA, Underwood AJ, van Franeker JA, Thompson RC, Amaral-Zettler LA. The ecological impact of microplastics in marine environments. *Environ Sci Technol.* 2016;50(11):5295-5303. https://doi.org/10.1021/acs.est.6b01512

Tekman MB, Gutow L, Macario A, Haas A, Walter A, Bergmann M. Microplastic litter impacts on Arctic biodiversity. *Front Mar Sci.*2022;9:1-15. https://doi.org/10.3389/fmars.2022.857651

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