Assessment of Industrial Contribution to Environmental Pollution through Wastewater and Air Emissions Integration

GULZAR AHMAD DAR Bhagwant University, ajmer

SHREYANCE SHARMA Bhagwant University, ajmer

BHARAT PHULWARI Bhagwant University, ajmer

RAM KUMAR GODARA Bhagwant University, ajmer

UPENDRA SHARMA Bhagwant University, ajmer

VIKRAM Bhagwant University, ajmer

Abstract

Industrial activities significantly contribute to environmental pollution, with wastewater and air emissions being major avenues for pollutant discharge. This study assesses the integrated impact of industrial operations on environmental pollution by analyzing both wastewater and air emissions. Employing a multi-faceted approach and advanced monitoring techniques, pollutant concentrations are quantified, contamination sources identified, and environmental implications assessed. The effectiveness of existing regulatory measures is examined, and strategies for mitigating industrial pollution are proposed. By integrating wastewater and air emissions analysis, this study offers a holistic understanding of industrial contributions to environmental pollution, facilitating informed decision-making for sustainable industrial practices and environmental management.

Keywords: Industrial pollution, Wastewater, Air emissions, Pollution control, Environmental management.

Introduction

Industries release a plethora of air pollutants and wastewater discharges, directly impacting surrounding areas. Pollution levels are contingent upon these emissions, with regulatory agencies setting emission limits. However, in developing nations like India, rapid industrialization poses challenges, leading to significant environmental degradation. While small and medium-scale industries contribute substantially to economic growth, their environmental impact is concerning. This study aims to categorize industries based on pollutant emissions, aiding in identifying critically polluting industries and enhancing environmental stewardship.

India has implemented various pollution control measures since the 1970s, enacting legislation to mitigate pollution at its source. However, inadequate implementation persists due to factors such as the presence of the informal sector. Efforts have been made to foster cleaner production practices, yet challenges remain in transitioning from concentration-based standards to mass-based standards. The Comprehensive Environmental Pollution Index (CEPI) and categorization methodologies aim to assess industries' pollution potential, but shortcomings exist in assessing individual industries effectively.

Objectives

The main goals of this research study are as follows:

- Formulating a methodology to assess the Integrated Environmental Pollution Potential Index (IEPPI) for industries, considering their wastewater discharges and air emissions.
- Devising a color-coded classification system to categorize industries according to their IEPPI values.

Literature Review

Previous studies have highlighted the environmental impact of small industries in India and the importance of monitoring air quality. Various methodologies, such as Fuzzy MCDM and TODIM methods, have been employed to calculate pollution indices. However, existing methodologies may not effectively assess individual industries' pollution potential.

D'Souza (2001) investigated small industries in India and the central discussion of this paper highlights the importance of small industries and their role in the economy. Despite their importance, small industries pollute and are faced with numerous problems-major and minor. Technical and financial issues are problems that can be handled internally but external problems such as legislative and regulative compliance should be addressed efficiently. This article seeks to shed some light on small manufacturing industries and their environmental performance.

Arulmozhivarman et. al (2017) explained the importance of monitoring the quality of air that which is inhaled to stay away from the respiratory diseases. In this paper, the different regression models to forecast air quality index (AQI) in particular areas of interest is presented. Support vector regression (SVR) and linear models like multiple linear regressions consisting of gradient descent, stochastic gradient descent, and mini-batch gradient descent were implemented. In these models, the air quality index (AQI) dependents on pollutant concentrations of NO2, CO, O3, PM2.5, PM10 and SO2. Among these models, support vector regression (SVR) exhibited high performance in terms of investigated measures of quality.

Lanzafame et. al. (2015) studied on air quality in urban areas and represented an important objective to raise awareness and participation of citizens towards those measures aimed at containing and reducing vehicular traffic. For several years at the international level, evaluation procedures have been adopted by indices. One of the first synthetic indices, adopted by the United States Environmental Protection Agency (US-EPA), was the Pollution Standard Index (PSI). In 1999, the EPA replaced the PSI index with Air Quality Index (AQI), which includes two new sub-indices, the ozone at ground level and fine particulate.

Gorai et. al. (2015) explained about Air quality index (AQI) or air pollution index (API) which is commonly used to report the level of severity of air pollution to public. A number of methods were developed in the past by various researchers/environmental agencies for determination of AQI or API but there is no universally accepted method exists, which is appropriate for all situations. Different method uses different aggregation function in calculating AQI or API and also considers different types and numbers of pollutants. The intended uses of AQI or API are to identify the poor air quality zones and public reporting for severity of exposure of poor air quality. Most of the AQI or API indices can be broadly classify as single pollutant index or multi-pollutant index with different aggregation method. Every indexing method has its own characteristic strengths and weaknesses that affect its suitability for particular applications. This paper attempt to present a review of all the major air quality indices developed worldwide.

Data Collection

Data on air emissions and wastewater discharges were collected from textile processing industries in Jaipur, India. Wastewater quality monitoring data before and after treatment was analyzed, along with air emissions data, forming the basis for pollution potential assessment. This dataset serves as the cornerstone for our evaluation of the Pollution Potential Index across various industrial sectors. Leveraging the methodology we have developed, we have conducted

Sr. No	Test Parameters	Unit	Results at Main Gate of industry			Permissible Limits by CPCB for Ambient Air
			Textile Industry (TI)			Quality monitoring
			TI 1	TI 2	TI 3	
1	Ambient Temperature	°C	31	29	30	-
2	Relative Humidity	%	38	66	39	-
3	Particulate Matter (PM10)	µg/m3	115	84	125	100
4	Particulate Matter (PM2.5)	µg/m3	30	25	70	60
5	Sulphur Dioxide (SO2)	µg/m3	8.54	7.03	87	80
6	Nitrogen Oxides (NOx)	$\mu g/m^3$	17.81	9.97	90	80

a thorough assessment of the Pollution Potential Index, providing invaluable insights into the environmental impact of different industries. By employing this methodology, we have endeavored to contribute to the ongoing efforts aimed at enhancing environmental stewardship and promoting sustainable industrial practices.

Table 1.1 Ambient Air Sample Analysis Report of Textile Industries

(Source: National Ambient Air Quality Standards, CPCB, Notification, No. B-29016/20/90/PCI-I)

Table 1.2 Wastewater Sample Analysis Reports of Textile Industries

Sr. No.	Test Parameters	Unit	Results of Textile Industries (TI)						Permissible Limits by CPCB for discharge in inland surface water
			TI 1		TI 2		TI 3		
			L1	L2	L1	L2	L1	L2	
			Raw Effluent	ETP Final	Raw Effluent	ETP Final	Raw Effluent	ETP Final	
1	Color	Platinum-Cobalt	20	10	40	10	120	110	100
2	pH	pH Unit	7.45	7.52	6.45	7.3	8	9	6.50 - 8.50
3	Temperature	°C	29	29	27	27	31	31	40

4	TSS	mg/L	77	10	174	53	350	130	100
5	TDS	mg/L	3850	1450	3800	1950	3900	2300	2100
6	COD	mg/L	502	179	1820	129	530	160	250
7	Oil & grease	mg/L	0	0	0	0	20	12	10
8	Ammonical Nitrogen	mg/L	3.9	0.8	0	0	75	60	50
9	BOD	mg/L	150	47	685	45	190	70	30
10	Hexavalent chromium	mg/L	0	0	0	0	0.3	0.5	0.1
11	Sulphides	mg/L	2.4	2	1.59	0.96	5.5	3	2
12	Phenolic Compounds	mg/L	0.3	0.2	0.64	0.47	5	3	1
13	Total chromium	mg/L	0	0	0	0	6	3.5	2

(Source: The Environmental Protection Rules, 1986, Schedule – VI, General Standards for Discharge of effluents)

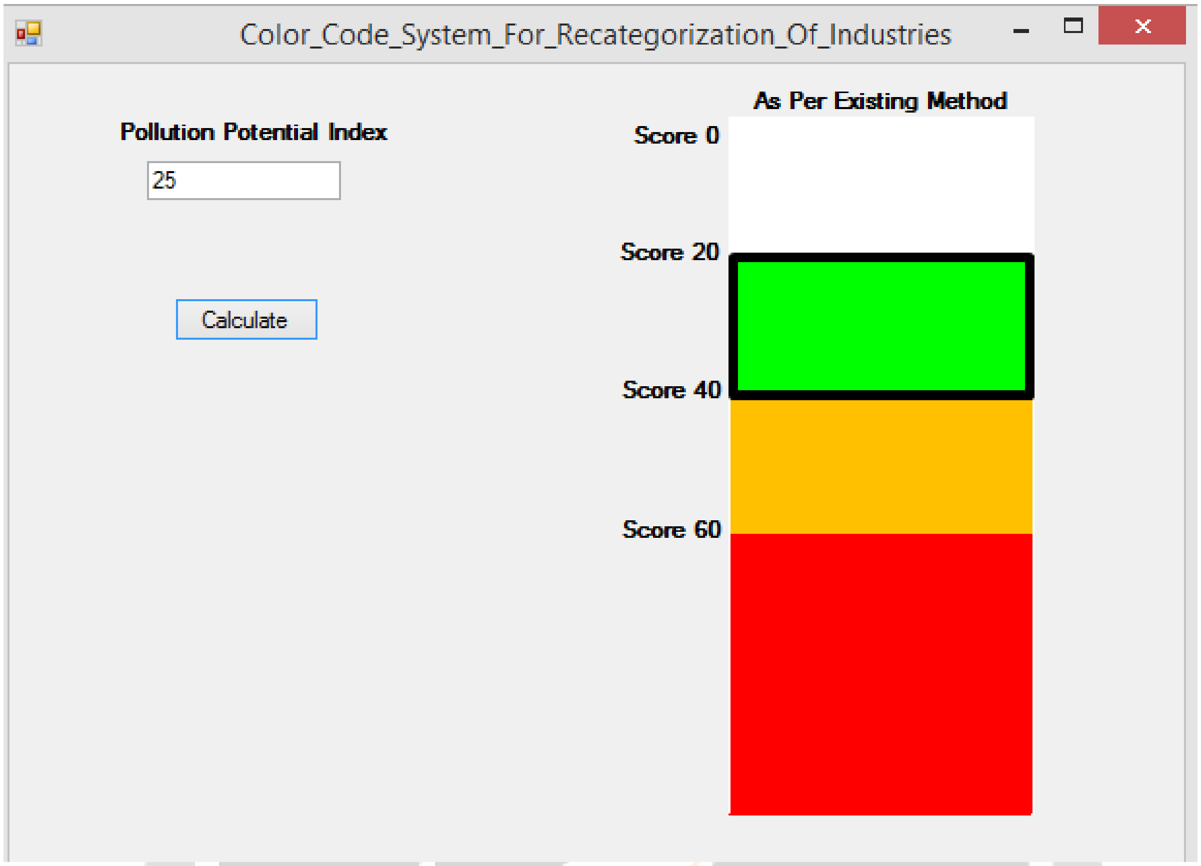
Methodology

A framework was developed to calculate the Integrated Environmental Pollution Potential Index (IEPPI) for industries, considering both air emissions and wastewater discharges. This framework addresses limitations of existing methodologies and proposes a refined color-coding system for industry categorization. Data analysis was conducted using the proposed framework and compared with other soft computing techniques to validate results. The CEPI methodology, while valuable, has limitations in assessing individual industries' pollution potential effectively. To address this, a modified approach is proposed, aiming to quantify industries' pollution potential through an index and enhance the clarity of color-coding systems used by regulatory bodies. The proposed framework establishes a scientific method for assessing pollution potential, considering both air emissions and wastewater discharges. It utilizes an Integrated Environmental Pollution Potential Index (IEPPI), calculated by weighting air and wastewater pollution equally. The index incorporates various indicators covering pollutant sources, fate, receptors, and pollution control measures. Despite challenges such as data uncertainty and weight selection, the framework provides standardized pollution potential indices for industries, facilitating informed decision-making for environmental management.

The Integrated Environmental Pollution Potential Index (IEPPI) in the proposed framework is calculated by considering air emissions and wastewater discharges as follows:

IEPPI = (0.5 x EPPI air)/100 + (0.5 x EPPI wastewater)/100.

Where, EPPI air = Environment Pollution Potential Index for Air EPPI wastewater = Environment Pollution Potential Index for Wastewater



Data Analysis

The proposed framework effectively calculated IEPPI for industries, ranking them based on pollution potential. Comparisons with existing methodologies demonstrated consistency in industry rankings. Case studies on textile industries showcased the framework's applicability and accuracy in assessing pollution potential.

Conclusion

The developed framework accurately assesses industries' pollution potential, with minimal deviation compared to existing methodologies. The research presents a robust framework for calculating the Integrated Environmental Pollution Potential Index (IEPPI), offering a comprehensive approach to assessing industries' pollution potential. Through meticulous analysis, it has been demonstrated that the proposed framework yields consistent results, with minimal deviation compared to existing methods. Moreover, the framework proves superior in accuracy by considering both emission and discharge rates of criteria pollutants, enabling targeted interventions to mitigate environmental impact. The developed industry ranking and color categorization systems provide valuable tools for regulatory authorities to monitor and enforce pollution control measures effectively. Moving forward, the future scope of work includes extending the framework to encompass additional pollution criteria such as land pollution, solid waste, and noise pollution, thus enhancing its applicability and relevance in addressing the multifaceted challenges of industrial pollution.

References

Akter, F. et. al. (2016). "Water Quality Index for measuring drinking water quality in rural Bangladesh: a cross-sectional study." *Journal of Health, Population and Nutrition,* 35(4).

- Arulmozhivarman, P. et. al. (2017). "Forecasting Air Quality Index using Regression Models: A Case Study on Delhi and Houston." *International Conference on Trends in Electronics and Informatics*, 248-254.
- Bhattacharya, A. and Sharma, M. (2014), "National Air Quality Index." *Central Pollution Control Board, Ministry of Environment, Forests & Climate Change, Government of India.*
- Boldo, E. et. al. (2017). "Industrial pollution and cancer in Spain: An important public health issue." *Environmental Research*, 159, 555–563.
- Burmaoglu, S. and Kazancoglu, Y. (2013). "ERP software selection with MCDM: application of TODIM method." *International Journal Business Information Systems*, 13(4), 435-452.
- Castanas, E. and Kampa, M. (2007). "Human health effects of air pollution." *Environmental Pollution*, 151, 362-367
- Cheng, Z. et. al. (2017). "Long-term atmospheric visibility trends in megacities of China, India and the United States." *Environmental Research*, 159, 466–473.
- Chojnacka, E. and Górecka, D. (2017). "Application of Mcda Methods in the Performance Evaluation of Public Benefit Organisations." *Optimum. Studia Ekonomiczne Nr*, 87(3), 93- 104.
- Darji, V. and Rao, V. (2013). "Application of AHP/EVAMIX Method for Decision Making in the Industrial Environment." *American Journal of Operations Research*, 3, 542-569.
- Darji, V. and Rao, V. (2014). "Intelligent Multi Criteria Decision Making Methods for Material Selection in Sugar Industry." *International Conference on Advances in Manufacturing and Materials Engineering, Procedia Materials Science*, 5, 2585 – 2594.
- Datta, S. (2016), "Application of TODIM for industrial robot selection." *Benchmarking: An International Journal*, 23(7), 1818 – 1833.