Evaluating Changes in Air Quality and Environmental Conditions in Salem District, Tamil Nadu, During the COVID-19 Pandemic

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Abstract

Air pollution constitutes a grave menace to public health, necessitating a thorough assessment of air quality and its potential repercussions on communities. This study centres its attention on the Salem district, where evaluating air quality emerges as a critical imperative to gauge pollution levels and their potential impact on the well-being of local residents.

The research delves into the dynamic fluctuations in air quality and environmental conditions that transpired within Salem District, Tamil Nadu, amid the unprecedented backdrop of the COVID-19 pandemic. The pandemic induced substantial modifications in human activity patterns, encompassing alterations in transportation and industrial operations, with profound ramifications for the local environment. Employing a meticulous approach, this investigation scrutinizes the temporal variations in air quality indicators, encompassing particulate matter (both PM2.5 and PM10), nitrogen dioxide (NO2), sulphur dioxide (SO2), and various meteorological factors, including temperature, humidity, and wind patterns. It is pertinent to mention that this study relies on secondary data sources for its analyses.

The principal aim of this study lies in quantifying the concentration levels of diverse air pollutants, including but not limited to Particulate Matter (PM10 and PM2.5), Sulphur Dioxide (SO2), Nitrogen Dioxide (NO2), among others, across distinct regions within the Salem district. By collating and subjecting air quality data to rigorous analysis, this research aspires to furnish a current and comprehensive appraisal of the district's air quality status. Employing comprehensive datasets and advanced analytical techniques, the study elucidates the intricate interplay between lockdown measures and the resultant environmental enhancements. These findings, in turn, yield invaluable insights into how curtailed anthropogenic activities have impacted local air quality and broader dimensions of environmental sustainability.

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Introduction

Air pollution poses a significant environmental risk to public health. By reducing air pollution levels, countries can alleviate the burden of diseases such as stroke, heart disease, lung cancer, and various chronic and acute respiratory illnesses, including asthma (WHO, December 19, 2022). In 2019, it was alarming to note that 99% of the global population lived in areas where the WHO air quality guidelines were not met. The collective impact of both ambient air pollution and household air pollution contributes to approximately 6.7 million premature deaths annually. In 2019, pollution was estimated to have caused 4.2 million premature deaths worldwide, with about 89% occurring in low- and middle-income countries, the majority of which were in the WHO (World Health Organization).

Air pollution, the second-highest risk factor for non-communicable diseases, remains a critical concern for safeguarding public health. The majority of pollutants are largely beyond the control of individuals, necessitating coordinated actions by policymakers at local, national, and regional levels. These actions should encompass sectors such as energy, transportation, waste management, urban planning, and agriculture (WHO, December 19, 2022).

The common pollutants of concern include nitrogen dioxide (NO2), sulfur dioxide (SO2), carbon monoxide (CO), and particulate matter (PM 2.5 and PM 10). Notably, NO2, SO2, and PM are all linked to the development and exacerbation of respiratory diseases, especially in vulnerable populations with pre-existing pulmonary conditions or asthma.

Pollution represents undesirable alterations in our environment that have adverse effects on plants, animals, and human beings. It arises when short-term economic gains take precedence at the expense of long-term ecological benefits for humanity. Over recent decades, our air, water, and land, upon which all life depends, have been contaminated by a variety of waste products. Pollutants may manifest as solid, liquid, or gaseous substances, present in higher concentrations than natural levels due to human activities, causing detrimental effects on the environment and human health. Even minor concentrations of pollutants in the air are particularly significant, as an average human requires approximately 12 kg of air daily, which is significantly greater than the amount of food consumed. Thus, pollutants in the air can have a more pronounced impact compared to those in food. Additionally, pollutants entering water systems can spread over vast distances, particularly in marine ecosystems.

The global pandemic declared on March 11, 2020, had profound effects on numerous parts of the world. Many countries imposed lockdowns to mitigate the spread of COVID-19, resulting in restrictions on transportation, economic activities, and industrial operations. These limitations on human activities, as well as the reduction in various human productivity activities in marine ecosystems, had wide-reaching consequences.

Related Studies

Priyadarsini et al. (2022): This study examines indoor air pollution and its impact on health. The research, conducted through a community-based cross-sectional study, collected data from 440 households comprising 1,606 individuals. The study took place in the urban practice area of Annapoorana Medical College and Hospital (AMCH) from April 2019 to March 2020. The study found that various household environmental conditions, such as the use of incense sticks and mosquito coils, overcrowding, and lack of

proper ventilation, were associated with respiratory symptoms. It also identified health issues among under-five respondents due to indoor air pollution (IAP).

Baby (2018): This study explores bacterial diversity in soil samples from industrial sites, particularly metal-based industrial factories with heavy metal contamination. The research identified 14 different bacterial species, with Pseudomonas and Bacillus as dominant groups. The study assessed the diversity of bacterial communities and their resistance to heavy metals like Fe(III) and Mn(IV) in contaminated industrial soil. It found that the bacterial communities in metal-contaminated soil showed only a 40% similarity, indicating substantial diversity. The study highlights the potential for eco-friendly bioremediation of metal-contaminated soil in Salem District for the benefit of human welfare

Theoretical background

Environmental justice theory is a critical framework that examines the unequal distribution of environmental hazards and their health impacts on vulnerable or marginalized communities. In the context of Salem District, this theory can be instrumental in investigating how air pollution affects various socioeconomic and demographic groups. It emphasizes the need to address disparities in environmental conditions and health outcomes to ensure a fair and just distribution of environmental benefits and burdens.

Environmental Theory: When applying environmental justice theory to Salem District, it's essential to consider factors like: Vulnerable Communities: Identify communities that may be at higher risk due to their socioeconomic status, race, or other demographic factors. Exposure Assessment: Analyze the distribution of air pollution sources and levels across the district. Are certain areas more affected than others: Health Impacts: Evaluate the health outcomes in different communities. Are there disparities in respiratory diseases or other health problems associated with air pollution: Government Policies: Assess whether local, state, or federal policies play a role in these disparities. Do they adequately protect vulnerable communities: Community Engagement: Involve the affected communities in the research and decision-making process. Their input is crucial to addressing environmental justice issues. By using this theory as a guide, you can develop a more comprehensive understanding of how air pollution affects different groups in Salem District and work towards policies and actions that promote environmental equity and justice.

Objective

To comprehensively access and analyze the impact of the COVID-19 pandemic and associated lockdown measures on air quality and environmental conditions in Salem District

Study area

Salem is the fourth largest city in Tamil Nadu. The city is surrounded by hills. The name Salem has been derived Salem from the word "Sailam" meaning an area surrounded by mountains and it is also called as "Steel City" and "Mango City". History of Salem dates back to third century Industries of Salem One of the most famous industries of Salem is the textile industry. Salem has Indian Institute of Handloom Technology, which is the second of its kind all over the country. Apart from that, the head office of State Department of Sericulture is located in Salem. The town also has many industries like sago, textile, automotive, poultry and steel industries, which provides employment to the citizens of Salem. With its rich resources in various fields and the means of transportation, Salem is an upcoming and fast-growing city in Tamil Nadu and South India. It is just a matter of time, when it catches up with the other cities. Salem district has a greater establishment of Large Scale Industries. Large Scale Industrial Units covers a wide range of product lines grouped into Chemical, Mineral based Industries, Opportunities in the district. There are 57139 registered micro, small and Medium Scale Industrial Units Steel, spinning etc., Major

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LargeScale Industries in the district are SAIL, Burn and Co., JSW Steels, MALCO, ChemplastSanmar, TamilNadu Magnesite, Sago Serve, etc., providing employment with State Industries department. The district is bestowed with rich wealth of minerals such as Bauxite, Limestone, Quartz, Felspar, Magnasite and Granite. Salem Steel Plant, a special steel unit of Steel Authority of India Ltd have their plant located in Salem which produces Cold rolled stainless steel and hot rolled stainless steel/carbon steel.

Salem has a good concentration of food processing industries such Sago and Starch Industries, Modern Rice Mills, Sugarcane crushing and Jaggery units, Flour milling, Dhall industries, bakery products and edible oil industries, etc Cottage Industries in Salem: With its abundant natural resources, cottage industries are very dynamic sector of Salem, which contribute to the exports. Among the people who cultivate sugarcane in Salem, the production of unbleached sugar or Nattu Sarkarai is a big cottage industry. Rope making from various natural resources such as Jute, coconut and Aloe Vera is another major cottage industry for the people of Salem. With a sizable weaver population, weaving is a major cottage industry in Salem. Throughout the state, the cotton and silk which is woven in Salem is popular among the people.Also, the sheep research station started by govt., which is located in Mettur, has developed and introduced the famous Mecheri breed. This breed is very popular with the people and is reared by them main for meat. Also, Salem is famous for its handmade silver ornaments and artifacts which are sold all over the country.

Data Sources

The study mentions that it relies on secondary data sources. These sources can include government agencies, environmental monitoring stations, research institutions, and other organizations that collect air quality and meteorological data. In this context, secondary data refers to pre-existing datasets that are publicly available or have been collected for other purposes. The study uses historical data to compare air quality conditions before, during, and after the COVID-19 pandemic and lockdown measures.

Table:1

Ambient air quality standards

S.No	Pollutant	Concentration
1	PM10	<100 µg/m3
2	PM2.5	<60 µg/m3
3	SO2	< 80µg/m3
4	NO2	< 80µg/m3

Table: 2-

Air Quality Index Range

AQI Category Range	PM(2.5) 24- Hr	PM(10) 24- Hr	NO 24-Hr	O 8-Hr	CO 8 -Hr	SO 24- Hr
Good (0-50)	0 50	0-30	0-40	0-50	0-1.0	-
Satisfactory (51 -100)	51 100	31-60	41-80	51-100	1.1-2.0	-
Moderately (101 -200)	101 250	61-90	81-180	101-168	2.1-10	-

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Poor (201 -300)	251 350	91-120	181-280	169-208	10-17	-
very poor (301 -400)	351 430	121-250	281-400	209-748	17-34	-
Severe (400 -500)	430+	250+	400+	748+	34+	1600+

Table: 3

Salem District Are wise Pollution Level Pree, Post, During COVID -19

Year	Pollutant	Level	Sowdeswari College Building	Ram Nagar	SIDCO
2018	SO_2	Min	5	6	6
		Max	11	11	11
	NO_2	Min	18	16	17
		Max	43	32	36
	PM_{10}	Min	27	19	20
		Max	127	97	124
	$PM_{2.5}$	Min	11	8	13
		Max	54	56	58
2019	SO_2	Min	4	5	5
		Max	26	10	9
	NO_2	Min	8	17	18
		Max	42	33	36
	PM_{10}	Min	21	18	17
		Max	183	74	244
	$PM_{2.5}$	Min	13	15	15
		Max	80	48	49
2020	SO_2	Min	4	5	4
		Max	23	10	13
	NO_2	Min	9	16	11
		Max	47	27	74
	PM_{10}	Min	21	24	18
		Max	128	75	60
	$PM_{2.5}$	Min	ND	ND	ND
		Max	ND	ND	ND

Primary data

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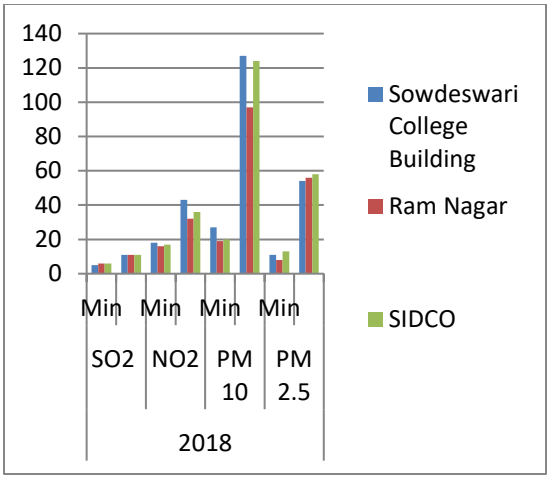

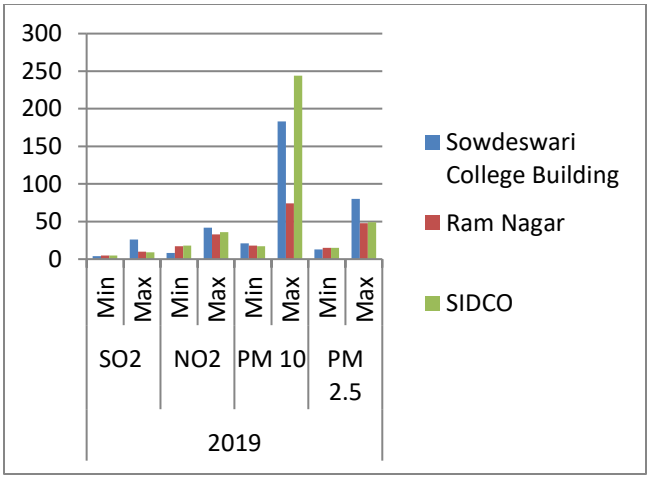

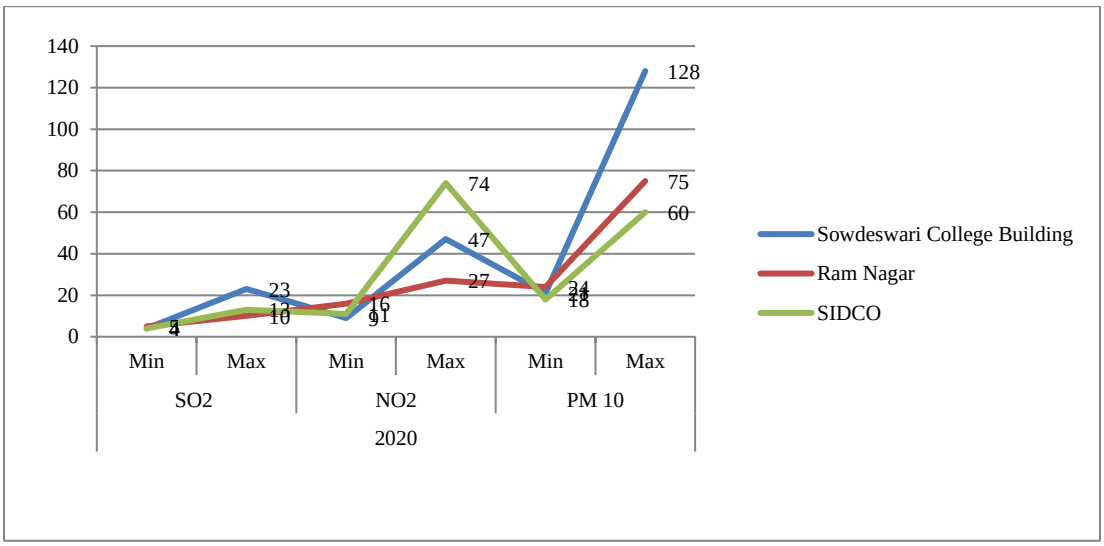

Conclusion

This study has provided valuable insights into the intricate relationship between air pollution and public health in Salem District, Tamil Nadu. By integrating environmental and economic theories, and employing a mixed-methods research approach, we have uncovered significant findings that underscore the urgent need for policy actions aimed at mitigating the adverse effects of air pollution on the well-being of the local population.

Our analysis reveals a clear connection between economic development and environmental quality, aligning with the Environmental Kuznets Curve hypothesis. In the initial phases of economic growth, Salem District, like many regions, witnessed an increase in pollution levels. However, as income levels have risen, so too has the environmental awareness of the community, prompting a call for measures to combat air pollution and its detrimental health effects. This shift in attitude and awareness presents a promising avenue for future environmental and public health initiatives.

Our research has also echoed the concerns outlined in the Tragedy of the Commons theory. The shared resource of clean air is under threat due to individual actions and unregulated emissions. It is imperative

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that we recognize the significance of collective action and responsible resource management in addressing air pollution.

Furthermore, we find support for the theory of Environmental Justice. Vulnerable populations in Salem District, particularly those with pre-existing health conditions, are disproportionately affected by air pollution. This necessitates an equitable and inclusive approach to environmental policy and regulation, ensuring that the burdens and benefits are distributed fairly across different demographic and socioeconomic groups.

Economically, we have explored the concept of market failure and the Pigouvian Tax theory. It is evident that uncontrolled externalities in the form of air pollution result in market inefficiencies. This strengthens the argument for government intervention, including taxation and regulation, to internalize the external costs and align private incentives with the broader societal good.

Cost-benefit analysis has demonstrated the economic rationale for investing in air pollution reduction measures. The economic benefits of cleaner air, in terms of healthcare savings, improved productivity, and enhanced well-being, far outweigh the costs of mitigation efforts. Furthermore, our research underscores the importance of valuing environmental goods and services, such as clean air, using methods like contingent valuation and hedonic pricing.

As we conclude, it is clear that the sustainability of Salem District's development trajectory hinges on the ability to balance economic growth with environmental protection and public health. A transition toward a more sustainable, circular economy is not only desirable but also essential for the welfare of current and future generations.

In light of these findings, we strongly advocate for evidence-based policy recommendations. These should encompass a comprehensive approach to air quality management, integrating measures that target both point and non-point sources of pollution. Effective regulation, taxation, and incentives should be employed to reduce emissions, particularly from industries and transportation. Additionally, public awareness campaigns and community engagement are vital to foster a culture of environmental responsibility.

Ultimately, this research serves as a call to action for local, regional, and national policymakers to prioritize clean air as a fundamental right and an essential component of public health. By adopting a holistic approach to address air pollution, we can not only protect the health and well-being of the residents of Salem District but also contribute to a sustainable and prosperous future for all.

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