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Posted Date: 10 May 2024

doi: 10.20944/preprints202405.0693.v1

Keywords: Taj Mahal; Environmental; Pollution; Policy; Climate Change.

 doi:10.20944/preprints202405.0693.v1

Review

India Environmental Policy: A Systematic Literature Review impact of Air Pollution toward Taj Mahal

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Abstract: This paper focuses on environmental policies for mitigating the impacts of climate change on the Taj Mahal, an iconic structure built on the banks of the Yamuna River from 1632 to 1653 with a blend of Persian and Indian architectural styles. The Taj Mahal is threatened by damage caused by climate change, including air pollution resulting in acid rain and floods that lead to erosion and discoloration of the main marble material of the Taj Mahal. This study employs a *Systematic Literature Review* (SLR) of peer-reviewed journal articles with a primary focus on environmental policy, the impacts of climate change, and the preventive measures undertaken by the Indian government. Based on the analysis of 270 papers, it is concluded that out of the total, 30 papers specifically address objectives relevant to this research. The study period spans from 2014 to 2024. The research findings reveal that air pollution has a significantly adverse impact on the Taj Mahal. Furthermore, nine policies are generally identified from the journal literature review aimed at preserving and protecting the Taj Mahal from the negative effects caused by air pollution.

Keywords: Taj Mahal; environmental; pollution; policy; climate change

1. Introduction

The recent contribution of Working Group II to the Sixty Assessment Report of the *Intergovernmental Panel on Climate Change* (IPCC,2022) has underscored a concerning reality that the impact of climate change is being felt in every corner of the globe, rendering humanity increasingly vulnerable [30]. Climate change not only affects ecosystems, alters weather patterns, increases the frequency and intensity of disasters, raises sea levels, and poses threats to human health but also significantly impacts historical buildings.

The onset of the Industrial Revolution has evidenced significant degradation in buildings. Although many factors contribute to this degradation, air pollution, particularly in the form of acid rain, can be considered the primary cause of this phenomenon. Sulfur dioxide and nitrogen dioxide are significant pollutants responsible for acid rain, both generated from the combustion of fossil fuels such as coal and oil [10]. Rapid industrialization has increased pollutant emissions, thus heightening the risk of degradation to buildings, especially those constructed from materials sensitive to corrosion or chemical reactions with such pollutants. Material damage caused by air pollution poses a serious issue as it significantly shortens the lifespan of buildings. Artificial pollutants have a more significant impact on building degradation than natural pollutants. The effects of contamination, degradation, corrosion, and erosion caused by *sulfur dioxide* (SO^2) are particularly severe. Air pollution can be observed through changes in color, material loss, structural damage, and soiling. Changes in color and structural failures may not be significant and may not lead to severe damage [5].

The Taj Mahal, one of the world's wonders, stands majestically on the banks of the Yamuna River in Agra, India. This magnificent monument was completed in 1653 by the Mughal emperor Shah Jahan as a tribute to his wife, Mumtaz Mahal. The beauty of the Taj Mahal lies not only in its flawless white marble construction but also in the message of the love it symbolized to the world at the time

 doi:10.20944/preprints202405.0693.v1

[5]. With its awe-inspiring wealth of historical heritage, India has emerged as one of the countries boasting the highest number of UNESCO-recognized historical buildings worldwide. From magnificent ancient temples to dazzling palaces, each brick and marble carving exudes grandeur and wonder. India is home to approximately 40 UNESCO-recognized historical buildings, showcasing its rich cultural legacy to the world [5]. The Taj Mahal was constructed using white Marble sourced from different regions across India, including Central Asia, and adorned with breathtaking carvings and mosaics. It seamlessly blends elements of Islamic, Persian, and Indian Architecture [23]. The Location of the Taj Mahal is in the City of Agra, India, which is High Pollution in India. Many Indian urban are consistently ranked among the most polluted cities worldwide [11].

According to data from the *World Health Organization* (WHO), from 2008 to 2013, India emerged as one of the most polluted countries (WHO, 2014). Agra City in India experiences high levels of air pollution, which can damage historic buildings in the city. Scientists say that, in the writer, when pollution is at its worst, breathing the air in Agra for a day is equivalent to smoking a pack of cigarettes [8]. Air Pollution is a pressing environmental concern that manifests on a global scale, as well as regionally, locally, in workplaces, and within landfills [2]. Traffic serves as a category of source encompassing primary *particulate matter* (PM) emissions from the exhaust, OM precursors originating from the combustion of fuels and lubricants, particles generated through the wear of brake linings, clutch, and tires, along with deposits on the road that become suspended alongside crustal/mineral dust particles and road wear debris. Improved road conditions and a more consistent operating speed result in reduced acceleration and braking, leading to fuel savings and decreased traffic-related air pollution. Although transportation being a significant contributor, domestic, economic, and manufacturing pollutants also play pivotal roles in urban air pollution [3,413], 70% of air pollution generated by vehicle emissions in industrialized and developing countries is primarily caused by the continued use of many old vehicles with poor maintenance, inadequate road infrastructure, and low-quality fuel [32].

Based on the spatial drivers and LULC of 2001 and 2011 *vegetation cover* (VC) results, there was a total loss of 17.89 km2 (13.06%) of green space between 1991 and 2021. There has been a significant increase in urban sprawl, with the growth rate reaching 11.20% from 1991 to 2001 and 9.97% from 2021 to 2011 (Kapil et al., 2022). Globally, 25% of PM 2.5 air pollution stems from urban environments, 15% from industrial operations, 20% from the combustion of domestic fuels, 22% from sources of human origin that are yet determined, and 18% from natural dust and soil (Karagulian et al., 2015). Air pollution causes acid rain, which can hurt the Taj Mahal building, especially the marble, which is the primary raw material for the Taj Mahal building. Air Pollution affects the Taj Mahal and has implications for Human Health. According to data from 2019, approximately 1.7 million people in India died due to air pollution related to suspended particulate pollution, such as nitrogen oxide, ozone, and other toxic substances. In 2021, the Agra government reported that the air quality in Agra, based on the *Air Quality Index* (AQI), was 486. This index is considered hazardous to health In addition to air pollution, flooding has also impacted the Taj Mahal. In 2010, flooding with a height of 495.8 feet (152 meters) submerged the park area behind the Taj Mahal [14]. Flooding in the Taj Mahal area was caused by heavy rainfall, resulting in the overflowing of the Yamuna River; not only that, but changes in the characteristics of the river have also contributed to flooding incidents. The Taj Mahal flood occurred in 1978 and 1988 [29].

Several studies have been conducted on the impact of pollution and climate change on the Taj Mahal [5,6,9,12,22,25,28,30,31] have been conduct in India, particularly in the City of Agra comprehensive analysis, researchers strive to identify emerging trends and patterns and provide recommendations to protect and preserve the authenticity and integrity of the Taj Mahal amidst increasingly complex environmental and social challenges. These studies serve as a crucial foundation for the effort to conserve this valuable heritage for the people of India and the world. In preserving the sustainability of historical buildings such as the Taj Mahal amidst the challenges posed by climate change, its identification as a valuable cultural heritage necessitates intensified climate change on historical structures, notably the Taj Mahal, and exploring concrete steps that can strengthen protection measures for the sustainability and authenticity of this iconic architecture. This

 doi:10.20944/preprints202405.0693.v1

study aims to Examine the Environmental Policies and assess the Impact of climate change on the Taj Mahal.

The preferred reporting items for Systematic Reviews and Meta-Analysis (PRISMA) approach, suggested by experts in the field, provide a comprehensive framework for reporting systematic reviews and meta-analysis. This systematic review will examine the published literature (*up to Maret 2024*) on the impact of climate change on the Taj Mahal. A systematic review aids in the identification of all documented pollutant-effect relationships and offers recommendations for future research. Its structured and standardized approach, along with its objective and transparency, provides distinct advantages over traditional review, minimizing the potential for biased results. The systematic surveying and selection of papers are reproducible and explicit, allowing for the replication of the process by other researchers. This review adheres to a quantitative systematic approach, as outlined by Pickering and Bryne, and follows a predefined review protocol containing details on research questions, inclusion, exclusion, search strategy, data extraction, and data analysis.

2. Materials and Methods

This study employed a systematic literature review approach, which required collecting data from various articles that had undergone rigorous selection processes, typically known as peer-reviewed. The identification process of these journals was systematically conducted following the procedures established in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), an internationally recognized guideline for reporting systematic literature reviews. A systematic literature review is frequently employed across various scientific disciplines Alexander, 2020 as it can comprehensively and objectively gather evidence from previous studies. One of the primary advantages of this approach is its ability to identify existing research gaps and provide guidance for further investigations [21]. A systematic literature review provides a clear and detailed overview of knowledge development within a specific field by thoroughly analyzing the available literature. Furthermore, this method also provided an opportunity to identify weaknesses and limitations of previous studies, enabling researchers to design more precise and targeted research in the future. Additionally, this approach offered a systematic and structured framework for literature analysis [17], ensuring the conclusions were based on robust and accountable evidence. Thus, a systematic literature review is valuable in developing knowledge and understanding across various scientific fields.

To minimize author subjectivity, the PRISMA method was applied to the Systematic Literature Review (SLR) to identify, filter, and evaluate the relevance of answers to the research questions [16]. The search was conducted on titles and abstracts using keywords (("*India*" AND "*environment*" AND "*policy*" OR "*regulate*") AND ("*impact*" AND "*climate*" AND "*change*" AND "*Taj Mahal*")). This search was carried out using two databases, *Science Direct*, *Taylor and Francis*, and *Google Scholar*. The articles included were restricted to English and published between 2014 and 2024. Articles were evaluated based on their quality and conformity with predetermined criteria to ensure accuracy and relevance in answering the research questions. Evaluation criteria included: 1. Publication in journals that had undergone peer review processes; 2. Conduct of research in India; 3. Relevance to subthemes such as Environmental Policy, Pollution Impact, and Heritage Conservation; 4. Presence of transparent methodology and accountable conclusions. After eliminating duplicates, a total of 270 articles were found, from which 30 articles were selected for further in-depth analysis Figure 1. The information presented in the journals includes the authors, names, titles, abstracts, relevant context, and subthemes. Thus, articles were selected carefully to ensure that the chosen literature met the established standards of quality and research needs. The articles obtained were screened based on titles and abstracts. Subsequently, further screening was conducted based on a review of the full texts. The results of the full-text review were then extracted, resulting in data that would be analyzed in-depth.

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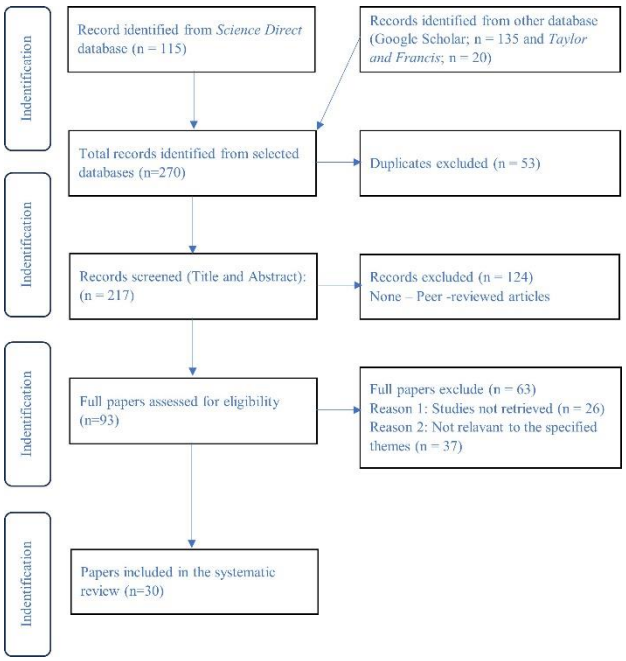

Figure 1. The PRISMA flowchart.

Table 1. Thematic classification of paper contents.

S/N	Sub-themes
i.	Climate Change
ii.	Air Pollution Impact
iii.	Environmental Policy
iv.	Heritage Conservation
v.	Taj Mahal

3. Results and Discussion

In this study, a total of 270 papers were successfully collected from various academic sources, with 135 papers obtained from Google Scholar, 115 papers from Science Direct, and 20 papers retrieved from Tailor and Francis. Upon review, 93 articles met the criteria to be included in the final analysis, and after a full review, only 30 articles were selected for in-depth processing. The highest percentage of selected papers was recorded in the year 2022, representing 20.00% of the total selected articles.

Table 2. Number of the selected papers based on years.

Year	Number of the selected paper	Percent
2014	3	10.00%
2015	2	6.67%
2016	2	6.67%
2017	1	3.33%
2018	2	6.67%
2019	2	6.67%

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2020	2	6.67%
2021	3	10.00%
2022	6	20.00%
2023	4	13.33%
2024	3	10.00%

3.1. Impact of Climate Change on the Taj Mahal

India is recognized as one of the most vulnerable nations to climate change and is ranked as the world's third-largest emitter of greenhouse gases. In addition to being a vulnerable nation, India is also recognized as one of the world's three largest emitters of greenhouse gases. Research findings indicate that emissions of greenhouse gases, including carbon dioxide (CO^2), methane (CH^4), and nitrogen oxides (NO_x), are produced in substantial amounts by critical sectors such as industry, transportation, agriculture, and power generation in India. This significant contribution not only exacerbates global warming but also accelerates climate change overall [6]. Air pollution, an inevitable consequence of climate change, results from various human activities such as motor vehicles, industries, biomass burning, and other industrial processes. Its impacts are significant as it contaminates the atmosphere with various hazardous or toxic substances, including dust particles, gases, and other chemicals. Consequently, air quality deteriorates, posing threats to human health and animals and causing severe environmental damage [23]. One increasingly concerning aspect is the impact of air pollution on the built environment, particularly on buildings. This has become a heated topic of discussion due to its detrimental effects, primarily on historical buildings, which are an integral part of a nation's cultural identity. The phenomenon of corrosion on building materials is one of the crucial impacts of this air pollution, threatening the structural integrity and aesthetics of buildings [24].

The primary cause of building corrosion is acid rain, formed from sulfur dioxide and nitrogen originating from various sources, ranging from the combustion of fossil fuels such as coal to vehicle emissions and industrial smoke [22]. As a result, building materials such as stone, marble, and metal can undergo significant degradation, reducing the lifespan of buildings and their authenticity as part of cultural heritage [23].

As one of the countries with UNESCO-recognized historical buildings, India is threatened by climate change due to air pollution. Examples include the Taj Mahal, Agra Fort, Gateway of India in Mumbai, Velha Goa, and the Murals of Alchit [8]. As one of India's most iconic historical monuments, the Taj Mahal faces significant vulnerability to the influences of weather changes, which pose severe challenges in its conservation and preservation of authenticity and beauty. The monument, predominantly constructed from white marble, exhibits characteristics prone to various forms of structural degradation, erosion, and color alteration due to exposure to diverse weather conditions. Research has highlighted that weather changes, encompassing fluctuations in temperature, humidity levels, rainfall patterns, and air pollution levels, can expedite the process of structural damage and significantly alter the aesthetic character of the Taj Mahal [13]. High humidity levels, for instance, can create conducive conditions for moss, fungi, and lichen growth on the marble surface, leading to stains and unwanted color changes. Meanwhile, extreme temperature variations, especially during summer and winter, can induce repeated expansion and contraction of the marble, forming cracks and crevices within the monument's structure. Additionally, the detrimental effects of acid rain caused by high levels of air pollution have been evidenced to corrode the marble surface, eroding the outer layers of the rock and jeopardizing its overall structural integrity (Rao et al., 2014). The fading of the white color of marble material on the Taj Mahal has been attributed to a phenomenon known as "Stone Cancer," believed to be caused by Acid Rain. Several studies have indicated that this deterioration results from the corrosive effects of Acid Rain on the marble surface. Reports collected from various parts of the world have also documented the impacts of "Stone Cancer" on historical buildings, with its root cause identified as Acid Rain [5]. Therefore, a profound understanding of weather dynamics and proactive and well-planned conservation efforts are key in ensuring the

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sustainability and preservation of the Taj Mahal as one of the world's most treasured cultural heritages [22].

The Taj Mahal, revered as one of the Seven Wonders of the World and an emblem of India's rich cultural heritage, is a majestic testament to love and architectural excellence. However, this iconic landmark now faces a looming threat from air and water pollution. Recent reports from the National Environmental Engineering Research Institute (NEERI) have raised alarm bells, highlighting the substantial damage inflicted upon the 17th-century monument due to prolonged exposure to air and water pollution despite concerted repair efforts by the government [28]. The Ministry of Environment, Government of India, has undertaken extensive surveys to comprehensively assess the pollution factors contributing to the deterioration of this historic mausoleum. The findings of these surveys paint a grim picture, revealing a sharp escalation in air and water pollution levels to alarming and hazardous extents. This surge in pollution levels can be attributed mainly to the rapid industrial expansion, burgeoning traffic congestion, and exponential population growth near the Taj Mahal [29].

Furthermore, the menace of illegal and haphazard constructions mushrooming in the vicinity of the Taj Mahal exacerbates the pollution predicament faced by this architectural marvel. The uncontrolled urban sprawl and unauthorized developments not only mar the aesthetic appeal of the surroundings but also introduce additional sources of pollution, further jeopardizing the integrity of the monument. Moreover, the highly contaminated waters of the Yamuna River, flowing near the Taj Mahal, pose an imminent threat to its structural stability and aesthetic grandeur. The rampant pollution of the river waters, laden with industrial effluents, untreated sewage, and chemical pollutants, tarnishes the pristine beauty of the monument's reflection pool and corrodes the marble facade over time, accelerating its decay. In light of these pressing environmental concerns, urgent and concerted action is imperative to mitigate the adverse effects of pollution on the Taj Mahal [9]. Comprehensive measures to curb industrial emissions, regulate vehicular traffic, enforce stringent pollution control norms, and implement sustainable urban planning strategies are urgently needed to safeguard this architectural marvel's integrity and heritage value for future generations to cherish. Fluctuations in groundwater levels also threaten the structural integrity of the buildings, as the water in the Yamuna River continues to be contaminated by waste discharge [29]. Many experts state that total particulate suspended matter (TSPM), respiratory suspended particulate matter (RSPM), sulfur, and nitrogen oxides threaten ancient monumental structures. The darkening of the surface structures due to the formation of dust layers over time exacerbates this challenge [15]. Examine environmental policies that directly or indirectly impact the heritage building of the Taj Mahal.

3.2. Environmental Policies on the Building of the Taj Mahal

Recognizing the importance of preserving this UNESCO World Heritage Site, the Indian government has implemented various conservation efforts to mitigate the impacts of climate change on the Taj Mahal. This paper focuses on air pollution policies, considering air pollution as a significant threat that needs attention. Environmental policies in India have been implemented to address various issues, notably air pollution. These policies aim to reduce the impacts caused by environmental damage, as environmental degradation directly impacts the Taj, which needs to be addressed as part of conservation efforts for the UNESCO site. Air pollution, primarily caused by industrial emissions and vehicular traffic, poses a significant threat to the original white marble of the Taj Mahal. Air pollutants like sulfur and nitrogen dioxide react with the marble surface, causing discoloration and yellowing (Possible pollution treatment). Water pollution from the Yamuna River flowing near the monument contributes to the degradation of the Taj Mahal. The polluted water contains harmful substances that can cause corrosion on the marble surface. The accumulation of debris from insect species breeding in the polluted waters of the Yamuna River causes the Taj Mahal to turn green. This poses a unique environmental threat to the monument [17]. Use either SI (MKS) or CGS as primary units. (SI units are encouraged) English units may be used as secondary units (in parentheses). An exception would be the use of English units as identifiers in trade, such as “3.5-inch disk drive”.

 doi:10.20944/preprints202405.0693.v1

In 1998, when it was revealed that the iconic white marble of the Taj Mahal had begun to turn yellow due to air pollution, an air pollution control program was introduced. The then President, Bill Clinton, firmly stated that the impact of pollution had reached unprecedented levels, surpassing even the damage caused by war, invasion, or natural disasters in the past 350 years, and had begun to deteriorate the beauty of the magnificent Taj Mahal. Immediate measures were taken, including restricting vehicle movement within a 500-meter radius of the building and installing advanced devices to monitor air pollution levels. The Indian government acted swiftly by implementing various environmental policies, both general and specific to the Taj Mahal. Vigorous efforts have been made to reduce air pollutant emissions by implementing various pollution control initiatives, which have significantly helped protect the cultural heritage and beauty of the Taj Mahal [22].

With the rapid urbanization and industrial growth in the vicinity of the Taj Mahal, one significant factor contributing to the change in the color of the marble is poor air quality. Studies have recognized that the soiling and discoloration of the marble, attributed to municipal solid waste, are consequences of deteriorating air quality. In response, the government has implemented natural protection measures to preserve the beauty and sustainability of the Taj Mahal by establishing green buffers. Although existing vegetation has the potential to mitigate air pollution and maintain environmental balance, there are still challenges that need to be addressed. One of them is the continued increase in air pollution due to motor vehicles, industries, and other human activities. Efforts to mitigate pollution, such as possible pollution treatment methods, are essential in safeguarding the iconic monument and its surroundings

On the other hand, concrete steps have been taken to reduce the impact of local air pollution around the Taj Mahal. These include measures such as restricting vehicles, closing over 200 companies in Agra, requiring iron casting factories to install scrubbers and filters on their smokestacks to reduce emissions, prohibiting new companies that cause pollution from being built within the designated buffer zone around the mausoleum, and most recently, banning the burning of cow dung cakes as cooking fuel municipal solid waste [18].

The National Clean Air Program (NCAP), launched in January 2019, is a comprehensive initiative to reduce the concentration of particles (PM10 and PM2.5) by 20-30% in 102 cities across India by 2024. The program includes several actions that are part of efforts to protect the Taj Mahal, such as enhancing air quality monitoring around the monument, increasing public awareness of the impact of air pollution on cultural heritage, and implementing specific action plans to control potential sources of pollution that could damage the beauty of the Taj Mahal [15].

In addition to the National Clean Air Program (NCAP), which aims to reduce air pollutant concentrations in various cities across India, the government has also strengthened air quality monitoring efforts through the National Air Quality Monitoring Program (NAMP). NAMP is designed to establish (clarity) a network of monitoring stations nationwide, including around the Taj Mahal, to continuously monitor air quality parameters such as PM10, PM2.5, nitrogen dioxide (NO^2), Sulphur dioxide (SO^2), carbon monoxide (CO), and ozone (O^3). The presence of monitoring stations around the Taj Mahal is a crucial step in preserving the beauty and integrity of this iconic monument. Data from this monitoring provides vital information about air pollution levels around the Taj Mahal, enabling the government to evaluate air quality trends and formulate effective pollution control strategies. The information obtained from NAMP not only aids in determining current air pollution levels but also allows for long-term trend monitoring. With a better understanding of the factors influencing air quality around the Taj Mahal, the government can design more precise strategies to protect this World Heritage site from the damaging effects of air pollution. Thus, NAMP plays a crucial role in air pollution monitoring and control efforts around the Taj Mahal, symbolizing India's beauty and cultural wealth. By ensuring good air quality, the government is committed to preserving the Taj Mahal's beauty and value for future generations [26].

The Air Quality Index (AQI) serves as an essential tool for conveying information about air quality to the public simply and understandably. However, it also holds significant relevance concerning the Taj Mahal, a UNESCO World Heritage site vulnerable to the impacts of air pollution. Through the AQI, the community can grasp the air conditions around the Taj Mahal and their effects

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on the beauty and preservation of the monument. By categorizing air quality into different levels, the AQI provides a clear picture of whether the air around the Taj Mahal is safe for visitors and the surrounding environment. This is crucial for the health of humans visiting the Taj Mahal and protecting the sensitive white marble susceptible to air pollution. By understanding the AQI, individuals can take necessary preventive measures when air pollution around the Taj Mahal reaches hazardous levels. This may include avoiding visits to the Taj Mahal on days with high air pollution levels or using protective masks when visiting to shield themselves from the adverse effects caused by polluted air. Additionally, the AQI is a vital tool for the Indian government in formulating policies and concrete measures to reduce air pollution around the Taj Mahal. By regularly monitoring air quality and understanding the pollution levels, the government can design effective strategies to protect the Taj Mahal from the increasing threat of air pollution, thus ensuring the preservation of this cultural heritage for future generations [26].

The implementation of Bharat Stage (BS) emission standards is a crucial step in the Indian government's efforts to reduce vehicle emissions, which also have significant impacts on air quality around the Taj Mahal. With the implementation of BS emission standards, the government has a tool to control and determine the permissible limits for vehicle pollutants. This step holds significant relevance concerning the Taj Mahal because vehicle emissions can cause damage to the structure and materials of the building, including the distinctive white marble of the Taj Mahal. By reducing vehicle emissions through implementing BS emission standards, the government aims to protect the beauty and preservation of the Taj Mahal from the adverse effects of air pollution. Moreover, vehicle emission control is integral to broader efforts to maintain air quality around the Taj Mahal. By reducing the amount of pollutants released into the air, implementing BS emission standards helps ensure that the air around the Taj Mahal remains clean and free from damaging contamination. Thus, the implementation of Bharat Stage emission standards is not only about limiting vehicle emissions but also part of the Indian government's commitment to protect and care for the Taj Mahal, one of the world's most valuable cultural heritage sites, from the damaging impacts of air pollution [25].

The Indian government has taken stringent measures to protect the Taj Mahal from the impacts of air pollution by implementing strict regulations for industries in its vicinity. Through the Environment Protection Act of 1986 and the Air (Prevention and Control of Pollution) Act, the government mandates industries to obtain operating permits, install pollution control equipment, and adhere to established emission standards. By closely monitoring industrial activities, the government aims to ensure that emissions do not exceed the set limits, thus maintaining the air quality around the Taj Mahal, keeping it clean, and preserving its beauty and integrity. In addition to the regulations enforced, the government also promotes using cleaner fuels such as Compressed Natural Gas (CNG) for vehicles and liquefied petroleum gas (LPG) for cooking. This step helps reduce emissions of harmful pollutants such as sulfur dioxide and particulate matter. Furthermore, promoting renewable energy sources such as solar and wind power is also a government focus to reduce reliance on fossil fuels and mitigate air pollution associated with power generation. With the combination of these measures, it is expected that these efforts will help preserve the Taj Mahal as one of the most valuable wonders of the world.

The implementation of the above policies should serve as the backbone of environmental policies applied in India, and these policies also impact conservation efforts for the Taj Mahal, reinforcing the Taj Trapezium Zone (TTZ) policy. The TTZ aims to control air pollution in the Taj Mahal area. The aforementioned policies support the TTZ in reducing the impacts of air pollution and improving air quality around the Taj Mahal. For example, industrial particles and emissions contribute to changes in the surface color of the monument's marble or the darkening of the Taj white marble [5].

In summary, although environmental policies in India generally protect the Taj Mahal, specific and sustainable efforts are needed to address the complex challenges of pollution and environmental degradation to ensure this cultural treasure's long-term sustainability and preservation.

4. Conclusions

 doi:10.20944/preprints202405.0693.v1

The environmental issues surrounding the Taj Mahal have emerged as an intriguing area of study, as evidenced by the findings within the thoroughly reviewed articles. Particularly, the issue of air pollution and its implications on the Taj Mahal has become a grave concern for the preservation of this cultural heritage. Air pollution stemming from vehicular emissions, industrial activities, and domestic waste has inflicted damage upon the marble structure of the Taj Mahal. From the review of articles, it is apparent that the impact of air pollution, particularly in the form of black carbon particles, has tarnished the walls of the monument, thereby affecting the marble's coloration, consequently diminishing the architectural beauty and endangering the material integrity of the structure. The Government of India and local authorities have undertaken measures to mitigate air pollution around the Taj Mahal through the implementation of several environmental policies. These policies include the adoption of *Compressed Natural Gas* (CNG), *Liquefied Petroleum Gas* (LPG), Pollution threat, Vehicle Restriction, Industrial Closing Activities, The *National Clean Air Program* (NCAP), The *Air Quality Index* (AQI), *Bharat Stage* (BS), dan *Taj Trapezium Zone* (TTZ). However, the study's findings reveal that policies specifically tailored to address environmental issues impacting the Taj Mahal remain insufficient. Consequently, air pollution continues to pose a significant threat to the sustainability of the Taj Mahal. If not earnestly addressed, it could lead to detrimental consequences for the monument's future. While the Government of India has implemented various environmental policies targeting air pollution on a broader scale across the country, their efficacy in safeguarding the Taj Mahal remains limited. Thus, concrete steps are imperative to protect this crucial cultural heritage from the menace of air pollution. Moreover, there is a pressing need for more robust and tailored environmental policies from the Indian government to shield the Taj Mahal from environmental degradation effectively.

Author Contributions: Conceptualization, M.; methodology, A.K. and R.H.; writing, M and A.K.; writing—review and editing, R.H and E.K. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding

Data Availability Statement: Data are available from the corresponding author upon reasonable request.

Acknowledgments: Regarding this research, we would like to express our gratitude for the valuable contribution from the journal that served as our primary reference.

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