



Deteriorating Taj Mahal – Impact of Climate Change and Pollution

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Abstract

The battle to protect the Taj from pollution began in the 1970s, and gained momentum in 1984 when environmental activist M. C. Mehta brought the problem of the discoloration and darkening of a Taj marbles across several places to the attention of Supreme Court of India. This discoloration was thought to be caused by "acid rains" caused by sulfur dioxide emissions. Within the Taj, the deterioration is more noticeable. The whole structure is bathed in a pale yellow hue. Ugly brown or black specks amplify the yellowish tone in certain areas. The ancient tombs of Shah Jahan wife Mumtaz Mahal are located in the inner chamber, which has suffered the most from fungal decay. The Supreme Court issued many decisions related to this matter over the following twenty-five years after its historic ruling in 1996.

Keywords: environmentalist, pollution, yellowing, acid rains, sulphur dioxide emission, ugly brown, fungal deterioration

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Introduction

The white marble of India's Taj Mahal, built in the 17th century, is gradually turning yellow & green due to pollution in the air in Delhi, the seventh most polluted city in the world. The Taj Mahal, one of the Seven Wonders of the World, is located in Agra, a northern city that is typically shrouded in dust and haze from billowing smokestacks and cars. An environmental attorney testified before India's highest court that tiny insects from

the dying Yamuna River, into which the city dumps its sewage, creep inside the Taj Mahal and leave their faeces, further ruining the marble. Built by the Mughal emperor Shah Jahan in honor of his wife Mumtaz Mahal, the court then criticized the administration for not doing more to protect the structure. M.C., an Indian lawyer, argued that if Indian scientists and conservationists were unable to complete the tasks at hand, international specialists or conservationists should be contacted. Mehta, who has spent the last three



decades protecting the Taj Mahal from pollution. The restoration team has been cleaning the marble with a paste made from a clay mineral. It attracts dirt and grime to its surface, where it may be easily rinsed away. The activists are worried that the water table is dropping in Agra, which might undermine the wooden structures' foundations. Concerns also include rampant building near the tomb and a traffic jam of polluting automobiles. Behind the Taj, near the river, smoke rises from a distant chimney, and a massive rubbish dump has accumulated. A funeral pyre may be seen outside the Taj compound.

Darkened Hue of the Taj

This new hue isn't completely unexpected. Soot and gases from industries and tanneries pose a threat to the ivory monument, which has long been a concern of environmentalists and historians. The government officials did not respond. Bhuvan Vikram, the Agra department's superintendent archaeologist, declined to comment to the media since he was not permitted to do so. Culture Minister Mahesh Sharma, whose office is responsible for historic sites, stated that the Environment Ministry was the most qualified to comment.

Francesco, a visitor from Argentina, said, "The Taj Mahal is one of the largest images of India, and the city could be lot cleaner and the government ought to take action on this."

Ongoing Threats to Taj Mahal Surface

Some of the conjectures and later verified facts have been offered towards pinning down the facts

(i) Insects whose excrement was leaving marks on the marbles were thought to have been brought about by phosphorous production in the river water, and this contamination of the Yamuna was identified as a threat to the Taj in the previous five years.

(ii) The degradation of the Taj's marble has been generally attributed to sulphur dioxide and industrial pollution, but new study suggests that hydrogen sulfide emitted from the dirty Yamuna is far more corrosive.

(iii) For a more conclusive understanding, the authors of this research on corrosion agents in the Taj advocated doing similar experiments on marbles over a 10-year period.

One of the New Seven Wonders of the World, the Taj Mahal was built in the 17th century by the Mughal empire, but its visitors have recently complained of a bad odor. The gas causing the stench is probably also to blame for the yellowing of the Taj Mahal's famed white stones. Hydrogen sulfide (H₂S), the gas responsible for the stench emanating from the Yamuna's murky waters, was investigated by a team of scientists to see whether it also had corrosive effects. They discovered that the corrosive effects of H₂S from contaminated Yamuna water were greater than those of sulphur dioxide (SO₂) from Agra city's industrial pollution.

The results are significant because, until the last five years, efforts to safeguard the Taj from pollution have focused mostly on reducing pollution from factories and cars, while the Yamuna River remained largely ignored. It has been hypothesized that sulphur dioxide is the principal pollutant causing the white marbles to deteriorate.

In 2016, the Archaeological Survey of India presented a study to the Supreme Court of India in which they, too, blamed pollution of the Yamuna for the deterioration of the Taj Mahal's marbles. The lack of aquatic life in the Yamuna's sluggish water served as a perfect breeding ground for insects of the species *Goeldichironomus*, the subject of the study. Hence, the polluted Yamuna might be having more than one effect on the Taj.

Air pollutants such as sulfur dioxide (SO₂), nitrogen dioxide (NO₂), ammonia (NH₃), carbon monoxide (CO), carbon dioxide (CO₂), and hydrogen sulfide (H₂S) were used in corrosion deformation tests. It's intriguing that H₂S was identified as the worst offender. According to Mongabay-India, one of the paper's co-authors, Dipankar Saha, is a former additional director of the Central Pollution Control Board (CPCB) and believes that the river Yamuna, which carries the untreated wastewater of all of Agra, is to blame for the formation of H₂S.

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Pandya told Mongabay-India that preventing the Yamuna from being dirty and only letting treated sewage from the

city flow into the river will protect the Taj from deterioration. There is no longer any usable water from the river. Yet, the Yamuna was visible in the original Taj Mahal's setting. The river had a crucial role in the design process. A corrosion deformation study was conducted on metals utilizing carbide tipped, zinc, as well as copper specimens left revealed at the Taj Mahal premises. The results showed that sulphur dioxide emitted to the atmosphere from of the contaminated Yamuna river flowing very close to the exit side (the presumed location of the Taj Mahal) has a significant impact on the erosion rate of metals.

Sharad Gupta, an environmentalist based in Agra, said the study's conclusions are to be expected. Untreated sewage, industrial trash, and even solid waste from the whole city all end up in the Yamuna. Agra has 90 nullahs, but only 4 plants purify the water from 25 of them; these plants also shut down at night. Untreated waste from sixty-five additional drains has been found in the Yamuna. He informed Mongabay-India that the supplies include scraps of leather and fake leather from over 3,000 shoe makers. He went on to say that chemicals used in the washing process of Agra's fake jewelry business are also discharged untreated into the city's sewers.

Changing Hues of the Taj Mahal – Then and Now

Morning finds the Taj Mahal pink, twilight finds it milky white, and night time finds it golden thanks to the moon. Despite the fact that this may have been the case in



the past, the Taj Mahal is now permanently covered with a coating of yellowish-brown due to pollution and inadequate maintenance. The Indian Supreme Court has condemned the "lethargy" of repair efforts and ordered the administration to either restore the Taj Mahal or demolish it. Agra, U.P., India is home to one of the world's most jaw-dropping buildings: the Taj Mahal. It was built by the Shah Jahan, the Mughal emperor, in honor of Mumtaz Mahal, his first wife who died giving birth to their child. White marble quarried in Rajasthan and transported to Agra for use in the construction of the Taj. The inlay was made of a variety of semiprecious stones, including jasper, jade, turquoise, precious stones, sapphire, and carnelian. The sandstone walls and gardens along the riverbed were finished in 1653.

Over the course of the last four centuries, the Taj Mahal has aged and darkened owing to natural oxidization, the marble counterpart of rust. Air pollution, acid rain, and the soot from companies and residences have all taken their toll. Agra has the same infamously bad air quality as the rest of India's major cities. Agra's oil refineries and tanneries, like those in many other Asian towns, are a major source of pollution. The dazzling white exterior of the Taj has been slowly worn and weathered to a yellow sheen by these pollutants, which include sulphur dioxide, Nox gases, and mostly carbon-based particles.

Photographs demonstrate a significant decline in the Taj's state over the past several years, despite the installation of a

4,000 square mile protection buffer surrounding the monument (the Taj Trapezium Zone), inside which emissions are reportedly rigorously regulated.

Emissions regulations have been challenged by builders for years and are routinely disregarded. Funeral pyres and trash heaps are often lighted and burnt within sight of the buildings, filling the air with smoke. The Yamuna River's pollution is an additional difficulty. Nutrient-rich waterways are produced by the city's untreated sewage and industrial waste. The wind carries these nutrients to the Taj, where they are deposited in the increasingly porous masonry, where they feed river-derived bacteria that turn the marble's surface green.

It has been suggested that insect waste, which is abundant in the polluted river water, has accelerated the damage, although this has far less of an impact than the sulfur dioxide and nitrogen dioxide released into the air by burning fossil fuels. Since 1998, several Indian scientific institutions have looked at ways to restore the discoloration, spending millions in the process. One strategy entailed covering the Taj with a face pack-style moist clay poultice. It was thought that they would remove the corrosive acids from the marble's surface, but instead they seem to have made things worse.

A Comparative Analysis of Corrosive Impact

Sir Christopher Wren, some 50 years after the Taj Mahal was finished, created a

similarly ambitious edifice in London. St. Paul's Cathedral, London, England, was constructed from the pale, calcareous rock, Portland Stone, and was completed about 1711. Similar to the Taj Mahal, St. Paul's has been darkened by acid rain, soot, air pollutants, and the passage of time. "Nevertheless, the extent of the weathering is now well recognized thanks to 40 years of monitoring by teams of university geographers using scientific procedures including repeated observation with microerosion meters. British readers of a certain age may remember the terrible haze that blanketed the country in the 1940s and 1950s. Due to 400 years of coal-powered home heating and more recent emissions from cars and coal-fired power plants, London's air now contains dangerous amounts of sulphur dioxide and tiny particles of carbon."

Sulfur dioxide has been blamed as the primary contaminant for the deterioration of the magnificent white marbles for more than three decades.

Polluted River Contaminants' Deterioration

Initial studies pointed to the river Yamuna as the source of the hydrogen sulfide; the Yamuna carries the untreated effluent of the whole city of Agra. Saha, who oversaw the air laboratory at the Central Pollution Control Board for 12 years, said, "Hydrogen sulphide gas is acidic and corrosive." This calls for a great deal of focus on the cleanup of the Yamuna River. The wind rose diagram constructed during the study period reveals that the wind's direction resisted the industrial pollutants

traveling towards the monument, and the researchers also determined that "hydrogen sulphide generated from the contaminated Yamuna River... has a major influence." The results of this research were recently released by the journal Environmental Science & Technology International. The other authors on the study with Saha are Jitendra Kumar Singh, DDN Singh and Sharma Paswan, from the Corrosive environment and Surface Engineer at the National Metallurgical Laboratory in Jamshedpur; and Achal Pandya, head of the preservation unit just at Indira Gandhi National Center for the Arts in New Delhi. For the sake of keeping the Taj white, it was essential that the Yamuna be purified and that only treated sewage from the city be discharged into the river. According to Pandya, the river has "ceased to be a river" since its water is unfit for human consumption. But remember that Yamuna was once a component of the Taj Mahal's landscape. After studying metals left exposed at the Taj Mahal premises, the report concluded that the river played an integral role in the planning of the entire premises and that hydrogen sulfide emitted from the polluted River Yamuna flowing very close to an exit side (the premise of Taj Mahal) plays a dominant role on the corrosion rate of metals. The report concludes that the "white stones of the Taj Mahal may have faded due to the corrosion attack of hydrogen sulfide generated by the filthy Yamuna River."

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Socio-Economic Concerns and Legal Redressal



"The degradation is more visible inside the Taj," the petitioner said. The whole structure has a sickly yellow tinge. Ugly brown and black specks amplify the yellowish tone in certain areas. The Supreme Court's historic verdict in 1996 and several subsequent judgments over the following two and a half decades stemmed from concerns about fungal decay in the inner chamber, which houses Shah Jahan and Mumtaz Mahal's original tombs.

Anurag Sharma, of the Agra-based water conservation organization Jaladhikar Foundation, stated, "If a scientific research suggests Yamuna pollution is damaging the Taj Mahal, then this is a serious issue and this has to be properly studied with more studies." In February, then-Minister of State (Independent Charge) for Culture and Tourism Prahlad Singh Patel told the Lok Sabha that the Archaeological Survey of India had suggested a number of measures to combat the insect problem. These measures included de-silting the Yamuna River to increase water flow and prevent stagnation, cleaning and removing vegetation growth from the river, and scientifically cleaning and preserving the monument fabric.

The Taj Mahal, one of the Seven Wonders of the World and a UNESCO World Heritage Site, has been fighting pollution from factories for decades. During the current winter session of Parliament, Member of Parliament from the Aurangabad district Chandrakant Khaire raised worries about the negative effects of pollution on the Taj Mahal. Mr. Khaire submitted the inquiries to the Ministry of

Environment, Forests, and Climate Change (MoEFCC), inquiring as to whether or not the Taj Mahal's marble is becoming discolored as a result of air pollution. "Pollutants from different sources have already been superficially depositing on the marble surface of the Taj Mahal as particulate matter and due to light being scattered by these particles, the marble surface of the Taj Mahal appears to have changed color," reads an official written reply from Dr. Mahesh Sharma, Minister of State. This is a direct quote from the Archaeological Survey of India.

Conclusion

Mr. Khaire inquired as to the government's current measures to safeguard the Taj Mahal. The Minister of State said that ASI has developed a scientific cleaning and restoration strategy to bring back the Taj Mahal's former glory. The proposal includes measures to prevent pollution from sticking to the Taj Mahal's surface. The four minarets, 8 facades, 4 pedestal marble walls, the internal area of the peripheral up to human height, and the four chhatris atop the main tomb have all been cleaned and treated, he added. Therefore, technological research is necessary before attempting to clear the main dome.

The Supreme Court has previously voiced worry about the Mughal-era monument's discoloration and bug infestation. It requested that the government of Uttar Pradesh (UP) bring in international specialists to aid with the preservation of the country's white marble monument, which dates back to the 17th century. The



state government of Uttar Pradesh recently reported to the Supreme Court that it had commissioned a vision paper for the preservation of the Taj Mahal from the School of Architecture and Planning (SPA) in Delhi. Union Minister Nitin Gadkari said earlier this year that the government has taken the Supreme Court's comments on the condition of the Taj Mahal into consideration. To combat air pollution and save Agra's monuments, he said that biofuel, renewable fuel, and electric cars will soon become the norm in the city.

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