Erosion research at iconic St. Paul's shows benefit of declining pollution levels

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A cleaner, greener future? St. Paul's Cathedral, London.

One of London's most iconic buildings, St Paul's Cathedral, is safer from pollution eroding its limestone façade than it has been since it was built 300 years ago, according to scientists – but it might turn green in the future.

The team, including Dr Cherith Moses, Senior Lecturer in physical geography at the University of Sussex, conducted the longest-ever study of erosion rates on a single building and found that sulphur dioxide levels – responsible for acid rain – have fallen by 95 per cent over 30 years.

The drop is largely due to a decrease in industry and power generation in central London and the capital increasingly moving to cleaner energy.

Acid rain is now responsible for a fraction of one per cent of the damage to St Paul's and the rate of erosion at the cathedral is now dominated by natural rainfall, which is a weak carbonic acid with a pH of about 5.6.

The researchers conclude that the building is now safer than it has ever been, having survived the ravages of the Industrial Revolution, the nearby Bankside Power Station's plumes of sulphuric dioxide gas and smoke, and Londoners' love of coal fires.

Scientists from Sussex, Portsmouth, Oxford and Cambridge monitored the rate of erosion on the balustrade between 1980 and 2010 using a Micro Erosion Meter to take periodic readings of pollutants in the natural stone.

The findings are published in the journal Atmospheric Environment. They found atmospheric sulphur dioxide concentrations fell from a daily average of 80ppb in the early 1980s to less than 3ppb by the late 2000s.

The researchers are now looking to see if natural organisms that might no longer be retarded by pollution or aggressive erosion could in future colonise natural stone buildings like St Paul's and pose a new erosion risk.

Dr Moses, who is an expert in limestone weathering processes and products, says: "With predicted changes in rainfall linked to climate change, our research findings make it even more important for us to understand whether microflora, including algae, lichens and microorganisms, erode or protect stone surfaces.

"Natural stone buildings, under predicted wetter conditions, may be become 'greener' in the future because of microfloral colonisation. Our research will continue to investigate this over the next ten-year measurement period."

Dr Robert Inkpen (University of Portsmouth), who led the research, says: "We were surprised that the

results were so compelling – the drop in erosion over 30 years is quite dramatic and the data clearly illustrates erosion rates have now fallen to levels you would expect with just natural rainfall."

The unique dataset collected by the scientists may provide more effective predictions for building conservation projects – and provide valuable analyses of other major natural stone buildings. In addition to St Paul's, the British Museum, the east side of Buckingham Palace, the Bank of England and many of London's monuments are built from Portland limestone, as are some of the country's other cathedrals.

The research team began their study a year before the closure of Bankside Power Station in 1981. It had been generating electricity for 29 years emitting carbon dioxide, sulphur dioxide and nitrous oxide. The year it opened, in 1952, pollution across the city was commonplace and London's 'great smog' of that year saw thousands die due to pollution.

The research team measured five sites inside the cathedral's balustrade, including those facing north, south, east and west. The west-facing site, directly exposed to the pollution plume from the now defunct power station, showed the most erosion.

Dr Inkpen said: "London is probably the largest exposed outcrop of Portland limestone in the world. Wren chose it to build St Paul's and others followed his lead."

The researchers have continued studying erosion and surface change rates at the cathedral and will report their next findings in 2020.

The cathedral was designed by Sir Christopher Wren and completed in 1710 and the balustrade was added, against Wren's wishes, in 1718.

Provided by University of Sussex