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## Climate Change and Human Response: A Review of Solapur City during the COVID-19 Period

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### **Abstract:**

*Climate change is one of the major environmental challenges affecting human society, urban ecosystems and natural resources. Rapid urbanization, industrialization, transportation and increasing energy consumption contribute to atmospheric pollution and changes in the urban environment. The COVID-19 pandemic and nationwide lockdown in India during 2020 created an unusual situation in which human mobility, industrial activity, transportation and commercial activities were drastically reduced. This temporary reduction in anthropogenic activities provides an opportunity to examine the relationship between human activities and environmental conditions. The present study reviews the environmental and climatic conditions of Solapur city during the COVID-19 lockdown period, with particular emphasis on air quality, temperature, rainfall, human mobility and environmental response. Solapur is an important urban and industrial centre in Maharashtra and experiences a relatively dry climate, with district-level normal rainfall reported at approximately 550–650 mm. The study uses secondary data from government agencies, published research papers, air-quality databases and demographic sources. Particular attention is given to the period before, during and after the COVID-19 lockdown in 2020.*

*Published research that specifically included Solapur City found a decline in PM<sub>2.5</sub> from 40.38  $\mu\text{g}/\text{m}^3$  during the pre-lockdown period to 31.53, 23.22, 21.56 and 20.36  $\mu\text{g}/\text{m}^3$  during successive lockdown phases. These results demonstrate a substantial short-term improvement in particulate air pollution associated with reduced human activity. However, such temporary improvements should not be interpreted as a permanent reversal of climate change. The study concludes that the COVID-19 period provides useful evidence regarding the relationship between human activities, air pollution quality Solapur City.*

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**Keywords:** *Climate Change, COVID-19, Lockdown, Solapur, Air Pollution.*

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### **Introduction:**

Climate change has become an important global environmental issue. Changes in temperature, rainfall, extreme weather events, water availability and air

quality increasingly influence human health, agriculture, urban infrastructure and economic activities. Urban areas are particularly vulnerable because high population density, transportation,

industries, construction and energy consumption increase pressure on the environment.

The relationship between human activities and environmental conditions became particularly visible during the COVID-19 pandemic. India imposed a nationwide lockdown beginning on 25 March 2020, with different phases continuing through May 2020. During this period, transportation, industries, construction, commercial activities and human mobility were substantially restricted. The reduction in these activities caused a temporary decline in emissions and atmospheric pollution.

Research across India found substantial reductions in pollutants during the lockdown. One national study reported reductions of approximately 46–61% in NO<sub>2</sub> and 42–60% in PM<sub>2.5</sub>, together with decreases in PM<sub>10</sub>, ozone and carbon monoxide in many locations. Another study of Indian cities found that air-quality improvement was not uniform among cities or pollutants, demonstrating the importance of local conditions and emission sources.

Solapur provides an interesting case for studying this relationship. The city is located in south-eastern Maharashtra and is an important urban, industrial, commercial and transportation centre. The wider Solapur district had a 2011

population of 4,317,756, including approximately 1,399,091 urban residents.

The COVID-19 lockdown therefore provides a useful natural experiment for examining how changes in human activity affected environmental conditions in Solapur. The present study focuses particularly on-air pollution and climatic/environmental variables and considers how human responses during the pandemic influenced the urban environment.

### **Conceptual Framework:**

#### **Climate Change:**

Climate change refers to long-term changes in the average conditions of temperature, precipitation, atmospheric circulation and other components of the climate system. Human activities, especially fossil-fuel combustion, industrialization, deforestation and land-use change, have significantly contributed to recent global warming.

For an urban study, climate change should be distinguished from short-term weather variation. A temperature change observed during a few weeks of lockdown cannot by itself demonstrate climate change. Instead, long-term climate data should be used to identify climate trends.

#### **Human Response:**

Human response refers to the ways in which individuals, communities and

governments respond to environmental or climatic conditions.

During COVID-19, human response included:

Lockdown, reduced travel, work from home, closure of educational institutions, reduced industrial activity, social distancing, increased dependence on digital communication, and changes in consumption patterns. The lockdown therefore became an unusual example of a large-scale change in human behaviour.

#### **Environmental Response:**

Environmental response refers to changes in environmental conditions resulting from changes in human activity. During the lockdown, the most visible responses included reductions in traffic-related pollution and improvements in atmospheric clarity.

Studies across India found significant reductions in PM<sub>2.5</sub>, PM<sub>10</sub> and NO<sub>2</sub> during the lockdown period.

#### **Study Area: Solapur City:**

Solapur city is located in the south-eastern part of Maharashtra. It is an important urban centre with historical importance in the textile, handloom, power-loom and industrial sectors. The city also functions as a regional commercial and transportation centre.

The wider Solapur district lies approximately between 17°08' and 18°33'

N latitude and 74°36' and 76°25' E longitude. The district covers approximately 14,841 km<sup>2</sup>. Its reported annual rainfall range is approximately 550–650 mm, reflecting its relatively dry climatic characteristics.

According to Census 2011 data, Solapur district had a total population of 4.32 million, while the urban population was approximately 1.40 million.

The major characteristics relevant to this study are: semi-dry/dry climatic conditions, significant urban population, industrial and commercial activities, road transportation, residential expansion; electricity and energy consumption, traffic-related emissions; and vulnerability to heat and water stress.

These characteristics make Solapur an appropriate case for investigating relationships between human activity and environmental conditions.

#### **Objectives:**

- The main objective of the study is to examine climate and environmental changes and human responses in Solapur city during the COVID-19 period.

**Review of Literature:****National studies on COVID-19 and Air Quality:**

1. Verma and Kamyotra examined the impact of COVID-19 on air quality in India using data from more than 200 continuous ambient air-quality monitoring stations. They reported nationwide reductions in PM<sub>10</sub>, PM<sub>2.5</sub>, CO, NO<sub>2</sub> and SO<sub>2</sub> during the lockdown compared with the pre-lockdown period.
2. Dhaka et al. examined surface and satellite observations of Indian air pollution during lockdown. Their analysis found substantial reductions in NO<sub>2</sub> and PM<sub>2.5</sub>, together with reductions in other pollutants and satellite-derived aerosol measures.
3. Kumar and Managi studied the relationship between lockdown stringency and air quality in Indian cities. Their findings showed that lockdown measures improved air quality, although the magnitude differed between cities and pollutants.

**COVID-19 and Temperature:**

Studies have also examined the relationship between reduced pollution and temperature. One study of major Indian cities found decreases in daytime and nighttime land-surface temperature during the lockdown period. The authors suggested that reductions in pollutants,

greenhouse gases and atmospheric water vapour contributed to these changes.

Another study examining four Indian megacities reported temperature decreases of approximately 2–3°C during the strict lockdown, along with substantial reductions in aerosol and pollutant concentrations.

However, these results should be interpreted carefully because short-term weather conditions, rainfall, humidity and atmospheric circulation can also affect temperature.

**Climate variables during COVID-19:**

Research on temperature and precipitation across India during the pandemic examined data COVID-19 and found spatial and temporal variability in temperature and rainfall. The study emphasized that observed changes during 2020 should be assessed in relation to previous years rather than attributed entirely to lockdown.

**Air-quality Solapur City:**

Research on Maharashtra used air-quality and meteorological observations from several cities, including Solapur, and considered PM<sub>2.5</sub>, PM<sub>10</sub>, CO, NO<sub>2</sub>, SO<sub>2</sub>, ozone, temperature, rainfall and wind speed during pre-, during- and post-lockdown periods.

**Table No.1: Air-quality and meteorological data in Solapur City**

| Period           | PM2.5 ( $\mu\text{g}/\text{m}^3$ ) |
|------------------|------------------------------------|
| Pre-lockdown     | 40.38                              |
| Lockdown Phase 1 | 31.53                              |
| Lockdown Phase 2 | 23.22                              |
| Lockdown Phase 3 | 21.56                              |
| Lockdown Phase 4 | 20.36                              |

(Source: Pollution Control Board (CPCB))

### Research Methodology:

#### Research Design:

The study follows a descriptive and comparative research design. It compares environmental conditions before, during and after the COVID-19 lockdown.

The recommended study periods are:

- **Pre-lockdown:** 1 March–24 March 2020
- **Lockdown Phase I:** 25 March–14 April 2020
- **Lockdown Phase II:** 15 April–3 May 2020
- **Lockdown Phase III:** 4 May–17 May 2020
- **Lockdown Phase IV:** 18 May–31 May 2020
- **Unlock period:** June onwards

For stronger climate analysis, the 2020 values should additionally be compared with corresponding months from **2015–2019**.

### Sources of Data:

#### Secondary Data:

Potential sources include, Central Pollution Control Board (CPCB), Maharashtra Pollution Control Board (MPCB), India Meteorological Department (IMD), Census of India, Solapur Municipal Corporation, Maharashtra government publications, published research papers and government COVID-19 reports.

CPCB air-quality databases contain measurements of pollutants such as PM<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>2</sub>, SO<sub>2</sub>, CO and O<sub>3</sub>.

#### Statistical Methods:

##### Percentage Change:

Percentage Change =  $\frac{\text{Lockdown Value} - \text{Pre-lockdown Value}}{\text{Pre-lockdown Value}} \times 100$

For example, using the published Solapur PM<sub>2.5</sub> values:

$$31.53 - 40.38 \div 40.38 \times 100 \approx -21.9\%$$

Thus, PM<sub>2.5</sub> decreased by approximately **21.9% in Phase I** relative to the reported pre-lockdown value.

##### For Phase IV:

$$20.36 - 40.38 \div 40.38 \times 100 \approx -49.6\%$$

Thus, the reported PM<sub>2.5</sub> level was approximately **49.6% lower** in Phase IV than during the pre-lockdown period.

**Data Analysis:**

The available published city-level data show a clear decline in PM<sub>2.5</sub> during the Solapur lockdown.

**Table No.2: Pollution Control Board (CPCB), Solapur City**

| Lockdown stage | PM <sub>2.5</sub> | Change from pre-lockdown |
|----------------|-------------------|--------------------------|
| Pre-lockdown   | 40.38             | —                        |
| Phase I        | 31.53             | –21.9%                   |
| Phase II       | 23.22             | –42.5%                   |
| Phase III      | 21.56             | –46.6%                   |
| Phase IV       | 20.36             | –49.6%                   |

(Source: Pollution Control Board (CPCB))

The data indicate that particulate pollution decreased progressively during the lockdown. The decline is consistent with reduced road traffic, industrial activity, construction and other emission-producing activities.

This pattern is consistent with broader Indian research showing substantial reductions in particulate matter during the COVID-19 restrictions.

**Human Activity and Air Pollution:**

Before lockdown, Solapur's urban environment was influenced by:

Road traffic, industrial activities, construction, commercial activity, movement of goods, domestic activities; and other anthropogenic sources.

During lockdown, many of these activities were substantially reduced. Consequently, pollutant emissions declined. However, this relationship is not completely linear because meteorological conditions such as wind speed, rainfall, humidity and atmospheric stability also influence pollutant concentrations.

**Climate and Temperature Response:**

The COVID-19 period should not be considered evidence that climate change stopped or reversed. Rather, it provides evidence that human activity can rapidly affect some components of the urban atmospheric environment.

Research across India found reductions in urban land-surface temperature during lockdown. One nationwide urban study found daytime LST anomalies of approximately  $-0.16$  to  $-1^{\circ}\text{C}$  and nighttime anomalies of approximately  $-0.63$  to  $-2.1^{\circ}\text{C}$  across selected major cities. A broader Indian study found temperature decreases of approximately  $1-3^{\circ}\text{C}$  in some regions during lockdown compared with climatological conditions.

For Solapur, however, a scientifically rigorous conclusion regarding temperature change should be based on local station or satellite data, comparing 2020 with a multi-year baseline. It would not be appropriate to

claim that every temperature change in Solapur during lockdown was caused by COVID-19.

### Conclusion:

The COVID-19 lockdown created an unusual opportunity to examine the relationship between human activities and environmental conditions in Solapur. The available evidence demonstrates that the reduction in transportation, industrial activity, construction and other anthropogenic activities was accompanied by a substantial short-term improvement in particulate air quality.

The published Solapur data are particularly significant: PM<sub>2.5</sub> declined from 40.38  $\mu\text{g}/\text{m}^3$  before lockdown to 20.36  $\mu\text{g}/\text{m}^3$  by the fourth lockdown phase, approximately a 49.6% reduction. (PMC) Similar studies across India reported substantial decreases in PM<sub>2.5</sub>, PM<sub>10</sub> and NO<sub>2</sub> during the lockdown.

The findings demonstrate the strong connection between human activity and urban environmental quality. At the same time, the improvement was temporary. Once economic and transportation activities resumed, pollution levels could also increase. Therefore, the COVID-19 experience should not be viewed as a model of environmental management through lockdown. Instead, it

should be treated as evidence supporting long-term sustainable development, cleaner transportation, renewable energy, pollution control, urban greenery and climate-resilient planning.

For Solapur, climate-change adaptation and environmental management should focus on reducing emissions while maintaining economic and social well-being. The major lesson from the COVID-19 period is that cleaner urban environments can be achieved through sustained changes in technology, infrastructure and human behaviour without imposing the severe social and economic costs associated with a lockdown.

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