

Assessing Climate Change Impacts on Rural Livelihoods: A Case Study of Palghar District

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Abstract

In particular, environmentally sensitive and socio-economically fragile places, such as the Palghar district of Maharashtra, are particularly exposed to the damaging effects of climate change, which poses a substantial danger to rural livelihoods. This study investigates the influence that climatic variability has on the security of livelihoods, with a particular emphasis on the quality of the air in the surrounding environment and the consequences that this has for rural populations. The research was carried out in ten different villages located within the Palghar district. The monitoring of the air quality was carried out over the course of a year, beginning in January 2016 and ending in December 2016. For the purpose of calculating the Air Quality Index (AQI), measures and analyses were performed on a number of important pollutants, such as PM₁₀, PM_{2.5}, SO₂, NO_x, and NH₃.

According to the data, the concentrations of particulate matter (PM1 and PM2) regularly exceeded the permitted requirements. This was mostly caused by the combustion of biomass, emissions from vehicles, and the resuspension of road dust. Despite the fact that gaseous pollutants including sulfur dioxide, nitrogen dioxide, and nitrogen monoxide were found to be within acceptable levels, their presence led to a general decline in air quality. An investigation of the Air Quality Index (AQI) revealed that few areas, such as Sakhare, Belwad, and Suryamal, were subjected to high levels of air pollution, while the majority of other locations were found to have moderate levels of pollution.

According to the findings of the study, there is a significant connection between environmental deterioration and the vulnerability of rural livelihoods, particularly in regions that are controlled by tribal communities and are dependent on natural resources. This highlights the urgent need for comprehensive policy interventions, which should include the promotion of renewable energy, efficient waste management, and activities that promote sustainable development. This research makes a significant contribution to a better

knowledge of the localized implications of climate change and provides a foundation for the development of climate-resilient livelihood options in rural India.

Keywords :- Palghar District, Air Quality Index, Climate change, Rural livelihood

Introduction

As a result of shifting rainfall patterns, increasing temperatures, and coastline erosion, the Palghar district is experiencing a high level of vulnerability as a result of climate change. The district has one of the highest exposure ratings in the state of Maharashtra. The unpredictable weather has a tremendous influence on agriculture and fisheries, which in turn causes considerable losses of livelihood for the communities that are located in the area.

Climate change has emerged as one of the most important global concerns of the twenty-first century, with far-reaching consequences for the stability of the environment, the growth of the economy, and the well-being of people. There has been a disruption in natural and socio-economic systems all over the world as a result of rising global temperatures, shifting patterns of precipitation, rising sea levels, and an increase in the frequency and severity of extreme weather events such as droughts, floods, and heatwaves. Despite the fact that climate change is a process that occurs on a worldwide scale, its effects are not uniformly dispersed. It has a disproportionately negative impact on poor nations and vulnerable people that have very little ability for adaptation. Taking this into consideration, climate change has evolved into not just a problem for the environment but also a significant problem for economic growth and the maintenance of livelihoods, particularly for rural and agricultural cultures. India is extremely susceptible to the effects of climate change as a result of its geographical variety, vast population, and substantial reliance on industries that are sensitive to climate change.

Agriculture and activities related to agriculture, such as livestock husbandry, fisheries, forestry, and wage labor in the informal sector, are the primary sources of income for rural India, which is home to roughly two-thirds of the country's population.

One of the most important aspects of rural lives is agriculture, which continues to be the primary source of employment and income for a significant number of people. On the other hand, the industry is mostly dependent on rainfall, which makes it extremely vulnerable to shifts in monsoon patterns, fluctuations in temperature, and extreme weather events. In addition to agriculture, non-agricultural livelihoods in rural areas, including as seasonal migration, construction labor, and small-scale enterprises, are also indirectly dependent on the weather conditions and the economic stability of rural areas.

The term "livelihood" in rural India comprises a number of different aspects, including as a consistent income, chances for work, food and nutritional security, access to natural resources, and social protection. These aspects are undermined both directly and indirectly by climate change, which has an impact on crop output, animal health, the availability of water, and the general economic resilience of rural areas. Agricultural harvests and farm revenues are negatively impacted by erratic rainfall and lengthy droughts, while floods and cyclones cause damage to infrastructure, assets, and dwellings. Rural households are frequently forced into debt, poverty, and migration with suffering as a result of such disturbances. Small and marginal farmers, landless laborers, women, and populations that are marginalized are more vulnerable to the effects of climate change because they have fewer resources available to deal with the effects of climate shocks.

Because of this, the connection between climate change and livelihood is not only complicated but also composed of several dimensions. As a result of the interaction between climate-induced pressures and pre-existing socio-economic disparities, institutional inadequacies, and development obstacles, vulnerability in rural regions is exacerbated. Despite the fact that India has implemented a number of policy measures, including the National Action Plan on Climate Change (NAPCC), State Action Plans on Climate Change (SAPCCs), and rural development programs like MGNREGA, there is still a substantial gap between the policy objective and the actual consequences on the ground. A significant number of adaptation solutions continue to be sector-specific, fragmented, or inadequately integrated into the planning of local livelihood patterns. When viewed against this background, the primary research concern that is being investigated in this study is the rising threat that climate change poses to the security of livelihoods in rural India, as well as the insufficiency of the systems that are currently in place to completely address this challenge.

There is a need for a comprehensive approach that ties climate impacts to broader livelihood dimensions, such as employment, income stability, food security, and migration, despite the fact that there is a growing amount of scholarly attention being paid to climate change and agriculture. In addition, the majority of the research that have been conducted thus far concentrate on the biophysical effects, to the exclusion of the social and institutional aspects. The significance of this work lies not just in the realm of academia but also in politics. In the realm of academia, it makes a contribution to the expanding body of literature by combining the analysis of climate change with ideas on the security of livelihoods and governance. It provides a complete knowledge of the ways in which socio-economic vulnerabilities in rural India interact with climatic conditions. This study highlights the need for climate-resilient livelihood strategies that are inclusive and give insights into the limits of existing adaptation frameworks. It also provides insights into the limitations of existing adaptation frameworks. The purpose of this study is to provide policymakers, development practitioners, and academics who are engaged in the process of building sustainable and equitable solutions to climate change in rural India with information by highlighting the experiences of vulnerable rural populations.

OBJECTIVES

- To examine the major impacts of climate change on livelihood security in rural India.
- To study Assessing Climate Change Impacts on Rural Livelihoods: A Case Study of Palghar District.

RESEARCH METHODOLOGY

Ten villages in the Palghar District of the state of Maharashtra, which is located in the Konkan Division, were the locations where the research was conducted. The talukas of Palghar, Vada, Vikramgad, Jawhar, Mokhada, Dahanu, Talasari, and Vasai-Virar were included in the newly formed district of New Palghar, which was carved out of the old Thane District. Thane and Nashik Districts, which are located to the east and north-east of the district, as well as the Valsad District of Gujarat state and the Union Territory of Dadra and Nagar Haveli, which are located to the north, are the boundary of the district. The quality of the air in the region is the consequence of a complex interplay between the natural environment and the environmental conditions caused by human activity.

For the purpose of this study, locations were chosen in the Palghar District that are located in the vada, vikramgad, Jawhar, and Mokhada Talukas. These locations are located close to the main highways where cars are constantly moving. There are people who belong to the Katkaris, Kolams, and Madia Gonds, which are regarded to be the Primitive Tribes of the state. The majority of the villages are associated with scheduled tribes. The other tribes that are more well-known are the Warli, Bhils, Gonds, Mahadeo kolis, Malahar kolis, Koknas, Thakurs, and others with similar names. Backwardness is a term that is commonly used to describe tribal people, which refers to their inability to make use of the possibilities for progress that are available to them. Therefore, the most important concerns in their growth are not only connected to the provision of infrastructure and development plans, but also to the development of their capacity to utilize these things on an equal level with other people of the District or state.

For a period of one year, monitoring of the ambient air was performed twice a week, for a total of twelve months. Therefore, data for ambient air monitoring is gathered for a period of twelve weeks for a single location. The operation was carried out between the months of January and December in the year 2016. In table 1, the locations of ambient air monitoring stations are listed in relation to the talukas in which they are located.

Table 1: Sites for Ambient Air Monitoring at Palghar District

Sr. No	Site in Village	Talukas
1	Malwada	Vikramgad
2	Waki	Vikramgad
3	Sakhare	Jawhar
4	Walvande	Jawhar
5	Belwad	Shahapur
6	Balivali	Shahapur
7	Parli	Wada
8	Suryamal	Mokada
9	Mangrul	Wada
10	Dhaipatpada	Wada

Every single one of the ten locations had samples of PM₁₀ and PM_{2.5} taken from them. Two times a week, samples of PM₁₀ and PM_{2.5} were collected from ten different locations for a period of twenty-four hours each. The samples of PM₁₀ and PM_{2.5} were obtained using a respirable dust sampler (APM 460DX, Envirotech, New Delhi) and a Wins-Anderson impactor (APM 550, Envirotech, New Delhi) with a finer cut point of 10 μ m and 2.5 μ m, respectively. The filter papers used were Whatman GF/A and Teflon-Millipore. The flow rates of the high volume sampler and the WinsAnderson impactor were 1.0 m³ per minute and 16.67 l per minute, respectively, when they were in operation. Before beginning the sample process, each of the filter papers was dried out for a period of twenty-four hours and then pre-weighed on

an analytical weighing scale. Following the conditioning and weighing of the filter papers, they were placed in a filter holder cassette for PM_{2.5} and a zip lock polybag for PM₁₀, and then they were transported to the field for sampling. This was done in order to prevent contamination. The initial volume and timer readings for PM_{2.5} were recorded, and the manometer reading for the PM₁₀ sampler was recorded. This was done before the filter papers were loaded into the samplers. At the same time as the individual samplers were being started, filter papers were loaded onto them. Immediately following the collection of samples, the filled filter of PM_{2.5} was extracted using forceps, then placed in a cassette, and last wrapped in aluminum foil. A similar procedure was followed with the PM₁₀ filter paper, which consisted of wrapping it in aluminum foil and placing it back inside the zip-lock polybag. Both of the filter papers were then transported to the laboratory. For the purpose of determining the mass concentration of PM₁₀ and PM_{2.5}, filter papers were conditioned and weighed once more in the laboratory. For the purpose of conducting chemical analysis, the weighed filter papers were stored in the freezer.

With the use of an RDS APM 460DX equipped with a gaseous attachment APM 411, measurements of SO₂, NO_x, and NH₃ were obtained by sucking air into the appropriate reagent for a period of 48 hours each week at intervals of 24 hours. Following the completion of the air monitoring, the reagent was brought into the laboratory for examination of the concentration level. To collect sulfur dioxide, nitrogen oxides, and hydrogen sulfide, the material was bubbled in a specialized absorbing solution (Sodium tetrachloromercurate for sulfur dioxide, sodium hydroxide for nitrogen oxides, and 0.1N sulfuric acid for hydrogen sulfide) at an average flow rate of 0.2-0.5 liters per minute. Following the completion of the collection process, the impinge samples were immediately stored in the ice boxes and then transferred to a refrigerator until they were tested. The concentration of NO_x was determined using the modified standard technique [30], the concentration of SO₂ was determined using modified [31], and the concentration of NH₃ was determined using the Nessler method. At a height of between two and two and a half meters above the surface of the earth, the instrument was maintained.

Air quality indexb (AQI)

A real-time monitoring of the air quality in cities across the country is accomplished via the utilization of the Air Quality Index (AQI), which also serves to raise awareness among the general public. The Air Quality Index (AQI) is one example of a technique that may be utilized to effectively disseminate information on air quality to individuals. The Air Quality Index (AQI) will assist individuals in gaining an understanding of the quantity of pollution that is present in the surrounding air on a regular basis. The air quality index, often known as the AQI, is a measurement that determines the ratio of the concentration of pollutants to the status of the ambient air at a given location. Over the course of about 25 years, indices of air pollution or air quality have been utilized. In order to determine the air quality index of the locations that were taken into consideration, the following computation was utilized:

$$AQI = \frac{1}{4} \times (IPM_{10} / SPM_{10} + IPM_{2.5} / SPM_{2.5} + ISO_2 / SSO_2 + INO_x / SNO_x + INH_3 / SNH_3) \times 100.$$

Where:

IPM₁₀, IPM_{2.5}, ISO₂, INOX and INH₃ = Individual values of particulate matter (10 and 2.5), sulphur dioxide oxides of nitrogen, and ammonia respectively.

IPM₁₀, IPM_{2.5}, ISO₂, INOX and INH₃ = Standards of ambient air quality.

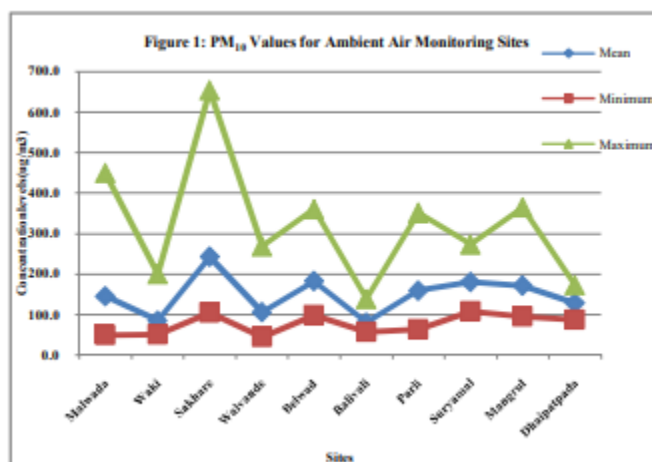
The indices use health based descriptions to provide meaningful information to the public. The five levels of AQI are given in table 2.

Table 2: Index Values of air quality index calculation

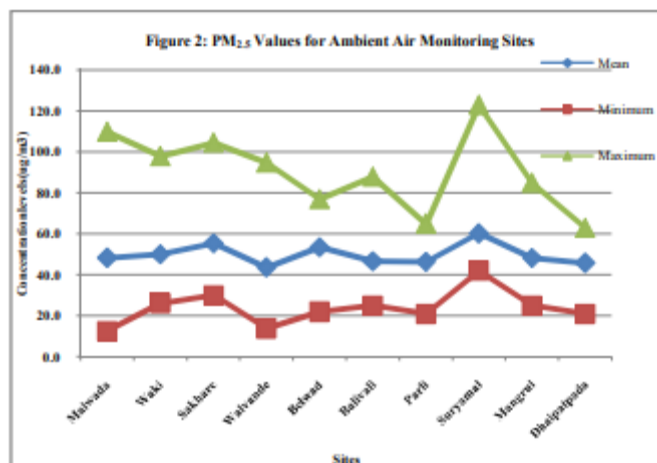
Value of Index	Remarks
Between 10–25	Clean air
Between 26–50	Light air pollution
Between 51–75	Moderate air pollution
Between 76–100	Heavy air pollution
Above 100	Severe air pollution

RESULTS AND DISCUSSIONS

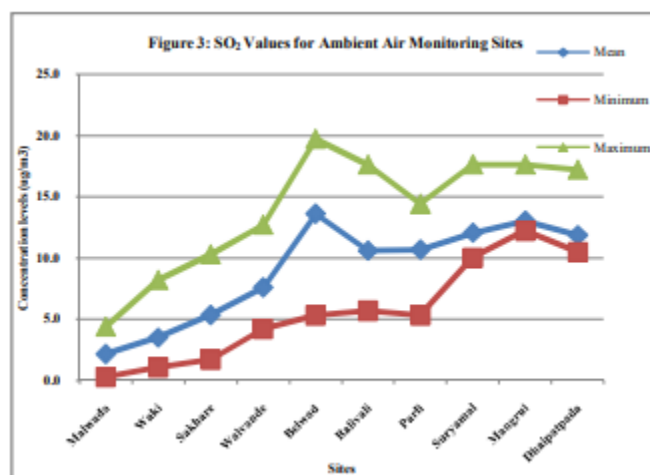
The mean PM₁₀ readings across all locations vary from 81.00 µg/m³ at the Balivali site to 243.2 µg/m³ at the Sakhare site. The minimum and greatest values are recorded at the Walvande site (45.6 µg/m³) and the Sakhare site (654.2 µg/m³), respectively. All maximum values at each location surpass the Air Quality Standards (i.e., over 100 µg/m³) established by the NAAQS in 2009, attributed to local combustion of fuel wood, incineration of leaves and dry waste materials, and resuspension of road dust in the atmosphere. Figure 1 illustrates the average, minimum, and maximum PM₁₀ levels across all monitoring locations.



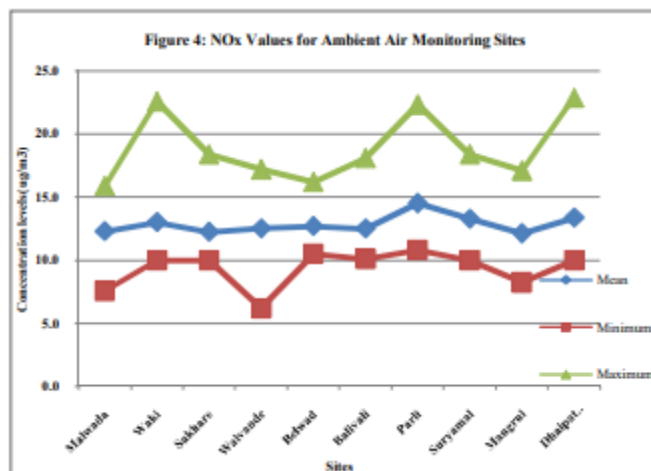
The average PM_{2.5} levels at each location range from 48.2 ug/m³ at the Mangrul site to 60.3 ug/m³ at the Suryamal site. The average readings for the Malvade site were 12.5 ug/m³, whereas at the Suryamal site they were 123.0 ug/m³. The Air Quality Standards (i.e., more than 60 ug/m³) NAAQS, 2009 have been surpassed at all locations, according to the observations. Reasons for the elevated PM_{2.5} levels include the resuspension of road dust and the combustion of biomass for domestic heating and cooking. The average, minimum, and maximum PM_{2.5} levels across all monitoring locations are displayed in Figure 2.



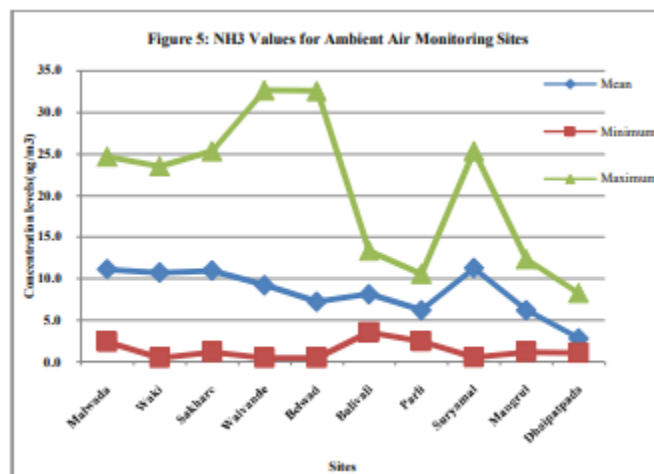
The average SO₂ levels at each location range from 2.2 ug/m³ at the Malvada site to 13.6 ug/m³ at the Belwad site. The lowest recorded average value was 0.3 ug/m³ at the Malvade site, while the highest was 12.2 ug/m³ at the Mangrul site. Results at all locations fall within the parameters set by the Air Quality Standards (i.e., greater than 80 ug/m³) NAAQS, 2009. Figure 3 displays the range of SO₂ levels across all monitoring locations, including average, minimum, and maximum readings. The combustion of fossil fuels and emissions from industrial processes are the main sources of sulphur dioxide (SO₂) (WHO, 2002).



The average NO_x levels at the various locations vary from 12.1 ug/m³ at the Mangrul site to 14.5 ug/m³ at the Parli site. Walvande site had the lowest average value of 6.2 ug/m³, whereas Dhaipatpada site had the highest average value of 22.9 ug/m³. Results at all locations fall within the parameters set by the Air Quality Standards (i.e., greater than 80 ug/m³) NAAQS, 2009. Figure 4 displays the range of NO_x values across all monitoring locations, including average, minimum, and maximum values. Nitrate aerosols, which include particulate matter 2.5 and ozone, are the most common source of NO_x. These aerosols are a byproduct of burning fuels, power plants, and automobile engines (WHO, 2002).



From 2.9 $\mu\text{g}/\text{m}^3$ at the Dhaipatpada site to 11.2 $\mu\text{g}/\text{m}^3$ at the Malwada site, the mean NH_3 readings are consistently within this range. The Waki site had the lowest average value of 0.5 $\mu\text{g}/\text{m}^3$, whereas the Belwad site recorded the highest average value of 32.6 $\mu\text{g}/\text{m}^3$. Results at all locations fall within the parameters set by the Air Quality Standards (i.e., greater than 80 $\mu\text{g}/\text{m}^3$) NAAQS, 2009. All monitoring stations' average, minimum, and maximum NH_3 readings are displayed in Figure 5. In addition to agricultural sources, non-agricultural ones include things like gasoline vehicle catalytic converters, sewage treatment plants, landfills, composting, combustion, industry, and even wild animals and birds.



The ambient air quality for the average parameters and corresponding AQI is displayed in Table 3. According to the AQI, Sakhare, Belwad, and Suryamal exhibited severe pollution (AQI 76-100), whereas Malwada, Waki, Walvande, Parli, Mangrul, and Dhaipatpada shown moderate pollution (AQI 51-75).

Table 3: Ambient air quality with respect to the average parameters and respective AQI

Sites	PM ₁₀	PM _{2.5}	SO ₂	NO ₂	NH ₃	AQI	Quality of Ambient Air

Malwada	146.1	48.3	2.2	12.3	11.2	64.7	Moderate air pollution
Waki	85.7	50.0	3.5	13.0	10.8	50.8	Moderate air pollution
Sakhare	243.2	55.4	5.4	12.3	11.0	92.8	Heavy air pollution
Walvande	106.7	43.6	7.6	12.5	9.3	54.0	Moderate air pollution
Belwad	183.5	53.4	13.6	12.7	7.3	78.6	Heavy air pollution
Balivali	81.0	46.6	10.6	12.5	8.2	49.4	Light air pollution
Parli	159.7	46.3	10.7	14.5	6.2	69.1	Moderate air pollution
Suryamal	181.0	60.3	12.0	13.3	11.3	81.8	Heavy air pollution
Mangrul	172.3	48.2	13.0	12.1	6.3	73.0	Moderate air pollution
Dhaipatpada	129.3	45.8	11.9	13.4	2.9	60.2	Moderate air pollution

CONCLUSION

In addition to lowering emissions of greenhouse gases, which contribute to global warming, switching to renewable energy sources can improve people's health and lessen air pollution. Air pollutants can be greatly

reduced by decreasing the use of traditional biomass in residential areas. However, the only way to completely eliminate indoor PM_{2.5} emissions by 2040 is to completely switch to modern, clean cooking technologies by 2030. During the same period, emissions of NO_x and SO₂ can be reduced by 65 to 75 percent (IEA, 2021). To assess the trend of particle pollution and determine source contributions, an emissions inventory is conducted, followed by a dispersion modeling experiment. While these figures alone won't be enough to lower pollution levels, when combined with other data, they can help policymakers set baselines and develop a strategy to improve air quality over time. It will take further policy initiatives to achieve this goal. One other thing that people can do to help slow global warming is switch to cleaner cooking fuel. The need for baselines and a beginning to address air pollution is critical and pressing, given the expanding population and settlements. An easily understandable picture of the ambient air pollutant principally responsible for air quality can be provided by the total AQI. According to the AQI research, particle matter (PM) was the primary culprit for the longest durations across all locations, whether in an urban or rural area. In terms of air quality index (AQI), most PM₁₀, PM_{2.5}, SO₂, NO_x, and CO readings are adequate. The fast expansion of metropolitan areas, the proliferation of vehicles, the frequency of dust storms, and the resuspension of dust might all be contributing factors. With the exception of Boisar, there was no variation in pollutant characteristics between rural and urban locations. Because to its proximity to the industrial zone, the Boisar site had a higher PM₁₀ score than the others. Factors contributing to elevated PM levels include building construction, road works maintenance, and dust resuspension (on road). A town-wide education campaign, in addition to routine road cleaning, appropriate fencing, and water sprinkler use, can significantly cut down on particulate matter (PM) pollution.

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