

A photograph of a woman in a green sari and a floral headscarf, smiling as she cooks over a wood fire. The fire is burning in a traditional stone stove. The background is a textured wall.

Impact of Air Pollution

on Human Health

Uttarakhand

Gati Foundation

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Gati Foundation, a Dehra Dun, Uttarakhand based, is a research and policy think-tank. Looking at development through the prism of sustainable development in the Himalayas, Gati has been working in the field of environment, urban governance and public health. It believes in the doctrines of three A's - analysis, advocacy and action – that lead to sustainable and tangible changes. The Foundation has pledged to adopt a participatory approach, engage with citizens, undertake policy research and facilitate better standards of governance.

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Foreword

Humans have always exploited nature for its benefit be it in the name of growth, development, industrialization, infrastructure development, urbanization, etc. Our environment has always been at the receiving end. Mother Nature has been enduring all excesses, trying to maintain balance. Now we have reached a stage where these compensatory environmental mechanisms are no longer able to maintain balance. Effects of which are being perceived globally and recognized in various forms. One of the visible effects of environmental change is the change in ambient air quality, esp. in urban areas. There are multiple factors responsible for this change. Initially, it was observed that air pollution was causing problems in big congested cities, but now we observe that even small cities and towns are getting affected.

Dehradun city which has always been loved for its clean, peaceful environment, no longer appears to be so. Hill state of Uttarakhand which was supposed to be a preferred place for fresh, rejuvenating environment for many from large cities seems to be losing its sheen. Many places in Uttarakhand which were famous for its beautiful natural environment now appear as big urban business centers of the metropolitan city. These changes in ambient air in cities have been affecting the health of humans as well, the fact which has been recognized and shared globally. Many studies have highlighted different health conditions linked to poor air quality, some of which are alarming and have been a cause of mortality as well.

Past studies on the effect of air pollution on human health and its various components were conducted in places where air pollution was perceived to be at alarming levels. But there are no studies done in smaller cities. In our study, we have made an effort to uncover the growing issue of air pollution in the Himalayan state of Uttarakhand. We have interacted with different sections of society like doctors, police personnel, children, parents etc. and tried to highlight the nexus between air pollution and its lasting impact on human health.

However, I strongly feel that there is a need to conduct this study on a much larger scale so as to generate significant data to start a statistical debate. I want to thank all the participants of this study and hope to continue working on this issue.

Dr. Rimant Gupta

Medical & Public Health Advisor, Gati Foundation, Dehradun, Uttarakhand

List of Abbreviations

AQI	Air Quality Index
ARI	Acute Respiratory Infection
BMTC	Bangalore Metropolitan Transport Corporation
COPD	Chronic Obstructive Pulmonary Disease
CPCB	Central Pollution Control Board
CSE	Centre for Science and Environment
IARC	International Agency for Research on Cancer
IHD	Ischemic Heart Disease
MoEFCC	Ministry of Environment, Forest, and Climate Change
OECD	Organisation for Economic Co-operation and Development
NCAP	National Clean Air Program
NCR	National Capital Region
PM	Particulate Matter
SDG	Sustainable Development Goal
SP	Superintendent of Police
WHO	World Health Organization

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BACKGROUND

Today, one of the major challenges facing the global community is that of air pollution. Not restricted to only less economically developed countries, this menace, often seen to be a necessary corollary of industrialization and growth, affects richer European countries just as much. In fact, the World Health Organization (WHO) estimates find that around 90% of people worldwide breathe polluted air.¹

Studies have, for a while now, indicated a strong upward trend in the decline of air quality in countries across the world. For instance, a study conducted by the WHO estimates that nearly 7 million premature deaths are caused by air pollution, annually.²

Other studies that are more focused on India, specifically, have also seen similarly disturbing increases in the levels of air pollution in the country. A report titled ‘State of Global Air (2018)’³ finds that 10.6 percent of all deaths in India were attributable to particulate matter pollution.

India’s Ministry of Environment, Forest, and Climate Change (MoEFCC) has recently launched the National Clean Air Program (called NCAP, henceforth). The NCAP had many hopefuls thinking that it would successfully lead to some changes in the present situation. A study of the NCAP done by the foundation, however, revealed that it is rather passive, and does not really focus on the Himalayan states, at all, with its ‘one size fits all’ approach to achieving cleaner air. The 637 crore rupees allotted to the project hardly seem equally distributed between the Indian states, with the program’s major concern clearly being National Capital Region (NCR) of Delhi.

Real change must come from those that inhabit the state, and its cities. Movements must be participatory, tailored to fit the socio-cultural and geographic intricacies of the region. Agitations like the Zapatista Rebellion of 1994 prove that solutions to combat problems of the ‘less’ developed world need not emerge from the ‘developed West,’ and can be solutions rooted in indigenous knowledge, and local culture.

ICCAC Secretariat. (2018). “World Health Organization Releases New Global Air Pollution Data”, *Climate & Clean Air Coalition*. Available on: ccacoalition.org/en/news/world-health-organization-releases-new-global-air-pollution-data.

2 Ibid.

3 State of Global Air. (2017). Global Burden of Disease Study. *IHME*, Available on: www.stateofglobalair.org.

It is in this context that this report, a first of its kind for Uttarakhand, attempts to highlight the various ill effects of rising air pollution on human health. The report, mostly based on secondary research, shows how an increase in respiratory and cardiovascular diseases, complaints commonly linked with air pollution, mirrors the increase in pollution levels in the Himalayan state. This steady increase of both, highlighted in the report, should then provide to government agencies and citizens the impetus to take strong preventive action against air pollution.

Behaviorally, people tend to react to something after it affects them at a personal level. The threat of air pollution is usually not taken seriously because of the absence of strong causal links between symptoms and air pollution, and the long dormancy period of diseases related to particulate matter (PM) exposure.

To conclude, the report attempts to recognise what different stakeholders in society can do to mitigate the ever-growing levels of pollution.

EXECUTIVE SUMMARY

This report aims to show that urgent action is required to mitigate the problem of air pollution in the Himalayan state of Uttarakhand. It tries to establish that the increase in pollution levels seem to have resulted in increases in diseases attributable to air pollution. This report is an attempt to link human health and rising air pollution so that government and planning departments along with citizens realize the gravity of the situation, and realize that they must act now.

Though mostly restricted to secondary data analysis, the report does include primary findings, from interactions with various stakeholder groups. A number of doctors were interviewed to gain an insight into the trends of pulmonary disease in the state. Further, a number of parents of school-going children were interviewed to understand levels of awareness among parents, and also to see how many children were affected by serious respiratory symptoms, in the past year. Interactions with the head of the City Patrol Unit, and the SP, Uttarakhand Traffic Directorate, also proved helpful.

Results of all these interviews show that there has been an increase in the number of people affected by respiratory complaints. Interestingly, people have been found to display a strange behavioral trait- though most of these people are aware of the ill effects of air pollution, they take no measures to protect themselves from it.

The report then finds that the increasingly polluted air in Uttarakhand can only be the harbinger of bad news. Citizen engagement and participation have been recognised as crucial to combat the problem. Additionally, there has been an attempt to outline the role and responsibility of each stakeholder group in playing their role.

The report, however, realises the fact that this analysis conducted has some limitations. The paucity of time and technical backing restricted the study to secondary material, which restricted, somewhat, the scope of the study. This is just an indicative study aimed at highlighting the effects of air pollution on human health in Himalayan Uttarakhand.

INTRODUCING THE ISSUE: THE STATE OF GLOBAL AND INDIAN AIR

1.1 Air Pollution: The Global Scenario

In today's world, there are several issues related to environment and public health which confront human society. From world hunger to incurable diseases, a host of problems plague the world. In this long list of problems, however, the issue of ever-increasing air pollution gets hidden out of view. Correspondingly, a focus on the dire effects of increasing air pollution is simply ignored. Lack of strong causal links between symptoms and causes, and a long dormancy period of pulmonary diseases caused by pollution, only makes things worse.

According to the WHO report approximately 4.2 million people die due to exposure to ambient air pollution⁴, every year. But, that is not all. People are not even safe indoors—the WHO also finds that 3.8 million deaths every year are attributable to “household exposure to smoke from traditional cook-stoves and dirty fuels”.⁵ Scarcely, the phenomenon of air pollution is neither localised, nor is it restricted to only the less economically developed countries of the world. In fact, 91 percent of the world's population breathes air that violates all standards set by the WHO⁶ guideline limits.⁷ Because pollutants travel from sources of origin into other regions, air pollution is a problem that requires inter-region cooperation.

Emissions of harmful pollutants have only increased in quantity in the past few decades. The emission of sulfur dioxide, for instance, has increased from 36.72 million tonnes in the 1980s, to 51.73 million tonnes in 2010.⁸ Such an increase has its own set of ecological implications, but it also has a tremendously negative impact on the health of human beings.

Worldwide, “25% of all deaths and disease from lung cancer, 17% of all deaths and

⁴World Health Organization. (2018). Air Pollution, *World Health Organization*. Available on: www.who.int/airpollution/en/.

⁵ Ibid.

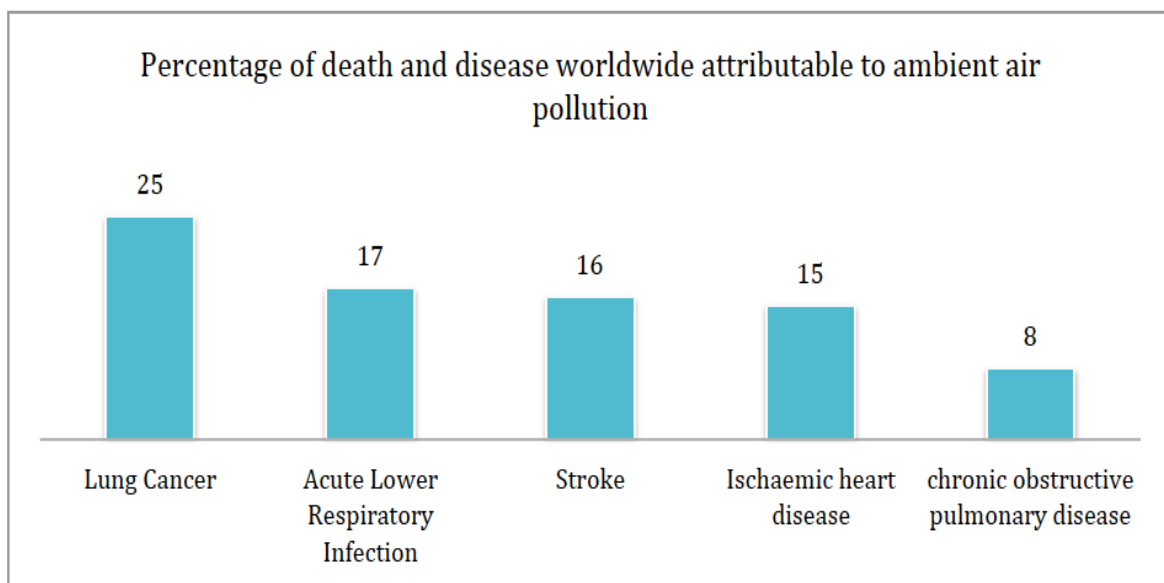
⁶ The guideline stipulates that PM_{2.5} level should not exceed 10 µg/m³ annual mean, or 25 µg/m³ 24-hour mean (WHO, 2016)

⁷ Ibid.

⁸Klimont, Z., et al. (2014). *Environmental Research Letters*.

disease from acute lower respiratory infection (ALRI), 16% of all deaths from stroke, 15% of all deaths and disease from ischemic heart disease (IHD), and 8% of all deaths and disease from chronic obstructive pulmonary disease (COPD)”⁹ are attributable to ambient air pollution.

Particulate matter (PM), or particles with a diameter of less than 2.5 micrometers per cubic meter, is the root of evil- they are respirable. These pollutants are miniscule and often get absorbed into the bodies of living beings. In humans, they have been found not only in the bloodstream, but also in sexual organs, the pulmonary tract, and even the brain. Touted to be the number one carcinogen, by the WHO¹⁰, in a report by their International Agency for Research on Cancer (IARC), PM pollution must be controlled, urgently.



Source: "Air Pollution." WHO, 2018

Figure 1: Percentage of death and disease worldwide attributable to ambient air pollution

The dismal situation of world air pollution can easily be discerned if one just glances at the numerous reports that deal with countries like China, and unfortunately, India, too.

1.2 Where does India stand?

⁹World Health Organization. (2018). Air Pollution, *World Health Organization*. Available on: www.who.int/airpollution/en/.

¹⁰Roychowdhury, Anumita.(2013). Air Pollution Is Group 1 Carcinogen, Says WHO Agency, *Down to Earth*. Available on: www.downtoearth.org.in/news/air-pollution-is-group-1-carcinogen-says-who-agency-42506.

Mirroring global trends, Indian cities have also been showing sharp increases in levels of air pollution. The WHO reports found that some of the most polluted cities in the world are Indian ones.

To put things in perspective, 14 out of the world's most polluted cities fall in India. Annual PM_{2.5} levels for these cities beat some of China's most polluted cities hollow. These levels of PM_{2.5} concentration are harbingers of really bad news. They will affect not only human health, but also that of animals and plants around.

Fourteen out of the world's most-polluted 20 cities are in India

City	*PM2.5	City	*PM2.5
Kanpur	173	Gurgaon	113
Faridabad	172	Jaipur	105
Varanasi	151	Patiala	101
Gaya	149	Jodhpur	98
Patna	144	Baoding	93
Delhi	143	Ulaanbaatar	92
Lucknow	138	Hengshui	87
Agra	131	Xingtai	87
Muzaffarpur	120	Anyang	86
Srinagar	113	Liaocheng	86

*(Annual mean, ug/m3)

Source: World Health Organization

BBC

Table 1: Top 20 most polluted cities in the world (Source: WHO)¹¹

The WHO sees PM as being capable of causing “cardiovascular, cerebrovascular and respiratory impacts”.¹² So, it is of prime import that as a nation, India starts treating the problem of air pollution as a serious one.

In 2017, things were so bad that “a public health emergency was declared in Delhi as pollution levels crossed 70 times the safe limit.”¹³ The Centre for Science and Environment (CSE) said that Delhi's air has been “the worst in 17 years”.¹⁴

11BBC News. (2018). “India Cities Dominate World Air Pollution List”, *BBC News*. Available on: www.bbc.com/news/world-asia-india-43972155.

12World Health Organization. (2018). “Ambient Air Pollution: Health Impacts”, *World Health Organization*. Available on: www.who.int/airpollution/ambient/health-impacts/en/.

13BBC News. (2018). “India Cities Dominate World Air Pollution List”, *BBC*. Available on: www.bbc.com/news/world-asia-india-43972155.

14 PTI. (2017). “Delhi's air quality plunged sharply in 2016”, *Indian Express*. Available on: <https://indianexpress.com/article/cities/delhi/delhis-air-quality-plunged-sharply-in-2016-4513756/>.

Mumbai seems to have fared slightly better, with reductions over the years. But they still have long way to go, if they are to meet national, or international air quality standards.

Learning from international success stories will also help India move forward in her battle against polluted air- the capital city of Denmark, Copenhagen, has more bikes than people, today. Such measures will have palpable effects on levels of air pollution. The United Arab Emirates has taken concrete steps too, to deal with air pollution. There are now “29 stations across the country capable of monitoring PM_{2.5} and the Ministry of Environment and Water has also recently signed an agreement with seven governmental agencies to launch the UAE Air Quality Network, enabling them to calculate an Air Quality Index (AQI)”.¹⁵ Zurich too has capped the number of parking spaces in the city, allowing only a certain number of cars into the city at any one time. The city has also started to build “more car-free areas, plazas, tram lines and pedestrianised streets”,¹⁶ which has resulted in “a dramatic reduction in traffic jams, and less pollution”.¹⁷ China’s Liuzhou city is another story to be inspired by. In fact, the entire series of environmental policy reforms taken by the People's Republic of China are praiseworthy and can be analyzed and replicated carefully by the Government of India.¹⁸ They recently unveiled plans that will eat up their smog- Italian architect Stefano Boeri’s project to combat air pollution.

Boeri plans to build “towers completely covered in trees and plants to combat air pollution”,¹⁹ and will use “nearly 40,000 trees and almost one million plants, comprising 100 different species”²⁰ that will be “designed to trail over balconies and the roofs of a series of skyscrapers spanning 175 hectares”.²¹

15The World Bank. (2015). “Understanding Air Pollution and the Way It Is Measured”, *The World Bank*. Available on: <http://www.worldbank.org/en/news/feature/2015/07/14/understanding-air-pollution-and-the-way-it-is-measured>

16Vidal, John. (2016). “How Are Cities around the World Tackling Air Pollution?”, *The Guardian*. Available on: www.theguardian.com/environment/2016/may/17/how-are-cities-around-the-world-tackling-air-pollution.

17 Ibid.

18Chaudhuri, Sriroop, Roy, Mimi et.al. (2018). “What India can learn from China’s Environment Protection Reforms”, *The Wire*. Available on: <https://thewire.in/environment/what-india-can-learn-from-chinas-environment-protection-reforms>

19Gibson, Eleanor. (2017). “Stefano Boeri Designs ‘Vertical Forest’ City to Eat up China's Smog”, *Dezeen*. Available on: www.dezeen.com/2017/06/28/liuzhou-forest-city-stefano-boeri-proposes-plant-covered-city-to-eat-up-chinas-smog/.

20 Ibid.

21 Ibid.



Figure 2: Concept image of Boeri's vertical forest for Nanjing, China
(Source: stefano boeri architetti.net)

However, it is not enough to depend on legislations. Though they can go a long way in starting the movement against air pollution, state machinery needs to ensure acceptance by citizens. Measures like banning the burning of wastes are blatantly violated by the public, for instance. In such a scenario, there is not too much state machinery can achieve.

While cities like Bangalore are consciously moving towards green solutions- the Bangalore Metropolitan Transport Corporation (BMTC) plans to convert all 6,000 diesel run buses to CNG run ones, and move towards e-buses²²- the need of the hour is for India to make concerted efforts to move, decisively, towards clean energy solutions.

²²Mathew Philip, Christin. (2018). "BMTC May Go E-Way, Dump Diesel Buses", *The Times of India*. Available on: timesofindia.indiatimes.com/city/bengaluru/bmtc-may-go-e-way-dump-diesel-buses/articleshow/63323272.cms.

Again, it is not enough to expect the government to do everything- it is imperative that citizens feel a sense of ownership and a sense of responsibility and help implement green measures. Government policy and citizens' lifestyle choices need to reflect, equally, a commitment to the cause of reducing air pollution. The steep rises both in the manufacture and buying of automobiles in the last few years, however, reflects that in India this is not the case. The increase in the number of privately owned vehicles is a significant cause of increase in levels of air pollution.

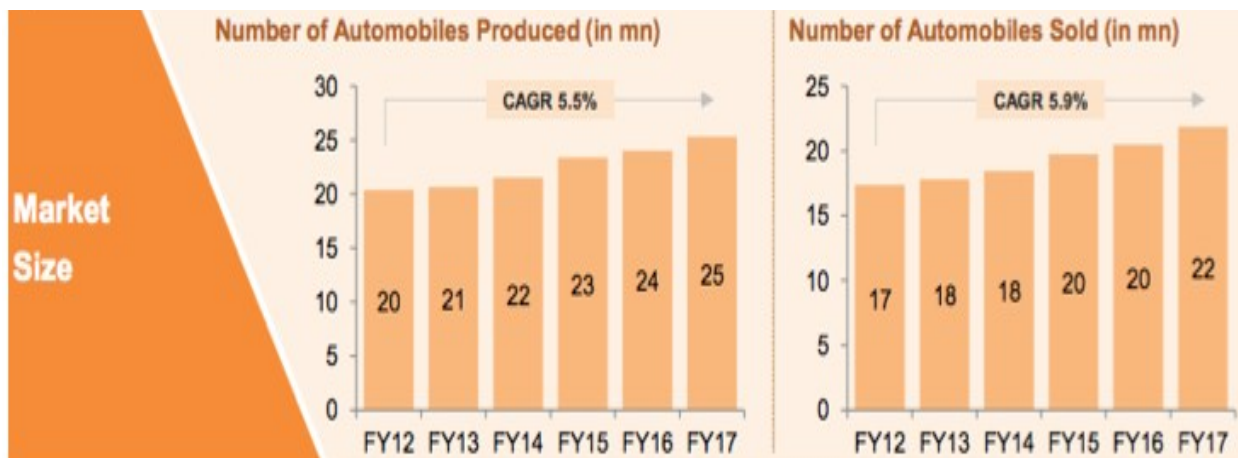


Figure 3: Automobile production/selling in India (FY12-17) (Source: India Brand Equity Foundation)

In a social context like India, however, some polluting activities are culturally coded, and any measures attempting to change these will face corresponding cultural barriers.

An example of such an activity is the use of *chulhas*, or traditional open clay ovens that use solid fuels used in rural homes, for cooking and heating purposes. Use of these stoves has become part of a way of life, almost like tradition, something that has been practiced for generations. Measures like provision of alternate cleaner stoves and fuels, therefore, are not enough. People must be made to understand why they should switch from using the *chulhas* they have always used, to cleaner fuels/stoves. Intensive awareness campaigns about the health and ecological impacts can be helpful. But more than

anything else, sensitivity towards cultural mores and indigenous ways of life, in such campaigns will help policy measures to be accepted by people.



Figure 4: Representational Image of Women Using a *Chulha* (Source: Uttarakhand News)

Community action, backed by the right legislative measures, and learning from countries like China can help India win her war against air pollution.

FROM GREEN TO GRAY: A CASE STUDY

2.1 Case Study of Dehradun, Uttarakhand

Consistent rises in air pollution in Dehradun have made its pollution levels comparable to some of the largest, most polluted cities across the country. The city, with its picturesque sites and natural charm, reels under the pressures of pollution from ever-increasing inflow of vehicles, and constant construction. The “concentration of PM₁₀ and SPM exceeds the Indian air quality guideline in this area”,²³ consistently. PM₁₀ levels at the heart of the capital city, Dehradun, offer a glimpse of what is going wrong.

Table 2: compares the pollution levels in Dehradun for the years 2016 and 2017 (Source: UEPPCB).

PM10 Levels, Dehradun, 2016				PM10 Levels, Dehradun, 2017			
Month	Clock Tower	Rajpur Road	ISBT	Month	Clock Tower	Rajpur Road	ISBT
Jan	226.92	219.5	388.67	Jan	162.36	174.79	321.06
Feb	187.88	235.1	338.06	Feb	164.99	191.82	306.14
March	194.92	236.6	306.34	March	214.69	216.13	320.32
April	209.79	377.76	316.04	April	239.69	225.85	302.47
May	160.17	298.34	289.41	May	230.9	297.19	321.9
June	141.8	483.18	311.4	June	244.91	255.97	323.91

In 2017, the city centre of Dehradun (Clock Tower) witnessed an increase in pollution levels as compared to the figures of the previous year. On the other hand, Rajpur Road observed a decline in the pollution levels as compared to 2016. ISBT remained constant, emerging as the most polluted zone in the city, mainly due to the movement of heavy vehicles.

²³Chauhan, Avnish, et al. (2010). “Ambient Air Quality Status in Uttarakhand (India): A Case Study of Haridwar And Dehradun Using Air Quality Index.” *Journal of American Science*, vol. 6, no. 9, pp. 565–574., Available on: www.jofamericanscience.org/journals/am-sci/am0609/65_3291am0609_565_574.pdf.

Such high levels of PM₁₀ violate prescribed concentration levels, as dictated by the MoEFCC. In fact, these levels, according to the MoEFCC's Air Quality Index (AQI), which was released in 2014, make the city moderately polluted. Correspondingly, the health impact of such levels may "cause breathing discomfort to people with lung disease such as asthma, and discomfort to people with heart disease, children and older adults".²⁴

Other regions in the state are not faring too well, either. Haridwar and Rishikesh both fall in the AQI's moderately polluted category, like Dehradun- actively posing a threat to human health. Being popular tourist sites, they see a huge inflow of vehicles, and people. Globally, tourism contributes to "more than 5 percent of global greenhouse emissions, with transportation accounting for 90 percent of this".²⁵ Therefore, it is only natural that these two cities also face similar problems.

The difference in PM₁₀ levels between tourist cities such as Rishikesh, Haridwar, and Haldwani are vast. Problems of waste mismanagement, vehicular emissions, and unregulated construction all contribute to rise in air pollution. To cater to the pressure of ever-increasing tourist inflows, the town has had to indulge in drastic and unplanned development, which has become the root of various other problems for the town. Apart from air quality, there has also been a negative impact on the water quality of the area.

Figure 5: Yearly average of PM₁₀ levels as per the air quality monitoring stations in Uttarakhand
(Source:UEEPCB)

The ambient air quality at the Clock Tower area, one of the most bustling spaces in town, should be another cause of worry. A study published in the Journal of American Sciences shows that between March 2009 and February 2010, the air quality according to international air quality standards, could be improved.²⁶ A sizeable portion of polluting emissions comes from the large number of three wheelers run in Dehradun. Being poorly maintained diesel vehicles, they emit heavily.

24 MoEFCC. (2014). "National Air Quality Index (AQI) Launched by the Environment Minister AQI Is a Huge Initiative under 'Swachh Bharat'", *Ministry of Environment, Forests and Climate Change*.

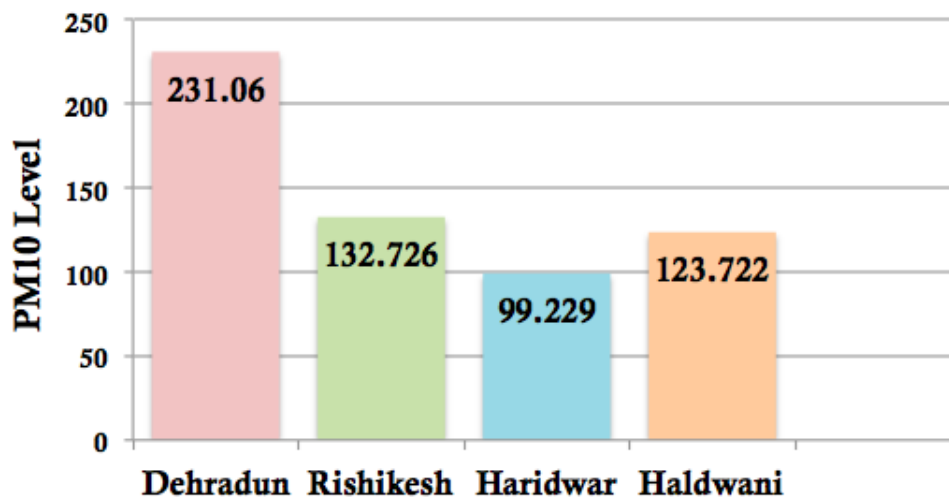
25 OECD (2008). "OECD Environmental Outlook 2030", *OECD*, doi: 10.1787/1999155x.

26 Chauhan, Avnish, et al. (2010). "Ambient Air Quality Status in Uttarakhand (India): A Case Study of Haridwar And Dehradun Using Air Quality Index." *Journal of American Science*, vol. 6, no. 9, pp. 565-574., Available on: www.jofamericanscience.org/journals/am-sci/am0609/65_3291am0609_565_574.pdf.

Over

Yearly Average PM10 Levels 2017

the



course of this study, in an interaction with the head of the City Patrol Unit, Mr. Pradeep Kumar, it was established that regular pulmonary function tests are made necessary, due to noticeable falls in the quality of ambient air in the city. All employees are made to use masks, due to long hours of exposure to vehicular emissions and dust. However, it is not only industrial and vehicular pollution that is on the rise- the use of solid fuels in many rural areas in and around Dehradun, and across Uttarakhand also contributes to ambient air pollution.

A study finds that aerosol concentrations in Mukteshwar, a rural area, change seasonally.²⁷ Aerosols are linked with poor visibility, and adverse health effects. In summers, and the post-monsoon months, aerosol and PM_{2.5} concentration is highest in the late-afternoons, due to local activities like cooking using traditional biomass cookstoves. However, in the winter months, the evenings see the highest concentration of pollutants. This can perhaps be explained by the fact that fires are used to combat the cold weather, or in other words, for heating purposes in the evenings. Monsoons see the lowest concentration. What this reveals is that the mass use of solid fuels in traditional cookstoves across rural areas in the state not only has negative repercussions on ambient and household/indoor air pollution levels, but also causes very serious health problems in those who are exposed to such emissions. Described as ‘indoor air pollution,’ such emissions lead to significant mortality and morbidity losses.

²⁷Panwar, T et al. (2012) “Atmospheric aerosols at a regional background Himalayan site-Mukteshwar, India.” *Environmental Monitoring and Assessment*. 185. 10.1007/s10661-012-2902-8.

There have been various studies that find the adverse effects of air pollution on health. The recent India State-Level Disease Burden Initiative report, of the Indian Council of Medical Research, the Public Health Foundation of India, and Institute for Health Metrics and Evaluation (IHME) that allows one to look at pulmonary disease trends in Uttarakhand.

The Institute of Health Metrics and Evaluation report reveals that in Uttarakhand, there have been substantial increases in deaths attributable to chronic pulmonary obstructive disease, and Ischemic heart disease. This increase, of course, mirrors the increase in pollution levels in the city. In 1990, Ischemic Heart Disease caused only 14.39 percent of all deaths in the state. But in 2016, IHD had caused 16.71 percent of all deaths. Lower respiratory tract infections caused only 4.42 percent of all deaths in 1990, but accounted for 8.33 percent deaths in 2016. Between 1990 and 2016, deaths attributable to lower respiratory tract infection have nearly doubled, therefore.

Similarly, 1990 saw 11.14 percent deaths being caused by COPD, while in 2016, this figure went up to 14.29 percent.

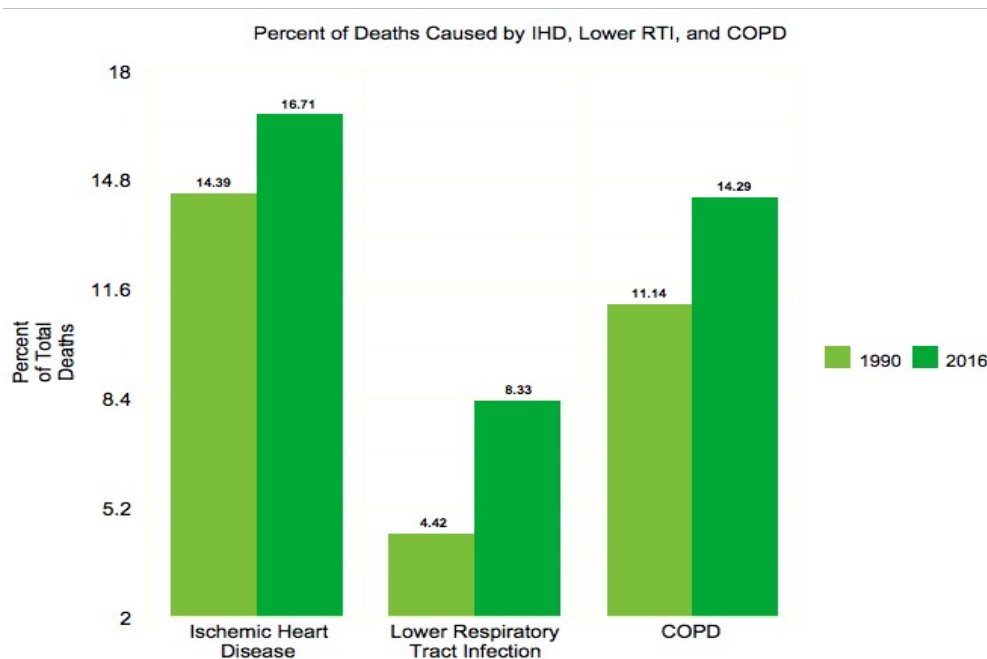


Figure 6: Percentage of deaths caused by different diseases (Source: India State-Level Disease Burden Initiative)

Further, there has been an increase in the number of deaths caused by most respiratory diseases between 1990, and 2016.

Cause of Death	No. of deaths/100,000 (1990)	No. of deaths/100,000 (2016)
Chronic Obstructive Pulmonary Disease	94.1 deaths	100.36 deaths
Ischemic Heart Disease	80.43 deaths	119.58 deaths
Lower RTI	76.85 deaths	51.46 deaths
Asthma	27.07 deaths	18.42 deaths

Table 3: Number of deaths caused due to different diseases in year 1990 and 2016 (Source: India State-Level Disease Burden Initiative)²⁸

Incidences of both IHD and COPD have seen marked increases, then, from 1990, to 2016.

The increase in the number of vehicles registered in the state is yet another reflection of the increases in air pollution levels:

Type of Vehicle	In 2010 - 11	In 2016 - 2017
Two-wheelers	31,395	40,536
Buses	155	559
Trucks	560	371
Autos/Tempos	130	435
Total registered vehicles*	46889	61100
*This total is not the total of the figures given in the table.		

Table Source: RTO Dehradun

4: Number

of Vehicles registered in Dehradun district from 2011 to 2017 (Source: RTO Office, Dehradun)

There has been a significant increase in the number of vehicles in Dehradun in the span of just six years. According to Guttikunda et al. (20XX) around 14.3% of contribution to air pollution is from the transport sector. With increasing tourism in the state, the share of transport related emissions is expected to increase. The current public transport network in Uttarakhand is inefficient and in conflict with various environmental norms.

²⁸Indian Council of Medical Research, et al. (2017). Health of the Nation's States: the India State-Level Disease Burden Initiative: Disease Burden Trends in the States of India, 1990 to 2016. *Indian Council of Medical Research*.

The state needs to work out a strategy for public and non-motorized transport and improve road infrastructure.

2.2 Air quality and health in the region

Some of the most renowned doctors from Dehradun have said in interviews conducted as part of this study that they have noticed a significant increase in health problems like cough & throat irritation, breath shortness and eye irritations associated with air pollution among patients. Others have said that there has been a definite increase in such complaints.

Though there is no clear way to link the occurrence of a disease with air pollution, there are a few that are associated with air pollution. They can be attributed to being caused by rises in pollution levels. All ten doctors have agreed that there has been an increase in the number of complaints regarding cough, and throat irritation in patients.

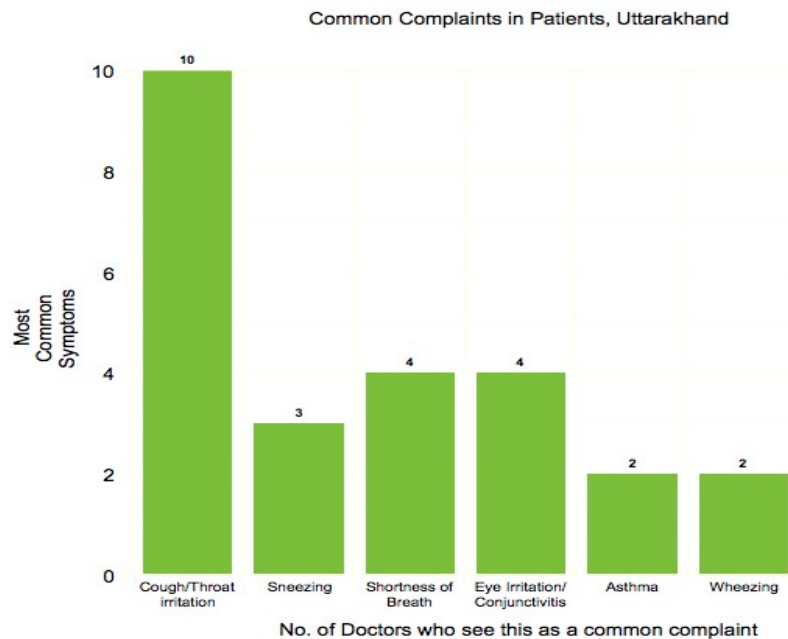


Figure 7: Most common symptoms related to air pollution as shared by Doctors

Conversations with doctors also revealed that the most acutely affected age groups are children, and the elderly.

Data for the past few years (2006–14) indicating incidences of Acute Respiratory Infection (ARI) in children, in Uttarakhand, show alarming increases. There has been a 61 percent increase in the reported incidence of ARI (from 130,283 in 2006, to 211,385 in 2014). The number of deaths attributable to the same has more than quadrupled—from 11, in 2006, to 89 in 2014, peaking to 92, in 2010. **Source: Ministry of Environment, Forests & Climate Change. (2015). Rajya Sabha Q. No. 1942. Retrieved from Rajya Sabha.**

The ICMR's website reveals that mortality attributable to lower respiratory tract infections in children under five has gone up from being the second most prevalent cause of death, to the first.²⁹

On interacting with few parents of school-going children, from two areas in Dehradun, it was found that many of them felt that their children were regularly exposed to polluted air from either vehicular emissions, or smoke from burning garbage, or both which had an adversarial impact on the health of their children.

The SP of the Traffic Police, Mr. Lokeshwar Singh, said that tourist vehicles contribute to an already high amount of vehicular emissions in the state. He said that anything between sixty thousand to eighty thousand tourist vehicles enter Dehradun alone, on a daily basis.

Some of the parents also complained that their children have developed chronic coughing, wheezing and allergies as a result of exposure to polluted air. Eye and throat irritation were some other common complaints associated with air pollution. However, they did not know whether these were air pollution related, or caused by seasonal flu and changing weather.

One pediatrician suggests that a simple way to ascertain whether a symptom is air pollution related or not, is to see whether flu or colds are occurring immediately before or after the festivals of Holi, and Diwali. These are both times of the year when seasonal

²⁹Indian Council of Medical Research, et al. (2017). Health of the Nation's States : the India State-Level Disease Burden Initiative : Disease Burden Trends in the States of India, 1990 to 2016. *Indian Council of Medical Research*.

changes often cause illnesses in children. If children suffer from such symptoms more often, and throughout the year, then perhaps they are not simply seasonal illnesses.

In our interview with the Head of the City Patrol Unit, Mr. Pradeep Kumar, it was seen that even employees of the Patrol Unit do not use the protective masks they are given, as they do not see why they need to, till they begin to fall ill.

It is not just pedestrians and commuters who are affected by long hours of exposure to emissions. A flyover is being constructed at the Mohkampur area in Dehradun city, and several shopkeepers, who own shops in the area, have said in personal interviews that they have experienced palpable health problems after the construction activity has begun.

Dust from the constantly milling construction site coupled with the vehicular emissions from the heavy traffic has caused many of them to develop skin irritation, irritation in the eyes, and the throat. A large number of people in this area are now vulnerable to numerous health risks.

Among the elderly, those above seventy years of age that is, COPD remained the most prevalent non-communicable cause of death.

Source: As found on the website- 3552.51 deaths in 1990; and 6538.84 deaths in 2016 (<https://vizhub.healthdata.org/gbd-compare/india>). Image for the same, from the website. Hovering over the disease shows figures.

One chest specialist, who has been practicing in the city for nearly two decades, revealed that approximately eighty percent of all patients affected by such symptoms require regular, and in most cases, lifelong medical support- citing factors like the increased incidences of COPD in patients as a reason. In fact, seven doctors find that just in the last one year, there has been a significant increase in the number of cases of COPD.

There has been a clear increase in the number of deaths attributable to respiratory diseases other than tuberculosis between 2008, and 2013. From 8 deaths in 2008-09, respiratory diseases other than tuberculosis caused 127 deaths in 2012-13.

	2008-09	2009-10	2010-11	2011-12	2012-13	Apr'13-Dec'13
Respiratory Diseases (Other than TB)	8	211	238	59	127	266

Source: HMIS Trend Analysis- Uttarakhand (2008 to April-December, 2013) ³⁰ □

Table 5: Trend of respiratory diseases in Uttarakhand from 2008 to 2013 (Source: HMIS Trend Analysis)

The ICMR's study of India's disease burden attributes 15.92% percent of all deaths in Uttarakhand, in 1990 and 16.48% of all deaths in 2016, to air pollution. Here, chronic respiratory diseases contributed to 11.69% deaths in 1990 and 16.02 % in 2016, and cardiovascular diseases contributed to 13.55 and 22.92% of all deaths respectively. So both causes saw marked rises between baseline and end-line data.

Source: <https://vizhub.healthdata.org/gbd-compare/india>

Occupation-related increases have also become more common, doctors have said. For instance, many who complain of respiratory trouble work indoors, in factories located in and around the industrial areas. What they face is indoor air pollution. This contributed to 5.72 percent of all deaths in the state, between 1990 and 2016.³⁰

It is not only human health but also the health of trees in the city that has been affected. Gently swaying mango trees, or the old sacred fig, and *Ashoka* trees, and the vibrant *gulmohar* trees that burst into bloom even in the hottest summer, have always formed part of the city's scenery. Today, however, studies find that there is a steady reduction in the trees' chlorophyll levels. Dehradun must soon come together to fight the menace of air pollution; or our trees will no longer grown in Dehra.³¹To most people interviewed over the course of this study, the solution to problem was a fairly commonsensical one- they saw intensive reforestation drives across the state as the most effective and simple measure.

³⁰ Ibid.

³¹

PRE-EXISTING REGULATORY FRAMEWORK

3.1 National and State-level Regulatory Framework

India's participation in the Stockholm Conference of 1972, led her to enact the Air (Prevention and Control of Pollution) Act, 1981 ("Air Act") for the prevention, control and abatement of air pollution. To ensure implementation, a set of "Air Rules" was also enacted. The Air Act bestows on the Central and State Pollution Control Boards, regulatory power to curb air pollution.

To minimize the impact of environmental pollution particularly air pollution, the Government of India has inter alia taken the following actions in recent years:

- *Notification of National Ambient Air Quality Standards 2009, envisaging 12 pollutants;*
- *Setting up of monitoring network for assessment of ambient air quality;*
- *Introduction of cleaner/alternate fuel like CNG, LPG etc. and promotion of public transport network including Metro;*
- *Creation of infrastructure for industrial pollution control incorporating cleaner production processes, setting up of common pollution control facilities;*
- *Ban on stubble burning in northern India*
- *Ban on furnace oil use in industrial sector*
- *Ban on pet coke*

The Government after realizing the gravity of pollution, has also taken the following measures:

- *Clean India Mission (Swachh Bharat Abhiyan);*
- *Draft Rules for handling and management of municipal waste have been notified for comments of stakeholders.*

- *Standards for sewage treatment plants have been notified for comments of stakeholders.*
- *Implementation of Bharat Stage VI from 1st April 2020 throughout the country ;*
- *National Air Quality index was launched by the Prime Minister in April, 2015 starting with 10 cities;*
- *Banning of burning of leaves/ biomass;*
- *Relevant draft rules, including those pertaining to construction and demolition waste have been notified;*
- *Regular co-ordination meetings have been held at official and ministerial level with Delhi and other State Governments within the National Capital Region (NCR) on 6th April, 13th April and 24th July, 2015 to control environmental pollution in NCR adopting air-shed approach;*
- *Short-term plan has been reviewed and long-term plans have been formulated to mitigate pollution in NCR;*
- *Stringent industrial standards have been formulated and notified for public/stakeholder's comments;*
- *Government is giving high priority for public partnership in lane discipline, car pooling, vehicle maintenance, pollution under control certification etc.*
- *Out of 2800 major industries, 920 industries have installed on-line continuous (24X7) monitoring devices.”³²*

3.2 National Clean Air Program

32Javadekar, Prakash. Government Has Taken Several Measures to Minimise the Impact of Air Pollution, OAD. *Press Information Bureau, Govt. Of India*, Available on: pib.nic.in/newsite/PrintRelease.aspx?relid=124460

Most recently, the MoEFCC has launched the National Clean Air Program. Though many were hopeful that it would result in significant improvements in India's ambient air quality, a closer glance reveals the various loopholes with which it is suffering.

In India, clean air is a constitutionally protected right, part of the right to life.³³ Though the Government of India has taken, in the past, various initiatives to curb the rising air pollution across Indian cities, there has been little to show for it. It has been largely because of weak implementation of policy measures, which remains a key issue. This, despite a clearly documented pro—environmental rights stand of the Supreme Court, through the 1980s, all the way to 2010,³⁴ in most public litigation cases. Perhaps this stand can even be said to be continuing in many ways, even today.

India, like most developing nations, constantly struggles between the contradictory pulls of economic growth and poverty eradication, and sustainable development. The country has, in the last three decades, experienced a dramatic rise in industrial activity, leading to a corresponding rise in levels of air pollution. That India is committed to provide a clean and pollution—free environment to its people, is clearly reflected in certain Constitutional mandates, and the Sustainable Development Goals.

Despite this commitment, and repeated government interventions (through the National Air Quality Monitoring Program, or the Forty—Two Action Point, for instance), there has been very limited success in curbing the rise in air pollution levels, in the country.

The National Clean Air Program, 2018, aims to fill in the gaps left by previous programs, and policies. It aims to augment, firstly, air quality monitoring networks—it aims to raise manual monitoring stations from the existing 691, to 1000 plants, in two years. Since PM_{2.5} is an extremely dangerous pollutant, the NCAP suggests that the number of plants monitoring PM_{2.5} levels, be increased from 67 to 1000. Further, to better identify trends and generate more comprehensive data, the Program suggests that Continuous Ambient Air Quality Monitoring Systems (CAAQMS) be increased by a hundred. For similar reasons, source apportionment studies will be initiated from six to 94 cities.

³³ Article 21, of the Indian Constitution stipulates that no person shall be “deprived of his life, or personal liberty”

³⁴Sahu, G. (2014). Why the Underdogs Came Out Ahead: An Analysis of the Supreme Court's Environmental Judgments, 1980- 2010. *Economic and Political Weekly*, XLIX (4), 52-58.

The NCAP identifies the fact that the previous National Air Quality Monitoring Program did not have any stations in rural regions, and thus has said that it will aim to open fifty, within two years. Overall, the NCAP aims to foster collaborations between regions, state and central governments, and the Central and State Pollution Control Boards. It has a participatory, and inclusive approach to combatting the problem of air pollution.

However, a second look reveals that it does not really address the issues of air pollution that trouble the Indo—Himalayan states. The main sources of pollution for these regions, as quoted in the annexure of the NCAP itself, are, *inter alia*, vehicular emissions, road dust/re—suspension of dust and other fugitive emissions, air pollution from biomass burning, industrial air pollution, and air pollution from construction and demolition activities. There is no specific plan to address regional issues, in the NCAP, and no explicit mention of plans for different geographic regions. Surely, the plans to curb air pollution across the warmer, more arid Western states, and the Himalayan states cannot be similar.

As per the Lok Sabha reply on 15 December 2017 by Dr. Harshvardhan, Environment Minister, Govt. of India, Uttarakhand was identified by the CPCB as one of India’s most polluted states, with only eight monitoring stations. These stations have the monitoring power only for PM₁₀ and not for PM_{2.5}. Even the comparatively smaller state of Himachal Pradesh has a larger number of monitoring plants. The severely limited non—attainment cities list, under the NCAP, excludes many polluted regions in the Himalayas, including cities in Uttarakhand, including just two cities from the state, seven from Himachal Pradesh, and one from Jammu and Kashmir, for instance.

The UNEP identifies one of the main impacts of tourism being air pollution. Since these are all states with very heavy tourist footfall, therefore, they face heavy air pollution from the movement of tourist vehicles, too. It has been found that “air quality in Srinagar is worst among all Himalayan states in the country. There are inter-annual variations”,³⁵ and that there are seasonal variations in pollution levels; “dry weather in winter months spike up the pollution levels, while it decreases whenever there is rainfall or snowfall.”³⁶

35Singh, Karanvir. (2018). “Air Pollution In Srinagar Hits Hazardous Levels During Winters, Worst Among All Himalayan States, Says Study.” *Swachh India NDTV*, Available on: swachhindia.ndtv.com/air-pollution-in-srinagar-hits-hazardous-levels-during-winters-worst-among-all-himalayan-states-says-study-18137/.

36 Ibid.

Despite this, however, only one city in Jammu and Kashmir, Jammu city, has been included in the list of non—attainment cities, under the NCAP.

Though Himachal Pradesh has fared well in term of air quality, overall, it, too battles air pollution. “Broken roads, burning of garbage in open areas, huge number of vehicles on the road”³⁷ has “contributed to the alarming increase in the pollution areas.” While the NCAP would seem to address these problems at a surface level, by including Himachal’s most polluted cities amongst its non—attainment cities, there is no holistic approach to really deal with state—specific pollutants like burning of solid fuels, for heating, and cooking purposes, as was mentioned before, too.

Apart from the obvious negative repercussions that this has on human health, such degradation of air quality affects flora and fauna of a region, too. The Himalayan region is a very sensitive one, ecologically. Policies aiming to reduce air pollution must then be holistic, and move beyond simply attempting to make structural changes that will not translate into much, in actually bringing down air pollution levels. In fact, a study ³⁸ from Chauhan highlights the loss of chlorophyll in sacred fig, mango, Ashoka, and gulmohar trees, in the city of Dehradun. The NCAP does not seem to recognise this, and focuses mainly on Delhi and the NCR.

Relief features, and geography create “lower mixing heights, limited dispersion”,³⁹ in the Jammu and Kashmir region. Further, “long-range transport of pollutants results in higher pollution levels during winter, as the pollutants get trapped in the lower layers of the atmosphere.”⁴⁰ Such region specific issues have not been addressed in any way, in the NCAP.

Capacity building and other measures to spread awareness, mentioned in the NCAP, may help, this does not seem like it will be enough. A general timeframe, within which the complete implementation of the NCAP is to be achieved, does exist. But there are no

³⁷Times Now Digital. (2018). Not just Delhi, even hilly state Himachal battles with pollution. *Times Now*, Available on: <https://www.timesnownews.com/india/article/himachal-pradesh-nalagarh-sundar-nagar-kanpur-baddi-parwanoo-indian-institutes-of-technology-iit-kanpur-mba-surge-iit-kanpur/197172>

³⁸Chauhan, Avnish. (2010). “Tree as Bio-Indicator of Automobile Pollution in Dehradun City: A Case Study.” *New York Science Journal*, vol. 3, no. 6, pp. 88–95. Available on: www.researchgate.net/publication/264849758.

³⁹ Ibid.

⁴⁰ Ibid.

specific, transitory milestones, or time frames within which to achieve these, either. Such timeframes, and medium—term goals are imperative to ensure the success of long—term goals. While measures like extensive plantation drives, and capacity building might be helpful in the long run, the NCAP, in its present form, hardly seems to promise too much, in terms of reducing air pollution in the Himalayan region. Therefore, the NCAP does not really come as a path—breaking policy, supported by which the Himalayan region can palpably cut down air pollution.

So, it is, then, largely up to people to make sure that individual lifestyle choices reflect consideration for the environment. Care should be taken to avoid certain lifestyle choices that contribute to emission of air pollutants, till a more holistic policy document, and a corresponding plan of action are not being devised.

3.3 Sustainable Development Goals & Air Pollution

Sustainable Development Goals, (SDGs) are a set of seventeen global goals set by the United Nations in 2015, to succeed the Millennium Development Goals, ending in 2015. India, being a member nation, too, is bound to achieve these goals. Although the SDGs are mostly ambiguous on their position on air pollution, curbing the problem will allow India to achieve quite a few of these.



Figure 8: The Sustainable Development Goals as issued by UN (Source: Getty Images)

Promoting sustainable transport, clean energy, waste management and urban planning can improve air quality and health, as well as contribute to the Sustainable Development Goals for Health (3), Energy (7) and Cities (11). India can achieve the following goals by dealing with the problem of air pollution.

So, though each of these goals is difficult to meet, especially in a country that is still developing, working towards interlinking the goals, will help curb major problems. Pursuing SDGs will allow state and central machinery to work towards intermediate goals, that will in the long run help curb air pollution, and vice versa- policies directed at controlling air pollution, will help achieve various SDGs. Small steps will result in a healthier, more sustainable India.

RECOMMENDATIONS

Air pollution is a problem that must be dealt with, at various levels. And the first step to take is to make sure your actions do not contribute to air pollution, for it is affecting more people every day. Today perhaps it seems like a distant possibility, but it could affect public at large too- statistics reveal that mortality and morbidity attributable to ambient and indoor air pollution are rising, daily.

It is not enough to simply depend on state machinery to clean up the mess we contribute in making! So, first and foremost, a sense of ownership of the environment needs to be instilled in people, so as to ensure active participation to prevent further deterioration of it. Small lifestyle changes can go a long way in making a difference. Composting, carpooling, trying to maintain vehicles, and other, similar measures can make a big difference. Switching to solar powered electrical utilities is a major lifestyle change that will help cut down in a household's volatile organic compound emission.

Participatory measures, which people themselves see as necessary, should be implemented. Legislative measures cannot be fully implemented, without the support of local communities. For example, though the burning of waste is illegal, this is still done regularly, either for waste disposal, or as a source of heat to beat the cold weather, in the winter months. Lawmakers must provide viable alternatives for practices they ban. If people are made to understand the issue, they are more likely to comply, than they are if measures are implemented by some invisible, inaccessible agency. Awareness campaigns

could be organized as a way to increase compliance. Knowledge of an issue, and associated threats, is imperative for real societal change.

Non-governmental organizations (NGOs) - or civil society organizations, too have to take responsibility, and help create awareness. They have the ability to mobilize people through local campaigns, and involve them at a grassroots level.

At a state level, various success stories from the rest of the world could be adopted. Innovations, like Stefano Boeri's green buildings and vertical forests,⁴¹ must be adopted. Very polluted Chinese cities are adapting such innovations, too. India can do the same.

A local, and therefore perhaps more feasible variation is India's very own self-taught architect Didi Contractor's sustainable building methods, known all over Dharamsala. Laurie Baker, often called the 'father of sustainable architecture', left behind the realization that low-cost, vernacular buildings were not only profitable, but also sustainable. An exploration of his methods, too, could help India's mushrooming growth curb air pollution, caused due to the ever-increasing use of synthetic building materials. Policies that popularize these innovations could help in large-scale acceptance of them.

The role of central legislative action should ideally be only the backbone of all other measures, and initiatives taken by all other stakeholder groups. The impact of appropriate policy making will be stronger than most other measures, as it can be binding as the law of the land. Dependence on such measures should be minimal- citizen empowerment, and state-level action is the way forward. Further, in more rural areas, the relationship between the environment and people is much more organic, and symbiotic, not mercantile ones. This needs to be respected and solutions must be rooted in indigenous knowledge. While indoor air pollution through solid fuel ovens is a major problem, it must be tackled with great sensitivity, as it is part of the way of life for many people, in the hill state of Uttarakhand. Indigenous knowledge systems should not be discarded in favour of Western ones, because the former emerge organically from within a particular ecological context, and therefore are usually more sustainable.

⁴¹Gibson, Eleanor. (2017). "Stefano Boeri Designs 'Vertical Forest' City to Eat up China's Smog." *Dezeen*, Available on: www.dezeen.com/2017/06/28/liuzhou-forest-city-stefano-boeri-proposes-plant-covered-city-to-eat-up-chinas-smog/.

CONCLUSION

Devlbhum, or the state of Uttarakhand, has been witnessing steady increases in pollution levels. Alongside, however, there has been a more insidious rise, somewhat less noticeable. This is the rise of incidences of diseases associated with air pollution.

Things have gotten so bad that in the 2014-16 period COPD, asthma, ARIs, and IHD have remain among the top ten reasons of death across major cities in the state. 15.91 percent of all deaths in Uttarakhand in 2016, are attributable to air pollution. **Source:** <https://vizhub.healthdata.org/gbd-compare/india>

In this light, the recently launched National Clean Air Program seems woefully inadequate. What needs to be done is that various stakeholder groups must come together, and reconcile their interests. Citizens must work together with state and central bodies to ensure things change, and fast!

This study finds that the problem of air pollution is, apart from an ecological one, a social issue as well. The most affected social group is one that is both socially and economically disadvantaged. Thus, the problem is one that perpetuates already stark inequalities. Substandard building material and inappropriate waste disposal methods (for instance, solid waste burning) exacerbate this problem.

Issues of intergenerational equity can also be addressed by ensuring that everybody participates in efforts to save the planet. As Chief Seattle had said, we merely borrow the

earth from our children. So, people must all try and leave behind a habitable planet for future generations. So, it is crucial that everybody does his or her bit to prevent further contamination of the air. From composting to reforestation efforts, every little bit counts.

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ANNEXURE

Annexure 1: List of Stakeholders consulted during the study

Serial no.	Stakeholder
1	Ten Doctors in Dehradun
2	Parents of school-going children in Dehradun
3	Students from The Doon School, Dehradun
4	Shopkeepers from the Mohkampur area in Dehradun
5	SP, The Traffic Police, Dehradun
6	Head, City Patrol Unit, Dehradun

Annexure 2: The National Air Quality Index (The National Clean Air Program)

AQI Category	AQI	Concentration range*							
		PM ₁₀	PM _{2.5}	NO ₂	O ₃	CO	SO ₂	NH ₃	Pb
Good	0 - 50	0 - 50	0 - 30	0 - 40	0 - 50	0 - 1.0	0 - 40	0 - 200	0 - 0.5
Satisfactory	51 - 100	51 - 100	31 - 60	41 - 80	51 - 100	1.1 - 2.0	41 - 80	201 - 400	0.5 - 1.0
Moderately polluted	101 - 200	101 - 250	61 - 90	81 - 180	101 - 168	2.1 - 10	81 - 380	401 - 800	1.1 - 2.0
Poor	201 - 300	251 - 350	91 - 120	181 - 280	169 - 208	10 - 17	381 - 800	801 - 1200	2.1 - 3.0
Very poor	301 - 400	351 - 430	121 - 250	281 - 400	209 - 748*	17 - 34	801 - 1600	1200 - 1800	3.1 - 3.5
Severe	401 - 500	430 - 500	250+	400+	748+*	34+	1600+	1800+	3.5+

* CO in mg/m³ and other pollutants in µg/m³; 2h-hourly average values for PM₁₀, PM_{2.5}, NO₂, SO₂, NH₃, and Pb, and 8-hourly values for CO and O₃.

AQI	Associated Health Impacts
Good (0–50)	Minimal Impact
Satisfactory (51–100)	May cause minor breathing discomfort to sensitive people
Moderate (101–200)	May cause breathing discomfort to the people with lung disease such as asthma and discomfort to people with heart disease, children and older adults
Poor (201–300)	May cause breathing discomfort to people on prolonged exposure and discomfort to people with heart disease with short exposure
Very Poor (301–400)	May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases
Severe (401–500)	May cause respiratory effects even on healthy people and serious health impacts on people with lung/heart diseases. The health impacts may be experienced even during light physical activity