



Case Study

An empirical study towards air pollution control in Agra, India: a case study



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Abstract

Air pollution affects many people in developed and developing countries worldwide. It is costing around 2% and 5% of GDP (gross domestic product) in developed and developing countries, respectively. The air qualities have been deteriorating day by day and now the situation has become worst. An increase in air pollution will worsen the environment and human health status. Hence, there is an urgent need for air pollution control. Air pollution can be controlled by reducing the emission of air pollutants from industrial and domestic sources through source emission control decrease in fuel combustion, modifying technology, and growing plants. This is the ripe time to take some bold steps in controlling the menace of air pollution. The scientific bodies, NGOs, researchers, and policymakers have made several efforts but pollution levels are increasing everywhere. The UNEP (The United Nations Environment Program), IPCC (The Intergovernmental Panel on Climate Change), etc., have prepared several reports and organize every year COPs (Conference of Parties) meeting but all have gone in vain as the main culprit feedback has not been taken into the consideration. So, a sincere effort is required to fight the effects of climate change. This paper presents a case study of the Agra region over the Indo-Gangetic basin. The air quality of different sites in Agra has been evaluated, and a survey has been conducted to get the public opinion on air pollution, causes, impacts, and solutions. 75% of respondents were aware of the poor air quality of Agra, however, the percentage of respondent who was unaware is not small. It is a matter of concern. 85% of respondents think that poor education and unawareness are the major cause of air pollution. They suggested education, value-based education to improve air quality. Based on these outcomes, it has been concluded that nature-based solutions for air pollution control can be achieved by making people environmentally conscious through value-based education.

Keywords Air pollution control · Survey · Value-based education · Environmental consciousness

1 Introduction

Air pollution, global warming, and climate change have become a big issue all over the world as it affects the entire ecosystem and human health. Air pollution causes climate crisis and biodiversity crises and posed threats to the survival of human beings [1–3]. It is mainly due to an increase in emissions of polluting gases and particles in

the atmosphere. Gases and particles get emitted in the atmosphere from natural and anthropogenic activities viz. residential cooking, vehicles, industries, construction, and deforestation [4–7]. About half of the urban population being monitored is exposed to air pollution that is at least 2.5 times higher than the levels with WHO air quality guidelines. Worldwide, the most widely monitored air pollutants are PM, NO₂, SO₂, CO, and O₃. They are also called

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criteria pollutants as they are the most common indicators of air quality. In India, CPCB (Central Pollution Control Board) classifies cities as critically polluted if the levels of criteria pollutants are more than 1.5 times the standards. New Delhi, Beijing, Agra, Shanghai, and Mumbai are the most polluted cities in the world [7, 8]. The $PM_{2.5}$ levels of these cities have risen exponentially. It has also crossed the National and International standards (World Health Organization, US Environmental Protection Agency (USEPA), European Protection Air Quality (EUPAQ), China, National Ambient Air Quality Standards (NAAQS), India) (Fig. 1).

Various governmental organizations and international bodies have proved that air pollution is a major risk to the environment, quality of life, and health of the population [9]. Every year, approximately 6.5 million people die prematurely from illness caused by outdoor air pollution worldwide and premature deaths will rise 90% by 2040 in developing countries [7]. In the past decades, a considerable magnitude of air pollution pulls up the number of people suffering from respiratory disease and many times leading to deaths or serious health hazards [8, 9]. Air quality standards are set by most countries to protect the public health of their citizens [10–12]. In 2018, the WHO (World Health Organization) compiled a list of top 500 cities by $PM_{2.5}$ annual mean concentration across the world. Kanpur had the worst air quality in the world in that list, surprisingly nine other cities of India figured among the top 20 cities of the world viz. Faridabad, Gaya, Varanasi, Patna, Delhi, Lucknow, Agra, Gurgaon, and Muzaffarpur (Fig. 1). As per WHO global ambient air quality

update 2018, only 3% of cities in low- and middle-income countries with more than 100,000 inhabitants and 51% in high-income countries out of 4300 cities of 108 countries included in the WHO database complies with WHO air quality guidelines [8].

The air pollution problem was formally recognized in the 1972 United Nations Declaration on the Human Environment and The United Nations Framework Convention on Climate Change (UNFCCC) Conference (COP) 2011, held in Durban, South Africa. COP 2011 had representatives from 194 countries coming together with their progress plans, to finance environment-saving effort through Green Climate Fund. These types of concrete efforts need to be taken continuously and frequently as no single effort can be a panacea to this old sore. A problem of this scale, where causes and its effects are much diverse, it becomes very important to start once again from the basics and basics lies in education and awareness [13, 14]. Various studies have been focused on the risk assessment, perception of social factors, awareness among people about air pollution [15–20]. Improving awareness about sustainability involves issues like the impact of anthropogenic activities on human health, earth system, control of greenhouse gases, energy consumption patterns, pollution, and transport [21]. Living sustainability depends on a duty to seek harmony with other people and with nature. Recently, in the year 2015, UNFCCC (United Nations Climate Change Framework Convention), COP 21 was held in Paris, where several countries globally debated and came to a conclusion to set a limit of average global temperature increase

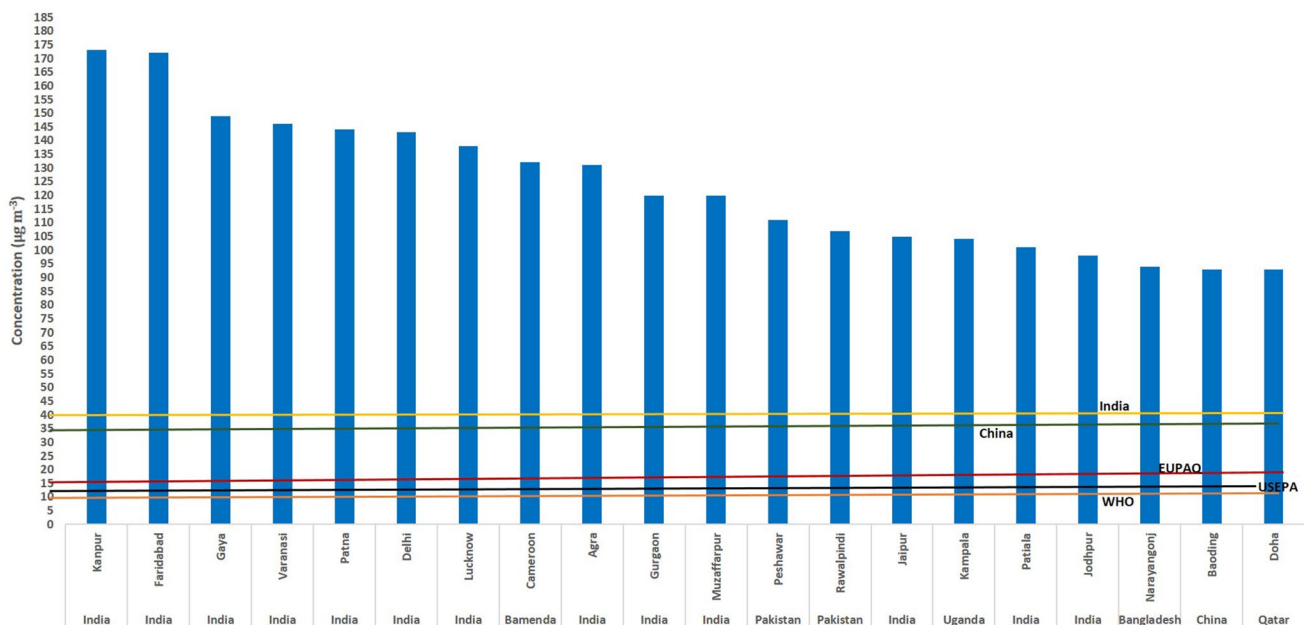


Fig. 1 The level of $PM_{2.5}$ over 20 most polluted cities in the world (standard value of WHO ($10 \mu\text{g m}^{-3}$); USEPA ($12 \mu\text{g m}^{-3}$); EUPAQ ($15 \mu\text{g m}^{-3}$); China ($35 \mu\text{g m}^{-3}$); India ($40 \mu\text{g m}^{-3}$)). Source: WHO 2018

to 1.5 °C. It directs countries to cut their carbon emission excessively. It can be materialized if people are directly involved in this step along with the industries. The aim of holding the increase in global average temperature below 2 °C or 1.5 °C would be a herculean task to achieve with current trends of trajectories of global greenhouse gas emissions. The existing trends are only pointing towards more deteriorating conditions as the emission graph is continuously tracked its known trend [21–25]. Postponement of implementation of much-needed changes will only hamper the revival chances through mitigation measures. It is very important to assess, re-plan, re-strategies, and re-prioritize our needs and paths to achieve development keeping the climatic conditions in the loop [26–28]. In this context, public opinion may be very important and eye-opening. In India, Agra is one of the most polluted cities and at the same time, it is a world-famous tourist destination. Hence, a survey-based study was conducted over the Agra region in India to get a glimpse of thought perceptions of the common public towards regional and global problems like air pollution, its causes, impacts, and solutions.

2 Material and methods

2.1 Site characteristics

Agra, situated at 27.17° N, 78.01° E over the Indo-Gangetic basin is presently among the most polluted cities in the country. The population of Agra is 15,85,704 as per the census of 2011 and the 30th most populated district in Uttar Pradesh in India. The urban agglomeration of Agra has a population of 1,760,285. Males constitute 53% of the population and females 47%. Agra is famous worldwide as it hosts the 'Taj Mahal', which is one of the seven wonders of the world, and other historical monuments. The poorly maintained roads, traffic congestion, wood and cow dung cakes burning for cooking, coal, petrol, and diesel combustion, and vehicular emissions in Agra have resulted in the city having a high pollution level. Agra is one of the most polluted cities in India. Therefore, it was an apt choice to do such type of study.

2.2 Survey

In this study, the data have been collected in the form of a survey. A questionnaire was developed (Fig. 2), served to the local community, and information was collected from various departments, colleges, and schools of Agra as well as local people. The response can be a real representation of the opinion of the common people towards such global challenges of air pollution. This also enables us to develop

an understanding regarding people's limited knowledge about environmental issues and shortcomings of the existing education system. The survey reported the educational approaches used in air quality research communities, both nationally and internationally. There are many factors which make an impact on individuals and community related to environmental concern, and there are various ways that people can learn about environmental issues and how to address them. Out of the total persons who took part in the survey, 20% of the respondents were females and 80% were male (Fig. 3). 50% were living in urban areas, 40% were from rural areas, whereas 10% were from suburban areas. 6% of the survey takers were in the age group of above 40 years, 56% were in the age group of 10–20 years, whereas 38% were in the age group of 21–40 years. The questionnaire survey has been designed in a very simple manner which is easily understandable for the local community in Agra. The questionnaire of survey data was collected by the researcher by offline mode. Before the statistical analysis, screening of survey data has been done and the responses were cross-checked.

2.3 Statistical analysis

Statistical analysis was employed on the datasets using SPSS. The nonparametric method was used for the determination of the statistical significance of the collected survey data. The *t* test has been used to assess the relationship between two categories of variables amongst gender, area, and age. The significant level was set at $p < 0.05$.

3 Result and discussion

3.1 Key findings of the survey

The feedback based on the survey conducted in Agra is very much fact-finding and presented in Figs. 4 and 5. There were 20 questions which have been asked to the respondent in the questionnaire regarding various issues related to air pollution, and their response statistics were plotted. The feedback of the respondent has been categorized into three major categories; gender, area, and age-wise. The views on the ways societies come to know about air pollution problems may reveal values, beliefs, and varieties of "truths" underpinning how problems are identified and approached. 91% of the total respondents (72% male and 19% female) (Figs. 4 (1) and 5 (1)) believe that air quality has deteriorated in the last few years. In (Figs. 4(2) and 5 (2)), 95% of total respondents in which 75% male and 20% female accepted that air pollution harms humanity. Air pollution is a serious problem, 75% of the total respondents (65% male and 10% female) know

Questionnaires-2015
(Topic: Role of value based education in air pollution control)

Name:	Age:	Gender: M/F
Profession:	Area: Urban/Sub-urban/Rural	

<ol style="list-style-type: none"> 1. Has air quality deteriorated since last few years? (a) Yes (b) No (c) Not aware 2. Are you aware of the adverse effects of air pollution on humanity? (a) Yes (b) No 3. To what extent air pollution is affecting you? (a) Very much (b) A little (c) Not at all 4. In what way are you being affected by air pollution? (a) Breathlessness, (b) Feeling depression (c) Irritation to eyes/nose/throat 5. Do you know that air pollution in Agra is higher than some other bigger cities? (a) Yes (b) No 6. Which fuel do you use for cooking food? (a) Kerosene (b) Coal (c) LPG (d) Induction stove (e) dung cake/fire wood 7. Do you agree to (a) Polluting companies should be imposed fine even if some jobs are put to risk. (Y/N) (b) Traffic policies for checking emission from vehicles must be made more effective. (Y/N) (c) Citizens should come forward for the safety of their environment. (Y/N) 8. Whether the ultimate solution to the problem of global warming and climate change is to make the people aware about its causes, consequences, culprits and control of energy consumption through education. (a) Yes (b) No 9. In this context, do you think environmental education may be an important means for society to meet the increased need for improving public understanding of environmental issues? (a) Yes (b) No 10. Do you know about AQI (Air Quality Index)? (a) Yes (b) No 11. Do you know that the main cause of air pollution is excess consumption of energy? (a) Yes (b) No 12. From where do you get information about air pollution? (a) Television (b) Newspaper (c) Radio 13. Do you agree that the environmental protection is a moral responsibility of all citizens? (a) Yes (b) No 14. Do you agree to bring changes in habits of daily life to minimize Energy Wastage? (a) Yes (b) No 15. Do you agree that some citizens for their self-interest and for their profits ignore their moral responsibility of environment protection and play significant role to cause air pollution? (a) Yes (b) No 16. Do you agree that negligence of our moral responsibility to protect the environment signifies our unconsciousness towards the human values? (a) Yes (b) No 17. Do you agree that it is possible to minimize the problem of air pollution by developing consciousness towards human values in the citizens? (a) Yes (b) No 18. Do you agree that student life is the period to lay foundation of intellectual and conscious citizens? (a) Yes (b) No 19. Do you agree that the values for consciousness towards environmental awareness can be developed among the students by imparting them value based education? (a) Yes (b) No 20. Do you agree that value based education must be imparted to the students from school level to university level for protection of environment by minimizing the air pollution? (a) Yes (b) No 21. Give your opinion to control the effect of air pollution, global warming and climate change by value based education. <p style="text-align: center;">This information will be used for Research and Teaching purposes.</p>	<ol style="list-style-type: none"> 1. क्या वायु-गुणवत्ता पिछले कुछ वर्षों से कम हुई है? (a) हाँ (b) नहीं (c) मालूम नहीं 2. क्या आप वायु-प्रदूषण से हमारे उपर पड़नेवाले कुप्रभावों से अवगत हैं? (a) हाँ (b) नहीं 3. वायु-प्रदूषण आपको किस सीमा तक प्रभावित कर रहा है? (a) बहुत अधिक (b) थोड़ा (c) बिल्कुल नहीं 4. वायु-प्रदूषण से आप किस प्रकार से प्रभावित हो रहे हैं? (a) साँस फूलना/ह - दय संबन्धी समस्याएँ (b) शक्तिहीनता महसूस करना (c) आँख, नाक, गले की समस्याएँ 5. क्या आप जानते हैं कि अगवा में वायु-प्रदूषण कुछ अन्य बड़े नगरों की तुलना में अधिक है? (a) हाँ (b) नहीं 6. आप खाना पकाने के लिए किस ईंधन का प्रयोग करते हैं? (a) कैरोसिन (b) कोयला (c) एल पी जी (d) इंडक्शिय स्टोव (e) गोबर के कड़े/लकड़ी 7. क्या आप सहमत हैं कि:- (a) प्रदूषण फैलानेवाली कम्पनियों को, उनसे प्राप्त होनेवाले रोजगार के अवसरों को खतरे में डालकर भी, आर्थिक रूप से दण्डित किया जाना चाहिए। (हाँ / नहीं) (b) बाइनों से होनेवाले उत्सर्जन को रोकने हेतु यालायाल नीति अपेक्षाकृत अधिक प्रभावकारी बनायी जायी। (हाँ / नहीं) (c) नागरिकों को अपने पर्यावरण की सुरक्षा हेतु आगे आना चाहिए। (हाँ / नहीं) 8. क्या लोगों को शिक्षा के जरिये वैश्विक उष्मीकरण तथा जलवायु परिवर्तन की समस्या के कारण, परिणाम एवं इसके लिए दोषी लोगों तथा उर्जा की खपत पर नियंत्रण के प्रति जागरूक करना इस समस्या का एक निर्णायक समाधान है। (a) हाँ (b) नहीं 9. इस संदर्भ में क्या आप ऐसा मानते हैं कि पर्यावरण संबंधी मुद्दों के प्रति जनता की समझ को विकसित करने की बढ़ती आवश्यकता को मदनजर पर्यावरण-शिक्षा समाज के लिए एक महत्वपूर्ण साधन साबित हो सकता है? (a) हाँ (b) नहीं 10. क्या आप एयर क्वालिटी इन्डेक्स के बारे में जानते हैं (a) हाँ (b) नहीं 11. क्या आप जानते हैं कि वायु-प्रदूषण का मुख्य कारण ऊर्जा की अत्यधिक खपत है ? (a) हाँ (b) नहीं 12. वायु-प्रदूषण के बारे में सूचनायें आप कहाँ से प्राप्त करते हैं? (a) टेलीविजन (b) समाचार-पत्र (c) रेडियो 13. क्या आप सहमत हैं कि पर्यावरण संरक्षण सभी नागरिकों का नैतिक दायित्व है ? (a) हाँ (b) नहीं 14. क्या आप अपनी दैनिक दिनचर्या में परिवर्तन करके ऊर्जा की खपत कम करने के लिए सहमत हैं ? (a) हाँ (b) नहीं 15. क्या आप सहमत हैं कि हम नागरिकों में से कुछेक अपने तुच्छ स्वार्थ की पूर्ति या अपने थोड़े से लाभ हेतु पर्यावरण संरक्षण की अपनी नैतिक जिम्मेवारी की अनदेखी कर वायु-प्रदूषण के महत्वपूर्ण कारक की भूमिका निभाते हैं ? (a) हाँ (b) नहीं 16. क्या आप सहमत हैं कि पर्यावरण संरक्षण की नैतिक जिम्मेवारी की अनदेखी करना, मानवीय मूल्यों के प्रति हमारी संवेदनहीनता का परिचायक है ? (a) हाँ (b) नहीं 17. क्या आप सहमत हैं कि नागरिकों में मानवीय मूल्यों के प्रति संवेदनशीलता उत्पन्न कर वायु-प्रदूषण की समस्या को कम किया जा सकता है ? (a) हाँ (b) नहीं 18. क्या आप सहमत हैं कि भविष्य के प्रबुद्ध एवं मूल्यों के प्रति संवेदनशील नागरिकों के निर्माण हेतु नीय डालने के लिये छात्र-जीवन ही सर्वश्रेष्ठ समय है? (a) हाँ (b) नहीं 19. क्या आप सहमत हैं कि छात्रों में पर्यावरण के प्रति जागरूकता हेतु आवश्यक मूल्यों का विकास, उन्हें मूल्य-आधारित शिक्षा प्रदान कर किया जा सकता है ? (a) हाँ (b) नहीं 20. क्या आप सहमत हैं कि वायु-प्रदूषण को कम कर, पर्यावरण संरक्षण हेतु विद्यालय स्तर से लेकर विश्वविद्यालय स्तर तक के सभी छात्रों को मूल्य-आधारित शिक्षा प्रदान की जानी चाहिए ? (a) हाँ (b) नहीं 21. मूल्य-आधारित शिक्षा द्वारा वायु-प्रदूषण, वैश्विक उष्मीकरण तथा जलवायु परिवर्तन के प्रभाव को कम करने के लिए आप अपना सुझाव दें। <p style="text-align: right;">Investigator: Ranjit Kumar, M.Sc., Ph.D.</p>
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Fig. 2 Questionnaire of survey

and understand the extent to which it can damage their life but 22% of respondents were in the opinion that air pollution will affect little while 3% are ignorant, which is a very large number (Figs. 4 (3) and 5 (3)). This is worrisome. They know the health hazards of air pollution and

73% of respondents blame air pollution for irritation in the eyes, nose, and throat, breathlessness is marked by 22%, and 5% think that depression may be also due to air pollution (Figs. 4 (4) and 5 (4)). 45% of the total respondents (35% male and 10% female) stated that the pollution

Fig.3 Percentages of the respondent **a** area, **b** gender and **c** age ratio

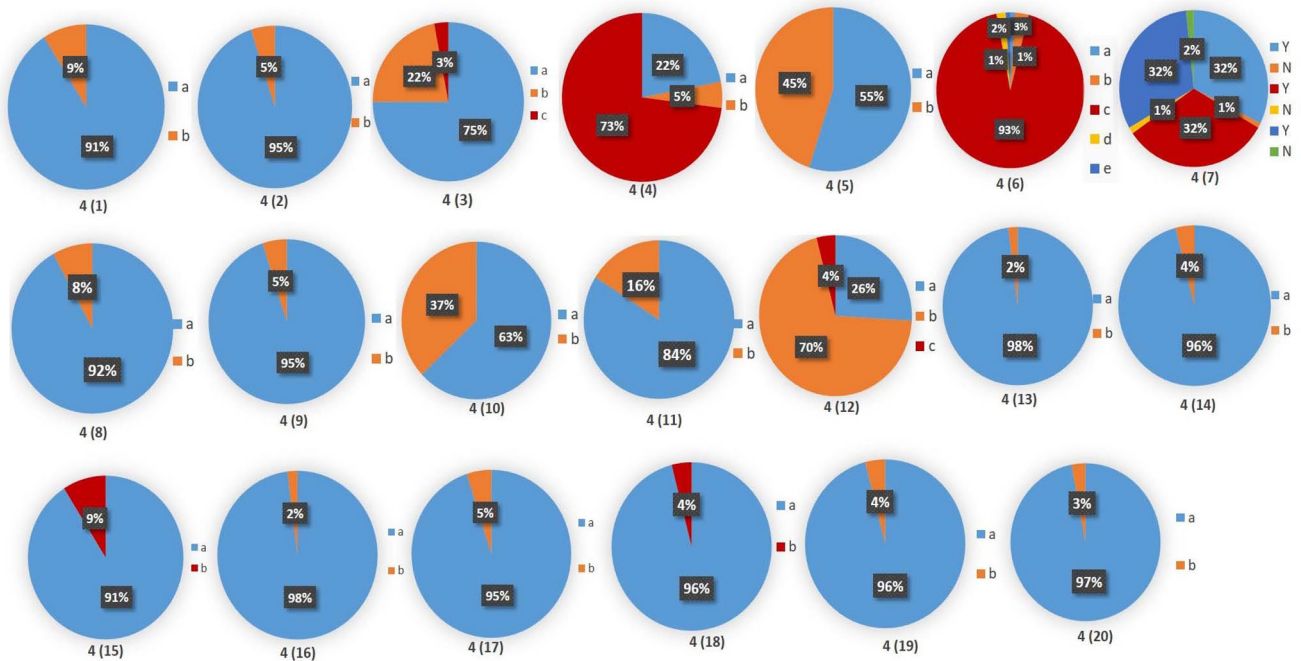
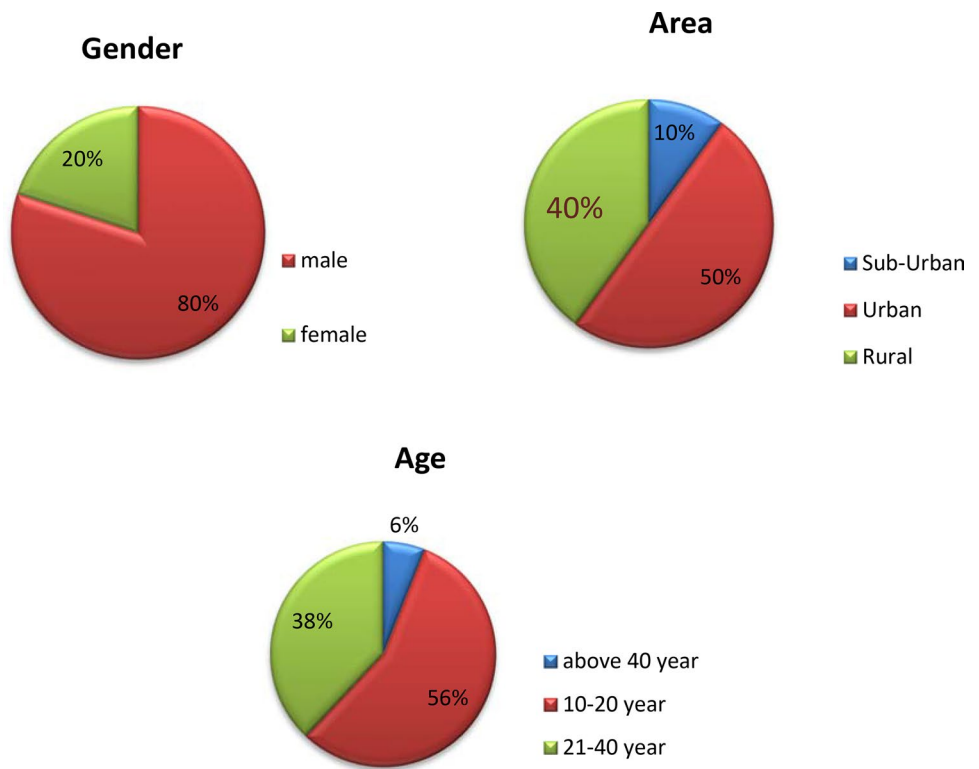


Fig. 4 A statistical response of total respondent to questions of the survey

level in Agra is cleaner than other big cities and the other 55% say it is worse (Figs. 4 (5) and 5 (5)). Cooking fuel is found to be one of the major causes of air pollution as 93% of respondents were dependent on LPG (liquefied

petroleum gas) as a mode of cooking while the rest of the respondent relies on kerosene, coal, and wood (Figs. 4 (6) and 5 (6)). People were in a clear opinion that polluting companies should be fined heavily to cut down air

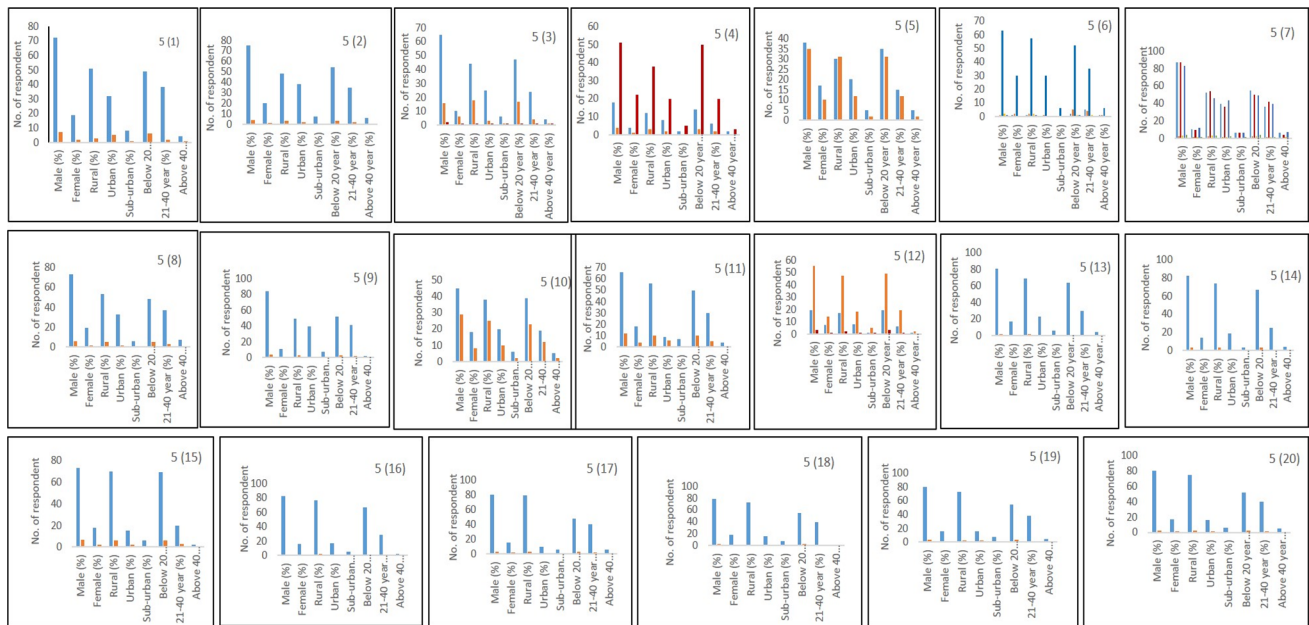


Fig. 5 Response to the questions of questionnaire

pollution even it may put some jobs at risk. They believe that citizens should now take the initiative in their hands for clean air and a safe environment and ask authorities to take actions judiciously. 92% of the total respondents (73% male and 19% female) were of the view that the ultimate solution to this glaring situation of global warming and climate change can be tackled by making common masses aware of causes, consequences, and culprits of air pollution (Figs. 4 (8) and 5 (8)). Environmental education may be an important means and 95% of respondents in which 84% male and 11% female feel it may improve public understanding of environmental issues (Figs. 4 (9) and 5 (9)). 91% respondents know the air quality index (AQI) (Figs. 4 (10) and 5 (10)). The excess use of energy causes air pollution, 84% of the total respondents (66% male and 18% female) are aware that air pollution is due to excessive use of energy, while 16%, which is not a small number, are unaware (Figs. 4 (11) and 5 (11)). The biggest source of knowledge regarding the air pollution and environment is print media, although digital media have surpassed all records of visual advertisement as 73% say newspapers are their main source on environmental issues whereas only 26% say it is a television (Figs. 4 (12) and 5 (12)). In the response to the question of the moral responsibility to minimize air pollution, 98% of the total respondents (81% male and 17% female) feel that air pollution control is our moral responsibility and believe that the negligence of our moral responsibility is doing more harm to the environment than any other thing (Figs. 4 (13) and 5 (13)). 98% of respondents in which 82% male and 14% female were in

view that bringing certain changes in daily habits of life may minimize the energy consumption (Figs. 4 (14) and 5 (14)). But the positives that can be taken from this survey is that they are ready to make changes in their lifestyles and want to contribute to the fight against the menace of air pollution. Taking moral responsibility is important to overcome this problem as 91% of the respondents (73% male and 18% female) feel that it is the selfish interest of some people that are hampering the cause (Figs. 4 (15) and 5 (15)). 98% of respondents in which 82% male and 16% female stated that ignorance of moral responsibility for self-interest or may be due to unconsciousness towards the human values (Figs. 4 (16) and 5 (16)) may be proven to be dangerous. Various studies have suggested that interest, beliefs, values, and the basis of knowledge power are linked with culture, nature, and economy [11, 29–35]. 98% of respondents have shown their willingness to take some steps for clean air and bring some changes in attitude regarding environmental issues. 95% believe consciousness and human values will go a long way (Figs. 4 (17) and 5 (17)). The socio-ecological approaches to environmental education emerged as ways for dealing with conflicting multilayered demands concerning the environment. The research finding of this survey was very similar to the earlier studies for socio-ecological perspectives on environmental education [11, 12, 20]. The characteristics of the survey were outlined for providing the foundation of socio-ecological approaches. The socio-ecological approaches illustrate how environmental problems are addressed, inquired, analysed, interpreted, and what

conclusions are drawn regarding the solution of air pollution [36]. 98% of respondents in which 78% male and 18% female are of the view that student life is the time to lay the foundation of intellectual and conscious citizens (Figs. 4 (18) and 5 (18)). 96% of them in one voice say that value-based education from elementary level can inculcate the habit of energy efficiency as well as consciousness towards the environment. They also believe that this will produce future intellectuals and very informed citizens (Figs. 4 (19) and 5 (19)). 97% of people in which 80% male and 17% female say that value-based education should be added to the curriculum starting from elementary level to research courses because our existence can only be supplemented on the pillars laid by the educating system (Figs. 4 (20) and 5 (20)). The statistical analysis was performed on the dataset, and the *t* test for all variables has been found statistically non-significant at $p < 0.05$. The *t* test with the participants from different gender, age group, area-wise, and

questionnaire is presented in Table 1. The categories of gender, area, and age have been observed that the *p* value ($T < = t$) was less than the absolute value (critical value). Respondent was positively found to be statistically significant with gender especially in males ($p = 0.28$). It may be due to the fact that the male respondent is more exposed outdoor than female ($p = 4.0 \times 10^{-7}$). In the area-wise, the respondent from a rural area ($p = 0.036$) has shown the statistical significance than urban ($p = 4.3 \times 10^{-6}$) and suburban (1.4×10^{-8}) area. The *p* value of different age group viz. below 20 years, 21–40 years, and above 40 years was less than the absolute value. The age group below 20 years ($p = 0.01$) was positively significant than other age groups. It may be due to the fact that the youngster is more sensitive to air pollution than older. Therefore, the results of the age group of 21–40 and above 40 years were not statistically significant.

Table 1 *t*-test statistic and degrees of freedom (df) with critical value of statistical significance at 0.05

		<i>t</i> -statistic	df	<i>P</i> value	<i>t</i> -critical	
	Total	5.2	53	1.2×10^{-6}	1.7	
Gender	Male	1.07	93	0.28	1.6	
	Female	5.8	51	4.0×10^{-7}	1.7	
Area	Rural	2.1	84	0.036	1.6	
	Urban	5.0	57	4.3×10^{-6}	1.7	
	Suburban	6.8	48	1.4×10^{-8}	1.6	
Age	Below 20 year	2.4	78	0.01	1.7	
	21–40 year	4.4	61	3.4×10^{-5}	1.7	
	Above 40 year	6.9	48	8.7×10^{-9}	1.7	
Survey questions	Q.1	3.6	6	0.005	1.9	
	Q.2	3.9	7	0.005	1.9	
	Q.3	2.4	9	0.03	1.8	
	Q.4	2.9	8	0.01	1.9	
	Q.5	0.5	14	0.57	1.7	
	Q.6	a	4.4	7	0.002	1.8
		b	3.4	7	0.01	1.9
		c	3.3	7	0.01	1.9
	Q.7	3.6	7	0.008	1.8	
	Q.8	3.8	7	0.006	1.9	
	Q.9	3.4	7	0.01	1.8	
	Q.10	1.5	12	0.15	1.7	
	Q.11	2.7	7	0.02	1.9	
	Q.12	2.0	9	0.06	1.9	
	Q.13	3.4	7	0.01	1.9	
	Q.14	2.9	7	0.02	1.9	
	Q.15	2.8	7	0.02	1.9	
	Q.16	3.1	7	0.017	1.9	
	Q.17	3.0	7	0.018	1.9	
	Q.18	3.3	7	0.012	1.9	
Q.19	3.2	7	0.014	1.9		
Q.20	3.3	7	0.012	1.9		

In the study, it is quite evident that the participation of females is limited. It may be due to their illiteracy and socio-economic status and understanding of air pollution and other environmental issues. There is an urgent need to enhance their understanding of such a common public problem of air pollution. The government should come up with a different innovative scheme and value-based education to address these issues. Value-based education means to be a starting point of the real-life solution where people are directly involved. They also expressed their fear in the feedback remark that they are sitting on a pile of explosives and in a situation of now or never. It will be too late if some drastic steps are not taken immediately. But it is also a fact that this survey was conducted in educational institutions and nearby areas where people are more active and are educated. But still, many are unaware of several implications, causes, and remedy of the menace of air pollution. So, a condition in core civil areas may be more disturbing.

3.2 Perception of value-based education

Education is an act of acquiring or imparting a particular set of knowledge or skills through the process of learning or teaching, especially in schools or colleges. But the most important demand for time is to change and that change should also be reflected in the education system. The necessity to add values of education has risen. The addition of values does not kill the essence of the traditional educational methodology but complements it. Value-based education integrates ethics, moral duties, cultural importance which develops the trainer as well as the learner to be a better human being. It is just a way of conceptualizing existing education practices with the purpose of good for all, at the core of its heart. It initiates a positive relationship with everything living or non-living around. It teaches to give respect to others whether living or non-living. The changes happening around the world are badly affecting the environment and there is a need for value-based education to educate people and come up with new ideas/techniques. These scenarios can be coupled with various areas, i.e. value-based education, socio-economic, climatic, cultural, and behavioural impact. The perspective needs to be discussed and a plan needs to be unraveled that how to implement these scenarios step by step to provide a complete framework of implementing value-based education in true spirit. Environmental problems need to be addressed through value-based education as it provides an opportunity to educate and train the people who are or will be making or breaking the environment further. This type of education should start from the elementary level to the advanced level and then to a very advanced level. The crucial and most difficult step of

the method is the implementation of plans as it demands changes in the way of life morally and the integrity of the administration to implement. Many times it demands changes in existing laws into a more stringent one, despite drawing flak from some parts of the society.

3.3 Control of air pollution: value-based education

Air pollution can be controlled through nature-based or technology-based solutions. Technology-based solutions control one type of pollution but also add other kinds of pollutants to our environment. The outcome or findings of the present survey provoked the nature-based solution of air pollution, global warming, and climate change. The result of the survey conducted clearly shows that people have migrated from sustainable development to unsustainable development mainly due to their ignorance towards the environment and selfishness. People accept their negligence and unawareness. The survey also points out that people due to their selfish ends sometimes do not care about the environment. The survey also had a suggestion-based question in which it was asked to suggest ways to control the menace of air pollution. Respondents suggested that environmental education be imparted from the elementary level and organizations such as educational institutions, the social, or religious body should be a frontrunner to bring changes in habit of inhabitants. They also suggested that the government should frame stricter laws and ensure its implementation. Reduction in the use of private vehicles and control in the consumption of energy were pointed out. A lot of people came out with the idea of the extensive plantation. Almost everyone suggested practical awareness among citizens in the form of workshops/conferences/seminars on causes, impacts, and solutions to air pollution. The new generations with the proper guidance of experienced are ready to embark on the journey to integrate value in the education system and also to work together for sustainable development. People are ready to improve their understanding of society and the common public on climate and future socio-economic scenarios. These deeply rooted values can be imbibed in students through value-based education. Some steps to make them aware have already been taken, but a lot needs to be done.

Based on the response of respondents, four-step strategies have been proposed viz. measurement and assessment, set standards, reduction of emission, and implementation (Fig. 5) to combat the menace of air pollution. Measurement and assessment of air quality are required and it involves the general public, local communities, schools, university, industry, non-governmental organization, community groups, and NGOs. There is a need to set the standard through consensus amongst

stakeholders, policymaker/decision-makers, industrialists, media, and the common public. There should be separate emissions standards for different sources. The reduction of emission at the source can be achieved by the betterment of technology through modification and replacement of existing equipment with more advanced ones. Hence, the reduction in dependencies on fossil fuels and the identification and use of clean and alternate energy sources are needed. Implementation and execution are of the most important as the whole model relies on the success of these steps. Hence, the direct involvement of the government body and judiciary is required. These four-way efforts should be made in parallel. This is like 1-2-3-4 formulae to formulate the problems of air pollution. Individuals (adults and children) may change their behaviour when their values, beliefs, and environmental understanding improve which can be achieved by becoming conscious of the environment. The new process of bidirectional perception is only a step towards bringing the separate tasks under one single umbrella (Fig. 6). There should be effective in dealing with the exchange of information, data collection,

knowledge, interpretation, implementation, and further actions and co-ordination between organizations. Value-based education will be the central idea of the bidirectional perception process, as it will develop a sense of working together in teams, bringing about a change in the thinking of present and generations to come. All this will go to improve the knowledge of air pollution, climate change, and mitigation. The contribution of the common public is the only way of success. But to develop a sense of belongingness with the environment, they must know about air pollution and its vulnerabilities. It should be backed by the proper amalgamation of scientific advancements and inculcation values and ethics in an individual which can be achieved through value-based education and being environmentally conscious. Its implementation should be time-bound and impacts must be monitored. Any control technologies can never be full-proof for such a diverse and complex issue of air pollution and climate change, but when efforts are made honestly and implemented properly, surprising results come. This mechanism may be very effective, cost-benefit, and sustainable.

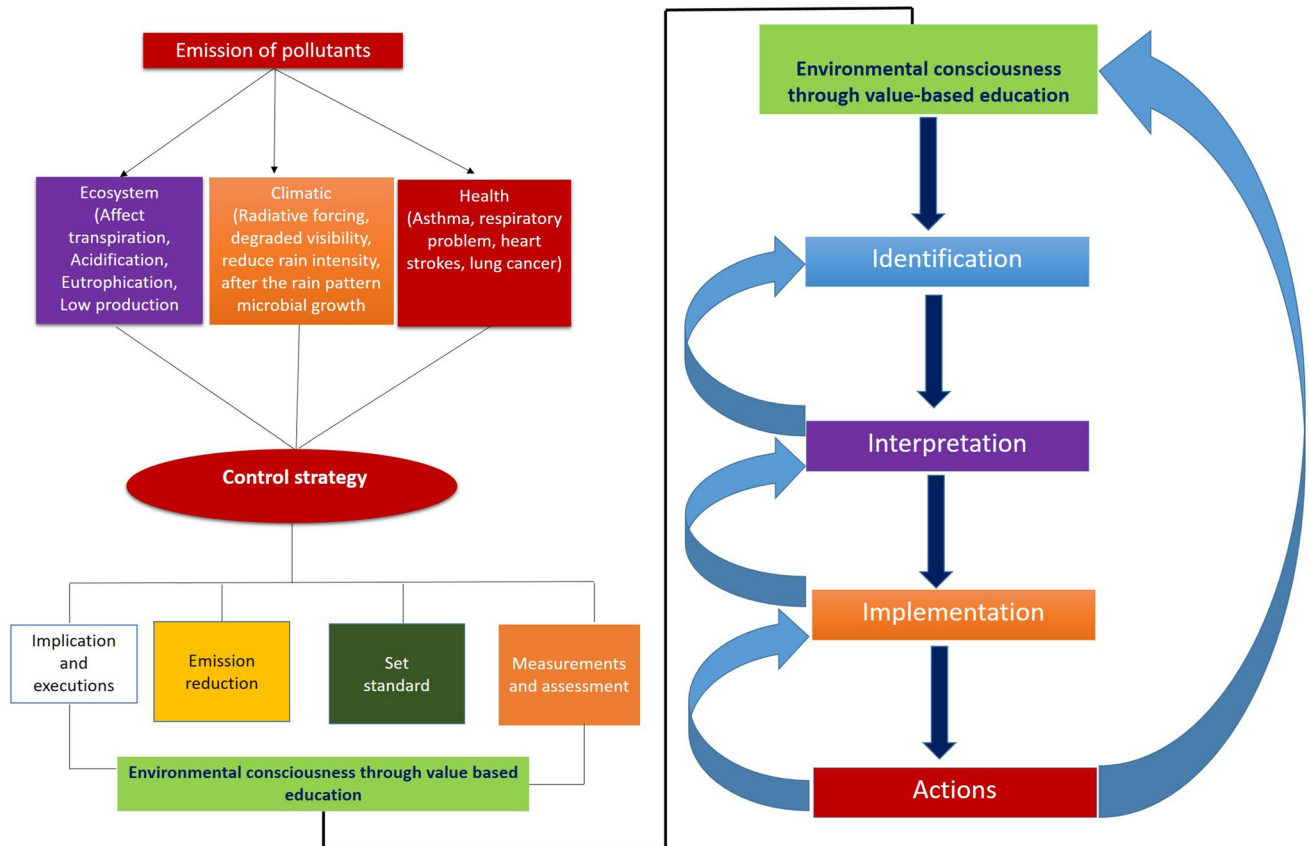


Fig. 6 Bidirectional perception of the process of value-based education

3.4 Policy implications

The findings of this survey suggested the awareness of air pollution and the implementation of air quality control measures. Value-based education can be a powerful tool to make people aware of such relations and get rid of ignorance. Therefore, value-based education has to play an important role. It builds character which is beneficial for the growth of both the individual and the societies. Value-based education also seeks to integrate the principle, values, and practices of sustainable development into all aspects of life, to address the social, cultural, and environmental problems we face in the twenty-first century. Environmental literacy for adults means developing and participating in social practices likely to change the way our societies think about and act upon ecological issues. Nature-based solutions and sustainable consumption and production is the need time and needed to be included in government policies.

3.5 Limitations of the work and potential future work

The present study focused on the public perception of the status of air quality in the Agra region over north-central India. Air pollution has become a big issue nowadays all over the world. The main sufferer of air pollution is human being and the main culprit is also human beings while the main cause of air pollution is indiscriminate exploitation of natural resources and excessive consumption of energy by human being. All the efforts made so far to control air pollution were technology-based in spite of knowing the fact that human being is the main culprit. In this study, the common public has been involved and opinions were invited in the form of questionnaires regarding causes, impacts, and solutions of air pollution. Respondents feedback were torch-bearing for environmentalists, educationists, academicians, government body, and stakeholders for the plan. Input obtained from the respondents of the Agra region only but it can be considered as a pilot work and can be representative of a regional perception on such a global problem. This is a limitation of this work. In the future, such type of a comprehensive study is required by involving the public of all segments which may help to design a proper plan for pollution reduction and a healthy environment.

4 Conclusion

A survey-based on questionnaires has been conducted to know the views of the public and explore the role of education in control of air pollution over the Agra region

in north-central India. This study reveals that the public is aware of deteriorating air quality, but they are not making efforts to fight them just due to ignorance and their selfishness. Based on the feedback of respondents, following conclusions and suggestions have been derived:

- A change in habit and lifestyle is required.
- Ban on the industry which pollutes air even at the cost of employment is needed.
- Value-based education is needed to combat the menace of air pollution.
- The ultimate solution to the air pollution problem is making the people aware of the causes, consequences, culprits, and control of energy consumption through education.
- A four-step non-destructive and holistic method has been suggested for air pollution control which can be achieved through value-based education and being environmentally conscious.
- Nature-based methods should be adopted for control of pollution as technology-based solutions are specific.
- An organization like educational institutions, indigenous groups, and religious bodies should be involved as they will act as a catalyst for bringing change in habit of the common public and future generation.

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Data availability All the generated and analyzed data are included in this article.

Compliance with ethical standards

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