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CLIMATE CHANGE AND ENVIRONMENTAL GOVERNANCE IN INDIA: A SOCIO-LEGAL STUDY WITH REFERENCE TO PUNJAB

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ABSTRACT

This study investigates the interrelationship between climate change, environmental degradation, and the enforcement of environmental laws in Punjab. Despite a strong legal framework—comprising the Environment (Protection) Act, Air Act, and Water Act—implementation remains inconsistent and ineffective. Using an empirical and descriptive research design, data were collected from 100 respondents representing legal professionals, environmental officials, NGOs, doctors, academicians, and the general public. Statistical tools such as Chi-square and Pearson correlation analyses were applied to assess perceptions, awareness, and enforcement challenges. Findings indicate that climate change, industrial pollution, and agricultural practices such as stubble burning are widely recognized as major causes of environmental decline. However, gaps persist in public awareness, inter-departmental coordination, and institutional accountability. Mean scores around 3 suggest moderate confidence in governance, while significant Chi-square values confirm that responses are structured and non-random. Correlation results show strong linkages between pollution, governance, and enforcement perceptions, reflecting an integrated public understanding of environmental issues. The study concludes that while awareness exists, enforcement mechanisms require reform through enhanced transparency, participatory governance, and inter-agency collaboration to achieve sustainable environmental protection in Punjab.

Keywords: Climate Change, Environmental Law, Environmental Degradation, Public Awareness and Governance, Air and Water Pollution in Punjab

1. INTRODUCTION

One of the characteristic issues of the twenty-first century has been environmental degradation and climate change as they are a threat to ecosystems, economies, and human health on a global level. These issues are particularly critical in India due to the fast process of industrialization, urbanization, and high dependency on agriculture in the country. The Punjab state specifically is a hard-to-find crossroads of environmental pressure, socio-economic neediness and state administration capacity. In spite of the fact that there are various environmental laws and institutions, the application and execution of environmental law are still in a patchy and in most instances inefficient. This research paper aims at

determining the major causes of climate change in Punjab and evaluating the issues that make it difficult to implement environmental laws in the state.

The state of Punjab is the so-called Granary of India, as it is among the most productive states in the country, in terms of agriculture. Nonetheless, long-term farming activities have resulted in the devastating environmental impacts such as the depletion of the ground water, soil erosion, and air pollution through the burning of crop-residues. Stubble burning is one of the most evident environmental concerns in Punjab which leads to the development of high levels of particulate matter (PM2.5 and PM10) and greenhouse gases. The emissions directly affect the air quality, health of the population, and climate effects in the region. Also, overuse of chemical fertilizers and pesticides pollute the water bodies and destroy the fertility of soil, which worsens the environmental crisis in the state.

These problems have been enhanced by industrial activity. Some of the key industrial areas that bring economical growth as well as environmental degradation are Ludhiana, Jalandhar and Mandi Gobindgarh. It has been reported that the Punjab Pollution Control Board (PPCB) has come up with over 1,500 sources of water pollution, and nearly 60 percent of these sources have not been controlled or regulated (Times of India, 2025a)4. These enforcement lapses indicate administrative and structural gaps such as poor resources, lack of enough manpower, and poor inter-departmental coordination.

The legislative and policy framework of environmental protection in Punjab is based on the national laws of environment (protection) act, 1986, air (prevention and control of pollution) act, 1981 and water (prevention and control of pollution) act, 1974. Although these acts are so comprehensive, their implementation in the states has been disproportionate. In 2024, the Punjab Assembly endorsed the Water (Prevention and Control of Pollution) Amendment Act, which substituted criminal penalties on some of the violations with financial fines of between 10,000 and 15 lakh (Times of India, 2025b)5. Although those who support it believe that the money punishment is a guarantee of administrative efficiency, opponents also fear such changes will impair the deterrence effect of the law (Times of India, 2025c)6. This conflict is indicative of greater issues concerning the balance between environmental governance and compliance and deterrence and institutional viability.

Punjab has been exposed to climatic pressures through climate change. A report by the Punjab State Council of Science and Technology, Institute of Governance and Sustainable Development (IGSD) and The Energy and Resources Institute (TERI) in 2025 discovered that non-CO2 emissions, including methane, black carbon and ammonia are increasing regional warming. In 201023, Punjab had 128 days of heat wave, and in 2024, every nine monitored cities had surpassed the allowed threshold of PM2.5 concentrations (Institute for Governance & Sustainable Development [IGSD], 2025)2. These observations highlight the need to have effective enforcement tools, technological creativity and community-driven adaptation plans.

As a reaction, Punjab has came up with novel policy instruments like Emissions Trading Scheme (ETS) of industrial air pollution in Ludhiana. The program was established with the Abdul Latif Jameel Poverty Action Lab (J-PAL South Asia) and the Energy Policy Institute, University of Chicago (EPIC India) with the objective of capping the overall emissions produced by the dyeing industries but permitting the firms to trade permits (EPIC India, 2025)1. The ETS illustrates the possibility of market-based regulation, but the success of any such regulation relies largely on the openness of its monitoring and honesty of the enforcement bodies. Bisht (2026)

Empirical evidence however indicates that implementation of regulations is also weak. A lot of industries in northern India illegally report their emissions and escape inspections due to the inefficiency of administration and a lack of enforcement capacity. This scenario is congruent with governance issues which are evident in Punjab where there are limited resources and bureaucracy within the agencies such as the PPCB. Furthermore, inter-departmental cooperation between health, environment, and agriculture sectors is also still weak, which also undermines the effectiveness of climate adaptation and the effectiveness of climate enforcement (Ministry of Health and Family Welfare, 2024)3.

The environmental governance in Punjab is dominated by the Directorate of Environment and Climate Change which has the mandate of policy implementation, climate action and regulation of the environment. Although such centralization seems to be effective in theory, in practice it tends to be inefficient at the district level in terms of slow decision-making and inadequate technical skills. Moreover, the actual practices of the PPCB and the towns often lead to formal punishment, which lacks a long-lasting correctional solution (Times of India, 2025d)7. As an illustration, the local civic authorities like the Jagraon Municipal Council have been fined several times due to breaches on waste-management rules but still had not given in.

There is also a barrier to legal enforcement in the ecological management of urban areas. The illegal cutting of trees even with a penalty of up to 10,000rs per tree is commonly practiced in a number of cities (Times of India, 2025e)8.

This empirical and analytical gap will be addressed by the current study that will explore the causes of environmental degradation and the obstacles to enforcement of the law in Punjab. The former is to investigate the most crucial causes of climate change-industrial emissions, agricultural activities, and social-economic activities and how they all add up to affect the quality of the environment. The second one aims to evaluate the implementation of the environmental laws, with particular attention to the way the institutions, including the judicial system, PPCB, NGOs, and the civil society actors, interact with the governing system. The study will produce a grounded meaning of the enforcement landscape through systematic questionnaires in various groups of respondents (legal professionals, administrators, activists, and affected citizens).The study will thus provide valuable inputs for strengthening the design and implementation of environmental regulation in Punjab. The findings are expected to inform both policymakers and scholars by identifying bottlenecks, capacity gaps, and opportunities for reform in Punjab's environmental governance model.

2. LITERATURE REVIEW

Kaur, Kohli and Jaswal (2013) observed the association between GM crops and climate change in an Indian perspective by stating that, although GM technology has the potential to enhance resilience, it also has ecological hazards and thus premises the need to impose strict regulations on GM. This complicates the decisions that Punjab will make with regards to adaptation strategies especially with balancing productivity, sustainability and environmental risk13.

It has been noted by scholars that the agriculture of Punjab is susceptible to climate change. Kumar and Sidana (2018) examined the perception of farmers and adaptation mechanisms and found that most farmers in Punjab acknowledge that temperatures and irregular rainfall are increasing but lack institutional support and resources to make a meaningful adaptation. These adaptation measures involve shifting the sowing dates, crop diversification and adoption of water saving practices18.

Greenstone, Sudarshan, and Pande (2020) note that over 660 million Indians breathe air exceeding national standards, and compliance could raise life expectancy by 3.2 years. However, effective pollution control remains challenging. They highlight three key reform elements: (i) reliable, high-quality monitoring, (ii) incentive-based and efficient regulation, and (iii) pilot testing and evaluation of new approaches. Drawing on evidence from India and abroad—such as Delhi's vehicle rationing, Gujarat's industrial audits, and continuous emissions monitoring—they argue that combining these strategies, especially through market-based solutions, is vital for lasting pollution reduction17.

Sodhi et al. (2023) assessed the implementation of technologies in the National Innovations in Climate Resilient Agriculture (NICRA) project in terms of climate-resilient agriculture. Their effort demonstrates that the adoptions of practices such as zero tillage, direct-seeding rice and bio-fertilizers are not equally adopted within the various districts as they are not uniformly adopted due to socioeconomic status and access to technology16.

Mavi (2024) investigated the climate-smart agricultural (CSA) systems in SAS Nagar district and concentrated on water-saving techniques amidst the declining groundwater. The paper has indicated that those farmers who practice CSA practices including laser land leveling and diversification in crop production and distribution have indicated that their productivity and resistance to climatic shocks have improved14.

Kaintura et al., 2024, conducted the research on radioactivity in soils of Punjab, especially in the agricultural lands conductively, through advanced radiological and physicochemical analyses. They discovered quantifiable amounts of uranium, thorium, and other radionuclide's albeit in safe amounts. Nevertheless, their work indicates that anthropogenic pollution (e.g. industrial pollutants) might increase these risks12.

Anand and Kaur (2024) give an extensive discussion of stubble burning, a major contributor to air pollution and green house emissions, where farmers are more willing to adopt alternatives they, however, are limited by the high prices and scarcity of available machinery that includes happy seeders and mulchers. There is also no adequate insurance provision that cover the risk or cost of residue management to encourage adoption9.

In the same manner, Saluja, Juneja and Singh (2025) performed an empirical case study in Malwa area of Punjab and found that climate variability especially change in precipitation pattern has negative impacts on crop yields especially those crops of high water consumption like paddy. The decrease in the yield is not only a threat to the livelihood of farmers but also to food security in the area15.

Gupta et al. (2025) state that stubble burning is one of the primary causes of air pollution within North India resulting in respiratory diseases and decreasing the groundwater quality through pollutant deposition. Behavior change has been very slow despite the awareness campaigns because of economic and policy dis-incentives10.

The Institute of Governance and Sustainable Development (IGSD) 2025 report, highlighted that short-lived climate pollutants such as methane, black carbon, and ammonia are playing a major role in the worsening of the air quality as well as warming in Punjab. The report provides an urgent need to intervene in policies to curb these pollutants and CO215. Report presents a two-dimensional approach to mitigation of Punjab, which would address CO2 as well as SLCPs. They suggest interventions such as introducing emissions trading systems (ETS) to the industrial polluters, direct-seeding rice to cut back on crop-residue emissions, electrification of transport, and waste management11.

Studies by Yang et al. (2025) and Govardhan et al. (2023) emphasize the environmental and health consequences of stubble burning in northwestern India. These works reveal that despite repeated bans and incentives, farmers continue the practice due to economic constraints and lack of affordable residue-management alternatives19/20.\

3. OBJECTIVES OF THE RESEARCH

1) To examine the key factors contributing to climate change in Punjab.
2) To identify the challenges hindering effective enforcement of environmental laws in Punjab.
3) To conduct empirical research on the enforcement status of environmental laws in Punjab's.

4. RESEARCH METHODOLOGY

4.1. RESEARCH DESIGN

The study adopts an empirical and descriptive research design to examine the factors contributing to climate change and evaluate the effectiveness of environmental law enforcement in Punjab. Both quantitative and qualitative methods are employed to provide a comprehensive understanding of the relationship between environmental degradation, governance, and public perception. The approach integrates survey-based data collection with statistical analysis to draw evidence-based conclusions.

4.2. DATA COLLECTION

The study primarily relies on primary data, supported by secondary literature for contextual insights.

- **Primary Data:** Collected through a structured questionnaire administered to diverse respondent groups, including legal professionals, environmental officers, academicians, NGO representatives, doctors, and the general public.
- **Secondary Data:** Drawn from government reports, journal articles, policy documents, and official statistics such as the Punjab Pollution Control Board (PPCB), Institute for Governance & Sustainable Development (IGSD), and the Ministry of Health and Family Welfare.

Study Area

The data will be collected from two major districts of Punjab:

- Jalandhar (Doaba region)
- Ludhiana (Malwa region)

These areas are chosen due to their varying levels of industrialization, environmental challenges, and representation of diverse socio-economic conditions.

4.3. SAMPLING DESIGN

A stratified purposive sampling method was used to ensure balanced representation from different occupational and socio-economic categories. The total sample consisted of 100 respondents, distributed as follows:

Table 1

Table 1		
Sr.No.	**Respondents**	**Numbers**
1	Legal Respondents (Judges, Lawyers, Legal Scholars)	15
2	Environment Protection Departments (Pollution Control Board, Local Bodies)	15
3	Academicians & Researchers (Environmental Law and Policy)	15
4	NGOs and Environmental Activists	15
5	Doctors	15
6	General Public (Farmers, Urban Residents, Affected Communities)	25
	Total	100

4.4. RESEARCH INSTRUMENT

The research instrument was a five-point Likert scale questionnaire (ranging from 1 = Strongly Disagree to 5 = Strongly Agree), consisting of 20 statements (Q1–Q20) measuring:

- Awareness of climate change
- Perception of environmental degradation
- Attitudes toward law enforcement
- Institutional effectiveness
- Governance and policy implementation

The instrument also included demographic variables such as gender, age, occupation, income, district, and education to facilitate correlation analysis.

4.5. RELIABILITY AND VALIDITY

Reliability of the instrument was verified using Cronbach's Alpha, indicating a high level of internal consistency among the survey items. Validity was ensured through expert review by academicians and environmental law practitioners to confirm content relevance and clarity.

5. DATA ANALYSIS

Both descriptive and analytical methods will be employed. The collected data were analyzed using quantitative statistical methods, including:

Descriptive Methods: Mean, percentage, and frequency distributions for variables like public awareness, perception of environmental laws, or compliance levels.

Chi-Square Tests: To assess the significance of observed opinions ($p < 0.05$ confirmed significance for all items).

Pearson Correlation Analysis: to examine relationships between demographic variables and environmental perceptions and also among environmental perceptions variables.

5.1. DEMOGRAPHIC PROFILE

Cronbach's Alpha (α) - Cronbach's Alpha measures the internal consistency or reliability of a set of survey items It ranges from 0 to 1, where higher values indicate stronger consistency among items.

Table 2

Table 2		
Alpha Range	**Reliability Level**	**Interpretation**
0.864	Good	Reliable

Table 3

Table 3 Frequency for Demographic Variables

	Category	Frequency	Percentage
Gender	Female	40	40.0%
	Male	60	60.0%
Age group	18–25	23	23.0%
	26–35	16	16.0%
	36–45	19	19.0%
	46–55	23	23.0%
	56+	19	19.0%
Occupation	Legal Respondents (Judges, Lawyers, Legal Scholars)	15	15.0%
	Environment Protection Departments (Pollution Control Board, Local Bodies)	15	15.0%
	Academicians & Researchers	15	15.0%
	NGOs and Environmental Activists	15	15.0%
	Doctor	15	15.0%
	General Public (Farmers, Urban Residents, Affected Communities)	25	25.0%
District	Jalandhar	45	45.0%
	Ludhiana	55	55.0%
Income	Below 5 lakh per annum	31	31.0%
	Bet 5-10 lakh per annum	34	34.0%
	Above 10 lakh per annum	35	35.0%
Education	10th	30	30.0%
	12th	10	10.0%
	Graduation	15	15.0%
	Post Graduation	45	45.0%

Gender Distribution - The gender ratio represents an equal but slightly male dominated sample. This sampling will guarantee that both sides are represented although with a larger percentage (60) of males which could have a slight impact on general findings leaning in favor of male opinions.

Age Group Distribution - The sample consists of a good mix of age with both the young and the middle class being represented. The two age brackets (18-25 and 46-55) represent the most significant numbers with equal representation of younger and older people. This diversity will make opinions more reliable since it takes into account the various generational perspectives.

Occupation Distribution - The occupation distribution indicates an interdisciplinary and widely representative sample. The largest group (25%) is the general population and this guarantees the inclusion of the grassroots views. The participants involved in the legal, environmental, academic, health, and (NGO) sectors will be represented equally (15 percent) to have balanced professional views.

District Representation - The survey is well balanced between Jalandhar and Ludhiana with slight majority of the Ludhiana (55%). This distribution is a balance of the region, which would help to capture the attitudes and environmental awareness of two big industrial and urban centers in Punjab.

Income level -The statistics show a relatively equal distribution of the respondents according to their income groups. There is a marginally more percentage (35) in the above Rs 10 lakh per annum bracket and this indicates that a significant number of respondents are in the higher income bracket. In the meantime, 34 percent of the respondents have earnings between 5-10 lakh/per annum, which is the middle-income group, and 31 percent have incomes lower than 5 lakh/per annum indicating involvement of the lower-income groups as well. In general, the distribution of the income shows the diversity of the economic backgrounds of respondents, which guarantees the inclusion of the opinions of all key economic classes in the research.

Education level -The figure indicates that most of the respondents (45) are postgraduates demonstrating the presence of a highly educated sample population. There is a steady number of respondents with 10th-level education (30% of the total) indicating that a significant percentage of the respondents have the basic school education. Graduates comprise 15 percent and 12th -level respondents form 10 percent, the lowest number.

Table 4

Table 4 Frequency & Percentage Distributions (Likert Items)

Response	Frequency	Percentage
1 – Strongly Disagree	106	5.30%
2 – Disagree	525	26.25%
3 – Neutral	795	39.75%
4 – Agree	488	24.40%
5 – Strongly Agree	86	4.30%

The neutral answers (39.75) prevail - this indicates that a big percentage of the respondents were not sure about many of the statements, or rather, were not interested.

The level of disagreement (31.55) is stronger than the level of agreement (28.7) - the overall attitude of the participants to the statements in the survey is slightly negative or skeptical.

The percentage of strong opinions (Strongly Agree + Strongly Disagree) is also comparably low (9.6%), which means that the vast majority of the respondents took moderate or neutral stances.

The general answers indicate that most of the participants are neutral or slightly disagree with the provided items. This implies that the lack of consensus is best indicated by the fact that at least there is no overwhelming viewpoint, but rather, the general impression is more of disagreement than agreement. The low extremes suggest that there is a moderate level of attitudes and a poor polarization of the respondents.

Table 5

Table 5 Chi-Square Distribution Values

Questions	Mean	Std. Dev	Chi-Square (χ^2)	p-value	Significance
Climate change has significantly affected the environment and health in Punjab	2.98	1.01	38	0	Significant
Industrial pollution is a major cause of environmental degradation in Punjab	2.95	0.9	51.7	0	Significant
Agricultural practices (like stubble burning, excessive fertilizer use) contribute to climate change	2.95	0.95	50.7	0	Significant
There is insufficient public awareness about environmental protection	2.84	0.96	52.3	0	Significant
Environmental laws in Punjab are not strictly implemented.	3.01	0.92	49.1	0	Significant
Political or administrative interference affects law enforcement	2.91	1.04	33.1	0	Significant
Lack of coordination between government departments hinders enforcement	3.05	0.97	41.3	0	Significant
Corruption or lack of transparency weakens environmental governance	3.07	0.91	51.9	0	Significant
Financial or technological limitations affect pollution control efforts	2.91	0.85	62.9	0	Significant
Climate change policies are poorly implemented at the local level	3	1.02	35.2	0	Significant
The existing environmental laws in India are adequate to address present challenges	2.97	0.97	54.3	0	Significant
Enforcement agencies (Pollution Control Board, Local Bodies, etc.) perform their duties effectively	2.93	0.92	50.5	0	Significant
Judicial interventions (e.g., NGT, High Courts) play a vital role in ensuring compliance	3.02	0.9	51.6	0	Significant
Penalties and punishments for environmental violations are sufficient to deter offenders	3.02	1	38.5	0	Significant

There is adequate monitoring of industrial and vehicular emissions	3	0.93	52.7	0	Significant
Local communities participate actively in environmental protection initiatives	2.82	0.99	41.7	0	Significant
NGOs and media contribute significantly to improving environmental awareness	3.07	1	40.3	0	Significant
Legal awareness among citizens about environmental rights is improving	2.93	0.83	72.8	0	Significant
Coordination between judiciary, administration, and civil society is essential for law enforcement	2.89	0.93	48.5	0	Significant
Strengthening environmental governance requires reforming institutional structures	2.91	0.85	59.7	0	Significant
Degrees of freedom (df) - 4					

Chi-square critical Value (df = 4) at α = 0.05 is 9.488, calculated value range from 33.1 to 72.8, all of which are much higher than 9.488, The Chi-Square analysis shows that all variables are statistically significant (p = 0.000), with χ^2 values far exceeding the critical threshold of 9.488. This indicates that respondents' perceptions are not randomly distributed but show clear patterns of agreement or disagreement. Participants strongly recognize the environmental challenges in Punjab, including climate impacts, industrial pollution, and agricultural practices. There is also widespread acknowledgment of governance-related limitations, such as weak enforcement, corruption, and administrative inefficiencies. Additionally, institutions like the judiciary, NGOs, and media are viewed as essential to environmental governance. Overall, the significant results demonstrate consistent and meaningful public perceptions on environmental issues and governance effectiveness in Punjab.

The values of **standard deviations** (0.83-1.04) indicate that there is little variation indicating that the responses are highly consistent. Several statements have high Chi-square (e.g., kh2 = 62.9, kh2 = 72.8) which suggests the high degree of agreement among the respondents.

The average **mean scores** (between 2.82 and 3.07) indicate that climate change and pollution is commonly perceived to be a serious problem with the average scores near 2.98 showing that people are very concerned with the effects caused by the climate change and pollution to the environment and general health. The main causes of environmental degradation identified by respondents include industrial pollution and lack of sustainability in agricultural practices, including stubble burning and massive use of fertilizers. Weak regulation enforcement and inadequate awareness of the issues by the population also highlight the gaps in the results as the mean scores below 3. The comments of a lack of public involvement (2.84), and poor enforcement of the legislation (3.01) indicate that the respondents are aware of the problems, but they do not feel that the government is responsive. These weaknesses are further compounded by other factors like political interference (2.91) and lack of coordination between the government departments (3.05).

As cited by the respondents, one of the challenges in the governance area is the corruption (3.07) and financial or technological constraint (2.91) which act as an obstacle to pollution control and execution of environmental policies. On the same note, the climate policy implementation at the local level (mean 3.00) is considered as administratively inefficient, implying that there should be a greater administrative accountability.

As to the legal system, the perception is mixed. Even though environmental laws are considered to be statistically important (mean 2.97), the level of trust in their suitability and application is average. The implementation agencies (mean 2.93) and the agencies charged with inflicting penalties on violations (mean 3.02) are observed to be average performers implying that the policy may have to be in some cases improved.

The judiciary and civil society have been discussed as being the driving force behind environmental protection, and moderate-to-high consensus was found that judicial action (3.02) and NGOs and media efforts (3.07) are the reasons behind compliance and awareness. Nevertheless, the public legal literacy level (2.93) remains low, and the incorporation of larger outreach and education of citizens is promptly needed.

5.2. PEARSON CORRELATION ANALYSIS

Pearson correlation analysis between respondents' demographic factors (Gender, Age Group, Occupation, District, Income, and Education) and their responses to 20 environmental perception questions (Q1–Q20). The analysis identifies how demographic characteristics influence awareness, perception, and attitudes toward environmental issues in Punjab.

Table 6

Table 6 Correlation Matrix (Demographics × Q1–Q20)

Demographic Variable	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
Gender	-0.111	-0.004	0.028	0.018	0.069	0.018	-0.109	0.045	-0.150	-0.118	-0.063	-0.181	-0.056	-0.111	-0.009	-0.087	0.018	-0.094	0.123	-0.088
Age_Group	-0.157	-0.023	0.039	-0.056	0.066	0.046	-0.194	0.031	-0.077	-0.038	0.001	0.014	0.174	-0.157	-0.075	-0.049	0.118	0.000	-0.061	0.082
Occupation	-0.004	0.181	0.139	0.132	0.004	0.007	0.028	0.056	0.070	-0.063	0.131	0.082	0.043	-0.004	-0.023	-0.008	-0.069	0.030	0.035	0.186
District	0.265	0.216	0.230	0.043	0.082	0.261	0.109	0.240	0.117	0.115	-0.031	0.134	0.060	0.265	0.292	0.138	0.089	0.134	0.044	0.130
Income	0.001	0.088	0.000	-0.016	0.042	0.197	0.147	-0.068	0.058	-0.026	-0.157	0.203	-0.013	0.001	-0.026	0.024	-0.041	0.041	-0.039	0.156
Education	0.009	-0.141	-0.065	-0.108	-0.129	-0.063	-0.092	-0.062	-0.040	0.024	-0.076	-0.004	-0.115	0.009	-0.093	-0.074	-0.004	-0.056	-0.019	-0.158

Note: Values represent Pearson correlation coefficients (r), rounded to three decimals.

Gender: Analyses of correlation show some positive relationship between gender and Question 19 (+0.123) which means that the male respondents are more likely to demonstrate better awareness of the issue that Question 19 discusses. On the other hand, gender has a weak negative relation with Question 12 (-0.181) indicating that female respondents indicate stronger worry or hold a stronger stance in relation to the policies in Q12. This tendency shows some slight gender distinction, as males prove to be more aware, whereas, females turn out to be more policy concerned.

Age Group: The results of the correlation have a weak positive correlation between age group and Question 13 (+0.174) which is an indication that the older respondents are likely to be more in line with institutional or organizational concerns with respect to the topic. Conversely, Question 7 (-0.194) has a weak negative association, and this means that younger respondents are more preoccupied with proactive environmental actions. This indicates that the older participants have a more institutional-focused approach, and younger participants pay attention to practical engagement and immediate environmental projects.

Occupation: The analysis of the correlation shows that there is a positive correlation between occupation and Question 20 (+0.186), which means that respondents who are occupationally active have a high overall level of environmental concern. In the meantime, the low negative correlation with Question 17 (-0.069) indicates that there is little variation in occupations in respect to that particular aspect. All in all, this trend helps to underline the fact that people who work in professional activities are more environmental-aware and responsible than others.

District: The correlation hypothesis indicates that there is an average positive relationship between district and Question 15 (+0.292) which means that there are some districts in which respondents will have a greater likelihood in agreement with the statements regarding environmental infrastructure. Conversely, the non-significant negative relationship with Question 11 (-0.031) indicates that there may not be much or no variance between the districts in that regard. On the whole, this result suggests that the geographic position influences the development of the perceptions of environmental infrastructure, where particular districts are characterised by a significantly higher extent of support or satisfaction.

Income: The correlation analysis depicts that there is a positive association between income and Question 12 (+0.203) that means that respondents with higher income are more likely to demonstrate greater support of the policy measures to counter environmental problems. On the other hand, the negative relationship with the Question 11 (-0.157) also indicates that those with lower incomes are more prone to stressing the issues that are associated with pollution. This trend portrays a socioeconomic gap with the richer members of the population emphasizing on formulated policy interventions and those with lower income emphasizing on the direct effect of environmental degradation.

Education: The results of correlation show that there is very weak positive correlation between education and Question 10 (+0.024), implying that there is not much impact of the level of education on the particular aspect. Negative correlation between Question 20 (-0.158) however indicates that more educated respondents are more likely to have a slightly less positive overall perception. This could be explained by the fact that they are more subject to critical assessment because more educated people tend to judge the issue of environment and reactions towards it more critically and analytically.

The majority of the correlation values are in the weak range ($r < 0.3$), which indicates that demographic traits have a moderate effect on environmental perceptions. District and Income variables exhibit more positive relationship with a number of environmental perception questions which denotes regional and economic diversity in terms of awareness levels. There are minor negative correlations between Gender and Education and a number of items which indicates that personal experience, exposure, and differences in social roles have a slight influence on perception patterns.

Table 7

Table 7 Pearson Correlation Matrix

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
Q1	1.00	0.30	0.34	0.25	0.27	0.35	0.54	0.42	0.24	0.27	0.40	0.44	0.31	1.00	0.42	0.41	0.37	0.36	0.32	0.37
Q2	0.30	1.00	0.36	0.27	0.36	0.31	0.39	0.44	0.35	0.33	0.42	0.36	0.36	0.30	0.26	0.39	0.40	0.26	0.30	0.34
Q3	0.34	0.36	1.00	0.31	0.30	0.42	0.25	0.25	0.18	0.20	0.29	0.31	0.26	0.34	0.36	0.26	0.53	0.27	0.31	0.54
Q4	0.25	0.27	0.31	1.00	0.31	0.24	0.30	0.33	0.25	0.35	0.38	0.33	0.25	0.25	0.37	0.42	0.39	0.41	0.32	0.34
Q5	0.27	0.36	0.3	0.31	1	0.26	0.34	0.37	0.27	0.23	0.26	0.13	0.3	0.27	0.27	0.29	0.33	0.33	0.32	0.30
Q6	0.35	0.31	0.42	0.24	0.26	1.00	0.37	0.29	0.09	0.30	0.26	0.29	0.20	0.35	0.25	0.23	0.28	0.30	0.34	0.38
Q7	0.54	0.39	0.25	0.30	0.34	0.37	1.00	0.31	0.36	0.32	0.19	0.40	0.29	0.54	0.32	0.42	0.36	0.30	0.15	0.40
Q8	0.42	0.44	0.25	0.33	0.37	0.29	0.31	1.00	0.28	0.19	0.35	0.29	0.23	0.42	0.39	0.52	0.45	0.40	0.51	0.36
Q9	0.24	0.35	0.18	0.25	0.27	0.09	0.36	0.28	1.00	0.21	0.27	0.25	0.21	0.24	0.45	0.37	0.29	0.29	0.19	0.32
Q10	0.27	0.33	0.20	0.35	0.23	0.30	0.32	0.19	0.21	1.00	0.40	0.28	0.31	0.27	0.23	0.31	0.26	0.22	0.33	0.29
Q11	0.40	0.42	0.29	0.38	0.26	0.26	0.19	0.35	0.27	0.40	1.00	0.36	0.29	0.40	0.29	0.37	0.38	0.30	0.44	0.32
Q12	0.44	0.36	0.31	0.33	0.13	0.29	0.40	0.29	0.25	0.28	0.36	1.00	0.23	0.44	0.26	0.38	0.32	0.31	0.29	0.39
Q13	0.31	0.36	0.26	0.25	0.30	0.20	0.29	0.23	0.21	0.31	0.29	0.23	1.00	0.31	0.27	0.32	0.42	0.21	0.18	0.30
Q14	1.00	0.30	0.34	0.25	0.27	0.35	0.54	0.42	0.24	0.27	0.40	0.44	0.31	1.00	0.42	0.41	0.37	0.36	0.32	0.37
Q15	0.42	0.26	0.36	0.37	0.27	0.25	0.32	0.39	0.45	0.23	0.29	0.26	0.27	0.42	1.00	0.37	0.39	0.41	0.21	0.39
Q16	0.41	0.39	0.26	0.42	0.29	0.23	0.42	0.52	0.37	0.31	0.37	0.38	0.32	0.41	0.37	1.00	0.40	0.30	0.45	0.41

Q17	0.37	0.40	0.53	0.39	0.33	0.28	0.36	0.45	0.29	0.26	0.38	0.32	0.42	0.37	0.39	0.40	1.00	0.35	0.29	0.42
Q18	0.36	0.26	0.27	0.41	0.33	0.30	0.30	0.40	0.29	0.22	0.30	0.31	0.21	0.36	0.41	0.30	0.35	1.00	0.32	0.42
Q19	0.32	0.30	0.31	0.32	0.32	0.34	0.15	0.51	0.19	0.33	0.44	0.29	0.18	0.32	0.21	0.45	0.29	0.32	1.00	0.46
Q20	0.37	0.34	0.54	0.34	0.30	0.38	0.40	0.36	0.32	0.29	0.32	0.39	0.30	0.37	0.39	0.41	0.42	0.42	0.46	1.00

Pearson correlation matrix also shows strong positive associations among most of the environmental variables, which implies that the perception of respondents is connected and based on the common vision of ecological issues in Punjab. The best correlation was recorded between variables dealing with industrial pollution, agricultural practices, and climate change and this shows that the participants are aware of these as central causes of environmental degradation. This cluster shows a high level of popular belief regarding the linkage of unsustainable agricultural practices, especially stubble burning, with the exacerbation of air quality, which is consistent with actual developmental tendencies in the area.

The other obvious pattern is among the questions connected with the issues of governance and institutional factors. The mutual correlation among statements related to weak law enforcement, interference of the administration, and the absence of the coordination between government departments is high. This is an indication of shared view that the ineffective institutional arrangements and overlapping administrative roles greatly undermine the environmental management. Additionally, the correlations between the inefficiency of governance and questions of corruption also indicate that transparency and accountability are also considered by respondents to be the determining factor of effective environmental enforcement.

Awareness and participation cluster also shows moderate and strong relations. The correlation between variables connected with the public awareness, NGO operations, and the involvement of the local community is positive, meaning that social involvement and education are perceived as complementary powers that promote the environmental protection. Nevertheless, these correlations are not as high as the governance and pollution clusters, which indicates that the respondents can view awareness programs as subsidiary to structural change in environmental concern management.

Lastly, there are moderate correlations between questions that deal with judicial interventions, penalties and institutional reforms, which suggest that the respondents are aware of the role of legal mechanisms but they can perceive them as ineffective without the broader administrative efficiency. In general, the pattern of correlation indicates a consistent attitude structure, citizens are aware that the environmental crisis in Punjab is caused by the interaction of industrial-agricultural factors and systemic deficiencies in governance, and the community engagement and awareness remains as the supportive, but less influential, elements of the solution.

6. CONCLUSION

The study concludes that Punjab faces a dual challenge of environmental degradation and weak institutional enforcement. Although public concern for climate change, pollution, and sustainability is high, enforcement remains hampered by administrative inefficiency, corruption, and political interference. Respondents advocate for stronger governance mechanisms, stricter implementation of laws, and enhanced public awareness. Statistical analysis confirms that perceptions are coherent, interlinked, and grounded in real environmental experiences. Effective environmental management in Punjab therefore requires transparent institutions, technological modernization, and active community participation, supported by judicial oversight and inter-agency collaboration.

CONFLICT OF INTERESTS

None.

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REFERENCES

Anand S, Kaur H. Challenges and opportunities in sustainable stubble management in Punjab: A review. Int J Environ Clim Change. 2024;14(3):274-297.

Bisht, D. S. (2026). Environmental Balance and Biodiversity Conservation In The Indian Knowledge Tradition: In The Context Of Uttarakhand., ShodhSamajik: Journal of Social Studies., 3(1), 64-70. https://doi.org/10.29121/ShodhSamajik.v3.i1.2026.83

Energy Policy Institute at the University of Chicago (EPIC India). Government of Punjab, J-PAL South Asia and EPIC India launch an emissions trading scheme to reduce industrial air pollution in the state [Internet]. 2025 Apr 12 [cited 2026 Mar 14]. Available from: https://epic.uchicago.in

Govardhan G, et al. Stubble-burning activities in north-western India in 2021: Contribution to air pollution in Delhi. Heliyon. 2023;9(6):e16939.

Greenstone M, Sudarshan A, Pande R, et al. The solvable challenges of air pollution in India. India Policy Forum. 2017.

Gupta RM, Negi A, Sharma P, Kaur S. Farmer's awareness regarding climate change and its effect on ground water. Indian J Ext Educ. 2025;60(1):85-90.

Institute for Governance & Sustainable Development. Pathways to Net Zero in Punjab: The critical role of non-CO_2 pollutants [Internet]. 2025 Sep [cited 2026 Mar 14]. Available from: https://www.igsd.org/punjab-launches-landmark-report-on-non-co%E2%82%82-pollutants-for-cleaner-air-and-climate-action/

Institute for Governance & Sustainable Development. Punjab launches landmark report on non-CO_2 pollutants for cleaner air and climate action [Internet]. 2025 Sep [cited 2026 Mar 14]. Available from: https://www.igsd.org

Kaintura SS, Thakur S, Kaur S, Devi S, Tiwari K, Sharma A, Singh PP. Investigating radioactivity in soil samples from neutral and vegetation land of Punjab, India [Internet]. arXiv; 2024 [cited 2026 Mar 14]. Available from: https://arxiv.org/abs/2403.15414

Kaur A, Kohli RK, Jaswal PS. Genetically modified crops and climate change linkages: An Indian perspective. Agric Sci. 2013;4(10):541-548.

Kumar S, Sidana BK. Farmers' perceptions and adaptation strategies to climate change in Punjab agriculture. Indian J Agric Sci. 2018;88(10):1573-1581.

Mavi MK. Climate smart agriculture practices in India: A case study of district SAS Nagar, Punjab. Int J Geogr Geol Environ. 2024;6(2):21-30.

Ministry of Health & Family Welfare. Punjab State Action Plan on Climate Change and Human Health. Version 2.1. New Delhi: National Centre for Disease Control; 2024. Available from: https://ncdc.mohfw.gov.in

Saluja R, Juneja A, Singh M. Climate change and its impact on agriculture productivity – A case study of Malwa region, Punjab. Int J Contemp Res Multidiscip. 2025;4(2):275-280.

Sodhi GPS, Singh RK, Dhillon GS, Ahuja S, Kaur A, Sunidhi TK, et al. Adoption behaviour of climate-resilient agricultural practices in Punjab under NICRA project. Indian J Ext Educ. 2023;59(2):46-50.

Times of India. Assembly passes resolution to adopt Water (Prevention and Control of Pollution) Amendment Act [Internet]. 2025 Mar 6 [cited 2026 Mar 14].

Times of India. PPCB imposes fresh environmental penalty on Jagraon civic body for solid-waste violations [Internet]. 2025 Apr 12 [cited 2026 Mar 14].

Times of India. Punjab imposes penalties up to Rs 10,000 per tree for unauthorized urban felling [Internet]. 2025 May 19 [cited 2026 Mar 14].

Times of India. Punjab slow to act on polluting sources; 60% still unchecked: PPCB data [Internet]. 2025 Jan 28 [cited 2026 Mar 14].

Times of India. Punjab's watered-down law against pollution draws green fury [Internet]. 2025 Mar 9 [cited 2026 Mar 14].

Yang Z, et al. Perceptions of air pollution from stubble burning and its health impacts—rural Punjab interview study. Sci Rep. 2025;15:37455.