Enhancing Environmental Education to Promote Pre-Emptive Smog Mitigation Strategies in Urban Areas of South Punjab: An Overview

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Abstract

This review evaluates the causes, effects, and mitigation measures regarding the smog problem in the South Punjab of Pakistan. Air pollution comprises major pollutants, including smog resulting from emissions by industries, automobiles, and crop residue burning, which leads to several public health emergencies, such as respiratory and cardiovascular diseases. Though governmental initiatives have been made to reduce smog through policy mechanisms, there has not been much improvement due to weak implementation and several socio-economic factors in the region. According to this paper's viewpoint, stringent environmental laws and effective implementation measures are critical to combating the increasing pollution challenge. In addition, environmental education in awareness and behavioural change concerning long-term smog control is also discussed. From cross-national cases, including Beijing and northern India, the review also provides details of strategies that may be implemented in South Punjab. Some of the recommendations are to improve policy and compliance, offer farmers subsidies, introduce environmental components into schools and other learning institutions, and increase public awareness campaigns. Therefore, it becomes reasonable to state that only a combined regional and countrywide approach can help improve the air quality in the South Punjab region through a more intensive focus on economic development and environmental measures, for which steps have been identified in the following paragraphs.

Keywords: Smog, Air Pollution, Environmental Education, South Punjab, Public Health.

Introduction

Background on Smog in South Punjab

The smog problem is more acute in the South Punjab of Pakistan and has been largely due to the province's astonishing industrialization, agriculture, and rising urbanization. Lahore and Multan show that air quality is extremely poor in any city, which adversely affects public health and makes the environment unsuitable (Kaur & Singh, 2022). PM is a combination of aerosols, nitrogen oxides, and particulate matter arising from automobile exhausts, emissions from industries, and the burning of agricultural residues (Riaz & Hamid, 2018; Singh & Kaskaoutis, 2014).

Smog has become a critical issue in South Punjab, particularly affecting the big cities of the region. The main contributors to smog include traffic pollution, crop burning, and industrialization (Ashraf et al., 2022). This air pollution significantly reduces life expectancy

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and causes numerous health problems, including respiratory issues and cancer (Tajammul, 2023; Malik, 2022). The Government of Punjab introduced the 'policy on controlling smog, 2017' to address this issue, but it has been criticized for not leveraging lessons from other cities and lacking consistency with recent scientific research (Tajammul, 2023). Measures to combat smog include effective legislation, public awareness programs, use of face masks, air purifiers, and tree plantation (Malik, 2022). Long-term strategies are needed to address the multidimensional determinants of poor air quality, and innovative solutions like smog-free towers are being explored (Mukhtar, 2017).

Hence, it becomes a problem not only in terms of environmental quality but also in terms of health in the long run. It has been attributed to respiratory diseases, cardiovascular diseases, and other diseases (Solomon, 2011). The socioeconomic consequences are not less unfavorable: poor-quality air reduces labor productivity and increases healthcare expenses (Ghafoor et al., 2021). Nevertheless, efforts to come up with a solution to this problem are still lacking, particularly in the implementation of policies/sensitizations.

Significance of the Issue

The smog issue in South Punjab requires the development of new policies and an increase in population awareness. Even though the government has put some measures in place, such as releasing new policies to check emission levels and encouraging cleaner industrial energy sources, these efforts need to be revised with better compliance and low community awareness (Kaur & Singh, 2022). In addition, environmental education, which helps increase knowledge and environmentally responsible behaviors, is not exactly established in the region (Zulfiqar et al., 2020).

Objectives of the Review

This review aims to:

1. Analyze the primary causes of smog in South Punjab, focusing on industrial emissions, vehicular pollution, and agricultural practices.
2. Evaluate the public health impacts of smog, particularly its relationship with respiratory and cardiovascular diseases.
3. Assess the effectiveness of existing policies on smog mitigation in South Punjab, including those targeting industrial practices and crop residue burning.
4. Investigate the role of environmental education in promoting public awareness and behavioral change to reduce smog.
5. Propose actionable recommendations for policy reforms and educational initiatives based on current gaps in the literature.

Methodology

The approach used in this review is systematic in order to find, assess, and consolidate current literature on smog situation in South Punjab, Pakistan. The analysis brings qualitative and quantitative information into consideration in order to offer the big picture of the problem.

Literature Selection

The review draws on peer-reviewed articles, government reports, and case studies related to air pollution, smog, and environmental education in South Punjab. Sources were selected based on relevance to the region, with an emphasis on recent studies conducted in similar geographical and socio-economic contexts. Databases such as Google Scholar, PubMed, and Scopus were searched using keywords like “smog in South Punjab,” “air pollution in Pakistan,” “environmental education,” and “crop residue burning.”

Inclusion Criteria

- Studies published within the last 15 years.
- Articles addressing the causes, health impacts, or policy measures related to smog.
- Research examining the role of education in addressing environmental issues.

Data Analysis

The information obtained from the selected studies was grouped under major themes such as sources of smog, health effects, policies and perception. Both the qualitative descriptions and the quantitative results were integrated in order to give a wide picture of the existing gaps in knowledge about smog in South Punjab.

Table 1: Key Causes of Smog in South Punjab

Cause	Source	Description
Crop Residue Burning	Singh & Kaskaoutis (2014)	Burning rice straw produces aerosols, contributing significantly to smog.
Industrial Emissions	Kaur & Singh (2022)	Factories emit particulate matter and nitrogen oxides, leading to smog.
Vehicular Emissions	Riaz & Hamid (2018)	Urbanization and increased vehicle use have intensified air pollution.

Literature Review

Causes of Smog in South Punjab

Pollution in South Punjab is mainly due to industries, vehicles, and fires produced by burning agricultural residues. Compounding these challenges are issues of rapid urban growth, weak regulatory compliance, and old infrastructure. Coal burning emissions represent a major component of smog, with factories emitting NOx, a toxic compound, and SO_2 gases that further contribute to smog development. Motor vehicle exhaust fumes also aggravate this problem as the rising usage of cars, buses, and trucks emits particulate matter (PM2.5 and PM10) in locations with high population density in cities like Lahore and Multan (Riaz & Hamid, 2018). In addition, Asghar et al. (2022) provide monthly average AQI, which shows the air pollution of particles like PM2.5, PM10, NO_2, SO_2, and O_3.

Another source is agriculture, the main cause of which is the burning of crop residues (Singh & Kaskaoutis, 2014). During the autumn, farmers in the region set fire to rice straws after harvesting, releasing aerosols and VOCs that, if combined with the number of air-polluting particles, fill the densely hazed rural and urban areas. Crop residue fire is reported to contribute to 40 per cent of the smog in South Asia, which easily avoids the attempt to decrease pollution rates in Punjab (Kaskaoutis et al., 2014).

Table 2: A Comprehensive Overview of Smog Causes in South Punjab

Cause	Description	Source
Stubble Burning	Burning of leftover crop residue, especially paddy straw, by farmers.	BBC
Industrial Emissions	Emissions from large and small industrial units, often using high-sulfur fuels.	Punjab Government
Vehicular Emissions	Pollution from vehicles, particularly those using diesel engines.	(Khurshid, 2023)
Burning of Municipal Waste	Incineration of household and municipal waste.	Punjab Government
Construction Dust	Dust from construction activities and unpaved roads.	The Express Tribune

Brick Kilns	Smoke from traditional brick kilns using outdated technology.	The Express Tribune
Agricultural Residue Burning	Similar to stubble burning, involves burning other types of crop residues.	Teri
Atmospheric Conditions	Low-level inversion and lack of wind dispersing pollutants.	(Bilal et al. 2022)

The table 2 highlights the primary contributors to smog, including agricultural practices, industrial activities, and vehicular emissions in South Punjab.

Impact of Smog on Public Health

While smog is a form of air pollution and a severe nuisance, it has adverse health and cost implications in all the world's regions. It contains toxic and adverse gases and particles, leading to respiratory diseases, cardiovascular diseases, and endocrine disorders (Thao et al., 2022; Saleem et al., 2024). In Southeast Asia, open biomass burning is a significant source of PM2.5 and results in high mortality and economic costs (Thao et al., 2022). Found ingredients of smog can disrupt hormone function, resulting in metabolic problems and difficulties in conception (Saleem et al., 2024). Due to the outbreak of COVID-19, researchers have argued that particulate matter can contribute to virus transmission (Kumar et al., 2021). This study looked at smog as a pollution problem in Pakistan and is seen as flowing from the issues of rapid urbanization and industrialization, especially in Lahore (Raza et al., 2021. These range from energy conservation through the reduction of fossil fuel consumption, utilization of green energy, checking industrial spillage and emissions to individual protective measures such as use of face shields and having foods high in antioxidants (Kumar et al., 2021; Saleem et al., 2024).

Current Policy Measures in South Punjab

However, much of the smog problem can be considered severe, and policy interventions in South Punjab have remained inadequate. Present laws and policies regarding environment control, for instance, the emission control policies of industrial plants and vehicular standards, are weakly implemented and thus have continuously worsened air quality (Kaur & Singh, 2022). Nonetheless, some attempts have been made to address the crop residue burning issue, but these efforts have not met with desired success due to the absence of better options for farmers (Singh & Kaskaoutis, 2014).

Even state and central government interventions to encourage cleaner technologies, like reformed brick kiln technologies and car/truck emission standards, have yet to be very effective. While some efforts have been made to increase consciousness regarding the effects smog has on health, there still is no strategy to look at the source of the problem in the region (Rana & Bhatti, 2018). Thus, the lack of an effective policy in the field remains a major issue and prevents initiatives to mitigate air pollution from coming merely from local authorities who cannot navigate a thin line between economic development and environmental protection.

Role of Environmental Education

Environmental education is a significant social need, but being an undeveloped area can become an effective tool, as compared to many others, to combat smog in South Punjab. Efforts to increase public concern about air pollution exist, but these efforts are made mainly for the urbanites rather than the rural people (Zulfiqar et al., 2020). Moreover, there is a problem with incorporating environment-related education into the school curricula: separate programs fail to create the desired interest and concern among the younger generations (Sattar et al., 2012).

Education generates awareness, provides knowledge, and develops skills necessary for environmental protection (Choudhary et al., 2019). Studies show that environmental education positively influences students' environmental concern, willingness to adopt eco-friendly

behaviors, and volunteer attitudes (Sharma et al., 2023). Teachers are key agents in imparting environmental knowledge and sensitizing students and society about environmental issues (Kaur, 2013). They can utilize both formal and non-formal educational channels to create a workforce of enlightened and motivated learners. Environmental education aims to deepen students' engagement with environmental and scientific issues, encouraging them to take sensitive actions to improve quality of life (Prasad & Mogla, 2016). It is essential to start environmental education from early childhood to inculcate good values and habits, laying a strong foundation for sustainable development and responsible behavior towards the environment.

While programs exist, these initiatives frequently need more support and tools for success. For instance, when environmental education is implemented in some regions, sociocultural factors and economic challenges hinder everyone, mainly females and vulnerable people (Ahmad, 2022). This has led to a poor level of environmental concern, which has greatly inhibited the community's chance to engage in preventive measures against smog (Sultan et al., 2020).

Discussion

Evaluation of Current Policies

Increased smog in Punjab, Pakistan, especially in the megacities of Lahore, Faisalabad, and Gujranwala, has been on the rise since the early 2000s with often severe health and economic outcomes (Tajammul, 2023; Ashraf et al., 2022). Some sources include increased population density and infrastructural development, electro-thermal energy use, vehicle emissions, and burning of crop residues (Raza et al., 2021; Singh & Kaskaoutis, 2014). The government initiated the ‘Policy on Controlling Smog’ in Punjab in 2017, which has often been accused of not learning from other cities and being out of sync with recent scientific findings (Tajammul, 2023). There are measures in place, but these have been deemed inadequate in dealing with the problem under discussion (Ashraf et al., 2022). The smog issue acts as the cause of different diseases affecting the respiratory, pulmonary, and skin systems (Raza et al., 2021). For this increasing threat, better approaches and community participation are required (Ashraf et al., 2022).

Currently, generic policies are in place to control smog in South Punjab, but they need to be more robust and need a transformation. Understanding why industrial emission controls are ineffective is paramount; Kaur & Singh, (2022) established that nation-states must implement them more effectively because of flawed legal systems and corruption. Likewise, policies for controlling vehicular emissions are old. Despite international examples of the success of even developing countries such as Beijing and Delhi, a serious attempt has yet to be made by Pakistan to update vehicle emission standards (Zhao et al., 2013).

Despite being one of the major culprits for smog, the agricultural sector still needs to be under control. Efforts towards the reduction of crop residue burning have been negligible. While most state governments have passed laws to ban crop residue burning, support in terms of incentives or technical know-how for farmers to adopt the ban has yet to be provided (Singh & Kaskaoutis, 2014). The policies and measures launched for the recycling and utilization of residuary agricultural waste have not shown less effect as the machines are very costly and require high initial investments and regular maintenance by the farmers, which most in rural areas can hardly afford.

Another factor is the need for amendments to the South Punjab region's current environmental policies about the region's socio-economic environment. There has been forceful pushback against further reforms, particularly within industries and farmers because the government does not adequately consider environmental regulation when focusing on economic development (Rana & Bhatti, 2018). Thus, it is imperative that any future policy reform takes into

consideration these socio-economic realities and aims at achieving a balance between economic growth and environmental conservation.

The Argument for Stronger Environmental Education

Environmental education (EE) is crucial for addressing global environmental challenges and promoting sustainable behavior. Researchers argue that EE should be a core component of all education systems by 2025 to support necessary social and environmental changes (Reid et al., 2021). Integrating EE into school curricula can develop skills for understanding human-nature relationships and foster responsible decision-making (Yarkandi et al., 2012). Experiential learning approaches in higher education can enhance environmental studies and science courses, better preparing students to address future environmental problems (Uzzell, 1099). By linking empirical research findings to educational policy and practice, the quality and impact of EE can be improved. However, the impact of formal EE programs on environmental awareness and concern remains limited, highlighting the need for evidence-based improvements (Palmer, 1999). Overall, strengthening EE across all educational levels is essential for cultivating environmentally conscious generations capable of tackling complex ecological issues.

However, policy measures must be emphasized, though the place of environmental education should be addressed. If effectively conducted, EE maximizes an informed populace capable of practicing responsible environmental practices and ensures politicians deliver the message as per the content (Sultan et al., 2020). Several studies have established their argument in regions where environmental learning is valued, knowledge of air pollution is enhanced, and there is support for pollution control (Zulfiqar et al., 2020).

However, investing in environment education programs in schools in South Punjab is a challenge as the programs could be better funded and easier to reach. This is especially manifested in rural areas due to a number of factors that hinder society from fully engaging in educational processes (Sattar et al., 2012). Similarly, gender also impacts the attainment of environmental information since women's education rights are restricted (Ahmad, 2022).

For an effective fight against smog, it is necessary to enhance the role of environmental education at all levels. Schools should be mandated to incorporate environmental matters in their curricula, and social promotion activities should encompass rural and other deprived factions of the population. It is not helpful to cause people to become more attached to the environment and demand strict environmental policies by informing them of the health risks that smog entails.

In northern India, efforts to reduce crop residue burning through the introduction of mechanized farming equipment and government subsidies have had mixed success, largely due to the financial burdens placed on farmers (Singh & Kaskaoutis, 2014). This highlights the need for more robust financial support systems for farmers in South Punjab, ensuring that they can adopt environmentally friendly practices without facing economic hardship.

Conclusion

Specifying multifaceted sources of smog, such as industries, automobiles, and crop stubble burning, which has long been the case in South Punjab, is pertinent. The health effects are severe and are felt in both rural and urban areas; the common effects are cardiopulmonary diseases, heart diseases, and compromised quality of life among people in affected areas. Though there have been some attempts to alleviate these challenges, they are still prevalent since existing policies are poorly enforced, regulations are regressive, and there is no adequate financial incentive to adopt sustainable environmental measures.

One of the highlights of this review is that smog is an area where environmental education offers a great opportunity to reduce smog by increasing people’s awareness and promoting the

adoption of appropriate behaviors. However, the present situation of environmental education in South Punjab in marginalized rural communities is very limited. In order to strengthen the ecological outlook of society, education programs must be developed further and incorporated as part of the schooling curriculum, and governmental support must be needed. It will aid in minimizing smog and enable groups of people to push governments towards better policies and governance.

By comparing case studies, such as the successful smog control in Beijing through strict emissions controls and India's partially effective control of crop residue burning, South Punjab can learn valuable lessons. However, these strategies must be adapted to the socio-economic context of the region, ensuring that growth does not come at the expense of the environment.

Key Recommendations

1. **Strengthening Policy Enforcement**: In order to control environmental pollution, the government should promote clean technologies, enforce strict industrial and vehicular emission standards and ensure their implementation.
2. **Supporting Farmers**: Farmers can be prevented from burning crops by providing financial and technical support. Government can provide subsidies and alternative methods such as composting or mechanized waste management to reduce farmers' dependence on harmful practices.
3. **Expanding Environmental Education**: In order to overcome the environmental problems, environmental awareness can be promoted in the less educated areas by expanding the scope of environmental education to rural areas. There is a need to include environmental education in the curriculum for effective prevention.
4. **Adopting International Best Practices**: South Punjab should implement modern standards and promote sustainable agriculture in the light of successful international policies to control environmental pollution. Regulatory bodies will have to adapt themselves to modern methods to effectively monitor air quality.

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