

Comprehensive Review on Air Pollution Control Measures for Non-Attainment Cities of Uttar Pradesh, India

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Abstract

Introduction: The Indian state of Uttar Pradesh (UP) for the past many years has been reported to have many cities with highly polluted air quality. The state has been taking meticulous steps in combating air pollution in the form of action plans, introduced especially in its 17 non-attainment cities (NAC). To assess the progress and development of these action plans in UP, the present study has done an in-depth analysis and review of the state's action plans and city micro action plans. **Materials and Methods:** In this research study, the analysis of the latest action plan reports, micro action plan reports as well as the recommendations for combating air pollution-related issues in the 17 NAC of the UP state has been well documented. Uttar Pradesh Pollution Control Board (UPPCB) has prepared these reports to highlight the progress of the plans in response to the growing air pollution in these cities. The information present in the reports has been used to further study sector-specific, category-specific action plans, institutional responsibility, and the present status of the action plans. **Results:** On average, the highest weightage in action plans was given to sector-specific categories such as Road dust and construction activities (24%). It was also observed that Urban local bodies (~50%) were majorly responsible to implement the action points and 56% of the action points were jointly implemented by multiple agencies.

Keywords

Air Pollution, Air Quality, Air Pollution Control, Non-Attainment Cities, India, Uttar Pradesh, Particulate Matter

1. Introduction

A vast and diverse country like India faces a lot of challenges in terms of poverty, population, and pollution. India was ranked the fifth most polluted country in the world according to the latest report by WHO with approximately 1.67 million deaths attributing to only air pollution in 2019 [1]. In India, Indo Gangetic Plains (IGP), which occupies 60% of the total area and consists of almost 40% population of the country, is one of the major hotspot regions of air pollution [2] [3] [4] [5]. The IGP states such as Delhi, Punjab, Haryana, and Uttar Pradesh (UP) usually remain highlighted in news due to the rising air pollution due to various local and non-local air pollution sources [6] [7] [8] [9] [10]. UP had the highest mortality rate in India due to air pollution in 2019 [1], hence the present study has endeavored to review the action plans introduced by the UP government to tackle the rising deteriorated air quality problem in its polluted cities.

The government of India has been taking serious and meticulous steps in combating pollution in the country (Figure 1). It is also added to India's constitution (Article 51A (g) and 48 A) that the state, as well as every citizen, must protect and improve their environment. National Clean Air Programme (NCAP) launched in January 2019 by the Ministry of Environment, Forest, and Climate Change (MoEF & CC), is one such initiative introduced by the government toward cleaner air for cities. The major aims of NCAP are: 1) To meet the prescribed standards set by Central Pollution Control Board (CPCB) and prepare action plans to reduce the PM_{2.5} and PM₁₀ concentration by 20% - 30% by 2024 taking 2017 as the base year, 2) Increase the number of Continuous Ambient Air Quality Monitoring Stations (CAAQMS) in India to 1000 stations by 2024, 3) Expand the monitoring station network to rural areas, 4) Establish a national emission inventory, 5) Research work on the source apportionment studies of specific cities, 6) Establish air information centre for data analysis, and 7) To promote programs and guidelines for the indoor air pollution [11].

NCAP designated 102 cities of India as non-attainment or non-fit cities in 2019 based on 2011 to 2015 concentration levels and later in August, 2019 added 20 more cities taking the total number of non-attainment cities (NAC) to 122. Presently there are 132 NAC in India. NAC are those cities that don't meet the national ambient air quality standards for the period of 2011 to 2015 (5 years) under the NCAP [12]. Presently, Maharashtra has the maximum number of NAC (18 NAC) in India followed by UP for which the number has now increased from 15 to 17 NAC. The NACs were advised to develop city-specific action plans to mitigate actions for prevention and control of air pollution and raise awareness among people, and promote capacity-building activities [11].

In 2018, a six-member committee called the Air Quality Monitoring Committee was formed by National Green Tribunal (NGT), comprising Directors of different sectors like Transport, Urban Development, and agriculture to develop clean air action plans. The 2017 clean air action plans for the National Capital Region (NCR), Delhi, were taken as an outline to prepare city-specific action

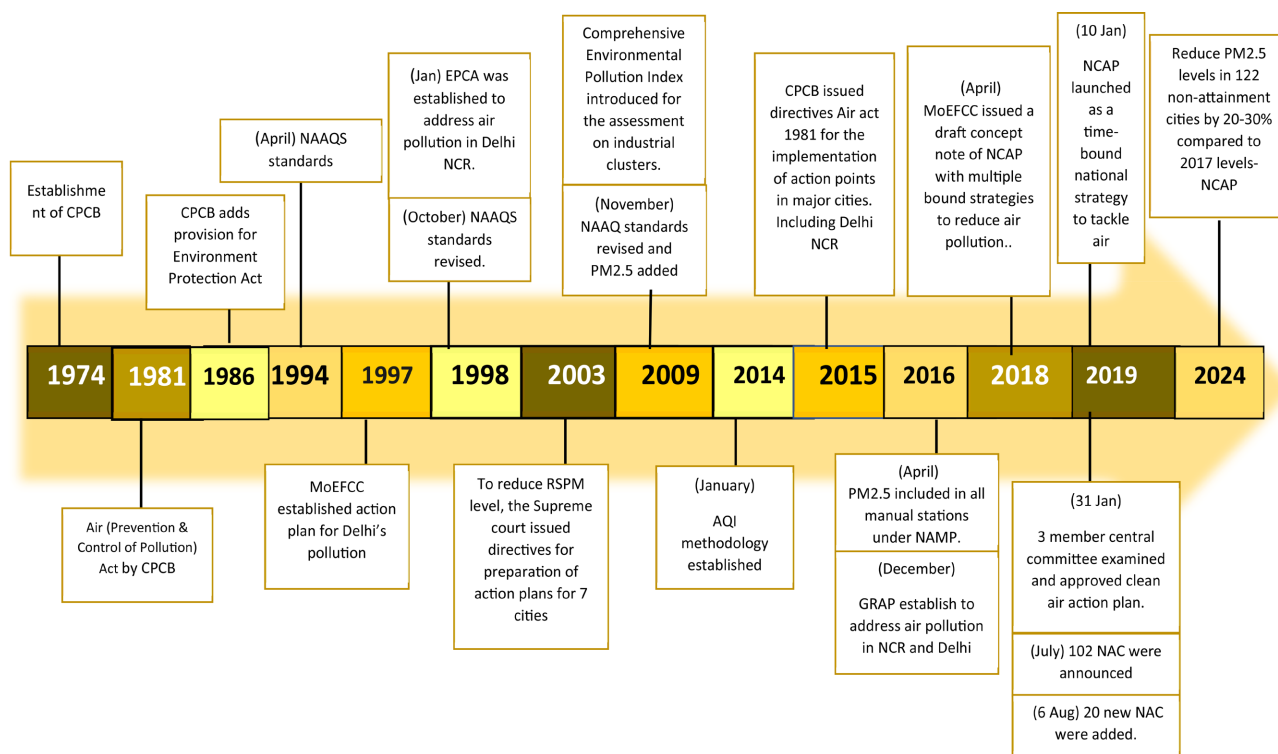


Figure 1. Actions taken over the years for clean air in India.

plans for the entire country. Generally, action plans are the source-specific steps, initiatives, policies, and programmes launched to improve the air quality of the non-attainment areas and reduce emissions, usually managed by the assigned departments [13].

The focus of the action plans based on emission sources has been categorized into six sectors, namely transport, industry, waste burning, construction, dust, and residential, which contain various action points. The responsibility to implement these action plans has been given to multiple agencies which need to coordinate for the proper implementation as well as the regular monitoring of these action points in the NAC. The responsible agencies are the transport department, National Highway Authority of India (NHAI), Public Work Department (PWD), Nagar Nigam, Nagar Palika Parishad, development authorities, vehicle manufacturing companies, Ministry of Road Transport and Highways, Traffic police, District supply officer, Oil companies, Forest Department, Irrigation Department, Agriculture Department, Urban Development Department, Housing companies, Pollution Control Board (e.g., Uttar Pradesh Pollution Control Board) and District industries centre (DIC) [14].

Due to the absence of information on the city-specific sources of air pollution, usually, the NAC of a state has identical action points. Presently, identical action points are followed in UP, Rajasthan, Uttarakhand, Odisha, Nagaland, Jammu and Kashmir, Himachal Pradesh, Assam, and Andhra Pradesh. States like Bihar, Chandigarh, Gujarat, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Meghalaya, Punjab, and Telangana have distinct action plans and action points

to curb air pollution in their NAC [13].

2. Study Area

Seventeen cities of one of the largest states of India, UP (Figure 2), have been designated as non-attainment by NCAP, which are Agra, Anpara, Bareilly, Firozabad, Gajraula, Ghaziabad, Gorakhpur, Lucknow, Jhansi, Meerut, Moradabad, Noida, Raebareli, Prayagraj, Kanpur, Khurja and Varanasi. UP is situated in the northern part of India with a total cover area of 240,928 sq. km and comes in the IGP area. Apart from having one of the highest populations in the country *i.e.*, 227.65 million [15], it also has a high vehicle population (3,529,817) in 2019-2020 [16], high number of industries (15 industrial areas) [15] [16], and many tourist places attracting as many as 535.8 million domestic tourists and 4.74 million international tourists in 2019 itself [15].

According to the studies conducted till now, the major sources of air pollution identified in the NAC of UP are vehicles, industries, biomass and waste burning, road dust, and the domestic sector [17]-[23] [30] [33] (Figure 3).

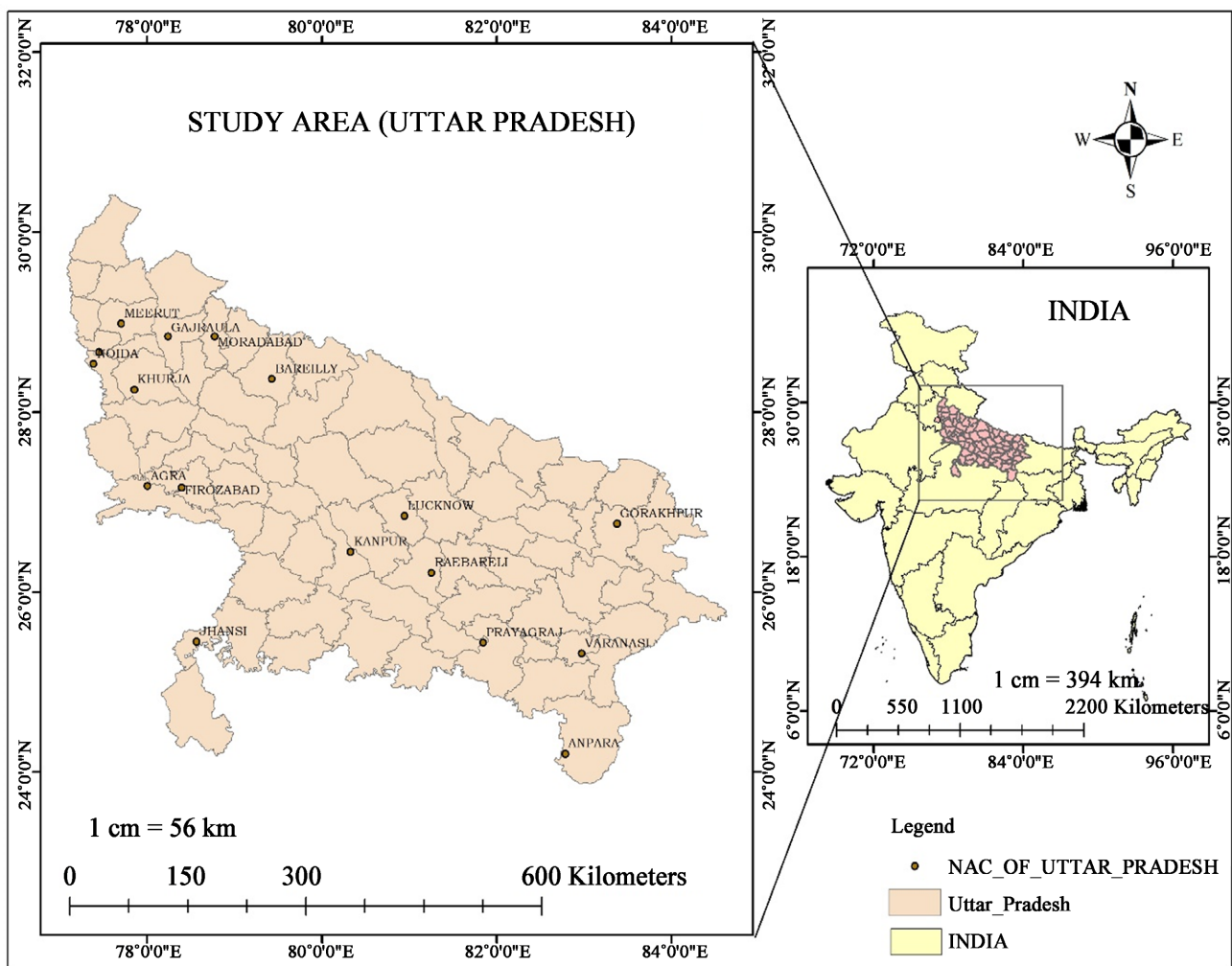
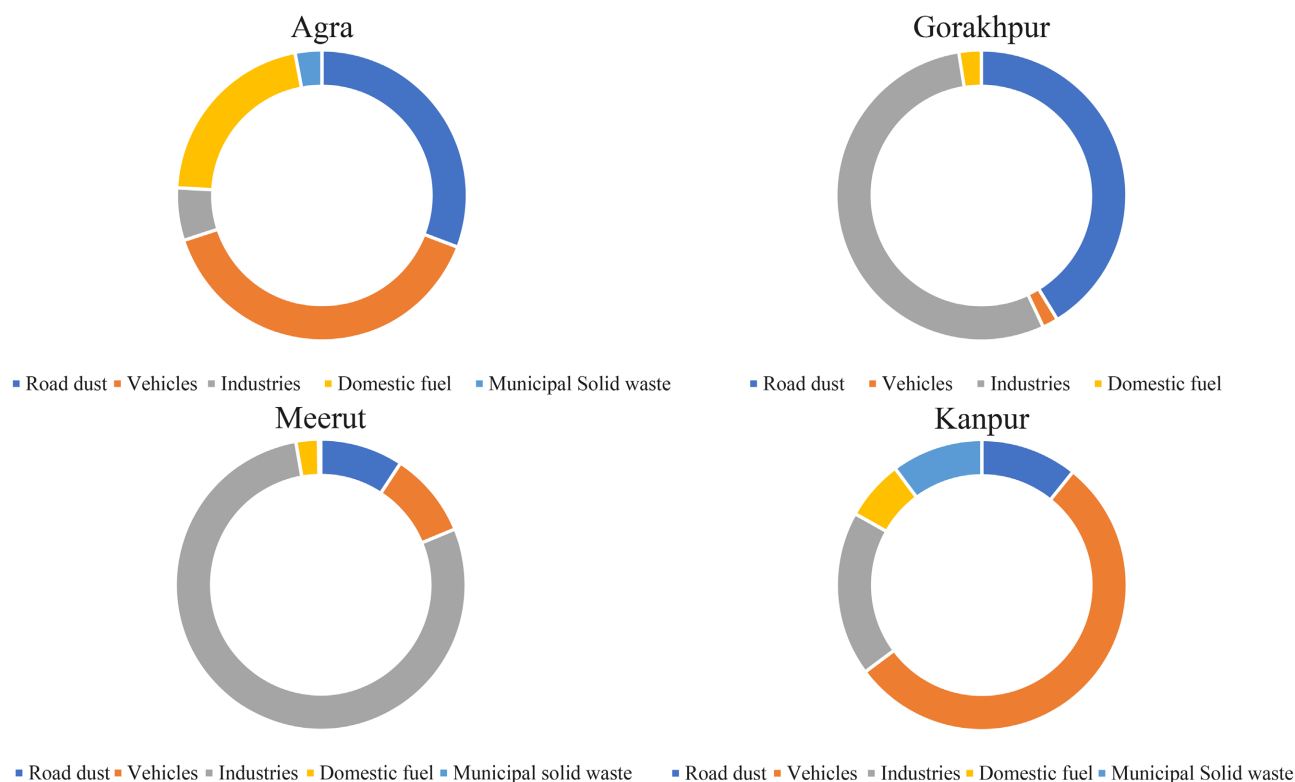


Figure 2. Map of Uttar Pradesh with its 17 NAC.



Source: Source apportionment studies of Agra and Kanpur and Clean air action plan report of Meerut and Gorakhpur.

Figure 3. Sources of air pollution in the different NAC of UP.

3. Materials and Methods

Data collection:

For the present study, the latest action plan reports [24]-[40], as well as the micro action plan [41]-[57] of the non-attainment city reports of the 17 NAC of UP are studied and reviewed to get an insight into the action plans. Uttar Pradesh Pollution Control Board (UPPCB) has prepared these reports to highlight the progress of the plans in response to the growing air pollution in these cities.

The present study has reviewed the action plans of the NAC of UP based on: 1) Sector-specific action points, 2) Category-specific action points, 3) Institutional responsibility, and 4) The Present status of the action plans. The action plans are broadly categorized into six sector-specific plans namely: Vehicles, Industry, Biomass and Waste burning, Road dust and Construction, and Domestic sector. Further, based on the time for implementation, the action plans are categorized into long-term and short-term action plans. The short-term or immediate plans are the activities that can be immediately implemented by the assigned authorities and don't require preparation in advance while long-term action requires prior preparation like the budget allocation and sanctions [14]. To address and understand the category-specific air pollution problems, the action points are also studied in categories like Organizational and technological innovation (representing the governance and technical capacities of the agencies),

physical (representing the physical and economic capacities of the institutions in completing the action points), and promoting (representing the promotion of the current action points using various methods) [58] [59]. For institutional responsibility, it was studied whether the action plans are implemented individually by the agencies or collectively. To understand the status of the action plans in different NAC of UP, a comprehensive table has been prepared consisting of all the major aspects to study and understand the interventions and action plans of UP.

4. Results and Discussion

1) Sector-specific action points

The action plans have been categorized into different sectors in the action plan reports of NAC of UP, namely: capacity building and monitoring network and source apportionment, public outreach, road dust and construction activities, vehicles, industries, and waste and biomass dumping and burning.

Vehicle emissions include action points like widening of the road, use of BS-VI fuel, creating cycle zones, and use of electric vehicles and their charging station. Some of the action points related to industries include introducing Online Monitoring of Industrial Emission and Effluent (OCEMS), and check on brick kilns. Interventions related to road dust and construction include roadside plantation, filling up of potholes, and spraying of water on roads, etc. Capacity building and monitoring networks include interventions related to hotspot identification and source apportionment studies. Interventions related to public outreach action plans are awareness programmes, and public health engagement. Summary of the different action points in different above-mentioned sectors is represented in **Figure 4**.

When the weightage given to different sectors in NAC was calculated from the micro city action plan reports of the 17 NAC, it was observed that on average, the highest weightage was given to road dust and construction activities (24%) closely followed by vehicles (21%), industries (20%) and biomass and waste burning activities (19%). It was observed that on average, only 9% and 5% weightage was given to capacity building and public outreach respectively in the action plans of the NAC of UP (**Figure 5**).

It was observed that the interventions included in the road dust and construction have effectively managed to reduce the pollution problems as per many studies. Green plantations [60] [61] road watering, dust suppressants, specialized traffic systems especially during heavy pollution load [62] [63] and dust control on construction sites [64] [65] have legitimately improved the air quality in many countries. As per the previous studies, it was also observed that reducing the speed of the vehicles and improving the drainage system can help in improving the quality of ambient air [63] [66].

2) Category-specific action plans

For the present study, the organizational and technical innovation category involves action points that include words like “assessment”, “engaging”, “preparing”,

Source: Action plan reports of NAC of UP, 2019

ACTION PLANS FOR COMBATING AIR POLLUTION IN UTTAR PRADESH

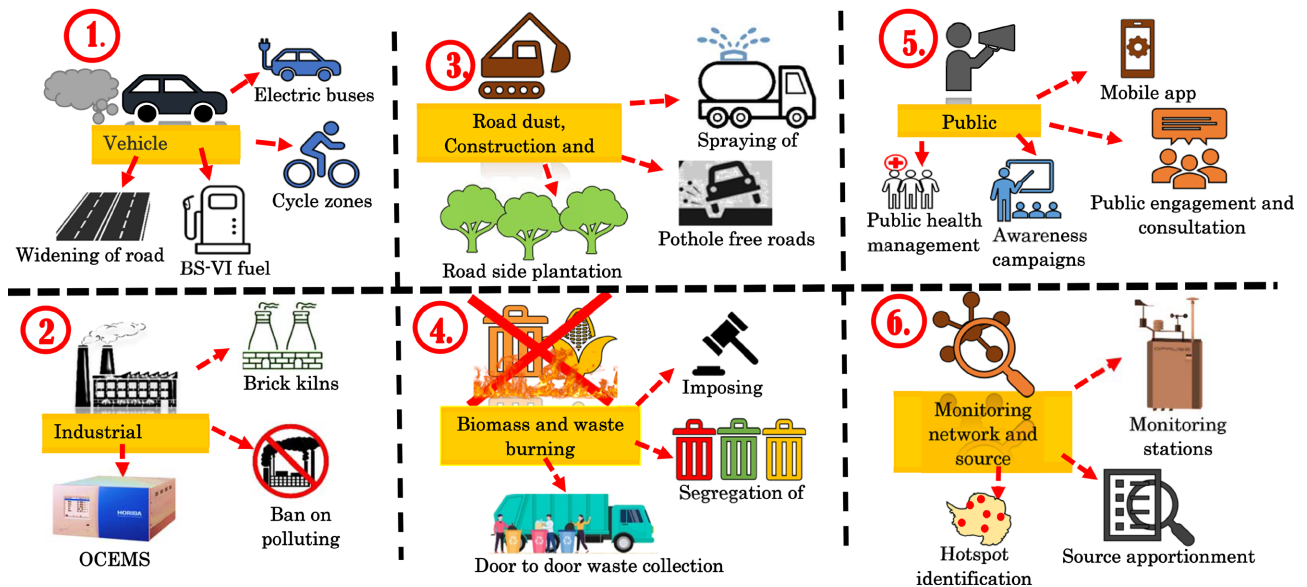


Figure 4. Summary of the sector-specific action plans and the action points.



*RD: road dust and construction, IN: Industries, PO: Public Outreach, BB: Biomass and waste burning, CB: Capacity building and monitoring network and source apportionment, VI: Vehicles.

Figure 5. City-wise weightage given to different sectors in NAC of Uttar Pradesh.

“ensuring”, “implementing”, “strengthening”, “creating”, “training”, and “planning”. The physical category-specific action points include words like “installing”, “checking”, “maintaining”, “cleaning”, and, “buying”. The promoting category-specific action plans include the words like “promoting”, and “launching”. On average, approximately 66.3% of the action points mentioned in the micro

action plan reports of NAC are related to organizational and technical innovations which generally aim to increase the responsible agencies' capacity-building, institutional and technical capacities.

Many of the interventions present in the organizational and technical innovations like deeper public engagement, an app-based system, a public grievance redressal system, training activities for officials, creation of green zones, clean energy, and clean fuel, ensuring safe transport of construction materials, etc. have found to be effective in improving air quality as per many studies [59] [67] [68].

3) Institutional responsibility

The responsibility to ensure the effective implementation of these action points in NAC of UP has been majorly given to 14 agencies namely Transport department, NHAI, Nagar Nigam, Ministry of road, transport and highways, RTO, District supply office, Traffic police, Forest department, Urban development authorities, UPPCB, Nagar Palika Parishad, Agricultural department, Irrigation department, Municipal corporation and other associated departments and companies (Figure 6). After reviewing the reports and literature, it was observed that most of the action points (approximately 50%) are covered by Nagar Nigam and Nagar Palika Parishad (Urban local bodies) followed by the Transport department, and UPPCB (jointly covering approximately 22%). The weightage of the responsibilities given to various agencies has been represented in Figure 7. It was also observed that almost 56% of all the action points are jointly implemented by multiple agencies, whereas 43% action points are individually directed (Figure 8). Many studies [59] [69] [70] [71] have studied and analysed the importance and role of institutions and agencies for the effective implementation and working of the action points.

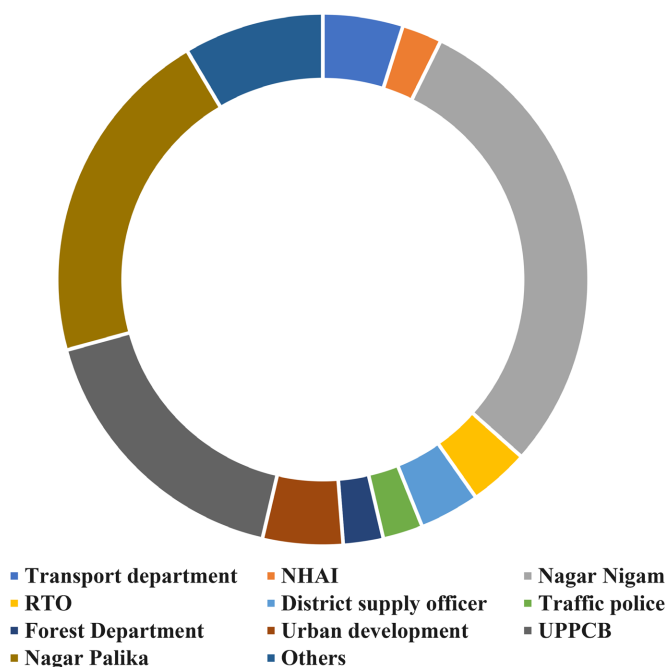


Figure 6. Major agencies responsible to implement action plans in the 17 NAC of UP.

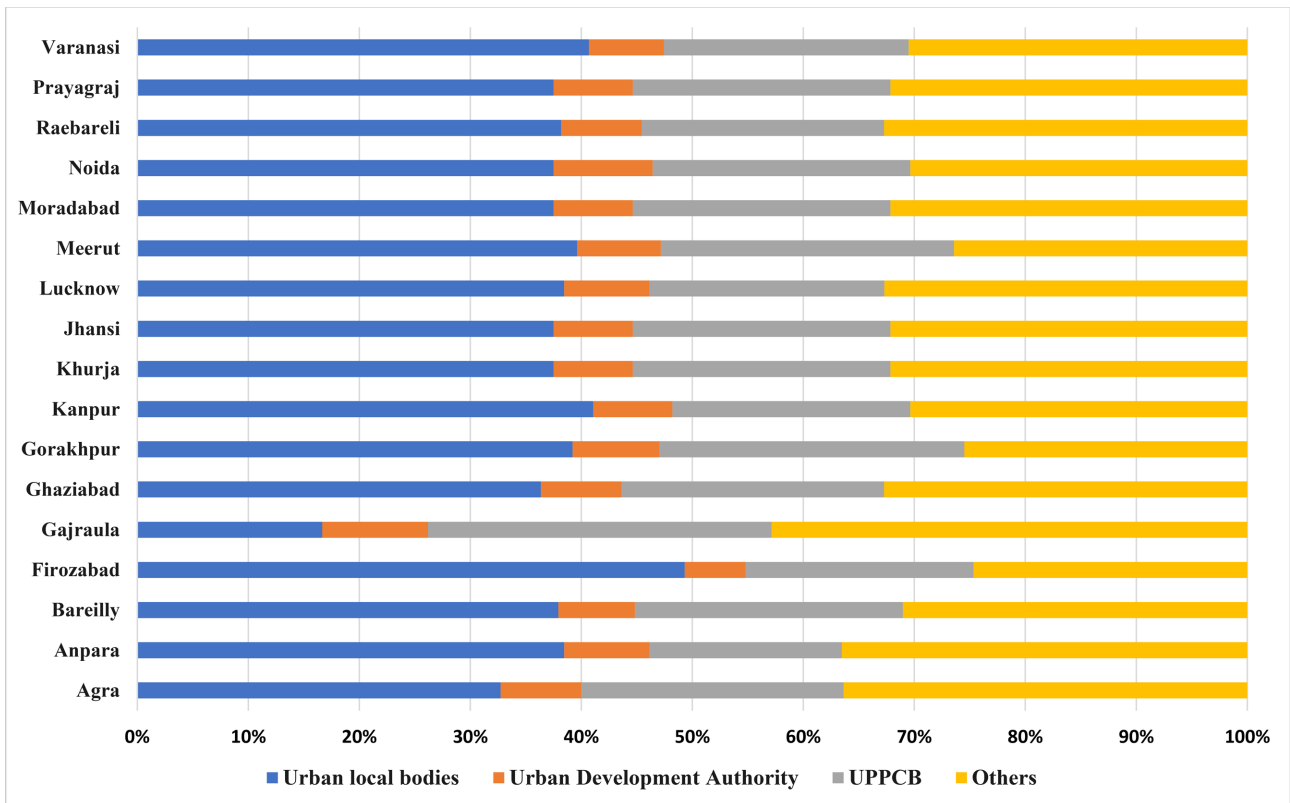


Figure 7. Weightage of the different agencies implementing action plans in NAC of UP. (*UPPCB: Uttar Pradesh Pollution Control Board).

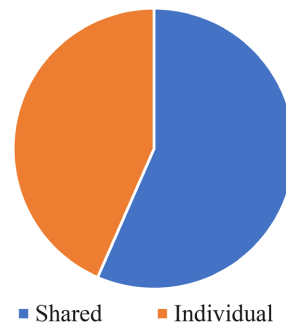


Figure 8. Percentage of action plans implemented jointly or individually.

4) Present status of the action plans

To get an insight into the present status of the action plans, micro city action plan reports of the NAC of UP are assessed and a city-specific assessment has been completed for the action plans.

The following **Table 1** represents the major action points that have been introduced in specific NAC of UP and their current status (as of May 2021). The major action points that are included in almost all the NAC have been included in the table to study the current status of the action plans. The current status of the action plans in the following table has been categorized into “completed (C)” if the action point has already completed its annual target as per the reports, and “under progress (U)” if it has not yet been achieved. In the present study, the

Table 1. Description of the action points and their current status in the 17 non-attainment cities of Uttar Pradesh.

S. No	Action Points (AP)	AG	AN	BA	BA	FZ	GJ	GH	GO	JH	KA	KH	LU	ME	MO	NI	PR	RE	VA
CAPACITY BUILDING AND MONITORING NETWORK AND SOURCE APPORTIONMENT																			
1.	CAAQMS	CW	U	CW	U	CW	CW	CW	CW	U	U	U	CW	CW	U	C	U	U	U
2.	Manual stations	CW	CW	CW	C	CW	C	CW	CW	CW	C	U	C	CW	U	C	C	C	C
3.	Emission inventory	CW	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	CW	U
4.	Source apportionment study	CW	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	CW	U
5.	Training of public officials	U	U	U	U	U	U	U	U	U	U	U	U	U	U	CW	U	U	U
6.	Infrastructure development	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
7.	Enforcement unit	CW	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	C
8.	Organization of meetings for implementing AP	RA	RA	RA	RA	RA	RA	C and RA	RA	RA	RA	RA	RA	RA	RA	CW	CW	CW	RA
9.	ERS	C	C	C	C	C and RA	C	U	U	C	C and RA	CW	C and RA	CW	C	CW and RA	CW	RA	C
PUBLIC OUTREACH																			
1.	AQ dissemination system	C	C	RA	RA	RA	RA	C	U	RA	C	U	C	C	C	RA	C	C	C
2.	Issuing public advisory for air pollution control	C	CW	CW	CW	CW	CW	CW and RA	U	CW	C and RA	CW	RA	C and RA	CW	RA	C	CW	CW
3.	Public engagements	U	U	U	U	U	U	U	U	CW	U	CW	CW	C and RA	U	CW and RA	U	U	U
4.	Mobile app to update public regarding AQ	C	C	C	RA	RA	C	C	RA	RA	C	C and RA	C	C	C	C	C	C	C
5.	App-based system	C	C	C	C	C	C	C and RA	C and RA	C	RA	C and RA	C	C	C	RA	C	RA and C	C
ROAD DUST AND CONSTRUCTION ACTIVITIES																			
1.	Immediate lifting of SW after cleaning of municipal drains	C	RA	C	C	C	C	CW and RA	CW and RA	RA	RA	C	C and RA	RA	RA and C	RA	C	C	C and RA
2.	Pothole free roads	C	CW and RA	CW	CW	CW	CW	CW	CW	C	CW	C	RA	CW	C	RA and C	RA	CW	C

Continued

3.	Cleaning of street and spraying of water	RA and C	RA and C	C	C and RA	CW	U	RA	RA	RA	C and RA	RA	RA	RA
4.	Blacktopping	CW	Nil	C and RA	C and RA	CW	CW	CW	CW	CW	C and RA	CW	CW	C and CW
5.	Action to remove dust regularly	U	C and RA	RA	U	C	U	RA	CW	RA	C and RA	CW	C	RA
6.	End-to-end pavement of roads	U	Nil	C and RA	C and RA	CW	C	C	CW	C	C and RA	C	CW	CW
7.	Water fountains at intersections	C	U	C	C	C	CW	CW	CW	Nil	C	U	C	U
8.	Widening of roads	C and RA	CW	RA	U	CW	CW	CW	CW	C and RA	CW	CW	CW	C
9.	Infrastructure improvement for decongestion of road	C	U	RA	C	CW	CW	U	CW	C	RA	CW	CW	C and RA
10.	Environment-friendly roads	C	RA	C	RA	C	C	CW	C	C	CW	U	C	C
11.	Identifying road stretches with high dust	CW and RA	CW and RA	C	C and RA	C and RA	C	C	C	C	C	C	C	C
12.	Canals should be brick-lined	C	C and RA	CW	C	C	CW and RA	Nil	CW	CW	C	RA	Nil	CW
13.	Creation of green cover	C	C	C	C	RA	CW	C and RA	CW	C	CW and RA	CW	CW	CW and RA
14.	Changes in byelaws for greening of open areas etc.	C	CW	C	C	C	C	C	C	C	C	C	C	C
15.	25%/33% green area in residential colonies	C	C	C	U	C and RA	RA	RA	C	CW	C	C	C	RA and C
16.	33% of forest area	C	CW	RA	U	C and RA	C and RA	CW	CW	C	RA	RA	U	CW
17.	Transporting construction materials in covered vehicles	CW	RA	C and RA	C	RA	RA	RA	RA	RA	C and RA	RA	C and RA	RA and CW

Continued

18.	Enforcing CPCB guidelines for construction	RA	CW	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA and RA
19.	No roadside storage of construction materials	CW and RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	CW and RA	RA	RA	RA and CW
20.	Covering of construction sites	CW	RA	RA	RA	RA	RA	RA	RA	RA	RA	C and RA	RA	RA	C and CW
21.	Separate zone to handle solid and other waste	CW	CW	U	CW	RA	RA	RA	RA	RA	U	C and RA	RA	RA	C and CW
22.	Facility of tar road		CW	C							C				C and RA
23.	Enforcement of construction and demolition waste rules	CW and RA	RA	CW	C	CW	C and RA	RA	C and RA	RA	C	CW and RA	RA	RA	U
24.	Policy for segregation of waste	C	RA	C	C	RA	Nil	C	C	U	CW	C	C	RA	CW
25.	Recycling of construction waste	C	RA	C	U	RA	U	CW and RA	RA	U	RA	U	C	RA	U

VEHICLES

1.	Strengthen PUC	CW	C	C	C	RA	CW	C	U	C	CW	RA	C	C	C	C and CW
2.	Checking vehicle emission and issuing PUC	CW	RA	RA	RA	CW and RA	RA	RA	RA	CW and RA	RA	RA	C and RA	RA	RA	CW and RA
3.	Linking PUC with remote server	C	U	C	C	C	C	CW	C	C	RA	RA	C	C	C	CW
4.	Checking overloading	C	C	C	C	C	RA	U	RA	U	C	RA	C	RA	C	C
5.	Clean fuel and fuel quality	CW and RA	RA	RA	RA	CW and RA	CW and RA	RA	RA	CW and RA	RA	RA	C and RA	RA	RA	CW and RA
6.	Alternate clean fuel policy	CW	RA	C	RA	CW and RA	C	RA	RA	CW and RA	CW	RA	C	RA	C	CW and RA
7.	No parking in non-designated areas (NDA)	RA	RA	CW	RA	CW	RA	RA	RA	CW and RA and RA	RA	RA	C and RA	RA	RA	RA and CW

Continued

8.	Multilayer parking	CW	Nil	U	U	RA	U	CW	CW	CW	U	U	C	C	CW	CW
9.	Fines on parking in NDA	CW and RA	RA and RA	CW	Nil	RA	RA	RA	RA	CW and RA	RA	RA	C and RA	RA	C	RA and RA
10.	Introduction of new electric buses and charging stations	CW	Nil	U	RA	RA	U	U	CW	C	C	U	U	CW	U	U
11.	Battery operated vehicles	CW	C	U	RA	C	U	CW	U	RA	C	CW	C	RA	C	RA
12.	Intelligent traffic system	CW	C	RA	CW	Not require	U	CW	C	CW and RA	CW	U	U	U	U	RA and C and CW
13.	Assessing traffic congestion hotspots		C	C	C	C	C	C	C	C	C	C	C	C	C	C
14.	Plan for widening of roads	CW	CW	U	CW	U	CW	CW	U	CW	C	CW	CW	RA	RA	U
15.	Public awareness for air pollution control	CW and RA	RA and CW	RA and RA	RA and RA	RA	CW	RA	RA	CW and RA	RA	RA	C and RA	RA	CW	RA
16.	Enforcement of law against polluting vehicles	CW	RA	RA	RA	RA	RA	RA	RA	CW and RA	CW	RA	C and RA	RA	C and RA	RA and RA

INDUSTRIES

1.	Monitoring of industries	RA	C	RA	C	CW	CW	CW and RA	C and RA	C	C	RA	RA	RA	RA	C
2.	Action against non-complying industries	RA	C	RA	RA	RA	CW	RA	RA	CW and RA	C	RA	RA	RA	RA	C and RA
3.	Shifting of polluting industries	RA	Nil	RA	RA	RA	C	RA	C and RA	C	CW	RA	RA	RA	CW	C and RA
4.	Ban on polluting industries	RA	Nil	Nil	C	CW	CW		C and RA							C and RA
5.	Online reporting system in industries	RA	RA	C	C	RA			RA	C	C		RA		R	C and RA
6.	Identification of non-polluting industries			C and RA	C		CW and RA				C	RA	RA	RA	RA	C and RA

Continued

7.	Installing and upgrading air pollution control devices	CW	C	C	C	C	C	C	RA	RA	RA	C	RA	C	RA	RA	C and RA
8.	Action against polluting units	RA	RA	C	CW	CW	RA	RA	RA	RA	RA	CW	RA	CW	RA	RA	C and RA
9.	Disposal of non-hazardous waste into dumping sites	C and RA	CW	U	C	RA	CW	C and RA	RA	RA	RA	CW	RA	CW	RA	C and RA	C and RA
10.	Bank guarantee for compliance of condition on CTO/CTE	CW and RA	CW	RA	C	RA	CW	RA	RA	RA	C	CW and RA	RA	RA	RA	RA	C and RA
11.	Implementing CEMS in polluting industries	C and RA	C	C	C	CW and RA	C	Nil	Nil	C	C	C	C	RA	RA	C and RA	C and RA
12.	Mobile facility for CAAQM	U	U	U	U	Nil	CW	CW	CW	U	Nil	U	U	U	Not proposed	Not proposed	U
13.	Live camera feed in industries	CW	CW	RA	C	C	CW	RA	RA	RA	RA	C and RA	RA	RA	RA	RA	RA and C
14.	New technologies for brick kilns	C and RA	CW	CW	CW	RA	Not require	RA	RA	RA	C	C	CW	CW	CW	RA	RA
15.	Identification of brick kilns	RA	CW	C	C	RA	Not require	RA	RA	RA	CW and RA	RA	RA	Nil	C	CW	CW
16.	Natural kilns to induced draft	RA	CW	C	C	CW	Not require	RA	RA	RA	C	RA	RA	Nil	C	CW	CW
17.	Closure of unauthorized units	RA	CW	U	U	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	CW
18.	Monitoring GS sets	CW	CW	RA	C	RA	RA	RA	RA	RA	CW and RA	RA	RA	RA	RA	RA	RA and CW

WASTE AND BIOMASS DUMPING AND BURNING

1.	Check and control of biomass burning	CW and RA	C and RA	RA	RA	CW and RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA
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Continued

2.	Fines on defaulters	CW	C and RA	RA	C and RA	RA	CW and RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA		
3.	Identify burning locations	RA	C and RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	CW and RA	C	RA	RA	RA		
4.	Complete ban on burning	CW	C and RA	C	C and RA	RA	CW	RA	RA	C	RA	C	RA	RA	C	CW	RA	C and RA		
5.	Launch drive against open burning	CW and RA	C and RA	RA	RA	RA	CW	RA	RA	RA	RA	RA	RA	RA	C	RA	RA	No burning	RA and C	
6.	Construction of advanced waste management sites	C and RA	C and RA	UP	C	RA	CW	CW	CW	C	C	C	C	C	C	C	C	C	C	
7.	Regular collection of MSW		C and RA	C	C	CW	CW	CW	CW	C	C and RA	CW	RA	RA	RA	RA	RA	RA and C		
8.	Waste composting machines and decentralized and segregated waste collection centers	CW and RA	C and RA	C and RA	C	CW	CW	U	U	C	C and RA	CW	C	RA	C	RA	C	C	C	
9.	Awareness against crop residue burning	RA	RA	RA	C	CW and RA	CW	RA	RA	C	RA	C	RA	RA	RA	RA	RA	C and RA	RA and C	
10.	Plantation on vacant land	RA	RA	RA	C and RA	C	U	U	U	CW and RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	
11.	Proper disposal of dead bodies of animals	U	CW	CW	U	U	C	U	CW and RA	C	C	C	C	RA	U	RA	RA	RA	U	
12.	Door-to-door collection of segregated waste	RA	RA	U	RA	RA	CW	CW	C	C and RA	CW	RA	C and RA	RA	C	RA	RA	CW	C and CW	
13.	Ensuring segregation of waste	CW	RA	RA	CW	RA	RA	RA	C	C and RA	U	CW	C and RA	RA	C	RA	RA	CW and C	C and RA	
14.	Proper collection of horticulture waste	RA	RA	RA	C	C	RA	CW	CW	RA	CW and RA	RA	RA	RA	RA	RA	RA	CW	U	C
15.	Recycling plants for dry waste		C	C	C	RA	CW	CW	CW	C	CW	CW	CW	CW	CW	CW	CW	CW	RA	RA

Continued		RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA and C
16.	AAQ monitoring of dumping sites	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA and C
17.	Check on stubble burning	RA	CW	RA	RA	CW	CW	No burning	CW	RA	Nil	RA
18.	Management of dumping sites to prevent fire	RA	RA	U	RA	RA	RA	RA	RA	RA	CW	RA and C
19.	Adopting zero-landfill policy	C and RA	RA	C	CW	C	U	C	C	C	C	C and RA
20.	Control usage of firecrackers	C and RA	C and RA	C	C	C	CW	RA	C and RA	RA	C	C and RA
21.	Increasing LPG connection to low strata	C and RA	RA	C	C	RA	CW	RA	RA	C	RA	C and RA

*Agra (AG), Anpara (AN), Bareilly (BA), Firozabad (FZ), Gajraula (GJ), Ghaziabad (GH), Gorakhpur (GO), Jhansi (JH), Kanpur (KN), Khurja (KH), Lucknow (LK), Meerut (ME), Moradabad (MO), Noida (NI), Prayagraj (PR), Raebareli (RE), Varanasi (VA) * Complete (C), Continuous work (CW), Regular activity (RW), Under Progress (UP). Source: Micro action plan reports of the 17 NAC of UP.

interventions have been further categorized into “continuous work (CW)” if the action points have not yet been achieved but continuous work is being done to achieve it and “regular activity (RA)” if the action point is done timely and as a regular activity. Some of the action points have also been categorised as complete and regular activity in the table if the action points have been achieved and still done as a regular activity.

On studying the status of the action plan through the reports it was observed that still many of the action points are under progress such as in capacity building and monitoring network category: CAAQMS, emission inventories, source apportionment studies and training of public officials are still under progress (due to COVID19 situation). In the public outreach category: public engagements were put on hold for 2 years due to spread of corona virus. In the road dust, and construction category: water fountains at major traffic intersections, recycling of construction waste and facilities of Tar road are still under progress in many NAC of UP. In the vehicles category: planning of widening of roads, multilevel parking, intelligent traffic system and electric buses with charging stations are still under progress for many cities. Though electric buses have been introduced in some cities, the construction of the charging stations is still under progress in many cities. For the industries category: mobile facilities for CAAQMS are still under progress. For the biomass and waste burning category: proper disposal of dead bodies of animals, recycling of dry waste, adopting zero landfill policy, and management of dumping sites are still under progress for many NAC of UP.

5. Recommendations

- **SOURCE IDENTIFICATION:** As per the status studied through action plan reports, it was observed that source apportionment studies and emission inventories are still under progress for many NAC (except Agra and Kanpur), hence there is no recognizable preference given to specific action plan as per the sources of air pollution. Identification of sources helps to prioritize the action points as well as the finances and to shift the attention to major pollution sources.
- **CITY-SPECIFIC ACTION PLANS:** It was observed that most of the action points of NAC of UP are similar which makes the action plans of the NACs generic instead of being context-specific and comprehensive as per the sources of air pollution of different NAC.
- **AIRSHED MANAGEMENT APPROACH:** Instead of the conventional approach of planning action plans and emission studies on city-specific local sources, it is also important to address the non-local and non-boundary sources which also degrade the air quality of the cities. An airshed management approach could be adopted to address non-local sources which can be managed by the regional airshed authorities.
- **SPECIFIC RESPONSIBILITIES OF AGENCIES:** It can be noted that many of

the action points have been given to multiple agencies which can cause confusion and disagreements leading to the delay in implementing the interventions. It then becomes important to assign the agencies with respective roles and duties like the planning agency and implementing agency for their better coordination.

6. Conclusions

It was observed that, on average, the highest weightage in action plans amongst the six sector-specific categories has been given to road dust and construction activities (24%). Also, the urban local bodies (~50%) were majorly responsible to implement the action points and 56% of the action points were jointly implemented by multiple agencies in the 17 NAC of UP.

Though the government has taken many appreciable steps over the years to improve the air quality of its NAC, the inferences from the reports suggest that there is still a lack of preference given to source-specific action plans in the different NAC. The generic nature of many of the action points, the non-segregated responsibilities and joint implementation of the action points by multiple agencies can cause delay and confusion in the implementation of the action plans.

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Ethical Considerations

In the present research, ethical issues like plagiarism, misconduct, data fabrication/falsification, informed consent, double publication and/or submission, redundancy have been completely and carefully observed.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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