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ASSESSING THE EFFECTS OF AIR POLLUTION ON TELANGANA'S ROADSIDE FLORA

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ABSTRACT

The primary causes of the concentration of air pollutants growing and their detrimental effects on the surrounding ecosystem are increased urbanization and an increase in the number of vehicles on the road. Roadside vegetation is commonly employed as an air pollution barrier to reduce emissions from vehicles. However, their tolerance capacity varies and they are susceptible to different pollutants. This calls for a scientific investigation into how roadside plantations, where specific trees might be grown to lower air pollution, might contribute to better urban sprawl planning and management. In an industrial and commercial region in Telangana, India, the relationships between different air pollutants and meteorological data are understood via the application of Principle Component Analysis (PCA) and Cluster Analysis (CA). Seasonal correlations are derived from a decade's worth of data used in the investigation. The findings from the two analyses revealed comparable patterns. The analysis's good outcomes have been demonstrated by the Bartlett test significant values and the KMO test sampling adequacy.

Keywords*: Air pollution, Flora, Plants, Telangana, Pollutants*

1. INTRODUCTION

Contaminants are substances that are introduced into the environment and result in negative changes. Chemical compounds or forms of energy, such as heat, light, or noise, can be considered forms of pollution. The elements that make up pollution, or pollutants, can be either naturally occurring or the result of outside materials or energy. When dangerous or excessive amounts of pollutants are added to the Earth's atmosphere, air pollution results. Particulates, biological molecules, and gases are some of the sources of air pollution. Air pollution harms all plants, including trees and our food crops, as is commonly seen. Ozone harms plants in the lower atmosphere by blocking stomata, which limits respiration and stunts plant growth. It also prevents photosynthesis.

The Latin word "pollutioneum," which means to pollute or create dirty, is where the word "pollution" originates. "Pollution is viewed as the unwariness of substances and energy as waste product of human activities that lead to harmful changes inside the natural environment," said the National Environmental Research Council. The main cause of pollution emissions into the environment and the introduction of dangerous materials into the atmosphere is growing industrialization and evolutionary activities. Improvements in vehicle parts and fuel quality have substantially reduced vehicle emissions in industrialized nations; however, this is not the case in developing nations, where a large number of outdated and badly maintained vehicles are used on public roads and fuel of inferior quality is used. Both locally and globally, transportation has been linked to significant air pollution due to the burning of petrol and diesel in cars. A significant amount of exhaust emissions from motor vehicles, including particulate matter, carbon monoxide (CO), Sulphur dioxide (SO2), nitrogen oxide (NOx), and volatile organic compounds (VOCs), contribute between 60 and 70 percent of the air pollution in urban areas (3).

Numerous industrial facilities and heavy traffic can release heavy metals and other toxic substances into the atmosphere, endangering human and animal health as well as affecting plant life and the global environment by altering the earth's air quality. No mechanical or chemical device exists that is capable of fully analysing the pollution emissions right at the source. The only thing that can save the air once pollutants are released is for plants to absorb and metabolize the pollutants, thereby removing them from the atmosphere. As a result, in recent times, plants' significance in abatement has been gradually acknowledged. Through the processing of characteristic response and symptoms, plants function as a sink or as living filters to reduce air pollution. Additionally, roadside plant leaves might pick up some heavy metals due to their direct interaction with air pollutants.

An impending problem is pollution, which modifies metabolism in all living things. Air pollution in urban areas is mostly caused by the fast expansion of industries and increased traffic density, which is a significant issue for cities. Growing cities in developing nations are particularly vulnerable to the negative effects of air pollution. The main causes of air pollution in the city are construction activities and vehicle emissions. More vows are being added as automobiles continue to proliferate. Because they operate as a sink for air pollutants, trees exchange gases, which significantly improves the quality of the air. By functioning as living filters, they reduce particulate matter and air pollution. Depending on their degree of sensitivity, trees exposed to environmental pollutants may absorb, collect, or incorporate these chemicals into their systems. Damage to plants might be seen in the form of individual metabolite buildup or changes in metabolic processes. These modifications are employed to evaluate the APTI of plants.

The effects of air pollution on plants have been studied by numerous researchers. The majority of plants go through physiological changes before their leaves become visibly damaged. Analysis of some biological factors of each species aids in calculating the tolerance level based on how plants respond to air pollution. There has been much research done on how air pollution affects the levels of ascorbic acid, chlorophyll, pH, and RWC in leaf extract. Ascorbic acid, total chlorophyll concentration, relative water content, and pH of leaf extract were the four characteristics that were analyzed and combined into a single formula in the current study to determine how sensitive plants were to air pollution. The plant's response to air pollution and its capacity to combat it are both determined by APTI.

Because emerging countries are rapidly becoming more urbanised, there is no clear demarcation between residential and industrial zones. Because of this, the main environmental issue in metropolitan areas is the decline in air quality. In addition to having a negative impact on human health, urban air pollution has a significant and hard to measure negative impact on plant life. Every kind of plant has a tendency to react differently to various contaminants and weather situations. Thus, the goal of the current study is to comprehend how plants may adapt and withstand air pollution.

1.1.Sources of pollution

Two categories of sources exist. Two are created by humans, one by nature.

1.1.1. Natural sources

Natural air pollution is caused by things like methane emissions from volcanoes, forest fires, and so on. Let's talk about them as follows.

- Forest Fires: The major causes of forest fires are either naturally occurring or caused by human activity. The majority of the forest will be destroyed by forest fires, which will also disrupt the flora and animals. Forest fires will also start bush fires. Carbon monoxide and carbon dioxide will be released into the atmosphere along with smoke from forest fires, which will generate massive air pollution. Additionally, it will result in cyclones, environmental imbalances, and changes in the climate.
- Volcanoes: Numerous volcanoes exist on Earth today, and their air pollution poses a threat to a wide variety of life forms. A volcano is an open crack in the earth's surface through which lava and volcanic ash can leak into the surrounding area. Carbon dioxide and Sulphur dioxide are the main gases emitted into the atmosphere during a volcano eruption. Additionally, it will have an impact on all local life forms as well as the surrounding ecosystem. Other gases, such as carbon monoxide, halocarbons, hydrogen sulphide, hydrogen chloride, hydrogen fluoride, and some metal chlorides, will be released into the environment in lower amounts.

1.1.2. Man made sources

- Vehicle exhaust: fossil fuel combustion, such as that of petrol and diesel Due to urbanization, cars, trains, and aero planes are increasingly needed for transportation. We may conclude that cars today play a significant part in air pollution, accounting for 8% of all air pollution and noise pollution. The three main pollutants originating from these sources are Sulphur dioxide (SO_2), carbon dioxide (CO_2), and carbon monoxide (CO). The gas that cars emit the most is carbon monoxide, followed by nitrogen oxides. Automobile emissions, which result from the burning of fossil fuels, send toxins into the atmosphere that harm both human and animal health as well as plant life. Tetra ethyl and Tetra methyl lead are released into the atmosphere as particulate lead compounds, which are pollutants, when petroleum is burned, producing lead products. Products released during the burning of fossil fuels like coal and petrol combine with nitrogen oxides to form photochemical smog, which is made up of secondary pollutants like ozone, PAN (peroxyacetyl nitrate), and aldehydes.

- CO is referred to be the silent killer. The main sources of cigarette smoke are automobiles, industries, and cigarettes. An estimate states that 6 billion tones of CO are created and emitted into the atmosphere each year. When breathed by humans, it impairs hemoglobin's ability to carry oxygen. Plants' ability for photosynthesis is disrupted by it.
- Fossil Fuels: As more fossil fuels are burned for home and industrial reasons, contaminants from these sources are discharged into the atmosphere, upsetting environmental balances and affecting or reducing air purity. Utilising alternative energy sources, like solar power for cooking, and adopting healthier lifestyle habits, such eating salads instead of processed food, can help lower the amount of fuel burned at home.

2. LITERATURE REVIEW

In 2015, Lohe.N et al. conducted research on the terrestrial plant species in the vicinity of Dehradun, India. To determine the air pollution tolerance index value for each of the seven plant leaves, an analysis of four physiological and biological factors of plants was taken into consideration. It was evident from the study that Eucalyptus globus exhibited greater pollution tolerance than the other seven plant leaves that were taken into consideration for examination. The assessment and capacity of the plants to absorb some of the gases present in the vicinity of Industrial Corporations situated in Nigeria was examined by N. Nwadinigwe et al. (2014) et al. According to the investigation, plants with high air pollution tolerance index values were Bougainvillaeaspectabilis, Delonixregia, Mangiferaindica, and Durantaerecta. It was advised that these plants be grown very close to high-pollution locations in order to absorb all of the hazardous gases and pollutants that are there and greatly contribute to climate variation in the earth's atmosphere.

In the course of their work, Marimuthu et al. (2014) investigated the evaluation of the air pollution tolerance index value at two distinct locations. It was discovered that the vegetative species subjected to persistently high levels of pollution changed the properties of their leaves and were pollution-sensitive.

Gopalakrishnan et al. (2013) used biochemical characterisation to study Passiloraedulus leaves. The findings demonstrated that a variety of illnesses might be treated with herbs and folkloric medicine.

In the Pithampur industrial region, ChouhanAarti et al. (2012) investigated how a few plants responded to the air pollution tolerance index. According to the study, certain plants, such as C. gigantea, were beneficial for developing green belts as a means of reducing industrial air pollution and for biomonitoring.

Mohammed Kuddus et al. (2011) investigated the commercially significant plant species cultivated in Allahabad's urban industrial region. The findings indicate that Mangiferaindica is a tolerant plant variety while Artocarpus sp. is a sensitive plant variety.

In Jalgoan City, Maharashtra, SarikaKarda and KiranPawar et al. (2015) investigated the state of the air quality and its impact on biochemical parameters on the species that are there. The findings showed that whereas Ficusreligeosa and Plumeriarubra are the species that are extremely sensitive in the examined area, species like Alstoniascholaris and Polyalthialongifolia are the variants from the selected species that are highly tolerant trees.

In Haridwar, Uttarkhand, Namita Joshi and Meha Bora et al. (2011) investigated the effects of the current air quality on the physiological characteristics of eight distinct plant species. The analysis of the data demonstrates that the combination of all physiological factors used for the investigation yields more accurate results than any one parameter alone. Psidiumgujava was found to exhibit

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the highest dust interception, and Ficusreligiosa was found to have the highest air pollution tolerance index.

In Saritavihar in New Delhi, India, ShailendraArora et al. (2014) investigated the relationship between two criteria, namely, biochemical properties and air pollution stress of some of the available and selected plants. Vehicle pollution had a greater impact on the vegetation-covered roadside area with heavy traffic than it did on the areas farther away from the roadside.

3. RESEARCH METHODOLOGY

Description of the area: Hyderabad is one of India's biggest metropolitan areas. Hyderabad has a maximum temperature of 41.52 c and a minimum temperature of 12.70 c. The current study is centred in the city's core, Sanathnagar.

Info: From 2007 to 2017, hourly data on PM, gases, and meteorological indicators were gathered from the CPCB station in Sanathnagar. More than 5% of the data were missing, indicating that they cannot be ignored or eliminated without reducing the sample size. IBM SPSS 26 was used to replace the missing values. Given that the MCAR test's P-value was more than 0.05, the multiple imputation approach is the most appropriate one. For the analysis, seasonally separated data—summer, pre-monsoon, monsoon, winter, and PCA, CA—is being employed.

The following make up the parameters: Particulate matter (PM) in µg/m3. 2) Gases (µg/m3) SO2, CO, NOx, and O3. 3) The characteristics of the weather include the following: temperature (ATo C), wind direction (deg), relative humidity (RH,%), radiation (SR, W/m2), wind speed (WS, m/s), and barometric pressure (BP, mmHg).

4. DATA ANALYSIS

Eleven parameters of the data set are subjected to Principle Component Analysis in order to identify the factors driving the seasonal changes in air pollution in each cluster that results from cluster analysis. Three components make up the SPSS 26 PCA output: descriptive statistics, a correlation matrix, and a rotated component matrix. KMO test sample adequacy is found to be

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greater than 0.5 for each of the four seasons, and Bartlett's test significance is less than 0.00, indicating that the analysis is satisfactory.

Table 1: PCs for summer seasons

Components	Parameters
PC1	WD
PC2	Temp, SR
PC3	Temp, RH, SR, NO CO

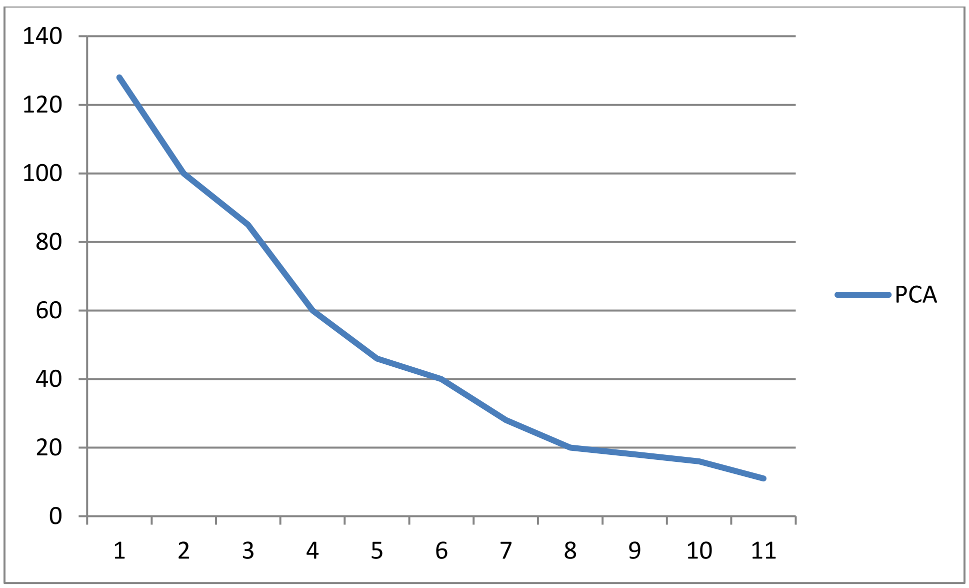

Fig 1: Scree plot Summer Season

The summer months According to descriptive statics, BP mm/Hg is the main influencer, with a maximum mean of 708.93. Temperature and SR have the strongest association of any of the parameters in the correlation matrix. Temperature = 128 and SO2 = 30 were the maximum and lowest retrieved values, respectively. Component 1, 2, and 3 had total variance percentages ranging from 126, 120, and 60.Between components 3 and 4, the curve flattens (fig. 1). Only three components were kept because the other two had Eigenvalues smaller than one. The following parameters (table no. 1) were found to be overloaded as Principle Components (PC) by the Rotated Component Matrix).

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Table 2: PCs for Pre-monsoon

Components	Parameters
PC1	NO, CO, SO2, PM
PC2	SR
PC3	Temp, WD

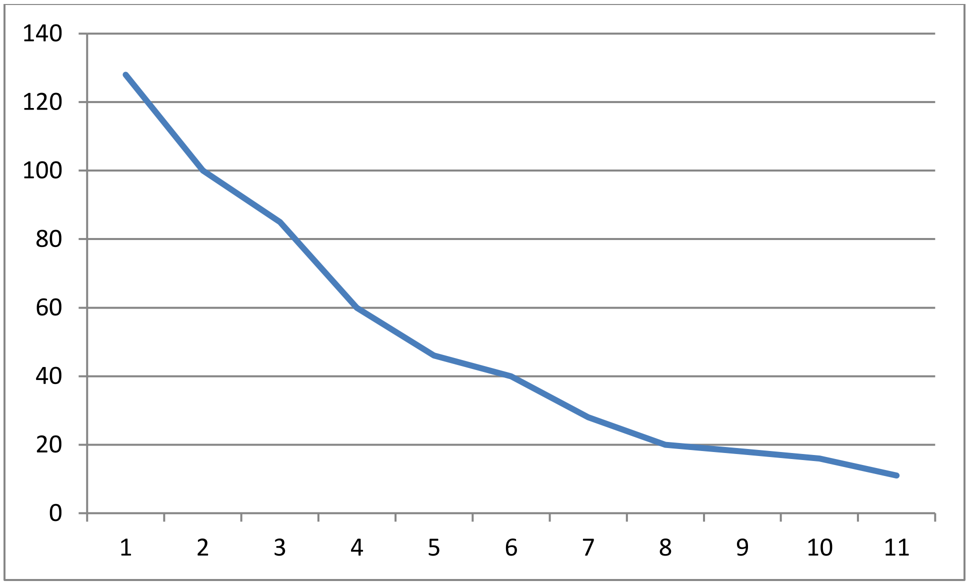

Fig 2: Scree plot pre monsoon

Pre-monsoon: According to descriptive statistics, the most significant influencing factors with the greatest mean are PM and blood pressure. According to the correlation matrix, NOx has the highest correlation and is the most influential parameter when compared to CO. The study of communities yielded a maximum value of O3 = 127 and a lowest value of WD = 11%. Components 1, 2, and 3 have total variances of 100, 85, and 60, respectively. Eigenvalues: The screen plot (Fig. 2) indicates that, when the curve flattens at components 3 and 4, only three PCs are preserved. The overloaded parameters as PCs are displayed in the following table. T.

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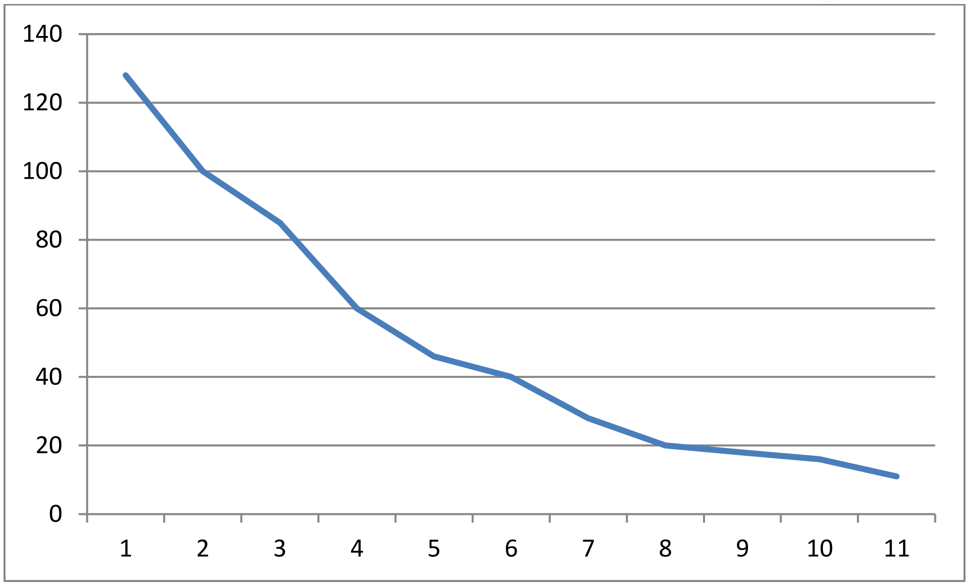

Fig 3: Scree plot monsoon

Monsoon: With a mean of 709.30, BP is the most significant factor. Findings from the co-relation matrix indicate that NOx and CO had the strongest association of any parameter. WD=126 is the maximum extracted value, and BP=11 is the smallest extracted value.Components 1, 2, 3, 4, and 5 have total variances of 100, 82, 60, 40, and 24, respectively. The curve flattens at components 5 and 6, according to eigenvalues displayed via scree plot (fig. 3). The overloaded rotational component matrices of the principal components are provided in tabular form.

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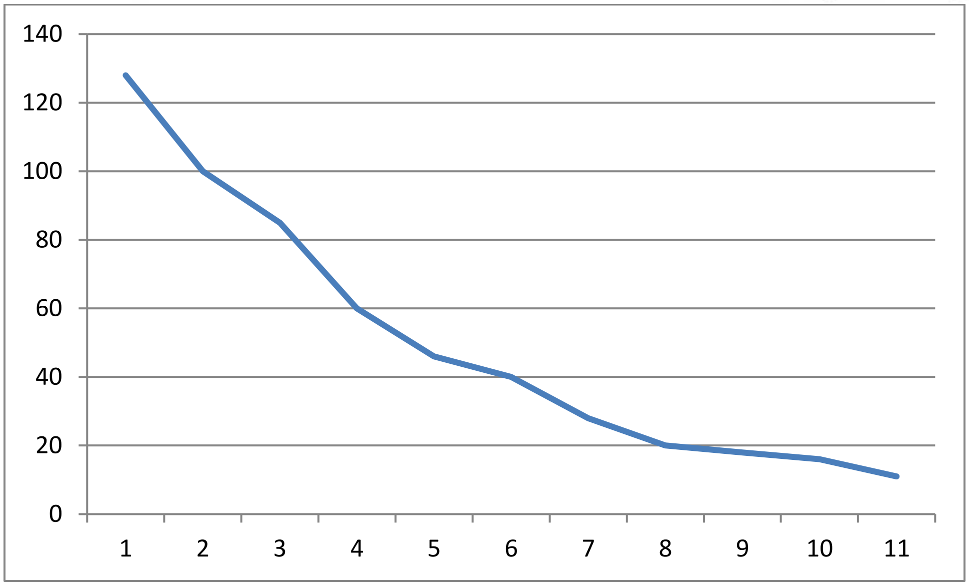

Fig 4: Scree plot winter season

Winter season: The influencing elements, PM (124) and BP (122), have the greatest means (fig 4). CO and NOx have the strongest association. SR (80) and WS (49) are the highest and minimum values of extractions, respectively. For components 1, 2, 3, and 4, the total variance varies from 29, 20, and 11 correspondingly. Three PCA components were loaded as PCs after being removed.

4.1.Cluster Analysis

Sorting cases, observations, or variables for a set of data is done statistically. The data in the current study were analysed using Hierarchical Agglomerative Cluster Analysis (HACA), and the results included a dendogram, an agglomerative schedule, and a proximity matrix. The proximity matrix displays the distance between any two examples, both the longest and the shortest. The biggest distance indicates a dramatic shift (Jump) in the coefficient between any two cases, while the shortest distance suggests that the two cases were united in the first cluster. In the output, an agglomeration schedule and a proximity matrix show how HACA gradually groups the cases or observations. A dendogram that is analysed from left to right appears at the conclusion of the SPSS output. A dendogram's vertical lines show how clusters and stages are grouped together. Comparing CA to PCA analysis is the last action that can be done for further validity once a set of

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significant subgroups has been identified.Ten cases and eleven stages in total were found by CA analysis for each of the four seasons. The summer season (Dendogram fig. 5) is divided into two clusters: Cluster 2 (WD, SR, BP) is somewhat correlated, while Cluster 1 (CO, WS, SO2, O3, NOx, Temp, PM, RH) is significantly correlated. The CO-WS cluster (6729.8), which formed as the first stage in the agglomeration table, had the smallest distance among the clusters, and the CO-BP cluster (612512234.63), which was recognised as the last stage, had the highest length. The factors that are significantly correlated in Pre-Monsoon (Fig. 6) and Monsoon (Fig. 7) include CO, WS, SO2, AT0 C, RH, O3, NOx, and moderately correlated in PM, WD, and SR. In the first stage, CO-WS was the least distance and CO-BP was the highest. Figure 8 depicts the winter season. The highly linked values are CO, WS, SO2, AToC, RH, and O3, whereas the moderately correlated parameters are PM, WD, SR, and NOx.

5. CONCLUSION

The use of statistical analysis (PCA & CA) to evaluate Telangana's air quality monitoring data revealed a strong correlation between plant air pollution and meteorological conditions. Similar tendencies were seen when comparing the PCA and CA values. According to CA, the pollutants are significantly influenced by parameters like BP, Temp, WD, and WS. Gases such as NOx have a strong correlation with CO, SO2, and O3, and particulate matter is also a seasonal influencer. It was established that there is a relationship between PM, gases, and meteorological parameters through a four-season analysis conducted between 2007 and 2017. There are restrictions in this field of study. A longer-term analysis of various terrains might have provided a more accurate explanation for the variances. A more thorough analysis might have been provided by including additional variables including precipitation, sunlight duration, various types of terrain, and geographic areas. Much better results could have been obtained from an analysis that took into account the impact of various altitudes on the diffusion of air contaminants in both vertical and horizontal directions.

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