Sonar : Jurnal Multidisiplin

https://jurnal.untirta.ac.id/index.php/sonar/index

e-ISSN: XXXX-XXXX

Vol. 1, No. 2, October 2024, Page 90 - 103

The Effectiveness of Weather Modification Technology in Handling Air Pollution in DKI Jakarta

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(Received: 10 September 2024; Accepted: 01 October 2024; Published: 30 October 2024)

ABSTRACT

Currently, the issue of air pollution is one of the pressing challenges in Indonesia, especially in the Jakarta area. Low rainfall during the dry season can cause pollutants in Jakarta's air space, especially PM2.5 concentrations, to increasingly accumulate, thereby worsening air quality. This research aims to analyze the effect of rainfall on PM2.5 concentrations during the dry season and analyze rainfall produced through Weather Modification Technology interventions in Jakarta. The data analysis used is simple linear regression using SPSS with rainfall data from BMKG and PM2.5 concentrations from KLHK with a period from January - October 2023 in Jakarta as well as analysis of GSMaP rainfall data from 6 - 23 August 2023 (before the implementation of the Weather Modification Technology) and 24 August – 10 September 2023 (during the Weather Modification Technology implementation) using GrADS to determine the rainfall distribution map in the seedling area (Jabodetabek). The research results show that there is an influence between the independent variable, namely rainfall, and the dependent variable, namely PM2.5 concentration, which is 6.3%. Meanwhile, 93.7% are other factors/parameters that were not studied by researchers. During the implementation of Weather Modification Technology, there was an increase in rainfall, especially in the DKI Jakarta, Depok, Tangerang and Bekasi areas with a fairly even rainfall distribution pattern, where before the implementation of Weather Modification Technology there was no rainfall observed, especially in the DKI Jakarta, Depok, Tangerang and Bekasi areas. And this indicated that the rain produced by Weather Modification Technology was effective in reducing the pollutant index.

Keywords: Air pollution, PM2.5 concentration, Pollutants, Rainfall, Weather modification technology

INTRODUCTION

One of the provinces on the island of Java, Indonesia, is Jakarta, which spans an area of 662.33 km^2, from 5°19′12″ - 6°23′54″ South Latitude and 106°22′42″ - 106°58′18″ East Longitude. With an average annual temperature of 27°C and humidity levels of 80 - 90%, Jakarta has a tropical climate. Jakarta is close to the equator, and the monsoon winds affect the direction of the winds. The dry season is caused by the east monsoon winds that blow from April to October, while the rainy season is caused by the west monsoon winds that blow from

October to April (Assad, 2019). Low rainfall during the dry season can cause pollutants in Jakarta's air to accumulate, thereby worsening air quality. According to the Air Pollution Standard Index data, the average air quality in Jakarta has been categorized as hazardous from 2018 to 2023, particularly during the middle of the year (KLHK, 2023).

Any chemical, physical, or biological substance that alters the characteristics of the atmosphere is considered an air pollutant, whether indoors or outdoors (WHO, n.d.). Air pollution is defined as the entry or introduction of substances, energy, or other components into the ambient air due to human activities, resulting in a decline in air quality to the point where the ambient air can no longer fulfill its intended purpose, in accordance with the Government Regulation of the Republic of Indonesia Number 41 of 1999 concerning Air Pollution Control. On August 15, 2023, the average level of fine pollutants dispersed in the air of Jakarta was 45.3 $\mu g/m^3$ (IQAir, 2023). This means that for sensitive individuals, the air quality in Jakarta is unhealthy.

0-12.0	Baik
12.1-35.4	Moderat
35.5-55.4	Tidak Sehat Bagi Kelompok Sensitif
55.5-150.4	Tidak Sehat
150.5-250.4	Sangat Tidak Sehat
>250.4	Beracun

(a) (b)

Figure 1. (a) PM2.5 Air Quality Index, (b) Air Pollution in Jakarta August 2023

Pollution is a term used to describe the deterioration of air quality caused by the release of toxic compounds into the Earth's atmosphere. Carbon monoxide (CO), nitrogen dioxide (NO_2), chlorofluorocarbon (CFC), sulfur dioxide (SO_2), hydrocarbons (HC), particulate matter, lead (Pb), and carbon dioxide (CO_2). These materials are also referred to as pollutants or various types of air contaminants (Dwangga, 2018). The Ministry of Environment and Forestry stated that various man-made and natural factors contribute to air pollution in Jakarta at present. Seasons, wind direction and speed, as well as the landscape of Jakarta are examples of natural factors. Human activities such as waste burning, industry, households, and the transportation sector are sources of unnatural factors. Air quality is closely related to the atmosphere's ability to disperse pollutants. If the air that is the source of pollution is not dispersed, the air will become more dangerous. The two most important atmospheric conditions that affect pollutant distribution are wind strength and air stability. When the wind is weak or calm, the concentration of pollutants is higher compared to when the wind is strong. High wind speeds mix polluted air into a larger volume of surrounding air, causing the pollution to become more diluted. When the breeze is gentle, turbulence and mixing are reduced, leading to higher concentrations of pollutants. When the atmosphere is stable, particles in the air face resistance to moving to higher altitudes. Meanwhile, when the atmosphere is unstable, particles in the air can move to higher altitudes, resulting in a decrease in concentration.

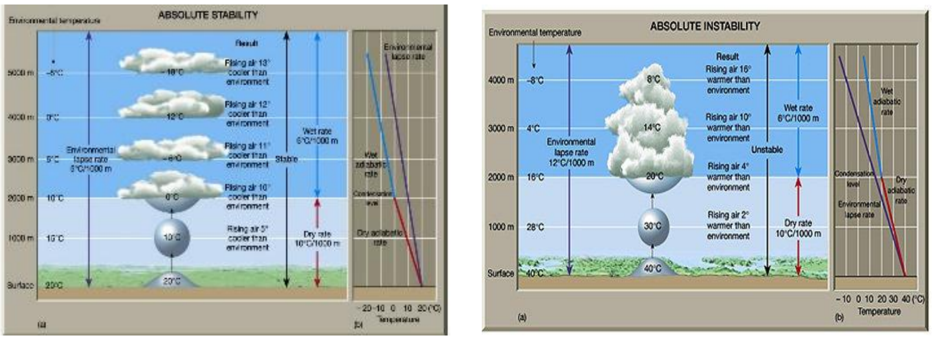


Figure 2. The atmosphere in stable and unstable conditions.

The government continues to strive to reduce air pollution in the Jakarta area, one of which is by implementing Weather Modification Technology through the Cloud Seeding method. The weather modification technology process involves cloud seeding with hygroscopic materials (substances that absorb water) to encourage the growth of raindrops within the clouds and accelerate the onset of rainfall (BPPT, 2019). Cumulus (Cu) clouds are used to create artificial rain. In an effort to modify the weather, one can increase the amount of rainfall in a specific area (rainfall enhancement) or decrease the amount of rainfall in a specific area (rainfall reduction). When inducing rain through Weather Modification Technology professionals are simply trying to encourage and accelerate the precipitation process or to make the water vapor already present in the atmosphere condense quickly, thus forming water droplets that can serve as the starting point for rain.

Figure 3. Scheme and Process of TMC Activities

Cloud seeding with NaCl seed material is carried out to maximize the potential of clouds that develop and pass through the target seeding area. The presence of potential clouds that can be seeded is expected to increase rainfall and produce rain that can filter out air pollution particles present in the atmosphere of Jakarta and its surroundings. While, cloud seeding using NaCl seed material can be carried out with seed material in powder form and seed material in the form of flares. The sowing of dry ice/lime powder is used to dissolve the inversion layer that has become a barrier preventing air pollution particles from rising to higher altitudes due to stable atmospheric conditions. The stable atmospheric conditions tend to trap air pollutants. The function of dry ice or quicklime can cool down or heat the conditions in the inversion layer, allowing pollutants to move into higher altitudes and thereby reducing the concentration of pollutants in the air. Several countries have implemented it, but the use of dry ice/lime in seed treatment requires more serious and extra handling in its application.

Air quality is closely related to the atmosphere's ability to disperse pollutants. To improve the air quality index, Weather Modification Technology is one of the government's efforts to reduce pollutants during this dry season. Based on the issues that have been revealed, this research aims to understand how the Weather Modification Technology concept can be applied and how effective it is in reducing air pollution in DKI Jakarta.

Problem Formulation

1. How does the weather during the dry season affect the increase in pollution?
2. What is the role of Weather Modification Technology in intervening in rainfall?

Research Objectives

1. Analyzing weather conditions during the dry season and their relation to pollution.
2. Analyzing the rainfall produced through Weather Modification Technology interventions.

RESEARCH METHODS

This research was conducted from September 2023 to February 2024 at LAB-TMC BRIN Serpong, BMKG, and KLHK Senayan. This research instrument uses hardware and software. The hardware used to support data processing and analysis is a laptop, which functions to display, process, manipulate, and store data. The software used includes GrAds, FileZilla, Microsoft Excel, and IBM SPSS Statistics, which are utilized for data processing. The type of data used in this research is secondary data. The data includes operational activities of the implementation of Weather Modification Technology for air pollution reduction, meteorological data such as rainfall, as well as wind direction and speed, and PM 2.5 pollutant concentration data from January to October 2023 in Jakarta.

The analysis used is simple linear regression analysis utilizing IBM SPSS Statistics software. This analysis is used to determine the extent of the relationship between the dependent variable, which is the concentration of PM 2.5 (Y), and the independent variable, which is rainfall. (X). The simple linear regression equation is as follows:

$$\boldsymbol{Y = a + bX}$$

Where:

Y = PM 2.5 Concentration

a = constant value

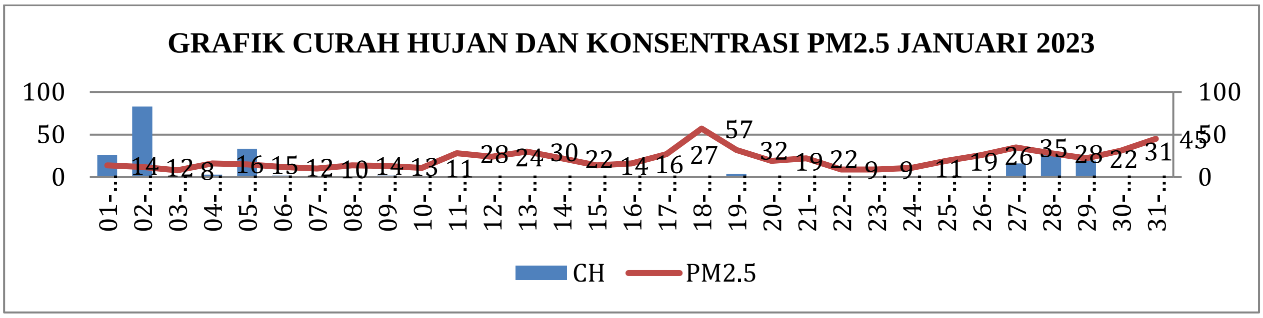
b = Simple linear regression coefficient

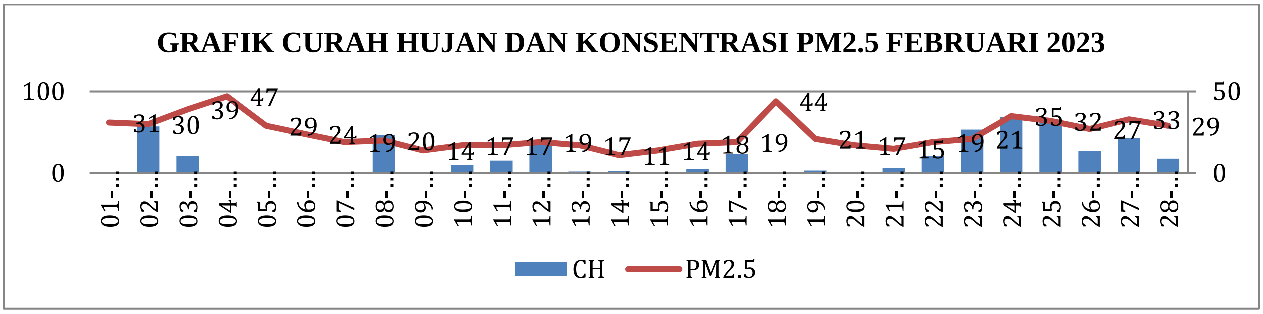
X = Rainfall

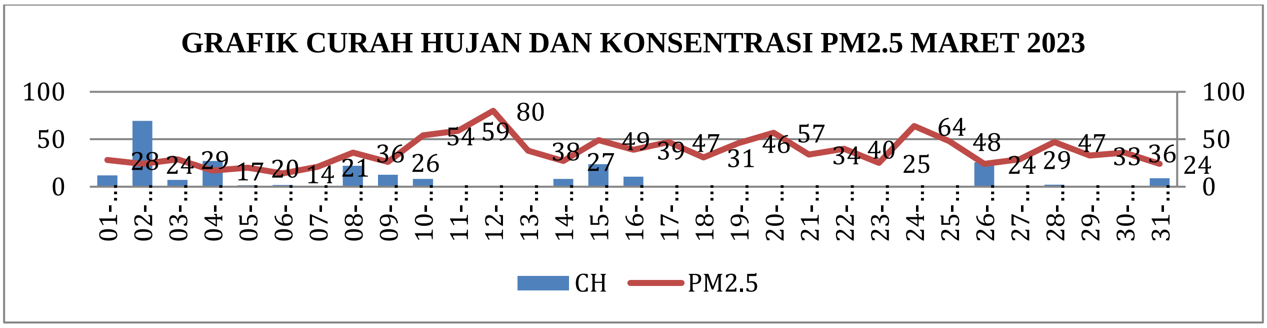
The next analysis will use GSMaP rainfall data in Jabodetabek before the implementation of Weather Modification Technology (August 6 – 23, 2023) and during the implementation of Weather Modification Technology (August 24 – September 10, 2023), which will be downloaded from FileZilla and analyzed using the GrAds application to observe the rainfall distribution maps.

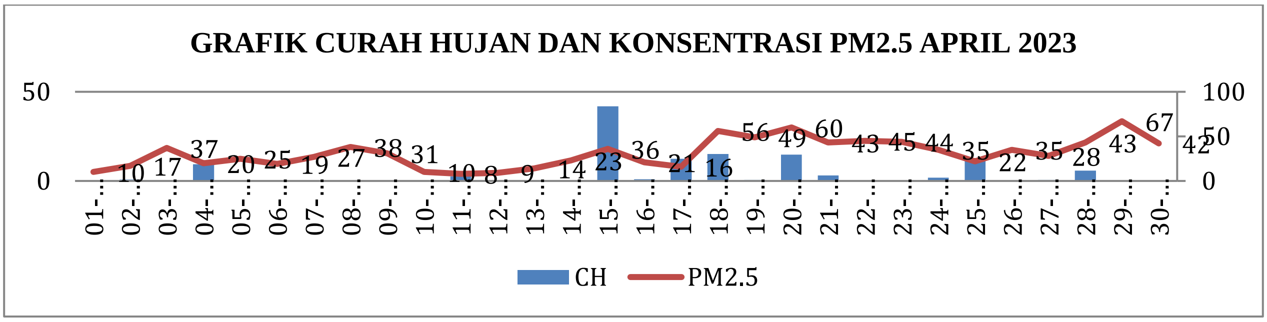
RESULTS AND DISCUSSION

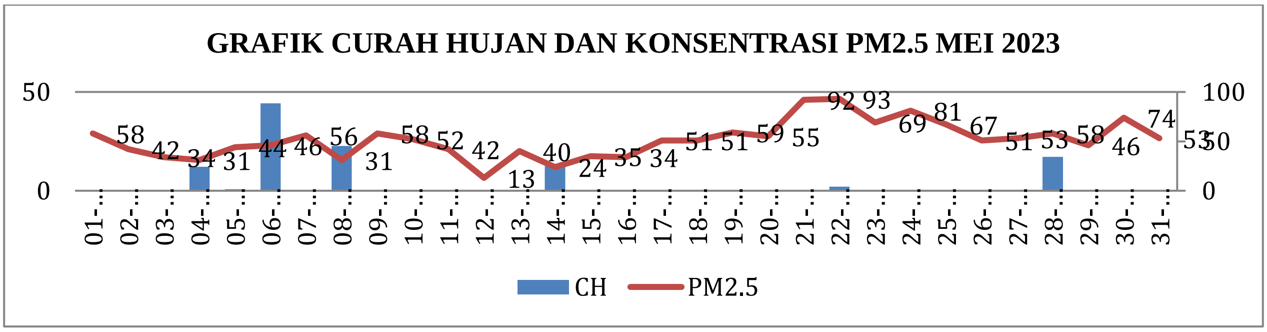
Identification of the Influence of Rainfall on PM2.5 Concentration in Jakarta in 2023











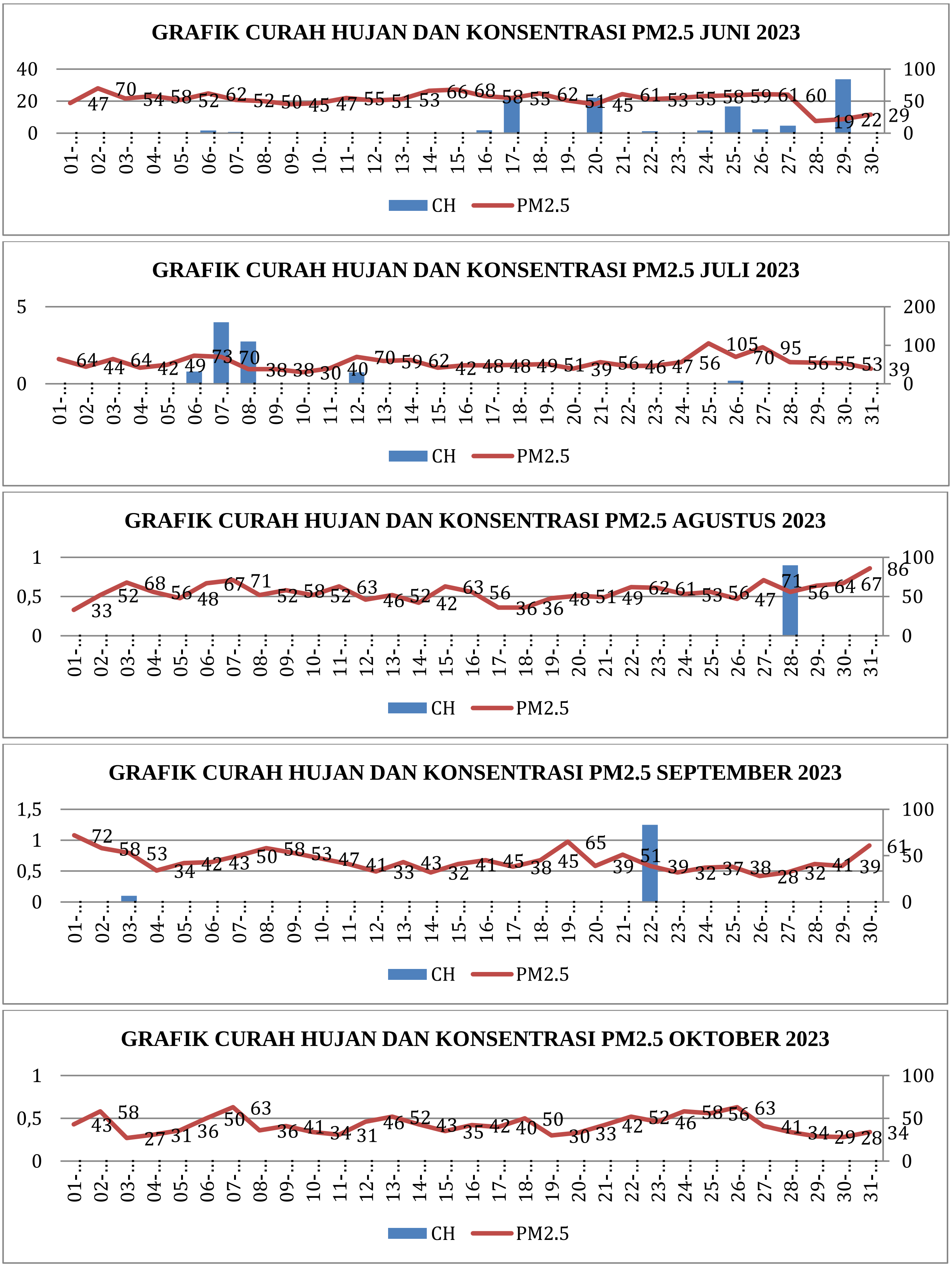


Figure 4. Rainfall Graph Against PM2.5 Concentration from January to October 2023 in Jakarta

Based on **Figure 4**, there is an influence of rainfall on PM2.5 concentration in Jakarta, as it is clearly seen that when the rainfall is high, the PM2.5 concentration in Jakarta will be low. Conversely, if the rainfall is low, the concentration of PM2.5 in Jakarta will be high.

Classical Assumption Test

Table 1. Test Results: (a) Kolmogorov - Smirnov Normality, (b) Heteroscedasticity, (c) Durbin-Watson (DW) Scale α=5%, (d) Autocorrelation, (e) Linearity.

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized Residual
N		304
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	17.29848045
Most Extreme Differences	Absolute	.033
	Positive	.023
	Negative	-.033
Test Statistic		.033
Asymp. Sig. (2-tailed)[c]		.200[d]

(a)

Coefficients[a]						
Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	14.267	.626		22.800	<.001
	Curah_Hujan	-.084	.049	-.098	-1.705	.089

a. Dependent Variable: ABS_RES

(b)

n	k=1	
	dL	dU
304	1.80529	1.818486

(c)

Model Summary[b]					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.251[a]	.063	.060	17.32710	.712

a. Predictors: (Constant), Curah_Hujan

b. Dependent Variable: Konsentrasi_PM2.5

(d)

ANOVA Table							
			Sum of Squares	df	Mean Squares	F	Sig.
KONSENTRASI_PM2.5 * CURAH_HUJAN	Between Groups	(Combined)	33161.198	79	419.762	1.479	.014
		Linearity	6076.415	1	6076.415	21.407	<.001
		Deviation from Linearity	27084.783	78	347.241	1.223	.129
	Within Groups		63584.157	224	283.858		
	Total		96745.355	303			

(e)

Based on **Table 2(a),** if the Sig value is > 0.05, then the residual values are normally distributed, and if the Sig value is < 0.05, then the data is not normally distributed. Based on the results of the Kolmogorov - S mirnov test above, it is known that the Sig. value is 0.200 > 0.05, so it can be concluded that the residual values are normally distributed.

Based on **Table 3(b),** if the Sig value is ≥ 0.05, then the data distribution does not show signs of heteroskedasticity, and if the Sig value is < 0.05, then the data distribution shows signs of heteroskedasticity. It is known that the Sig. value is 0.089 > 0.05, so it can be concluded that the data distribution does not exhibit heteroskedasticity symptoms. Based on

Table 4(c)(d), it can be concluded that there is no autocorrelation symptom because the value (4 – dW) > dU, where the value (4 – 0.712) > 1.818486.

Based on **Table 5(e),** it is known that the significance value of the linearity deviation is 0.129 > 0.05, so it can be concluded that there is a linear relationship between rainfall and PM2.5 concentration.

Hypothesis Test

Table 2. Test Results: (a) Coefficient, (b) Significance Value, (c) Simple Regression Coefficient, (d) Correlation of Rainfall to PM2.5 Concentration, (e) Hypothesis, (f) Coefficient of Determination.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.251[a]	.063	.060	17.32710

a. Predictors: (Constant), CURAH_HUJAN

b. Dependent Variable: KONSENTRASI_PM2.5

(a)

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6076.415	1	6076.415	20.239	<.001[b]
	Residual	90668.940	302	300.228		
	Total	96745.355	303			

a. Dependent Variable: KONSENTRASI_PM2.5

b. Predictors: (Constant), CURAH_HUJAN

(b)

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	43.195	1.059		40.780	<.001
	CURAH_HUJAN	-.373	.083	-.251	-4.499	<.001

a. Dependent Variable: KONSENTRASI_PM2.5

(c)

Correlations

		CURAH_HUJAN	KONSENTRASI_PM2.5
CURAH_HUJAN	Pearson Correlation	1	-.251**
	Sig. (2-tailed)		<.001
	N	304	304
KONSENTRASI_PM2.5	Pearson Correlation	-.251**	1
	Sig. (2-tailed)	<.001	
	N	304	304

**. Correlation is significant at the 0.01 level (2-tailed).

(d)

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	43.195	1.059		40.780	<.001
	CURAH_HUJAN	-.373	.083	-.251	-4.499	<.001

a. Dependent Variable: KONSENTRASI_PM2.5

(e)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error (the Estimat
1	.251[a]	.063	.060	17.327

a. Predictors: (Constant), CURAH_HUJAN

b. Dependent Variable: KONSENTRASI_PM2.5

(f)

Table 2(a), explains the magnitude of the correlation/value of the relationship (R), which is 0.251. From the table above, the coefficient of determination (R Square) is obtained at 0.063, indicating that the influence of the independent variable (precipitation) on the dependent variable (PM2.5 concentration) is 0.63%.

Based on **Table 2(b),** it is known that the calculated F value is 20.239 with a significance level of 0.001 < 0.05, thus the regression model can be used to predict the dependent variable (PM2.5 concentration), or in other words, there is an effect of the independent variable (precipitation) on the dependent variable. (konsentrasi PM2.5).

Based on **Table 2(c),** it is known that the value of the coefficient (a / constant) is 43.195, while the value of the independent variable (b / regression coefficient) is - 0.373. Thus, the regression equation can be written as:

$$\boldsymbol{Y = 43.195 - 0.373X}$$

Based on the equation above, the value of the constant is known to be 43.195.

Mathematically, this constant value indicates that when the rainfall is 0, the concentration of PM2.5 has a value of 43.195. Furthermore, the regression coefficient of X at - 0.373 indicates that for every 1% increase in rainfall, the concentration of PM2.5 will decrease by 0.373. The regression coefficient is negative, meaning that the relationship between the independent variable (rainfall) and the dependent variable (PM2.5 concentration) is inversely related.

Based on **Table 2(d)**, a Sig. value of 0.001 < 0.05, thus it can be concluded that the independent variable (rainfall) has an effect on the dependent variable (konsentrasi PM2.5).

Based on **Table 2(e)**, There are results from the hypothesis test :

1. Formulation of Hypothesis
   Ho : There is no effect of rainfall on PM2.5 concentration in Jakarta.
   Ha : There is an influence of rainfall on PM2.5 concentration in Jakarta.
2. Establishment of Criteria
   A Sig. value of 0.001 < 0.05, thus it can be concluded that the independent variable (rainfall) has an effect on the dependent variable. (konsentrasi PM2.5). It is known that calculated t_{count} is 4.499 > t_{table} of 1.960, so it can be concluded that the independent variable (rainfall) has an effect on the dependent variable (konsentrasi PM2.5).

   $t_{count} = \left(\frac{a}{2} : n - k - 1\right)$

   $= (0.05/2 : 304 - 1 - 1)$

   $= (0.025 : 302)$ shows that the distribution value t_{tabel}

   $= 1.960$
3. Decision Making
   If t_{count} > t_{table}, then the alternative hypothesis is accepted and the null hypothesis is rejected. The calculated t_{count} is 4.499 > t_{table} of 1.960, therefore the alternative hypothesis (Ha) is accepted and the null hypothesis (Ho) is rejected. In other words, rejecting the null hypothesis (Ho) and accepting the alternative hypothesis (Ha) for the testing of the two variables.
4. Conclusion
   It can be concluded that the independent variable (precipitation) has a significant effect on the dependent variable. (konsentrasi PM2.5). The results of the hypothesis testing proved that "There is a Significant Influence of Rainfall on PM2.5 Concentration in DKI Jakarta."

Based on **Table 2(f)**, after the calculated r_{count} is determined to be 0.251, the next step is to use the coefficient of determination R^2 expressed as a percentage to determine the level of influence of the independent variable (precipitation) on the dependent variable (PM2.5 concentration). Here are the results:

$R^2 = (0.251)^2 \times 100\%$

$R^2 = 0.063 \times 100\% = 6.3\%$

Based on the calculations above, it can be concluded that 6.3% of the dependent variable (PM2.5 concentration) is controlled by the independent variable (precipitation), while the remaining 93.7% is influenced by other factors.

The Role of Weather Modification Technology in Handling Air Pollution in DKI Jakarta

Particulate matter (PM2.5) is an indicator of pollution that is currently a major concern worldwide. The diameter is less than 2.5 μm. This is due to its very fine physical characteristics, which allow it to enter the human respiratory system and ultimately pose health risks. In addition, the chemical properties of PM2.5 matter have a negative impact on human health. Heart disease, lung cancer, and respiratory disorders can be caused by long-term exposure to PM2.(Wang et al., 2020).

The spread of pollutants is significantly influenced by the wind. Low wind speeds will cause pollutants to accumulate on the surface and harm human health as well as the environment, while high wind speeds can transport pollutants to other locations. The concept of wind is a mass of air that moves. When the wind forms, the air mass carries the pollutants within it as it moves. Thus, the wind facilitates the movement of pollutants from one location to another. One significant aspect of the climate that affects air quality is rainfall. Rain has the power to remove pollutants from the air, thereby reducing the amount of pollutants in the atmosphere.

Currently, air pollution is one of the pressing challenges in Indonesia, especially in urban areas. In recent times, the capital city of Jakarta has been in the spotlight due to its high pollution levels, ranking first for the worst air quality in Indonesia. According to the Meteorology, Climatology, and Geophysics Agency, the increasing air pollution in Jakarta is caused by the dry season. During the dry season, air pollution can increase because there is not much rain to wash away the pollutants, allowing them to remain in the air.

The President has instructed the relevant ministries/agencies to implement interventions that can improve air quality in Jabodetabek. One of the short-term solutions that must be implemented as soon as possible is Weather Modification Technology. With the implementation of Weather Modification Technology, it is hoped that rain can be accelerated to wet the Jabodetabek area in order to cleanse the air pollution and disrupt the layers that hold back air pollution, thus stabilizing the atmosphere.

Cloud seeding activities are used to mimic the processes that occur within clouds for Weather Modification Technology. Some hygroscopic particles carried by airplanes are intentionally injected or released directly into the clouds to initiate the process of water droplet accumulation within the clouds. Cumulus(Cu) clouds, which have the ability to transform into rain, are clouds that are used as seeding objects. Wind conditions will affect the cloud formation process. The strong wind conditions in the upper layers significantly disrupt the cloud formation process. The clouds that are forming are breaking apart due to the high wind speed, preventing the formation of cumulus clouds. Weather radar is very helpful in identifying potential clouds for seeding and is also used to obtain safe flight paths during cloud seeding. GPS is used to assist in guiding aircraft, recording and documenting the position and flight path of the aircraft during flight, as well as mapping the locations on a map where cloud seeding is conducted.

Table 3. Recap of the number of sorting, flight hours, and the use of seed materials during the implementation of Weather Modification Technology in Jabodetabek in 2023.

Pesawat	**Rekapitulasi Kegiatan Penerbangan TMC**	
CASA 212-200 (24 Agustus – 10 September 2023)	Jumlah Sorti	19 sorti
	Jam Terbang	29 jam 10 menit
	Bahan Semai NaCl	14.400 kg
	Bahan Semai CaO	800 kg

The Meteorology, Climatology, and Geophysics Agency (BMKG) has rain measurement instruments distributed at several points in the Greater Jakarta area. Although the rain gauge is a tool for measuring rainfall at a specific point, that information is still useful for assessing the success of Weather Modification Technology. Based on the rainfall gauge data from BMKG, during the period from August 24 to September 10, 2023, light rain events were observed in the Jabodetabek area, with an average regional value ranging from 0 to 24.50 mm/day, as shown in **Table 4.** The highest rainfall occurred on August 28, 2023, measuring 24.50 mm/day.

Table 4. (a) Rainfall During Cloud Seeding Activities in Jabodetabek, (b) Concentration of PM2.5 During Cloud Seeding Activities in Jakarta

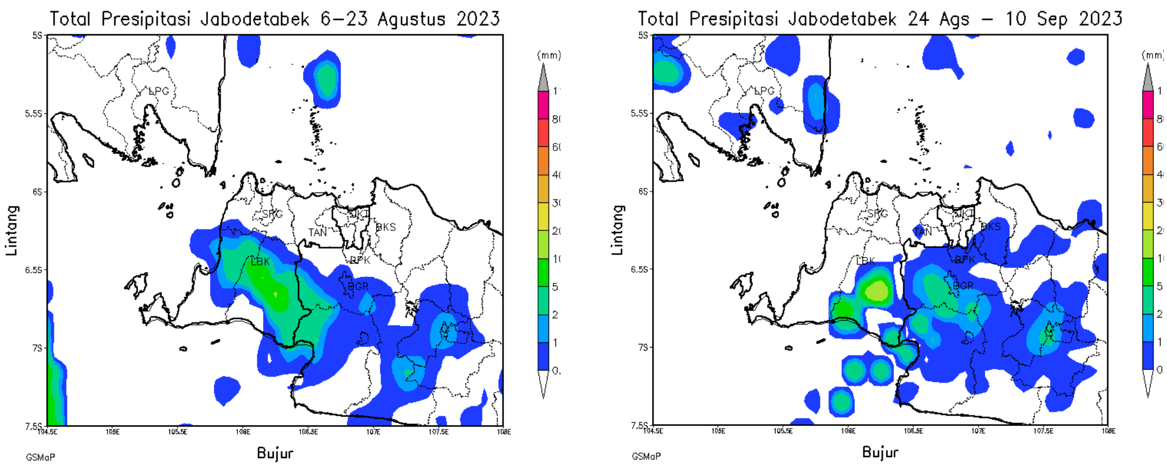
RATA-RATA CURAH HUJAN DI JABODETABEK PERIODE 24 AGUSTUS S.D 10 SEPTEMBER 2023 (mm/hari)																	
24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10
0,00	0,00	0,17	0,00	24,50	0,00	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	3,86	0,80	0,00

(a)

RATA-RATA KONSENTRASI PM2.5 DI JAKARTA PERIODE 24 AGUSTUS S.D 10 SEPTEMBER 2023 ($\mu g/m^3$)																	
24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10
53	56	47	71	56	64	67	39	72	58	53	34	42	43	50	58	53	47

(b)

Based on **Table 4(a)** and **Table 4(b),** on August 28, 2023, the high rainfall affected the decrease in the PM2.5 concentration index from 71 $\mu g/m^3$ to 56 $\mu g/m^3$. This condition may indicate that rainwater is an effective substance for cleansing the atmosphere of the pollutants that cover it.



(a) (b)

Figure 5. Distribution of Rainfall (a) Before the Implementation of Weather Modification Technology (August 6 - 23, 2023) in Jabodetabek, (b) Rainfall During the Implementation of Weather Modification Technology (August 24 - September 10, 2023) in Jabodetabek.

The rainfall distribution map with GSMaP rainfall data for the period before the implementation of Weather Modification Technology from August 6 to 23, 2023, in Jabodetabek is presented in the **Figure 5(a).** From the image, it can be observed that most areas of DKI Jakarta, Depok, Bekasi, and Tangerang are colored white, indicating that the rainfall recorded is between 0-0.1 mm over 18 days. Meanwhile, in the Bogor area, the rainfall varies significantly; some regions, particularly in the south, experience high rainfall of 1-5 mm over 18 days, while other areas, such as in the north, have low rainfall of 0.1 mm over 18 days.

The rainfall distribution map with GSMaP rainfall data for the period during the implementation of Weather Modification Technology from August 24 to September 10, 2023, in Jabodetabek is presented in the **Figure 5(b).** From the image, a small portion of the DKI Jakarta and Tangerang areas is observed in white, indicating that the rainfall recorded is 0-0.1 mm over 18 days. The Depok area is shown in blue, meaning the rainfall recorded is 0.1-1 mm over 18 days, while most of the Bekasi and Bogor areas have rainfall amounts of 0-5 mm over the same period.

When compared to the rainfall during the same period before the implementation of the Weather Modification Technology, specifically from August 6 to August 23, 2023 **Figure 5(a**), it can be observed that there was an increase in rainfall, particularly in the DKI Jakarta, Depok, Tangerang, and Bekasi areas with a fairly even rainfall distribution pattern, where prior to the implementation of Weather Modification Technology, no rainfall was recorded.

CONCLUSION AND SUGGESTION

Conclusion

Based on the results of the secondary data analysis, it was found that the rainfall data from January to October 2023 obtained from BMKG and the PM2.5 concentration data from January to October 2023 obtained from KLHK Senayan, as explained in the previous chapter, can be concluded as follows:

1. With the help of IBM SPSS software, a simple linear regression analysis was conducted, resulting in the following simple linear regression equation regarding the effect of rainfall on PM2.5 concentration in Jakarta:

   Y = 43.195 - 0.373X
2. There is a correlation between the independent variable, which is rainfall, and the dependent variable, which is PM2.5 concentration, with a correlation value of -0.251 (indicating a weak correlation).
3. There is an effect of the independent variable, which is rainfall, on the dependent variable, which is PM2.5 concentration, of 6.3%. Meanwhile, 93.7% is attributed to other factors/parameters not studied by the researcher, such as PM10 concentration, NO_2 (nitrogen dioxide), SO_2 (sulfur dioxide), CO (carbon monoxide), O_3 (ozone), and HC (hidrokarbon).

The implementation of Weather Modification Technology in Jabodetabek, which took place from August 24 to September 10, 2023, conducted 19 flight sorties for cloud seeding with a total flight time of 29 hours and 10 minutes, using a total of 14,400 kg of NaCl and 800 kg of CaO. During the implementation of Weather Modification Technology, there was an increase in rainfall, especially in the DKI Jakarta, Depok, Tangerang and Bekasi areas with a fairly even rainfall distribution pattern, where before the implementation of Weather Modification Technology there was no rainfall observed, especially in the DKI Jakarta, Depok, Tangerang and Bekasi areas..The region with the highest rainfall is Bogor, with cumulative rainfall intensity ranging from 0 - 5 mm/18 days. Meanwhile, the areas of DKI Jakarta, Depok, Tangerang, and Bekasi received cumulative rainfall ranging from 0 - 1 mm/18 days, and this indicated that the rain produced by Weather Modification Technology was effective in reducing the pollutant index.

Suggestion

This research focuses solely on the variables of rainfall and PM2.5 concentration. It is recommended that future studies examine rainfall in conjunction with other air pollutant factors/parameters such as PM10 concentration, NO_2 (nitrogen dioxide), SO_2 (sulfur dioxide), CO (carbon monoxide), O_3 (ozone), and HC.(hidrokarbon).

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