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BOGOR AGRICULTURAL UNIVERSITY
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FOREWORD

e International Seminar on Sciences 2013, which had the main theme "Perspectives on Innovative ences", was organized on November 15th -17th, 2013 by the Faculty of Mathematics and Natural ences, Bogor Agricultural University. This event aimed at sharing knowledge and expertise, as well building network and collaborations among scientists from various institutions at national and ernational level.

entific presentations in this seminar consisted of a keynote speech, some invited speeches, and out 120 contributions of oral and poster presentations. Among the contributions, 66 full papers ve been submitted and reviewed to be published in this proceeding. These papers were clustered in ır groups according to our themes:

A. Sustainability and Science Based Agriculture

B. Science of Complexity

C. Mathematics, Statistics and Computer Science

D. Biosciences and Bioresources

this occasion, we would like to express our thanks and gratitude to our distinguished keynote and ited speakers: Minister of Science and Technology, Prof. Manabu D. Yamanaka (Kobe University, an), Prof. Kanaya (Nara Institute of Science and Technology, NAIST, Japan), Prof. Ken Tanaka yama University, Japan), Emmanuel Paradis, PhD. (Institut de Recherche pour le Développement,), France), Prof. Dr. Ir. Rizaldi Boer, MS (Bogor Agricultural University), and Prof. Dr. Ir. Antonius wanto, M.Sc. (Bogor Agricultural University).

would like also to extend our thanks and appreciation to all participants and referees for the nderful cooperation, the great coordination, and the fascinating efforts. Appreciation and special nks are addressed to our colleagues and staffs who help in editing process. Finally, we nowledge and express our thanks to all friends, colleagues, and staffs of the Faculty of thematics and Natural Sciences IPB for their help and support.

gor, March 2014

Organizing Committee

ernational Seminar on Sciences 2013

Table of Content

D. Biosciences and Bioresources 323

Prediction of Dustfall Generation in Ambient Air over an Inceptisol Soil Area

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Abstract

Air quality deterioration due to bare land mishandling tends to increase according to the human activity acceleration. The environmental impact thereof is an increase of dustfall and particulate matter concentration in ambient air, increase of human respiratory diseases as well as visibility reduction. The objective of the research is firstly to measure dustfall concentration in ambient air over an area of which the land consisted of mainly Inceptisol soil. The second objective is to measure dustfall concentration in a laboratory scale ambient air. The third objective is to develop a mathematical model to predict dustfall concentration in ambient air as influenced by soil water content and wind speed. The field experiment was conducted in an open area in Bogor Municipality where the land consisted mainly of Inceptisol soil. The laboratory experiment was conducted in a tunnel model where the land surface was covered by Inceptisol soil layer of 3 cm depth. The development of mathematical model was based on those field and laboratory experiments. The materials and instruments used during the field and laboratory experiments were a set of dustfall canister [AS-2011-1], blower [Hercules; Ø 60 cm; 220 V; 170 W], digital anemometer [Lutron AM-4201], digital moisture tester [OGA TA-5], tunnel [7.6 m length; 0.76 m width; 2.4 m height], analytical balance [OHAUS Aventuror Pro], Petri dish [Ø=80 mm], filter paper 10μ [Whatmann #41], universal oven [UNB 400] and timer. The result of the experiments showed that average dustfall concentration in ambient air was 8.6 and 11.1 [ton/km^2.month] for field and laboratory scale experiment, respectively. The fittest mathematical model to predict dustfall generation [Y] over an area of Inceptisol soil as influenced by wind speed was $Y=8.87x^2-2.34x+5.198$ where "x" denoted the wind speed over the land. The prediction model as influenced by moisture content was $Y=259.1-11.7x$ where "x" represents the soil moisture content. The result of the experiment indicated that dustfall concentration in ambient air was strongly influenced by soil moisture content.

***Keywords:** ambient air, dustfall, generation, inceptisol, soil moisture content.*

I. INTRODUCTION

Naturally dustfall can be generated from dry soil carried out by the wind. Certain wind speed can lead to the lifting of the fines fractions of the soil surface resulting in dustfall [4, 20]. Based on the study [6], concentration of dustfall increases with increasing soil erosion due to wind. Judging from the pattern of movement by the wind, dustfall can impact both locally and globally on the ecosystem [7]. Factors affecting soil erosion are [3, 5, 8, 11, 13, 18, 19]: (1) Energy (erosivity), including the potential ability of rain and surface runoff/wind, (2) Sensitivity of land (erodibility), depending on the physical, mechanical and chemical factors, and (3) protection, dealing with land cover.

Levels of air pollution including dustfall on certain areas correlated with a combination of local meteorological factors [2]. On this basis, th objective of the research were to measure dustfal concentration in ambient air over an area o Inceptisol soil which is one of the major soil types i Java [15], to measure dustfall concentration in laboratory scale ambient air, and to develop mathematical model to predict dustfall concentratio in ambient air as influenced by soil water conter and wind speed.

II. RESEARCH METHODS

This study was carried out in February t March 2013. Measurements were carried ou over an open area of Inceptisol soil in th Bogor Municipality and laboratory c Environmental Engineering of the Departmer of Civil and Environmental Engineering.

The materials and instruments used during the field and laboratory experiments were a set of dustfall canister [AS-2011-1], blower [Hercules; Ø 60 cm; 220 V; 170 W digital anemometer [Lutron AM-4201], digit moisture tester [OGA TA-5], tunnel [7.6 r length; 0.76 m width; 2.4 m height], analytical balance [OHAUS Aventuror Pro], Petri dish [Ø=80 mm], filter paper 10μ [Whatmann #41], universal oven [UNB 400] and timer.

A. Measurement of Dustfall Generation in the Field and Laboratory

The placement of Dustfall Canister during direct measurements in the field was done according with national reference [14]. Measurements of soil moisture content and wind speed were conducted three times per day. The steps of dustfall concentration measurement in the field are presented in Fig. 1.

The laboratory experiment was conducted in a tunnel where the land surface was covered by Inceptisol soil layer of 3 cm depth (Fig. 2). Wind with 1.2 m/s speed was mechanically generated by a blower 1.5 m above soil surface in the tunnel, thus forming a dustfall generation in the ambient air and hence the soil water content decreases. Generation of the dustfall was measured based on the method as shown in Fig. 1.

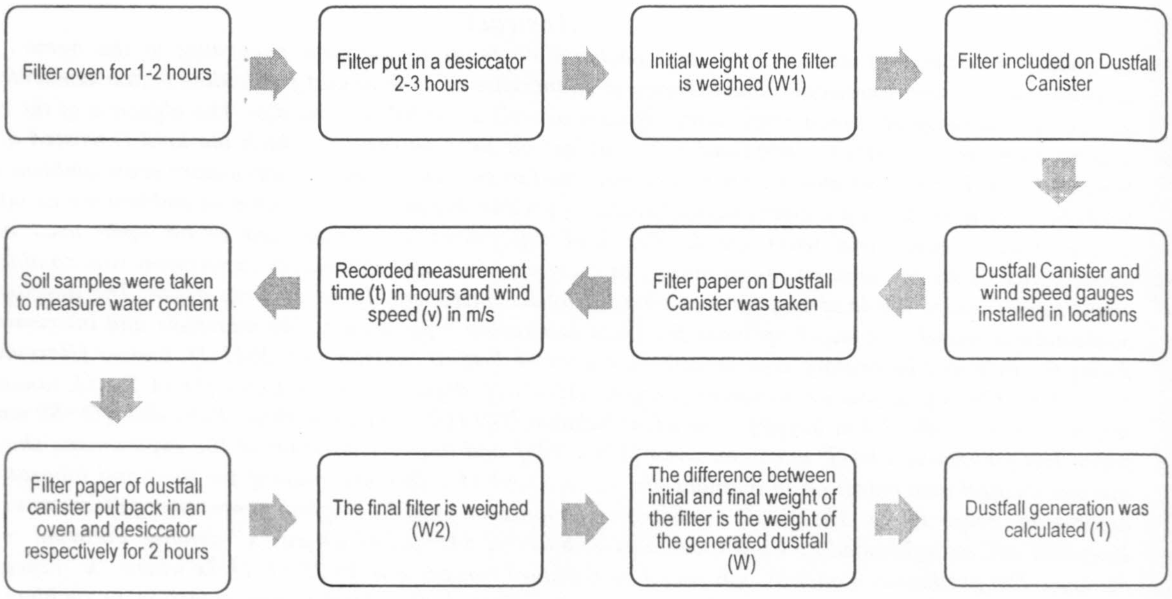


Fig. 1. Method of measuring the concentration of dustfall

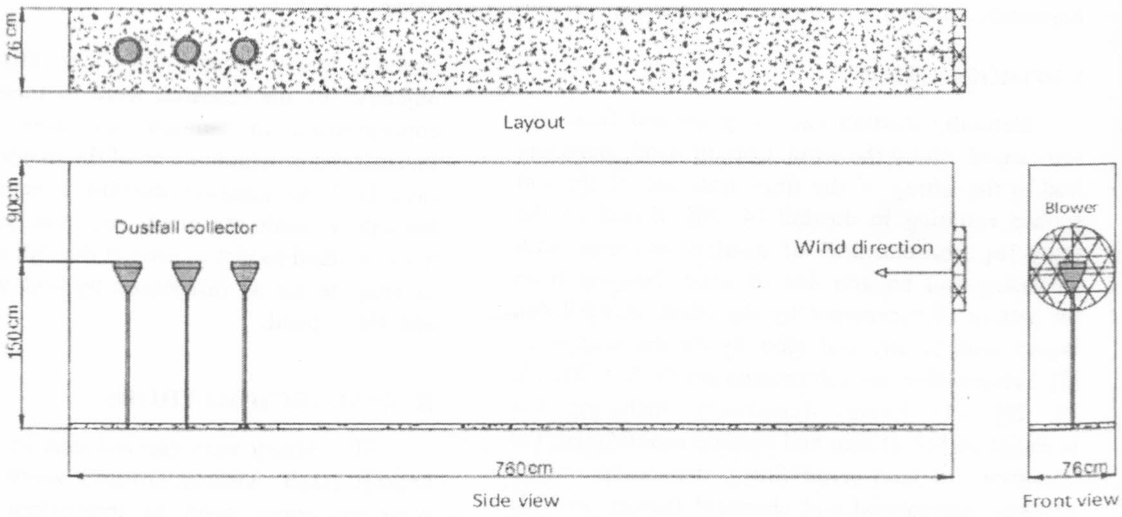


Fig. 2. Tunnel for the measurement of dustfall

$$C = \frac{W}{A \times T} \qquad (1)$$

Remarks:
W = dustfall weight (tons)
A = surface area of canister (km^2)
C = dustfall generation ($ton/km^2.month$)
T = measurement time (months)

B. Data Analysis Procedures

Referring to the book [16], the data analysis techniques used in this study is Pearson Correlation Technique. Data analysis was performed with the aid of a personal computer using data processing program Minitab. The development of mathematical model was based on those field and laboratory experiments.

III. RESULTS AND DISCUSSION

A. Measurement of Dustfall Generation in the Field

Generally, dustfall generation in the field was under the governmental standard according to the PP. 41 of 1999 pertaining on Air Pollution Control except on the land clearing location of the Forester Housing (Fig. 3). Dustfall generation on land clearing location of Forester Housing has a high value due to land at the site includes the land disturbed by human activities, so that the dustfall generation tends to be larger, while the dustfall generation in open fields (Gymnasium IPB) and in Carangpulang Village were relatively low due to the presence of trees and less human activities around the measurement point. Measurement of dustfall generation in the field is influenced by local conditions such as buildings and trees, topography (valley and mountain) and local weather or meteorological factors.

(a) (b) (c)

Fig. 3. Measurement of dustfall generation in Carangpulang Village (a); Gymnasium IPB (b); land clearing location of Forester Housing (c)

Based on the results of the correlation analysis with Pearson Correlation Technique, P-value generated in field measurements is less than the value of α (0.05). Thus, it indicated that there is a real relation between the dustfall generation, wind speed and soil water content on Inceptisol soil. The resulting Pearson correlation coefficient showed a negative correlation between the dustfall generation and the soil moisture content and a positive correlation between the dustfall generation and the wind speed. This means that the higher soil moisture content, the lower dustfall generation is formed. However, with higher wind speed, the dustfall generation formed will too high. This is consistent with research [3] where the increase in soil moisture content will increase the cohesive forces between soil particles, so it requires a higher wind speed to lift the fine fractions of the soil surface in wet conditions. Minitab Output on the measurement results directly in the field is given in Table 1. Measurement result of dustfall generation in the field is presented in Table 2.

Table 1. Minitab Output of correlation measurements in the field

Parameters		Magnitude
Pearson coefficient of dustfall and soil moisture content		-0.511
P-Value		0.011
R-Sq (%)	linear relationship	26.1
	quadratic relationship	27.4
Pearson coefficient of dustfall and wind speed		0.434
P-value		0.034
R-Sq (%)	linear relationship	18.8
	quadratic relationship	19.2

Table 2. Measurement results of dustfall generation in the field

Location	Dustfall Generation (ton/km^2.month)	Wind speed (m/s)	Soil moisture content (%)
Carangpulang Village	0.8-8.6	0.1-1.5	26.2-35
Gymnasium IPB	0.4-16.7	0.1-1.0	18.0-29.2
Land clearing of Forester Housing	8.4-16.8	0.1-2.0	17.8-32.0

B. Measurement of Dustfall Generation in the Laboratory

Laboratory measurement of dustfall generation is carried out in a tunnel with 7.6 m long, 0.76 m wide and 2.4 m high. Measurement of dustfall generation on soil samples in the tunnel is presented in Fig. 4. In contrast to direct measurements in the field (open area), the influence of external factors in the laboratory measurements is removed by using a tunnel. This is because laboratory measurement can be more controlled than the field measurement one. Dustfall generation from the laboratory measurements under 1.2 m/s wind speed and 20.6-21.6% soil moisture content was 2.9-19.2 ton/km^2.month.

Correlation is also indicated in the relationship between the dustfall generation, wind speed and soil water content in the laboratory measurements with the P-value less than α (0.05). The resulted Pearson coefficient showed that the soil moisture content was negatively correlated with the dustfall generation. Minitab output result of the measurements in the laboratory is presented in Table 3.

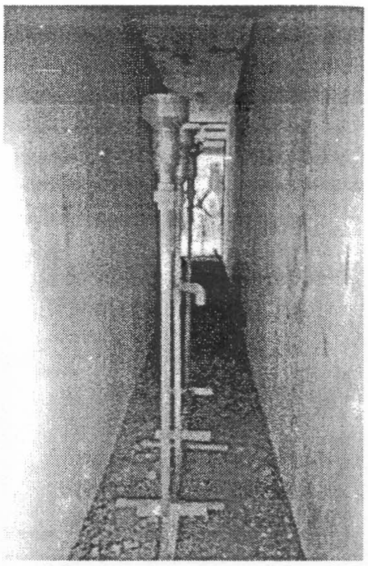


Fig. 4. Tunnel for measurement of dustfall generation on the soil samples

Table 3. Output Minitab correlation measurements in the laboratory

Parameters		Magnitude
Pearson coefficient of dustfall and soil moisture content		-0.852
P-Value		0.004
R-Sq (%)	linear relationship	72.6
	quadratic relationship	83.9

C. Correlation between Dustfall Generation, Wind Speed and Soil Moisture Content

Correlation between dustfall generation and wind speed on Inceptisol soil is quadratic with R-Sq 19.6% for wind speed 0.1-1.0 m/s (Fig. 5). It showed that dustfall generation on Inceptisol soil was influenced by local wind speed of 19.6%.

The relationship between dustfall generation and soil moisture content in the field is a quadratic one whereas such relationship in the laboratory scale is linear (Fig. 6). This quadratic relationship indicates that soil moisture content to a certain extent will not significantly influence the reduction of dustfall generation. Soil moisture content affects 27.4% (R-Sq=27.4%) of the dustfall generation in the field measurements with soil water content 17.8-35%, while for measurements in the laboratory on soil water content 20.6-21.6% obtained R-Sq 72.6 %.

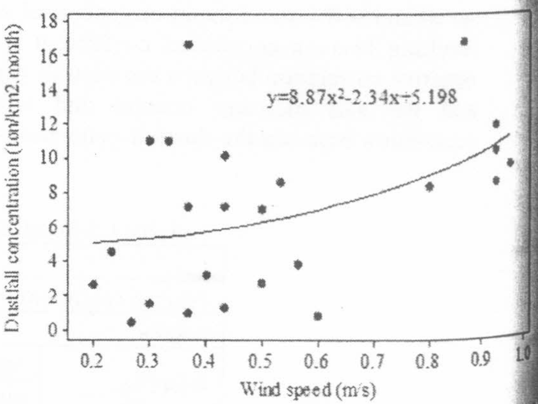
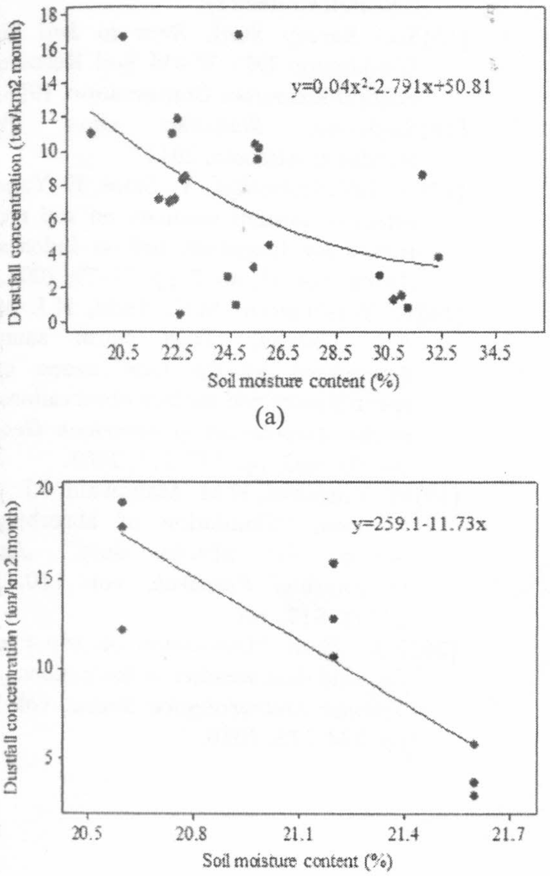


Fig. 5. Correlation between dustfall and wind speed on Inceptisol soil

The minor influence of the soil moisture content on the dustfall generation in the field measurements could be due to other factors that were not taken into account in this research.

Besides the wind speed, meteorological factors that could influence the measurement of dustfall directly in the field are temperature, relative humidity and atmospheric pressure [2]. Based on the research [9], direct influence of relative humidity on dustfall generation formed in the field was as much as 58.1%, whereas influences of wind speed and soil moisture content were 66.9% and 52.8%, respectively.



(a)

(b)

Fig. 6. Correlation between dustfall and soil moisture content in the field (a) and in the laboratory (b)

Soil texture is also suspected to affect the correlation between dustfall generation, wind speed and soil moisture content. Soil texture is an important factor in soil erodibility for determining soil texture consistency, cohesion and soil mobility [10]. Based on the research result [17], Inceptisol soil has 70.71% clay content, 23.74% loam and 5.55% sand. High clay content in the Inceptisol soil has led to a texture which tends to be sticky when it is wet and cohesive forces between grains of soil is high. As a result, generation of dustfall would be low.

Besides soil texture, wind speed and soil moisture content, the dustfall generation in the field was influenced by the C-organic content as well. C-organic content of the soil affects the physical properties of the soil as it serves an adhesive force between the soil particles. C-organic content of the Inceptisol soil that was determined by titration in acidic medium soil was 3.3% per gram soil samples [1].

IV. CONCLUSSION AND SUGGESTIONS

A. Conclusion

Dustfall concentration in ambient air was 8.6 ton/km^2.month for field measurement and 11.1 ton/km^2.month for laboratory scale experiment. Dustfall generation was positively correlated with wind speed and negatively correlated with soil moisture content. The fittest mathematical model to predict dustfall generation [Y] over an area of Inceptisol soil as influenced by wind speed was $Y=8.87x^2-2.34x+5.198$ where "x" denoted the wind speed over the land. The prediction model as influenced by moisture content was Y=259.1-11.7x where "x" represents the soil moisture content. The result of the experiment indicated that dustfall concentration in ambient air was strongly influenced by soil moisture content.

B. Suggestions

1. The next research should be carried out on the other main soil types commonly found in Indonesia, i.e. Ultisol, Andisol, Vertisol and Entisol.
2. Other meteorological factors such as relative humidity, temperature and sunshine intensity need to be taken into account in determining the dustfall generation from the soil surface.
3. The influence of soil texture, organic-C content and the percentage of land cover on dustfall generation needs to be studied so that the analysis of the correlation between these factors become more comprehensive.

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