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Recent Trends in Physics of Material Science and Technology

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Ford Lumban Gaol · Keshav Shrivastava
Jamil Akhtar
Editors

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Editors
Ford Lumban Gaol
Bina Nusantara University
Jakarta
Indonesia

Jamil Akhtar
Sensors and Nano-Technology Group
CEERI Pilani
Pilani
India

Keshav Shrivastava
University of Malaya
Kuala Lumpur
Malaysia

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Contents

Characteristic of Coal Stockpile in Lowland and the Effect to Environment

Rusdianasari, Susila Arita, Eddy Ibrahim and Ngudiantoro

Abstract Coal stockpile is a temporary shelter before they are sent to the consument and is the operational center for a coal port. Stockpile is also used to mix coal in order to fit the needs of homogenization. Coal stockpile has wetlands in the flat topography lowlands affected by the tide. Influence the ups and downs of sea water is higher in this region compared to the influence of rainfall. Liquid waste from run-off and coal stockpile wetting is containing suspended solids and some dissolved substances. The existence of liquid waste from leachate can reduce the degree of acidity (pH) and increase the content of total suspended solids (TSS), iron (Fe) and manganese (Mn). Monitoring the effect to the environment on the coal stockpile is intended to perform an environmental assessment of the effect which arise due to the existence and operation of coal accumulation. Effect analysis based on the value of the effluent, air pollution (dust), soil and water by looking at the parameters of the coal waste water pH, TSS, metals Mn, and Fe, the total suspended particulates (TSP) parameters of air pollution and noise, and soil pollution in the form of physical and chemical characteristic of the soil.

1 Description of Stockpile

Coal stockpile is temporary shelter of coal before it is sent to consument and center of operational for a Coal Port. Coal which is mined from the mine site will be brought into the port of coal by road and then shipped to the consument. Stockpile serves as a buffer between the delivery and processing process, as well inventories, strategic and minimize short-term disruption or long term. It also serves as a mixing and distribution place by type of coal to conform with the request as required. Besides these purposes, the stockpile is also used to mix coal so the homogenization

Rusdianasari (✉) · S. Arita · E. Ibrahim · Ngudiantoro
State Polytechnic of Sriwijaya, Palembang, Indonesia
e-mail: diana-vsi@yahoo.com

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process as needed. Homogenization aims to prepare the products from one type of material in which fluctuations in coal quality and size distribution are equated. In the homogenization process there are two types of blending and mixing [1].

Stockpile management is the process of setting or procedure which consists of the quality setting of the coal in the stockpile build up procedure. This is done as an effort to make coal produced can be controlled, both quality and quantity. In addition stockpile management is also intended to reduce the losses that may appear from the handling process or handling of coal in the stockpile, such as rain, dust in the dry season, or burnt caused of coal burnt in the stockpile. Coal stockpiling setting is very important because it is related with the maintenance problems of quantity and quality of coal stacked in the stockpile [2].

1.1 Types of Stockpile Based on the System of Stockpiling

There are some types of stockpiles based on the system of stockpiling, as follows [3, 4]:

a. *Cone ply* is a system with a cone shape on one of end point until the required height is reached and continued based on long of stockpile. This system uses bulk tools, such as stacker reclaimer (Fig. 1).
b. *Chevron* is a system by stockpiling placement in one line material, along stockpile and stack frequently until reaches the required height. This system is good for bulk tools such as: belt conveyor or stacker reclaimer (Fig. 2).
c. *Chevcon* is a combination of stockpiling between cone ply system and chevron system (Fig. 3).

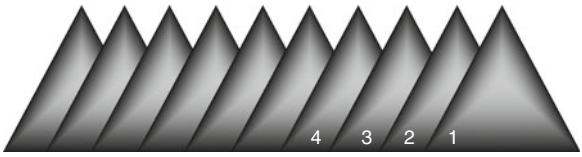


Fig. 1 Cone ply system

Fig. 2 Chevron system

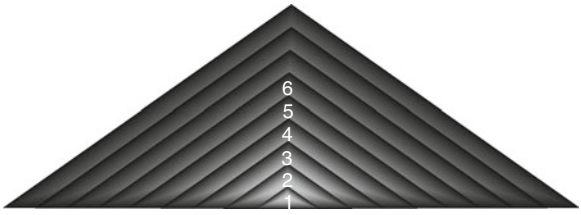
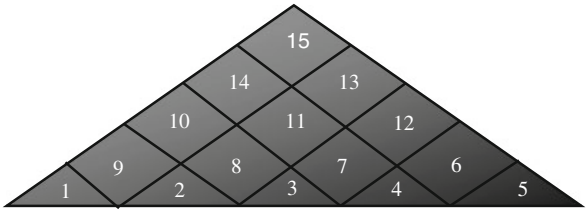


Fig. 3 Windrow system



1,2,3,4,5,6,.... = sequences of stockpiling

d. *Windrow* is a system with stacks in parallel lines along the width of the stockpile and continued until the required height is reached. Commonly is used in tools such as: the backhoe, bulldozers, and loaders.

Coal stockpile where the study was conducted, Stockpile system is using chevron type because: contour shape, types of tools used, ease of handling, and to avoid self heating.

1.2 Technical Terms of Stockpiling

In the implementation of the stockpiling and demolition process must be regulated well. This is to avoid the stockpiling overcapacity. In this case technical Terms of stockpiling include [3]:

a. Coal quality
Coal as one of the technical terms of stockpiling should also be considered. Coal which is influential as follows:

(1) Coal which is stockpiled is one type
To avoid higher grade coal is burnt so for each stockpiling location is used similar coal (same grade and quality). That is because a lower grade coal is easier and faster to be burnt by itself, so heat from a lower grade coal accumulated and will influence higher grade coal to be burnt.

(2) Grain Size
Grain size has an influence to self heating indication, so in the coal stockpile handling should avoid coal production with the same size, because same grain size will make large enough space in stockpile and it's easy to happen the flow of air.

b. Basic surface design of stockpile
Basic surface of stockpile must be stabilized and bedding by using material which is strong enough to support the weight of coal stockpile. In addition basic surface of stockpile must be slightly convex to make drainage of stockpile fluently. It is intended to prevent puddle which is trapped in the middle of stockpile when it is rain. In stockpile with cone shape, the weight point will be

around the center of circle. This will make basic of stockpile will be decrease. If occurs decrease of basic of stockpile, it will make water is trapped in cavity which make difference humidity in stockpile which in the long term will make self heating or be accelerator when the temperature of top coal is increase [5].

c. Stockpile place condition
Stockpile place condition which influence to technical term of stockpile as follows:

(1) Clean area stockpile
Coal stockpile area must be free of all of the flammable material such as wood and waste. Besides it must be free of a pieces metals.

(2) Source of water with high pressure
Source of water with high pressure is very required if there is burning process around stockpile, example hidrant. Source of water with high pressure is required if there is burning around stockpile if it is not immediately extinguished then will influence temperature of stockpile will be increase and self heating process will be happened in stockpile.

(3) Making conduit surroundings stockpile
To drain water from coal stockpile is well which is from rain, and from water spraying surrounding stockpile area must be made conduit which is finally drain to settling pond. Water which is through coal stockpile will dissolve small coal from coal stockpile, so that small coal will be carried by water flow. Therefore before water is drained to river, it needs water treatment for water from that stockpile, or at least making settling pond. It will make small coal which is carried by water flow from stockpile, and it will not contaminated environment especially river. Besides settling pond, if the water from settling pond has pH < 7, it must be neutralized. Acid water neutralization with calcium carbonate and will be treated after through settling pond or before is drained to river or sea.

(4) Stockpile position
Stockpile Position must be considered to wind direction. Stockpile position is not facing wind direction, especially for long stockpile to avoid oxidation process in Stockpile [5].

1.3 Coal Delivery

Coal delivery is activity to load and unload coal which is in stockpile. Stockpile delivery has some system as follows [2]:

a. LIFO (*Last In First Out*) System is a system where the last coal which is stockpiled will be taken for the first. In this system stockpiling process based on schedule but when delivery process the last coal which is stockpiled will be delivered in the first so this system may make coal is stockpiled for a long time.

b. FIFO (*First In First Out*) System is a system where the first coal which is stockpiled will be taken for the first too. FIFO management in each stockpile for the Coal Company and in the end user must be done. Because it will prevent the risk of spontaneous burning in the stockpile. It because if coal is exposed into the air it will make coal is oxidate and it means will be happened self heating until spontaneous burning. Usually FIFO management is threated with quality problem. Sometime coal which has stockpiled in the first in stockpile, it can not load and deliver with the reason that the quality is not required. But every FIFO management must be priority because besides as preventing some problem, FIFO system is cheapest.

1.4 Potential Effects of Coal Stockpiling

Potential effects of coal stockpiling is an effect or impact that could potentially appear from coal stockpiling. Potential effects of coal stockpiling varies in different types of coal, depending on the method of stockpiling [6]. Some potential effects of coal stockpiling that often occurs is as follows:

a. Self heating and self heating factor of coal stockpiling
Self heating of coal stockpiling is a common thing and should get the attention especially on large coal stockpiling. Coal will oxidize when exposed on the surface during mining, so coal which is stockpiled will be oxidized continuously. The result of the oxidation reaction between oxygen and volatile gases from volatile matter in coal will produce heat [7].
When the oxidation reaction happens continuously, heat product will be increase, it also happens to coal stockpile. This temperature increase is also due to air circulation and heat in the stockpile is not fluently, so the temperature in the stockpile will accumulate and increase until it reaches the point of combustion temperature, which can eventually lead to self heating on the stockpile [8].
Some factors which cause coal self heating process, among others:

(1) Stockpiling time
The longer coal will accumulate more heat which is stored in the stockpile, because the volume of air contained in the larger deposits, so the oxidation rate becomes higher.

(2) Stockpiling methods
In a stockpile of coal needs to get compaction. With the compaction will be able to inhibit the occurrence of coal's self heating, because the space between the grains of the material between the coal is reduced. The tool used for compaction is track dozer.

(3) Stockpiling conditions
Influence on the process conditions of self heating coal stockpiling, namely:

- High of stockpile
  Height of the stockpile is too high will cause more heat is absorbed, it is because of the hypotenuse is formed will become longer, so the area is not compacted will be more extensive and will result in greater surface oxidized. Bituminous coal are stockpiled for more than 30 days should be the maximum height of stockpile are 6 m. As for the lignite coal stockpile are stockpiled for more than 14 days and the maximum height of stockpile are 4 m.
- Angle stockpiles
  Angle which is formed from a stack on the stockpile should be smaller than the angle of repose of coal mine. In general, coarse-sized material has a larger angle of repose than fine-sized material. The slope of the coal's stockpile are quite ideal is 38°.
- Grain size
  Basically the larger the surface area in direct contact with the outside air, the faster the combustion process itself happens. Conversely the larger the size of the lump of coal, the slower the swabakar process. Grain size of coal also affects the rate of the Oxidation Process. The more uniform grain size in a large stockpile of coal, the greater porosity and consequently the greater permeability of outside air to be circulated in the coal stockpile.

(4) Coal Parameter
Parameters which is affecting self heating coal is as described at the beginning of this theory. Indication is affected the rate of oxidation increases as the decrease self heating coal rank.

(5) Self heating temperature
All types of coal have indication to happen self heating process, but the time required and the temperature required for the self heating process is not same. For low rank coals have require a shorter time and lower temperature when compared to coal that has a high rank.

2 The Characteristics of Coal Stockpile in Lowlands

Coal stockpile at Muara Telang, Banyuasin Regency, South Sumatra, Indonesia, is one of the few existing stockpile at the Port of Tanjung Api Api region in the lowlands area which is affected by the tides. Stockpile location located at coordinates 02° 31′00.22″S–02° 31′05.5″S 104° 48′00.7″E and 02° 30′37.6″S–02° 31′ 24.3″S 104° 48′18.11″E–104° 48′20.6″E, with an area ±61.09 Ha [9].

Coal stockpile at Muara Telang has flat topografi which is influenced by tide and wet tropical climate. Stockpile dimensions with a maximum height of stockpile ±15 m, with an angle of stockpile on conveyor belt, angle stockpile which is formed about 25°–30°, while angle stockpile which is pushed by bulldozer is 38°–44°,

grain size about 1–30 cm for coal from mine and 50–100 mesh for coal blending. The quality of coal in stockpile contain total moisture 30.19 %, ash content 6.63 %, volatile matter 41.05 %, fixed carbon 40.28 %, total sulfur 0.67 % and calorific value 5,926 kcal/kg.

3 Environment Quality of Coal Stockpile

3.1 Air Quality in Stockpile

a. Temperature
   Air temperature measurements are required, in which the gas content in the air is inversely proportional. At low temperatures, the concentration of gas pollutant in the air is considerably high (floating near the surface of the earth), increasing air temperature lowering the gas pollutant in air (gas rises in the atmosphere). The temperature of the air in coal stockpile locations ranged from 29.8 to 31.8 °C [9].
b. Carbon Monoxide (CO)
   Carbon monoxide is a toxic gas that is colorless, odorless, and has no taste. This component has a weight of 96.5 % of the weight of the water and does not dissolve in water. Carbon monoxide is present in nature from incomplete combustion of the carbon or carbon-containing components, the reaction between carbon dioxide and carbon-containing components at high temperatures, the carbon dioxide will decompose into carbon monoxide and oxygen.
   Several studies have shown, the effect of CO on plant is usually not seen in practice. Effect of CO in humans at high concentrations can cause death, whereas contact with CO at relatively low concentrations (30,000 ppm or less) can be detrimental to health. Effect of CO on the human body is mainly caused by the reaction of CO with hemoglobin (Hb) in the blood.
   The results of measurements taken at four sampling points below the level of CO was established standards 77–124 μg/Nm^3. For the content of CO in residential location, the content of CO is generally derived from the activity of motor vehicles and household activities [9].
c. Sulfur dioxide (SO_2)
   Pollution by sulfur dioxide is mainly caused by two components of sulfur forms a colorless gas, namely sulfur dioxide (SO_2) and sulfur trioxide (SO_3), and both are called sulfur oxides (SOx). Sulfur dioxide has a characteristic pungent odor and non-flammable in air, while the sulfur trioxide is a component that is not reactive. SO_2 in the air always produced in large quantities. The amount of SO_3 formed varies from 1–10 % of the total SOx.
   SO_3 in the air in the form of gas is possible only if the concentration of water vapor is very low. If the water vapor present in sufficient quantities, SO_3 and water vapor will soon combine to form droplets of sulfuric acid (H_2SO_4) with the following reaction:

$$SO_3 + H_2O \rightarrow H_2SO_4$$

The normal components contained in the air is H_2SO_4 not SO_3. But the amount of H_2SO_4 in the atmosphere is more than SO_3 emissions, this suggests that the production of H_2SO_4 also from other mechanisms. After being in the atmosphere as SO_2 is converted into SO_3 (later to become H_2SO_4) by photolytic processes and catalytic. Total SO_2 oxidized to SO_3 is influenced by several factors including the water content, intensity, time, and distribution spectrum sunlight.

SOx influence on plants can be affected by two factors, namely the effect of SO_2 concentration and contact time. Effects on humans and animals, SOx at concentrations much higher than the concentration required is irritation to the respiratory system. Measurement results performed SO_2 on four sample locations as in Table 1 (5.26–30.26 μg/Nm^3), which is consist of still below the threshold standards (900 μg/Nm^3) [9].

d. Nitrogen oxides (NOx)

Nitrogen oxides (NOx) are a group of gases in the atmosphere of gas nitric oxide (NO) and nitrogen oxide (NO_2). Although other forms of nitrogen oxides exist, but these two gases are most commonly found as an air pollutant. Nitrogen oxide is a gas that is colorless and odorless, whereas nitrogen dioxide has a reddish brown color and pungent odor.

The sun's rays can lead to compounds react with nitrogen oxides that damage the ozone (O_3), which is a chemical compound that plays a role in the formation

Table 1 The results of measurements of air quality and noise levels in the coal stockpile

No.	Parameter	Unit	Measurement results				Threshold standard[a]
			U-1	U-2	U-3	U-4	
1	Air temperature	°C	29.8	30.6	31.8	30.5	–
2	CO	μg/Nm^3	77	124	92.4	90.2	30.000
3	SO_2	μg/Nm^3	5.26	30.26	10.16	10.10	900
4	NO_2	μg/Nm^3	2.08	21.73	6.55	6.50	400
5	HC	μg/Nm^3	0.6	2.5	0.3	0.2	160
6	TSP	μg/Nm^3	12	44	11	10	230
7	Noise	dBA	45.9	50.3	44.8	41.3	55[b]
							70[c]

U-1 Coal stockpile location, *U-2* Sri Tiga Village, *U-3* Telang riverside, *U-4* Karang Anyar Village

[a] South Sumatra Governor Regulation No. 6 in 2012

[b] For residence area

[c] For industrial area

of nitrogen dioxide (NO_2), and formation of smog and acid rain. Some of the adverse effects caused by pollution is not caused by oxides NOx, but because of its role in the formation of photochemical oxide as a critical component in smoke. Presence of NOx in the atmosphere at a concentration of 3.5 ppm higher necrosis or damage woven leaf. NO_2 at a concentration of 5 ppm for 10 min inhaled by humans will result in a slight difficulty in breathing. The results of measurements on four sample locations, the actual NOx (2.08–21.73 μg/Nm^3) is still below the threshold standard [9].

e. Total suspended particulate

Dust particles generally contain a variety of different chemical compounds with different sizes and different shapes, depending on where the source emission. Naturally particulate dust can be generated from dry dust carried by the wind or derived from a volcano vomit. Incomplete combustion of fuels containing carbon compounds will be pure or mixed with organic gases as well as the use of diesel engines that are not well maintained. Particulate dust drift is also produced from the incomplete combustion of coal produces the aerosol forming compound of tar beads. Compared to the burning of coal, oil and gas combustion generates fewer particulates floating dust. Motor vehicle density can increase the total emission of black smoke particulate dust.

Size of dust particulate solid or liquid form in the air depends on the size. Size of dust particulates that endanger health generally range between 0.1 and 10 microns. In general, the size of about 5 micron of particulate dust is airborne particulate matter that can go directly into the lungs and settles in the alveoli. This situation does not mean that the size of particulates greater than 5 micron are not dangerous, because the larger particulates may interfere with the upper respiratory tract and cause irritation. This situation will be worsen if the synergistic reaction with SO_2 gas contained in the air which comes from the activity of stone crusher and unloading coal. Furthermore particulate dust that floated and fluttered in the wind will cause irritation to the eyes and can impede penetration eye (visibility). The existence of spills of toxic metals contained in particulate dust in the air is the greatest danger to health. In general, the polluted air containing hazardous metals only about 0.01–3 % of all particulate dust in the air. However, these metals can be cumulative and possibly synergistic reaction occurs in the body's tissues.

The results of measurements taken at four sample locations, the content of particulate dust 10–44 μg/Nm^3 and remained below established standards [9].

f. Noise

Noise in occupational health is defined as hearing voices that can reduce both quantitatively (increased hearing threshold) and qualitatively (narrowing of the spectrum of hearing) factors related to the intensity, frequency, duration and timing pattern. Noise is measured with a sound level meter. With the mechanism of action, if any object vibrates, it will lead to changes in air pressure that can be captured by these tools and will move the meter pointer.

Noise causes various disorders on society, labor and animals around him. Noise can cause disruption, such as impaired physiological, psychological, communication disorders and deafness, or disorders such as auditory disorders, such as disruption of hearing and non-auditory disturbances such as impaired communication, health hazards, decrease work performance, fatigue and stress. The results of conducted noise level measurements at four samples locations, the noise level is between 41.3 and 50.3 dBA, still below the threshold standard. The results of measurements taken at several locations in the stockpile area shown in Table 1. In Table 1 shows that the temperature has no significant difference, where the measurement takes place when the air temperature is quite bright [9].

3.2 Water Quality

Water quality can be seen from the parameters of physics and chemistry. Consequent changes in the physical parameters of the surface water are temperature and dissolved solids. The solids consist of organic and inorganic solids dissolved, and suspended sediment. This material will settle to the bottom of water causing specific siltation of water bodies. Another consequence of this solid growth of aquatic plants cause grow of water plant can be toxic to other creatures. The number indicates sludge solids contained in the water. Chemical parameters include the level of acidity (pH) and heavy metals.

a. Water temperature
   Surface water quality standards (water bodies) set at normal temperatures. High surface water temperatures (>45 °C) will affect the speed of chemical reactions as well as life in the water. Temperature changes show activity of biological chemistry in solids and gases in water. Decaying os at high temperatures can lower the solubility of oxygen in the surface water. Therefore the aeration process will inhibit degradation of organic matter. Furthermore it will give affect to kill biota in water bodies and also the vegetation tropical. However, the averaged water temperature of 25.5 °C is a good indicator and suitable to conditions (lower than average air temperature). The average value of the temperature measured was still met the quality standard [9].
b. Total suspended solids
   The solids consist of organic and inorganic solids dissolved, and suspended sediment. This material will settle to the bottom of water over time causing siltation in particular on surface water bodies receiving. Another consequence is the solid substances pose particular the growth of aquatic plants and can be toxic to other creatures. The number indicates the amount of sludge solids contained in the water. From the analysis of dissolved solids, dissolved solid substances classified as very high compared to environmental standards, the concentration

of dissolved solids ranging from 249–355 mg/L, indicating that the location of water samples containing very low dissolved solids than the Environmental Quality Standard of 200 mg/L [9].

c. Acidity value (pH)
Normal water pH value is between 6 and 8, meanwhile the pH value is polluted, for example waste water varies depending on the type exhaust. The changes in acidity in wastewater either to the alkaline (higher pH) or to the acid (lower pH) would greatly disrupt the lives of fish and aquatic animals in the vicinity. Waste water with a low pH is highly corrosive to steel and will cause corrosion on iron pipes. Environmental Quality Standards for the parameters of the surface water pH is 6–9. Furthermore, water is highly acidic or alkaline will result in disruption of marine life and even the equipment used. From Table 2 shows that almost all the locations showed low pH values (tends to be acidic) and beyond the environmental quality standards [9].

d. Dissolved oxygen
Dissolved oxygen is a basic requirement for plant and animal life in the water. Living being in the water depends on the ability of water to maintain the minimum oxygen concentration required for life. Fish are aquatic creatures that require the highest oxygen, then invertebrates and the smallest is the bacteria need oxygen. Minimum dissolved oxygen concentration for microbial life can not be less than 5 ppm. The concentration of dissolved oxygen is too low can result in fish (necton) and resulted in the rapid corrosion process because oxygen will bind hydrogen that coats the surface of the metal [9].

e. Heavy Metal and Toxic
Dissolved oxygen levels of the aquatic ecosystem in the vicinity of the study showed a relatively low value (less than 6 mg/L). Thus criteria, environmental quality aquatic ecosystems say less good or beyond the threshold standard.
Water is often contaminated with inorganic components, including heavy metals. Manganese (Mn) and iron are oxidized in water produced insoluble

Table 2 Analysis data of river water

No.	Parameter	Unit	Analysis results				Threshold standard[a]
			U-1	U-2	U-3	U-4	
1	Temperature	°C	26.5	26.5	26.5	26.5	–
2	pH	–	3.08	4.59	4.48	4.94	6–9
3	Total suspended solid	mg/L	249	310	355	289	200
4	Dissolved iron	mg/L	6.074	7,579	6.551	6.505	7
5	Dissolved manganese	mg/L	2.059	2.556	2.678	1.987	4

U-1 the main trench, *U-2* trench 3, *U-3* telang river, *U-4* trench 4
[a] South Sumatra Governor Regulation No. 8 in 2012 [16]

brownish color, which causes the water can not be used for domestic purposes and rocks containing compounds such as manganese and iron pyrite and hematite. In water bodies, iron (Fe) from the corrosion of heavy equipment and water pipes, metal materials as electrochemical reactions occurring on the surface. Water containing dissolved solids having electrically conductive properties to accelerate corrosion.

The results of laboratory tests on water samples taken showed levels of iron (Fe) in all locations are above the specified standards. This could be possible due to the oxidation of the pipes or objects that contain elements of iron along the river [9].

4 Environmental Impact of Coal Stockpile

4.1 Impact on Air Quality

a. Total Suspended Particulate (TSP)
Total Suspended Particulate is a very complex mixture of various organic and inorganic compounds in the air with the greatest diameter is very small, start from <1 to 500 microns. Dust particulate will be in the air within a relatively long time in suspended form in the air and into the human body through respiratory. In addition to negatively affect health, dust particle can also interfere with the power of invisibility eyes and also indicate chemical reactions, with different sizes and different shapes, depending on where the source emits [10]. Naturally particulate dust can be produced from the dry dust which is carried by the wind, oil and gas burning from the engine, and amount of motor vehicles. In the coal stockpile, when the dry season, the soil becomes dry so dust will scatter more, the operation of heavy equipment such as crusher stockpile also contributed dust, and truck traffic transporting coal from mines to coal stockpile and unloading coal contributes dust in the stockpile location.
Measurements have been done at some location. Content of particulate dust (10–15 $\mu g/Nm^3$) still below the quality standards established (threshold standard 230 $\mu g/Nm^3$).

b. Noise
Noise in the stockpile location cause of the sounds of heavy equipment during loading and unloading process of coal and transportation vehicles of coal. Noise not only varies according to the sound pressure, but is also highly correlated with the frequency. There are several ways to reduce the influence of noise: reduce noise at the source, making the barrier to conductive media, and put earplugs. Noise reduction can be carried out by planting crops such as grasses, shrubs and trees. Plant species is effective to reduce the noise that has a thick canopy with shady leaves. Beside can reduce noise, while wind can produce sound [11].
Trees can reduce noise by absorbing soundwaves by the leaves, branches and twigs. Vegetation planting trees in the form of shelter belt, with a tight closure

and layered, can be substantial noise reduction up to 95 % of the source. To cope with the noise at the location of the stockpile is done by revegetation. Planted vegetation is expected to be able to reduce the impact of changes in air quality [12].

Noise level measurement results which is done at some stockpile location, the noise level (41.3–79 dBA). For measurements in a residential area of population is still below the quality standards which is established (55 dBA) while in the stockpile location the quality standards is exceeded the quality standards which is established (55 dBA).

4.2 Impact to Water Quality

Water conditions in the coal's stockpile location and stockpile activity is influenced by rainfall. The existence of coal stockpile activity will affect the quality of water for pH, TSS, and metals content [6].

To determine water quality in the stockpile location it will take sample of the water at several place/location, namely in the drainage, trenches 3 and 4, settling ponds and in the Telang river. Water samples were analyzed in the laboratory and compared with the water quality standards based on by peraturan Gubernur No. 8 Tahun 2012 is threshold standard to pH 6–9, TSS 200 ppm, metal content 9 ppm of Fe and metal content 4 ppm of Mn.

a. pH value
   Normal pH value of water is approximately neutral is 6–8, while the pH value of the water is polluted, for example wastewater varies depending on debit. Acidity changing of the waste water either toward alkaline (pH up) or (pH down), would greatly interfere the lives of fish and other aquatic animals surrounding coal's stockpile location. In addition, waste water has a low pH is very corrosive to iron and steel and often cause corrosion on metal pipes [13]. Environmental Quality Standard for pH parameters on surface water area and waste water/water washing of coal is between 6 and 9 [14]. From the results of the laboratory analysis, pH values for water samples in the coal stockpile locations ranged from 3.08 to 5.87, and is still below the quality standard (threshold standard 6–9) and spatial distribution maps can be seen in Fig. 4.
b. Total Suspended Solids (TSS)
   Solids consist of organic and inorganic solid materials are dissolved, settle, and suspended. Which is include total suspended solids is sludge, clay, metal oxides, sulfides, algae, bacteria and fungi. This material will settle to the bottom of water which gradually raises special silting on the surface of receiving water. Another impact this solid will indicate growth of certain aquatic plants can be toxic to other aquatic creature. Total solid will indicate that the contain sludge in the water. Total suspended solids are generally removed by flocculation and filtration.

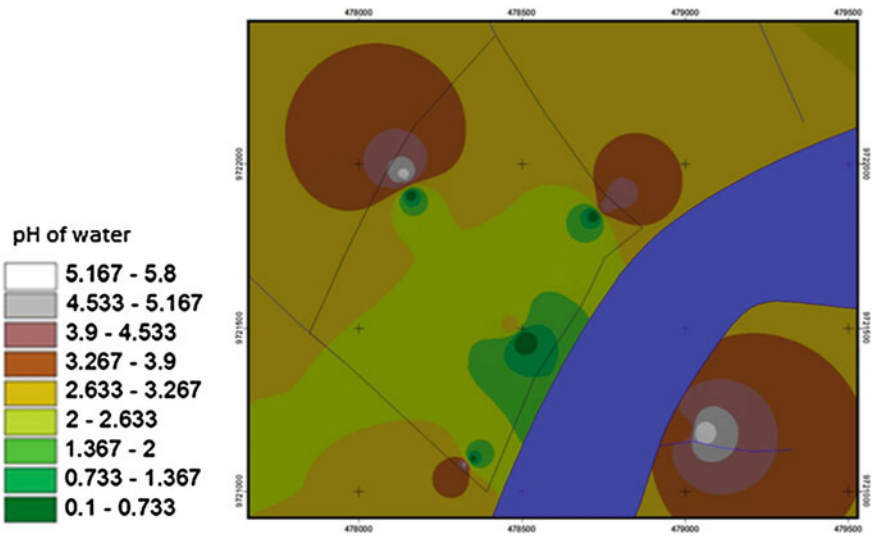


Fig. 4 Spatial distribution maps for pH of water in coal stockpile location

Total suspended solids contribute to turbidity (turbidity) by limiting light penetration for photosynthesis and visibility in the waters [15]. From the analysis of suspended solids, suspended solids content is high if compared to environmental quality standards, suspended solids concentrations ranged from 204–355 ppm, it shows that the water samples of location containing suspended solids higher than the Environmental Quality Standard of 200 ppm. Spatial distribution Map for pH values of water in the coal's stockpile locations can be seen in Fig. 5.

c. Heavy Metal

Water is often polluted by inorganic components, including heavy metals. Dangerous heavy metals are widely used in various purposes, therefore routinely produced on an industrial. Heavy metals in general, such as a mixture of iron (Fe), copper (Cu), total chromium (Cr), and aluminum (Al). Other metals were included in the heavy metal is manganese (Mn).

Manganese (Mn) and Iron (Fe) is oxidized in the brownish water and insoluble, which causes the water cannot be used for household and consumption of industrial water is so limited [14].

In the water surface, Fe levels is exceed of 1 ppm, but in groundwater, levels of Fe can be much higher. For the water which is poor of oxygen, such as groundwater, iron is present as Fe^{2+} fairly solid dissolved, while the river water flow and aeration occurs, oxidized Fe^{2+} is oxidized be Fe^{3+} which are difficult to dissolve at pH 6–8 (solubility only under a few μg/L), it also can be ferric hydroxide $Fe(OH)_3$ or one type of oxide that is solid and can settle. In river water, iron is present as Fe^{2+}. Fe^{3+} dissolved, and Fe^{3+} in the form of a colloidal organic compounds. Iron is a main food source for the bacteria of iron

(centothrix, leptothrix, and gallionella) that can cause bad smell, dirty looks, and had a strange taste.

The results of laboratory tests on water samples which is taken at some point in the stockpile locations showed levels of iron (Fe) is exceed of the specified quality (threshold standard 7 ppm), while the levels of manganese (Mn) is still well below the standards (threshold standard 4 ppm). Spatial distribution map of Fe and Mn content in the water can be seen in Figs. 6 and 7.

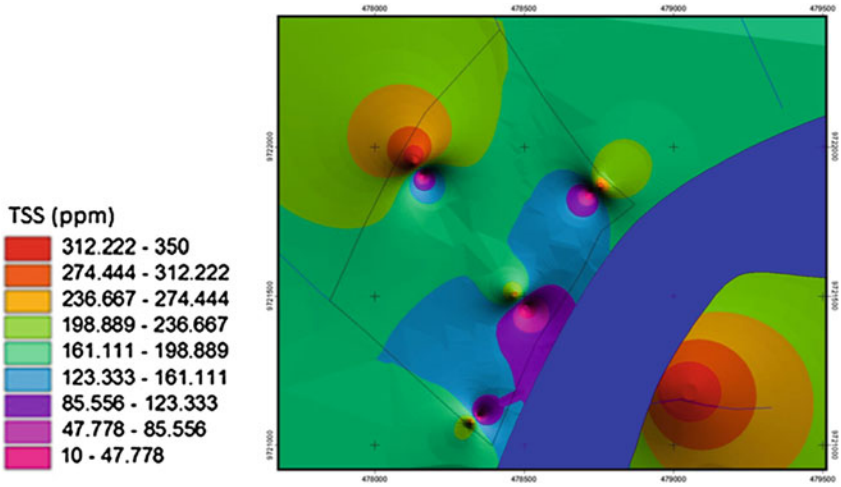


Fig. 5 Spatial distribution map for TSS of water in the coal stockpile locations

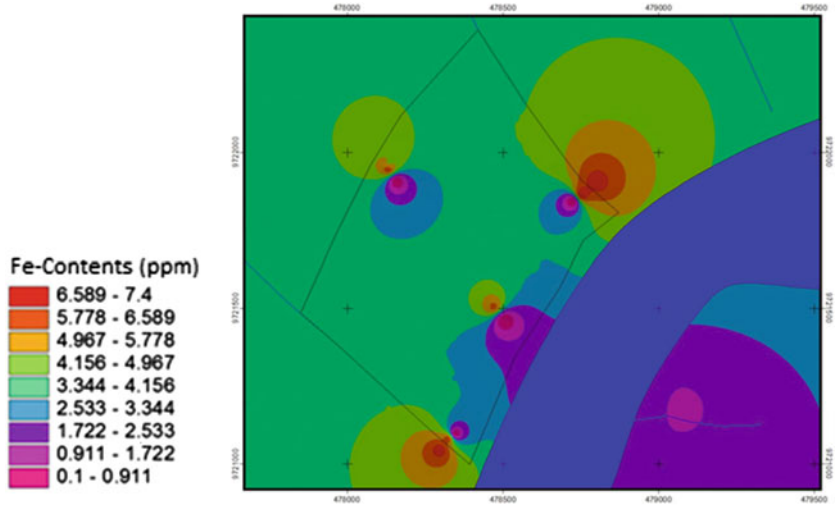


Fig. 6 Spatial distribution map of Fe content in the water

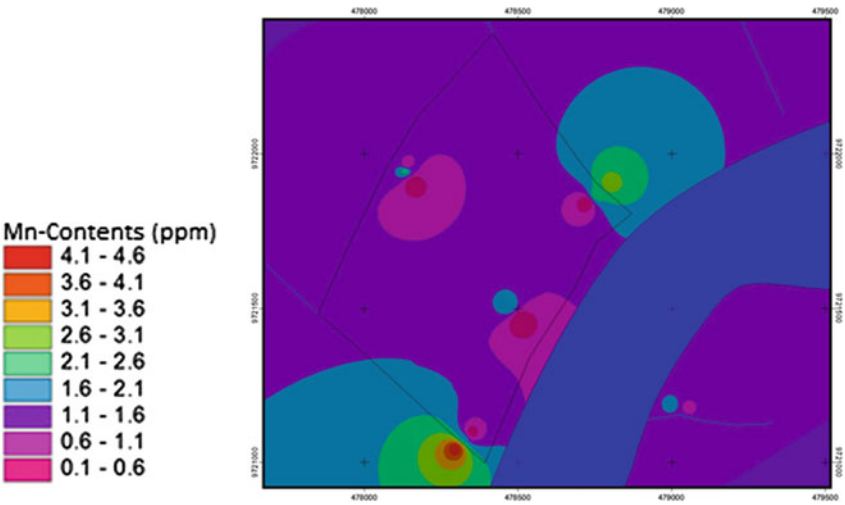


Fig. 7 Spatial distribution map of Mn content in the water

4.3 Impact to Soil Quality

The process of soil formation in the area of Muara Telang strongly influenced by water (alluvial processes), with the additional effect of a salt water seeping or flooding tide at surface of soil in some areas. Areas that are under the influence of flooding will formed lands alluvial. In the areas which is not affected by salt water will form tropaquent soil. Existence is determined by the length of study in the most years, fluvial process is happened because of epipedon histik, sodium saturation which is more than 15 %, and levels of pyrite is high. When pyrite close to the soil surface, so that soil is called by sulfaquent.

Based on the results of field studies, the condition of the soil around the stockpile is thin peaty marshland. Soil type generally alluvial with shrub land cover with *Gelam* vegetation, palm, and marsh grass in the area of tidal marsh.

a. Chemical Characteristic of Soil

(1) pH of soil

Soil reaction shows acid or alkalinity of soil which is indicated by pH value. pH value indicates the number of the hydrogen ions (H^+) in the soil. The higher concentration of H^+ ions in the soil, the more acidic the soil. In the soil besides H^+ and other ions were also found OH^- ions, and the concentration is inversely proportional between H^+ and OH. While Acid soils the amount of H^+ ions is higher than OH^-. While alkali soil contains more OH^- than H^+.

Alluvial or inceptisol generally have a very low pH of <4, so type of this soil is difficult to use for cultivation. Soil acidity (pH) is the characteristic

of soil that influence absorption of nutrients by plants and is an indicator of toxic elements that influence the growth of the organism.

Field observation several points that represent the existing land units, namely the trench 3 and 4 and the center of the land. Composite sampling is done at depths up to 30 cm though. The results of the laboratory analysis showed that soil in stockpile locations have high acidity (low pH) with a range of 3.28–4.9 and its distribution map is shown in Fig. 8.

(2) C-organic content

The content of organic matter in the soil is one of the main factors in determining an aquaculture farm be success. It cause of organic content can increase chemical, physics and biology fertility of soil. Organic content is determined based on amount of C-Organic.

Organic content of soil determines interaction between abiotic and biotic component in soil ecosystem. In her research state that organic content with C-Organic form in the soil must be maintained >2 %, it will make organic content in the soil is not decrease by time cause of mineral decomposition so soil must be added with absolute organic content every year. Organic content is closely related with Capacity of Cation Exchanger and can increase Capacity of Cation exchanger of soil. Without adding organic content to soil, it will make soil gets chemical, physics, and biology degradation which can affect aggregate of soil and will happened soil compaction.

From the results of analysis with chemical method where soil has C-Organic content about 0.40–4.01 %. Distribution map for C-Organic content can be seen in Fig. 9.

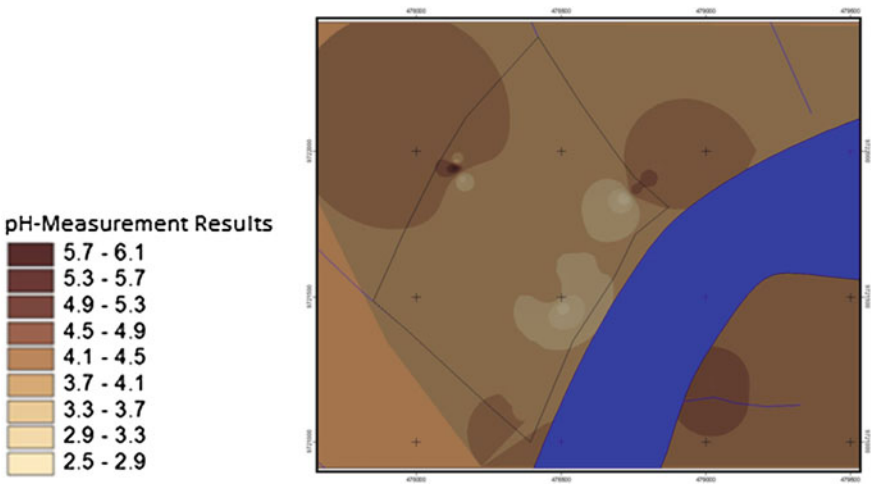


Fig. 8 Spatial distribution map for pH of soil

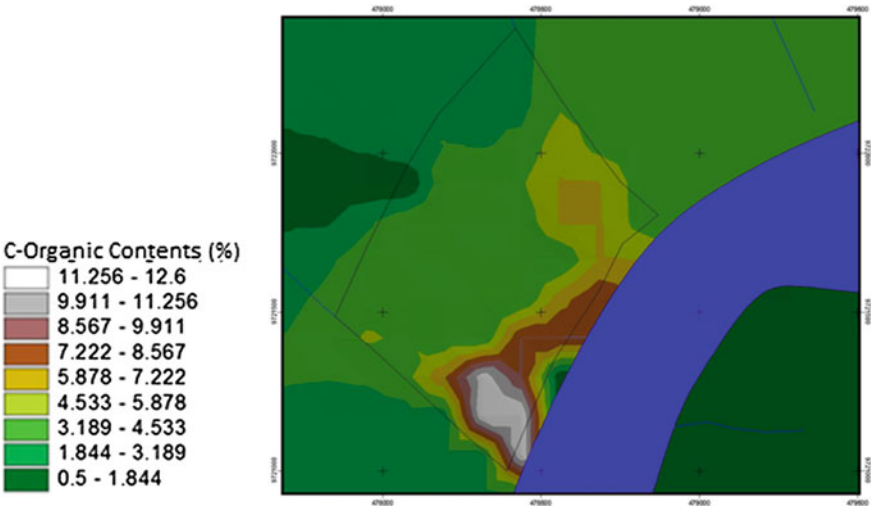


Fig. 9 Spatial distribution map for C-Organic content

(3) Nitrogen Content

Nitrogen is a macro essential nutrient, content about 15 % of the weight of plant and it uses in protein formation.

The source of N is atmosphere as primary sources, and others source are from activities in the soil as secondary sources. Symbiotic N Fixation is particularly presented in leguminosae (kind of plant) as certain bacteria. Organic content will miss N and other contents after decomposition process by microorganisms activities in the soil. N free from soil it cause of used by plant or microorganisms. Total N contents generally about between 2,000 until 4,000 kg/ha at 0–2 cm layer but it is provided for the plant are <3 % from total N contents. Function of Nitrogen is pushing the growth of plants in the vegetative phase and so important in the formation of chlorophyll, amino acids, fats, enzymes, and other compounds. Nitrogen content in the soil is in organic and inorganic forms. Organic form include NH_4, NO_3, NO_2, N_2O and elements of N. Plants absorb these elements, especially in the form of NO_3, but other forms are also able to absorb NH_4, and urea $(CO(N_2))_2$ in the form of NO_3. Furthermore, in the cycle, mineralization of organic Nitrogen will be happened in the soil while minerals get immobilization. Most N transported, mostly back as plant residues, lost to the atmosphere and back again, is lost through watering and increased again through fertilization. There are lost or gained cause of rain.

Relatively very low Nitrogen content ranged only from 0.05 to 0.22 %, spatial distribution map for the nitrogen content can be seen in Fig. 10.

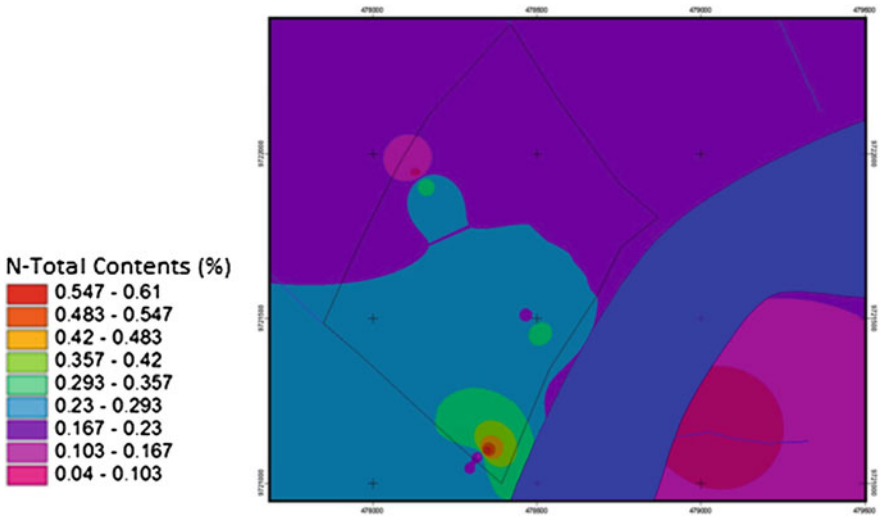


Fig. 10 Spatial distribution map for the nitrogen content

(4) Phosphorus Content (P-Bray)
Elements phosphorus (P) in soils derived from organic matter, fertilizers and minerals in the soil. Phosphorus is most readily absorbed by the plant at pH about 6–7. There are two types of phosphorus organic phosphorus and inorganic phosphorus. Organic phosphorus is usually found in the top layer is much richer in organic matter. If poor of phosphorus, inhibited cell division in plants and stunted growth. Phosphorus content of the soil of coal stockpile area ranged from 9.9 to 36.15 ppm and spatial distribution map for phosphorus content in the soil can be seen in Fig. 11.

(5) Content of Potassium
Potassium is the third nutrient after nitrogen and phosphorus is absorbed by plants in the form of K ions. Positive charge of the potassium will help neutralization process the electrical charge which is caused by the negative charge of Nitrates, Phosphates, or other elements. Potassium which is changed and absorbed by plants is dependent on the addition of external, fixation by the land itself and the addition of potassium itself.
Potassium soil is formed from weathering of rocks and minerals which is containing potassium. Through the process of decomposition of plant material and micro organisms will dissolve and then potassium back into the soil. Furthermore most of the potassium soil will be washed or eroded by soluble and process of loss will be accelerated again by the absorption process of plants and microorganisms. Some soil types have abundant potassium content. Potassium in the soil is found in weathered minerals

and release potassium ions. Adsorption ions on cation exchanged and absorbed quickly to plants. Organic soils contain a little of potassium. Potassium content in the soil of coal stockpile area is ranged from 0.19 to 1.28 me/100gr (Fig. 12).

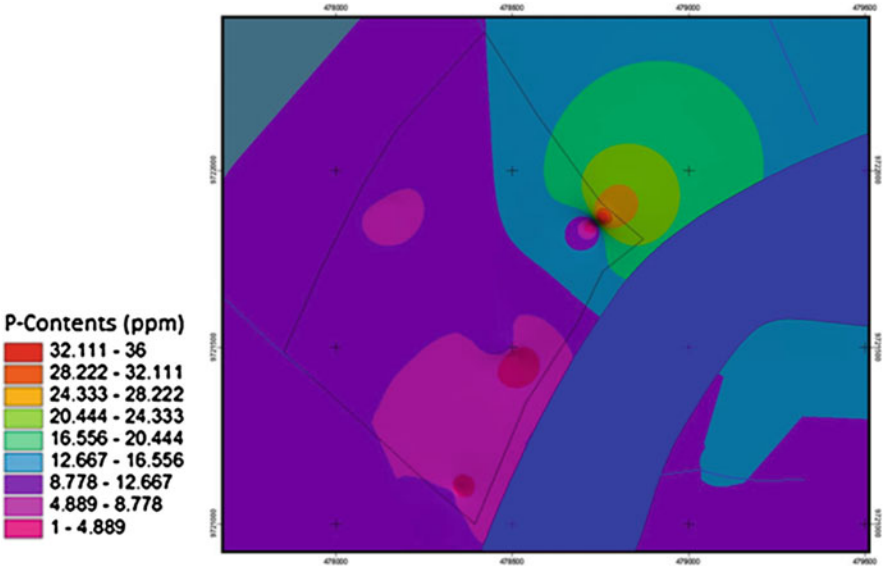


Fig. 11 Spatial distribution map for phosphorus content in the soil

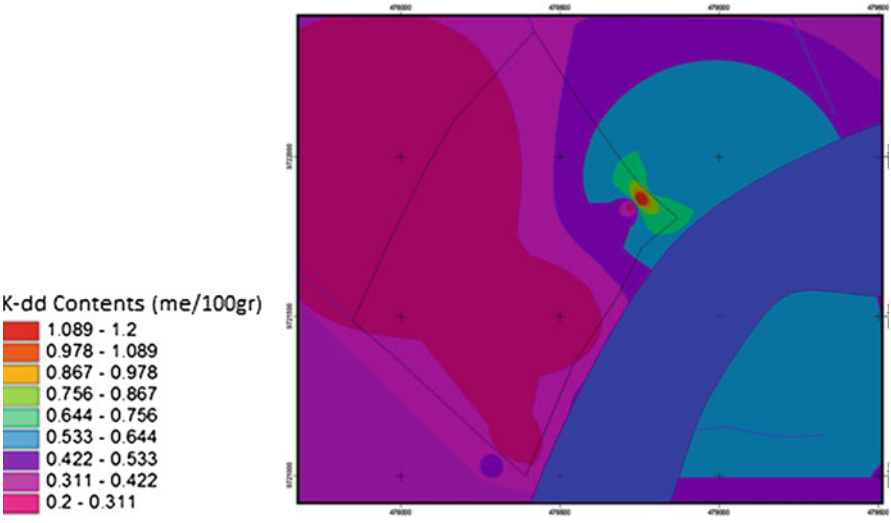


Fig. 12 Spatial distribution map for potassium content

b. Physical Characteristic of soil

(1) Porosity

Soil porosity is the ratio between the pore volume to the total volume of land, which shows the combination or arrangement of primary soil particles (sand, dust, and clay) for the secondary particles called aggregates [16]. Structure can change the texture effect by showing the relation of air humidity.

Aeration is one of the factors that determine the growth of plants. Soil aeration is a result of oxygen enter from the air through the pore spaces in the soil to the soil water to replace the oxygen which is used by plants and microorganism in the soil and carbon dioxide which is produce from soil to the air. Normal soil is soil which contains air and water in the sufficient quantities, balanced and steady. It is only found in the soil structure of the pore space, with the same ratio between macro and micro pores will stand from rain water. Porosity of the soil analysis results separately in the range 23–50 % of stockpile locations and spatial distribution map can be seen in Fig. 13.

(2) Permeability

Permeability is the ability of the soil to pass water. Soil with high permeability can increase the infiltration rate so it will decrease the rate of water run-off. On soil science, permeability is qualitatively defined as the reduction of gases, liquids or plant roots penetrate or pass. Soil permeability is a unit that includes soil infiltration and useful in soil treatment.

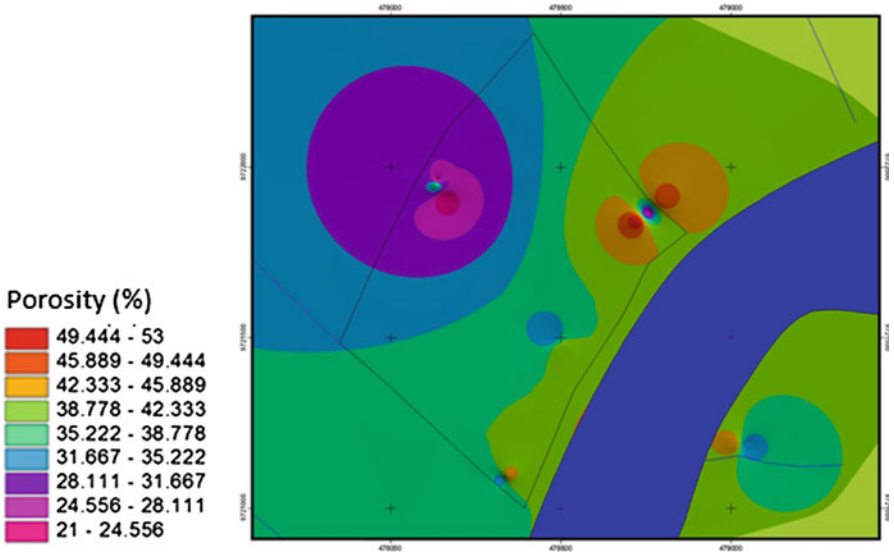


Fig. 13 Spatial distribution map for soil porosity

The top layer ranges from slow to moderately fast (0.20–9.46 cm/h), while in the bottom layer of relatively little slow to moderate (1.10–3.62 cm/h). Factors which is affecting the permeability is the texture, soil structure and porosity, viscosity and gravity, while the factors that influenced the permeability is drainage, infiltration, percolation, erosion, and evaporation. The results of soil analysis for permeability shows permeability of soil in coal stockpile has been rapid and very rapid (3.3–47.26 cm/h). Spatial distribution map for soil permeability can be seen in Fig. 14.

(3) Soil Texture

Soil texture is relative comparison between particles or fractions of primary soil, are sand, dust, clay and loam or well known in the field with a sense of roughness or smoothness of the soil. Particle/soil fraction is: sand <2–0.05 mm; dust <0.05–0.002 mm; clay <0.002 or <2 mm, which is known smooth clay <0.2 mm, while for colloidal material <0.001 mm. When it consists of particles/fraction of sand, dust and clay with the same ratio/proportional called clay. The smooth clay fraction are consist of smooth clay and colloidal materials, most of them are leached (leaching) to the bottom layer. The relation to plant growth, among which are:

(a) If the good soil texture, such as there will be a sandy loam soil it will happened porosity and aeration which is good, This will facilitate penetration or permeation of plant root widely.
(b) As the influence of extensive penetration of root, then the plant will have extensive root zone.

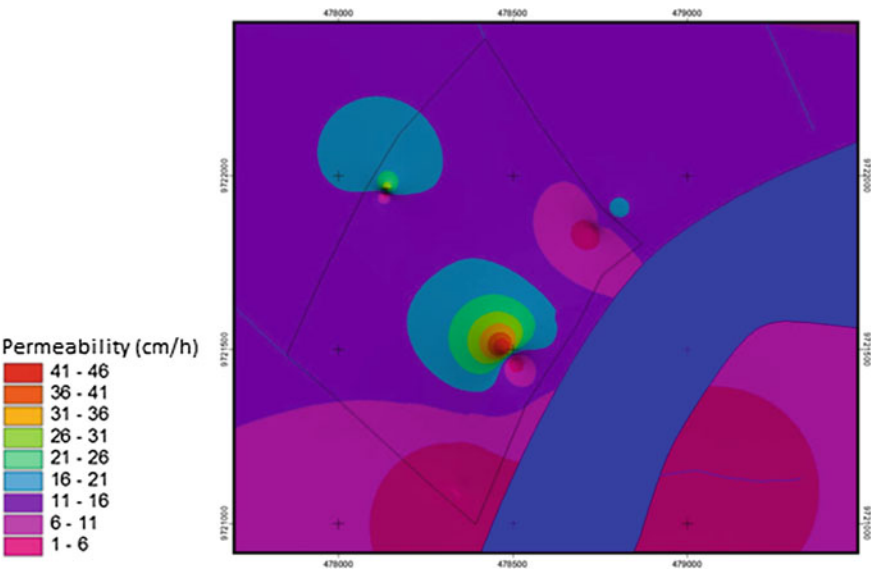


Fig. 14 Spatial distribution map for soil permeability

(c) The extent of the root zone, will ensure high retrieval (absorption) nutrient elements of plant in the soil, so the plant will fertile.
(d) The characteristic of good texture, soil structure will determine the formation of good soil.
(e) Clay content, a measure colloid content of soil. The size of particle (colloid) will have a surface area and high pore space that also has a high absorption capacity and exchanging capacity of colloid. Absorption capability can be used for water and nutrients, so it will show soil fertility is increase. But if the clay content in the dominant composition or high or a less than ideal for the cultivation and soil treatment. High clay content causes percolation, infiltrasi, permeability, soil aeration, so makes it difficult to lower water and air circulation.

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