IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 12, Issue 2 Ver. II (February. 2018), PP 77-82
www.iosrjournals.org

Waste Management with the Technology of Biopore Hole Absorption (LRB) Based on Biochar in Medan, Indonesia

Sumihar Hutapea[1], Gusmeizal[1], Rizal Aziz[1]
Agricultural Faculty, Medan Area University (UMA), Medan, Indonesia
Corresponding Author: Sumihar Hutapea

***Abstract**: The problem of waste in the city of Medan is a problem that can not be handled thoroughly. Garbage clogging drainage channels causes flooding in the rainy season. In addition, the less water absorption area due to many home pages and roads are made waterproof so that became the main trigger of flooding, especially in the rainy season. One way of waste management, especially for organic waste is the technology of biopori infiltration hole (LRB), has been known to accelerate the infiltration of water by utilizing organic waste. Some of the advantages of LRB are improving soil ecosystems, absorbing water and preventing floods, increasing groundwater reserves, and overcoming drought, facilitating waste management and maintaining cleanliness, converting waste into compost, reducing greenhouse gas and methane emissions, and overcoming the problem of inundation. This devotional activity uses LRB technology, so that greater water absorption is given the addition of biochar at the bottom, so that water absorption becomes more stable over long periods of time because biochar is not easy to decay and durable. Socialization of devotional activities using training methods, training, demonstration manufacture of demonstration demonstration plots, as well as organic waste processing practices in LRB on the partners of Part I community groups VI of Karya Kasih sub-district of Mashur Base Sub-district of Medan Johor and partner II of Datuk Kabu neighborhood of Trail Sub-district, Medan Trail District prone to flooding as pilot. The result of the devotion activity has been witnessed by the residents in both Partners that their formerly flooded homes, after the LRB water technology inundated rapidly, besides that. Organi composted in LRB can be used as compost fertilizer. The output of this activity is technology appropriate to make biochar-based LRB, and the ability to process household organic waste into a valuable compost fertilizer*

***Keywords**: Flood, garbage, LRB (Biopori infiltration hole), biochar, Medan City*

Date of Submission:03-02-2018 Date of acceptance: 26-02-2018

I. INTRODUCTION

Medan city is flood-prone area, because it is lowland, flat (flat), height of 2.5-40 meters from sea level (asl) and slope 0-4%. In addition, the city of Medan is traversed by the river Deli, the river that divides the city of Medan, and several other rivers such as the Babura river, Belawan River, Percut river, Glance river and other small rivers that if not managed very well susceptible to flooding (JICA , 1992, Medan City Government of Medan II, 2000) .Then the intensity and frequency of rainfall in Medan city is also very high so it can cause flood 10 to 12 times a year (Hasibuan, 2007). Flood Disasters in Medan City mostly occur along the Deli River. According to Hutapea (2013) about 33.2% of the Deli River area has very high runoff and very low water storage, increasing runoff will decrease groundwater filling and result in increased river flow discharge during the rainy season drastic and this condition is one of the factors causing the flood in Medan City. In addition, with the development of existing settlements in the city of Medan, the more land is covered by buildings, so that the rainwater absorbed into the soil less and less.

Biopore absorption hole technology (LRB) has been known to accelerate water absorption by utilizing organic waste. In use, LRB which is a cylindrical hole 10 cm in diameter with a depth of about 100 cm from the surface of the soil, filled with organic waste as the activator of the creation of biopori . According to Brata and Nelistya (2009) the benefits of LRB are to improve soil ecosystems, absorb water and prevent floods, increase groundwater reserves, overcome drought, facilitate waste management and maintain cleanliness, convert waste into compost, reduce greenhouse gas and methane emissions, as well as overcoming the problem due to inundation. By modifying the biochar-based Biopori Absorption (LRB) technology the water absorption rate is greater, since one of the materials that has a large water-absorbing capacity is biochar. Biochar is a pyrolysis-shaped residual residue (Mohammad et al., 2013) made of biomass of agricultural products, plantations, forestry produced by combustion processes at temperatures <250 - 700 oC (Lehman & Joseph, 2009, Hunt et al., 2010). Biocharks great ability to hold water because it has a high number of macro and micro pores (Major et al., 2009, Karhua et al., 2011), the presence of hydrophilic functional groups (Bruno et al., 2002). Another advantage of biochar feeding is increased soil microbial activity in decomposing organic matter (Lehmann et al., 2011). Then the addition of biochar to LRB is a function as the infiltration becomes more stable and over long periods because biochar is not easy to decay and hold up to 100 year (Steiner et al., 2008). Biochar to be used in this activity is biochar from kendaga and rubber seed shells (Hutapea et al, 2015), and biochar derived from jengkol peel.

The problem of waste in big cities, such as Medan city is a problem that can not be handled thoroughly. The ever-increasing volume of garbage has caused various problems related to health, sanitation and aesthetics, as well as environmental pollution (Astriani, 2009). The garbage that clogs the drainage channels causes flooding in the rainy season. This is exacerbated by the less water absorption area due to the many home pages and roads that are made waterproof to become the main triggers of flooding during the rainy season and drought in the dry season (Brata and Purwakusuma 2007).

One way of waste management is recommended in Law No. 18 of 2008 is the management of waste that is done close to the source, especially for organic waste. Biopore absorption hole technology (LRB) has been known to accelerate water absorption by utilizing organic waste. In use, LRB which is a cylindrical hole 10 cm in diameter with a depth of about 100 cm from the surface of the soil, filled with organic waste as the activator of the creation of biopori. According to Brata and Nelistya (2009) the benefits of LRB are to improve soil ecosystems, absorb water and prevent floods, increase groundwater reserves, overcome drought, facilitate waste management and maintain cleanliness, convert waste into compost, reduce greenhouse gas and methane emissions, as well as overcoming the problem due to inundation. With the development of existing settlements in the city of Medan, the more land is covered by buildings, so that rainwater absorbed into the soil less and less. Therefore, it is necessary to have LRB that can serve to reduce flood inundation and water flow in the soil surface. According Hutapea (2013) flood location with the highest frequency of flood every year is Kampung Aur Medan Maimun Sub district which is located exactly in the center of Medan City, and selected as partner I (first). However, after tracing the causes of flooding in this region is due to overflow of water Deli river, and the community resides along the river banks. Under these conditions the PKM Team does not choose this location as a partner to be trained in making biochar based LRBs. In addition, the location that is the second partner (two) in this activity should be the location of the National Housing built by the government but seems slum and often experience flooding. However, because this location is not including the city of Medan, we also do not choose it as a partner location in the implementation of PKM. According to survey results and interviews with residents who often experience floods due to the slow water absorbed into the ground is the location of the village of Mashur Base Medan Johor District and the location of the environment Datuk Kabu Kelurahan Medan Trail which has been defined as a community group as partners in this PPM. In these two areas, every rainy season, the settlement will be inundated. Floods that occur in this location due to water absorption into the soil is very slow and also exacerbated by a drainage ditch that is often clogged due to garbage that accumulate, and the lack of public attention to not dispose of waste in the wrong place.

II. LITERATURE REVIEW

Biochar is a porous wood charcoal substance, or often called charcoal or agrichar. Because the basic ingredients come from living things, biochar is also called biological charcoal. According to Cheng et al. (2007) and Lehmann and Joseph, (2009), biochar is charcoal of combustion (pyrolysis) without oxygen or with O2 temperature <700 ° C. Biochar comes from agricultural residues, plantations, livestock and forestry. The use of the term biochar is to avoid the understanding of coal derived from coal, the function of charcoal as fuel, the use of charcoal as an adsorbent in the food and pharmaceutical industries, the use of charcoal to overcome waste in contaminated solutions or water, and others (Brown, 2009). Some of the terms that appear in various scientific articles or writings such as agrichar, green carbon, carbon black are all carbon from plant tissue produced by burning (pyrolysis) which is designated as ameliorant to increase soil fertility. Downie et al. (2009) make the term limits to clarify the function and way of making it. The term Charcoal is used for fuel, char from the combustion of spontaneity (forest fires and other traditional charcoal making), biochar as adsorbent, and biochar as soil enhancer (amelioran). The quality of biochar is strongly influenced by raw materials, and the way of burning (Lehmann and Joseph 2009).

Biochar is a relatively new term, but not new to its substance. Soil around the world contains biochar produced through natural occurrences, such as forests and grassland fires (Krull et al., 2008; Hunt et al., 2010). In soil, biochar provides a good habitat for soil microbes, but can not be consumed by microbes like other organic matter. In the long run, biochar does not disrupt the carbon-nitrogen balance, but it can hold and make water and nutrients more available to plants. Biochar application to the soil is a new and unique approach in accommodating long-term atmospheric CO 2 in terrestrial ecosystems. After going through a production process that meets the requirements, biochar contains about 50% of the carbon present in the ingredients. Biologically decomposed organic materials typically contain less than 20% carbon after 5-10 years. If burned, organic matter leaves only 3% of carbon. In addition to pressing emissions and increasing greenhouse gas-binding capacity, biochar applications can also improve soil fertility, increasing crop production. The practice of using carbon to fertilize agricultural land has been done thousands of years ago though in different ways and without a broad understanding. Farmers burn land, or plant tissue before the land is planted, make charcoal stems from wood to grow orchids. In the Amazon basin was found a dark-colored land suspected to be a processing process by adding charcoal from 500 to 2500 years ago known as 'terra preta' (Glaser et al, 2003). The Chinese tradition (1915s) believed that the land became fertile by burning biomass). In Japan in the 1600s known as 'fire-manure' as a fertilizer for agriculture and fertilizer this is like biochar. Japan also has a long tradition of using charcoal in the soil, a tradition that is being revived and has been exported for 20 years to countries such as Costa Rica. Japanese tradition described Ogawa, M., Osaka Institute of Technology as the main speaker, Asia Pacific Biochar Conference, 17-20 May 2009: Charcoal has been used in agriculture in Japan. Since 1970 scientists began promoting the production and use of charcoal as an ameliorant in agricultural land, and in 1986 a technical group was established to study carbonization technology. The 80's use of biochar in Japan reached 30,000 tons / year (Major, 2010).

Biochar amelioration into the soil can increase total organic carbon and reduce microbial biomass, respiration, and aggregation and the effect of soil light coagulation, thus improving air and water circulation in the soil and may stimulate root growth (Weil, et al., 2003; Gusmailina, et al., 2002).

Biochar amelioration into the soil can increase total organic carbon and reduce microbial biomass, respiration, and aggregation and the effect of soil light coagulation, thus improving air and water circulation in the soil and may stimulate root growth (Weil, et al., 2003; Gusmailina, et al., 2002). According to Harsanti and Ardiwinata (2011) biochar can improve the physical, chemical, and biological properties of the soil. Biochar is effective in improving soil physical properties such as soil aggregates and the ability of soil to bind water. In the soil, biochar can help to decrease soil hardness and enhance groundwater binding capacity, thus contributing to increased activity of soil microorganisms. In the soil, biochar plays a role as a shelter or home for microorganisms. Small pores on activated carbon are used as bacterial dwellings, while large pores and cracks are used as gathering places. The statement is also affirmed by Balingtan (2013) that biochar application in vegetable cultivation land has many benefits, ie biochar can increase pH value (when acid soil) and decrease pH (if wet soil), increase CEC soil, and microbial population degrading pollutants.

III. METHODOLOGY

3.1. Problem-solving Framework

Approach method on the program to be implemented are:

a. Providing counseling on the benefits of biochar-based biopore infiltration (LRB) in the yard of the home can reduce the flooding occurring in residential areas of predetermined partner locations.
b. Provide training and demonstration of the making of biopory infiltration (LRB), based on biochar and manufacture of LRB technology demonstration plot in home yard.
c. Provide training and demonstration of biochar manufacture that comes from kendaga rubber seed shell and jengkol peel.
d. Provide training and demonstration of organic waste processing household and organic waste around the house can be used as compost in the hole biopory infiltration
e. Monitoring and evaluation and measurement of physical and chemical properties of waste processing in LRB with biochar based, as fertilizer with economic value.

The main stages of the activity are: 1) Preparation of materials and equipment, 2) Socialization to community groups and related instances of biochar-based LRB technology, 3). Site selection and manufacture of biochar-based LRB demplot technology 4). Measurement and analysis of some soil chemical and physical properties, and 5). The socialization of the results of the IBM activities with LBR technology based on biochar on the community and related institutions through mass media and direct exposure.

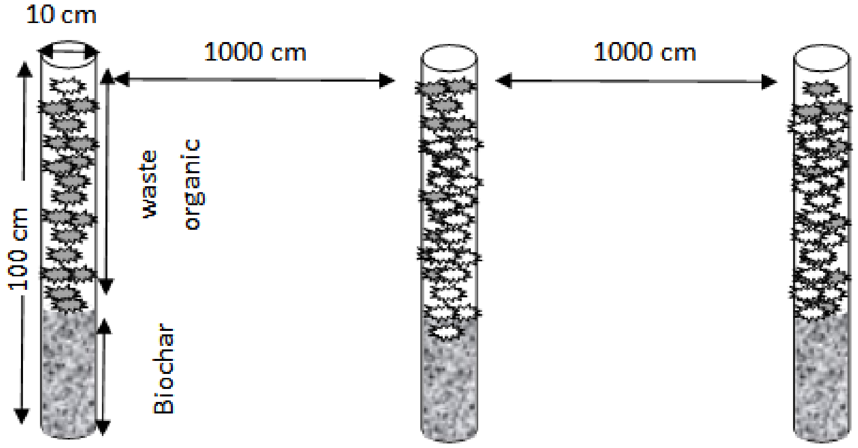
IV. DISCUSSION

This devotional activity is specifically done to be able to produce one solution to overcome the flood that always hit the city of Medan. Given the biophysical condition of Medan City that has high rainfall and is a lowland area with a slope of 0 - 4%, then with the Biopory infiltration Hole technology is expected infiltration can be increased, so that surface water (run off) and / or water that inundated the soil surface, can enter into the soil. Garbage, especially organic waste which is a product of agricultural waste that always interfere with the environmental comfort due to the smell it produces, and also one of the causes of flooding. However, this organic waste can be used as an LRB filler, so that the material will be reduced above the soil surface will also reduce the problems that cause flooding and also can overcome air pollution. Then with the provision of biochar to LRB, is expected to maintain LRB function so that its utilization can last longer in the same time is expected to increase soil fertility. The target achieved in this community service activity is the adoption of waste management with LRB technology based on biochar in tackling flood in Medan City. While the outcome is the skill to make LRB, the skill to make biochar from waste, and the ability to process household waste into fertilizer with economic value. In addition, there is a demonstration plot of biochar-based LRB in the Datuk Kabu neighborhood of II Trail, and in the neighborhood of VI of Karya Kasih Kelurahan Mashur Base Kecamatan Medan Johor. In addition, the results of this devotional activity will be published as a scientific article in the journal and will be disseminated at scientific meetings.

4.1. Transfer of Biopori Absorption Hole Technology (LRB)

Rainwater that falls on the surface of the soil can be 1). Infiltration water, ie part of the water that seeps into the soil and later becomes underground water and 2). surface flow is water flowing on the ground. The construction of the upper layer of buildings (roads, houses and offices), roads and other hardening causes the proportion of rainfall into the soil to decrease and the proportion of rainfall to the surface stream increases. The change in the proportion of the rainfall to the surface flow this becomes the main trigger for flooding in the rainy season and dry season drought. One technique of enlarging water into the soil is compensated for the impermeable layer with biochar-based Biopore Absorption technology. This technology can be applied to various land uses including residential and office (built area) and green open spaces. The LRB technology applied to this service activity can be seen in Figure 1.

Figure 1. Scheme of Biochar Based Biopore Infiltration Technology



The tools needed to make the Biopori Infiltration Holes are 1) The soil drill serves to make the cylindrical hole.2) The paralon is 20 cm thick, to be placed at the top of the cylindrical hole. 3) Close Paralon, bias made of hollow paralon, or wire cap, to cover the top of the hole. 4) The water bucket and the bucket used to flush the soil when making a cylindrical opening. 5) Cement and sand and cement spoon to cement the cylindrical opening of the cylindrical soil surface, if cement and sand are absent, may also be replaced with compacted soil around the surface of the cylindrical opening.

How to Create a Biopori Absorption Hole (LRB) based on biochar is as follows: 1) Choose a location that is often inundated, 2) Clean the soil surface from weeds / plants to be made LRB, 3) Flush the soil if very dry condition while done 4) Each drilling into drilling 20 cm then drill the ground lifted and the ground in the drill is removed from the ground drill bit. 5) This is done until the LRB reaches a depth of approximately 100 cm (before it reaches the groundwater level). If the ground water depth is reached before reaching 100cm depth then drilling should not be continued. LRB depth reaches 50 - 100 cm, 6) The distance between LRB 50 - 100 cm, can be a straight line or circular according to the condition of the stagnant area, 7) LRB mouth can be reinforced with paralon as deep as 20 cm or cemented with a depth of 10-20 cm, or compacted hole mouth with soil.

The benefits of LRB are as follows: 1) Improving the soil ecosystem, 2) Reshing water and preventing flooding, 3) Increasing groundwater reserves, 4) Overcoming drought, 5) Facilitating waste handling and maintaining cleanliness, 6) Converting waste into compost, 6) Reducing greenhouse gas emissions and methane, 7) Overcoming problems due to inundation.

From the transfer of biochar based LRB technology implemented in community service activity is expected all partner partners can adopt LRB manufacture in each partner yard will have at least 3 LRB. besides, with the making of demonstration demonstration demplot in every sub-district of Mashur Base camp Medan and Trail Sub-district can be an example for the community around him. Even if the kelurahan apparatus can monitor better, then these two locations are expected to be used as a pilot project of biochar based LRB technology adoption.

4.2. Transfer Technology Making Biochar Kendaga and Rubber Seed Rubber

Preparation of biochar consists of two stages, namely the process of carbonation of raw materials and activation process of carbonization process at high temperature. The process of carbonation is the process of decomposition of cellulose into carbon elements and the removal of non-carbon elements that take place at a temperature of 600 - 700 C (Kienle, 1986). The activation process is a process for removing hydrocarbons lining the surface of the charcoal, thereby increasing the porosity of the charcoal.

The activation process of charcoal can be done by activation using gas or chemical activation process. The basic principle of activation using gas is by giving water vapor or CO_2 gas to the heated charcoal. The charcoal is fed into the activation furnace, then heated to a temperature of 800-1000 ° C. The water or CO_2 gas is flowed during heating. During activation with the oxidizing gas, the irregular crystal carbonate layer undergoes a shift causing the crystallite surface or gap to open, allowing an inert activating gas to induce a hydrocarbon residue such as a compound methanol and other compounds attached to the charcoal surface. An effective way to encourage these residues is to flow the oxidizing gas on the carbon material surface (Pari, 1996)

The basic principle of chemical activation is soaking the charcoal with chemicals before it is heated. The charcoal was immersed in activating solution for 24 hours then drained and heated at 600 - 900 C for 1-2 hours. At this high temperature the activating material will enter between the hexagonal layers and then open the closed surface. Chemicals used include H_3PO_4, NH_4Cl, $AlCl_3$, HNO_3, KOH, NaOH, H_3BO_3, $KMnO_4$, SO_2, H_2SO_4 and K_2S (Kienle, 1986). The mineral elements of the added chemical compounds will seep into the charcoal and open the surface of the first closed chemical component, so that the active surface area grows larger (Ketaren, 1986).

Table 1. Results of the Best Quality Characteristics of Activated Biochar from Kendaga and Shell of Rubber Seeds

Parameter Type	Value	
Water content	3,97 % *	Max 15% **
Ash content	3,78% *	Max 10%**
Levels of Substance Yawning	30,91%*	Maks25%**
Carbon Levels Tied	65,27 % *	Min. 65%**
Absorption of the Iodized	875,97 mg/g*	Min. 750 mg/g**
Absorption of the Benzene	25,94 % *	Min. 25%**

Description: *) Biochar requirements based on SNI 06-3730-1995
**) Results of research Hutapea, et al (2015)

With the transfer of biochar manufacturing technology to the two partner locations, it is hoped that the community can process waste, especially organic waste that is difficult to decay because it contains high fiber, to be biochar and to be added as LRB base filler. Because making biochar is not too difficult, the benefits are many, hopefully the community can continue.

this technology on an ongoing basis. If all partners can adopt this technology, even on a household scale, organic waste that is difficult to decay will be a useful ingredient. Biochar produced can also be given to the plant medium as a soil enhancer that can improve soil fertility.

4.3. Transfer of Waste Processing Technology into Compost at Hole Biopori Based Biochar Enhancement

The making of Biopori Infiltration Holes is done in 2 partner locations in Medan City namely Karya Kasih Lingkungan street VI Village of Mashur Base and Trail Neighborhood II, Datuk Kabu street .Teknologi of waste management in LRB is done with the following stages of activities. After LRB is formed then LRB is filled with biochar (activated charcoal) one-third part (± 33cm), and then LRB is filled with organic waste (crop residue, grass / weed, organic waste of household waste such as vegetable scraps, coconut pulp, and others until full that is around LRB to full). Furthermore, the activator is given to the LRB so that organic waste is easily decayed, add molasses (can be brown sugar / liquid sugar into the hole), then close the LRB with paralon lid perforated, or can also be covered with wire or cans / containers of magnitude adjusted to the top LRB available at partner location. After that LRB is observed every day and done addition of new organic garbage if there is depreciation of garbage volume. Annual sugary added every day weighed .After 1 month, the garbage in LRB has changed to compost and can be lifted or harvested using a ground drill. The fertilizer produced in LRB can be used as organic fertilizer on the plants around the hole / home page especially because the partner location is in town with limited yard area.

Composting of ready made compost from LRB, should pay attention to the biochar which is the basis of do not also lifted. It should be noted that order to in LRB is not filled with other materials. Thus the refilled organic material is replenished and removed after composting. Composting harvest is ready used is done using a ground drill. From the first harvest results at 3 LRBs in each partner site, the results of the compost characteristics as listed in Table 2 are presented.

Table 2. Results of Chemical Compost Analysis of Biopori Absorption Hole (LBR)

Qualities Chemistry	Location					
	Masyhur Base	Masyhur Base	Masyhur Base	Trail	Trail	Trail
	LRB Paralon	LRB Without Cover	LRB Close Gauze	LRB Paralon	LRB Without Cover	LRB Close Gauze
pH(H2O)	6,63 Netral	6,65 Netral	7,08 Netral	6,29 Masam	6,71 Netral	6,89 Netral
P-Total Mg/Kg	596,78 *****	663,03 *****	720,05 *****	509,35 *****	711,94 *****	721,11 *****
P2o5-(Mg/Kg)	209,72	241,22	239,10	246,39	261,47	194,53
Kandungan Air	12,51	19,28	12,90	7,43	12,04	22,74
C-Org (%)	1,76 **	10,95 *****	11,60 *****	1,15 **	9,87 *****	10,21 *****
N total (%)	0,1700 **	0,3369 ***	0,3758 ***	0,1438 **	0,3982 ***	0,3448 ***
C//N	10	33	31	8	25	30
K- (%)	0,0532 *	0,0630 *	0,0549 *	0,0438 *	0,0663 *	0,0714 *
Ca- (%)	0,3742 *	0,5160 *	0,6928 *	0,3791 *	0,6013 *	0,5787 *
Mg- (%)	0,0882 *	0,0929 *	0,1067 *	0,0838 *	0,0969 *	0,1083 *
KTK (Me/100g)	14,207	36,342	31,404	23,806	30,237	34,132
K + (Me/100 g)	7,427 *****	17,046 *****	18,930 *****	7,235 *****	14,633 *****	18,100 *****
Ca (Me/100 g)	0,742 *	0,743 *	0,851 *	0,715 *	0,830 *	1,005 *
Mg (Me/100 g)	0,967 **	0,964 **	0,578 **	0,699 **	0,832 **	1,040 **
Na (Me/100 g)	0,466 ***	0,560 ***	0,436 ***	3,569 *****	2,574 *****	2,122 *****
Saturation Bases	66,01	53,76	66,22	51,32	62,41	65,24

Source: Laboratory of PT. SOCFINDO

Description: *) Very low; **) Low; ***) Medium; ; ****) High; *****)very high

V. Conclusion

The transferring of science and technology to the community (IbM) in handling of floods in Medan City through waste management with Biopore hole absorption (LRB) based on Biochar on partners of 1 (VI sub village of Jl. Karya Kasih sub district of Pangkalan Mashur, Medan Johor District) and the 2nd partner (Datuk Kabu VII Sub village of Denai Sub district, Medan Denai District) was conducted and the partners are very enthusiastic in taking part in every session of extension/training material delivered even in the demonstration held in the making of biopore hole absorption, the community members directly tried and used the ground drill for the manufacture of LRB. It is necessary to be reminded by the head of the environment or the head of a community group in the partner region to create a biopore hole absorption in the home yard of each partner's group, so that the water inundating the settlement can immediately seep. In order this science and technology program is sustainable and continual, there should be observed every week from PPM implementers and accompanied by the existing apparatus at Mitra, such as the Head of sub district and head of village.

References

[1]. Brata. K. R.. dan A. Nelistya. 2009. Lubang Resapan Biopori. Penebar Swadaya. Jakarta.

[2]. Brata. K. R. dan W. Purwakusuma. 2007. Teknologi Peresapan Air Tepat Guna Untuk Perbaikan Kualitas Perkotaan. Institut Pertanian Bogor. Bogor.

[3]. Bruno Glaser · Johannes Lehmann · Wolfgang Zech. 2002. Ameliorating physical and chemical propertiesof highly weathered soils in the tropics with charcoal a review. Biol Fertil Soils (2002) 35:219–230.

[4]. Hasibuan, G. M. 2007. Model Koordinasi Kelembagaan Pengelolaan Banjir Perkotaan

[5]. Terpadu. Disertasi Sekolah Pascasarjana Universitas Sumatera Utara. Medan. (Tidak

[6]. dipublikasi).

[7]. Hutapea, S. 2013. Kajian Konservasi DAS Deli Dalam Upaya Pengendalian Banjir di Kota Medan. Disertasi Program Pasca Sarjana Fakultas Pertanian Universitas Gadjah Mada. Yogyakarta. 20012. (Tidak dipublikasi).

[8]. Hutapea, S., E.L. Panggabean, dan A. Wijaya. 2015. Utilization of Rubber Seed Shells and Epicarp Wastes as Activated Biochar. Journal of Chemistry and Material Research, Vol. 7(12) Pg.9-14.
[9]. Hunt J. M. DuPonte. D. Sato. A. Kawabata. 2010. The Basics of Biochar : A Natural Soil Amendment. Colege Tropical Agriculture and Human Resources University of Hawai'i at Manoa. Honolulu. Hawaii. J. Soil and Crop Management Dec. 2010 SCM-30.
[10]. JICA Main Report. 1992. The Study on Belawan Padang Integrated River BasinDevelopment.
[11]. Medan.
[12]. Kienle. H.V. 1986. Carbon. Dalam Campbell. P.T.. Prefferkorn R.. dan Roundsaville. J.F. Ullman's Encyclopedia of Industrial Chemistry. 5th Completely Revised Edition. Vol. A5. Weinheim.
[13]. Lehmann J. & S. Joseph. 2009. Biochar for Environmental Management. First published by Earthscan in the UK and USA in 2009. P416.
[14]. Lehmann. J.. Rillig. M.C.. Thies. J.. Masiello. C.A.. Hockaday.W.C.. Crowley. D.. 2011. Biochar effects on soil biota: a review. Soil Biology and Biochemistry 43. 1812–1836.
[15]. Major J. Ch. Steiner. A. Downie & J. Lehmann. 2009. Biochar Effects on Nutrient Leaching 271-282. dalam Lehmann J. and S. Joseph. 2009. Biochar for Environmental Management. First published by Earthscan in the UK and USA in 2009. P416
[16]. Mohammad I. A.. A. Al Omran. A. H. El-Naggar. M. Nadeem. A.R.A. Usman. 2013. Pyrolysis temperature induced changes in characteristics and chemical composition of biochar produced from conocarpus wastes. Bioresource Technology 131 (2013) 374–379.
[17]. Pari, G. 1996. Active Charcoal Quality of Five Wood Type. Forest Products Research
[18]. Bulletin. Vol. 14(2):60-68. Forest Products Research and Development Center, Bogor.
[19]. Pemerintah Daerah Tingkat II Medan. 2000. Rencana Umum Tata Ruang Kota (RUTRK)
[20]. Kotamadya Daerah Tingkat II Medan. Medan
[21]. Steiner. C.. Glaser. B.. Teixeira. W. G.. Lehmann. J.. Blum. W. E. H. and Zech. W. 2008. Nitrogen retention and plant uptake on a highly weathered central Amazonian Ferralsol amended with compost and charcoal. J. PlantNutr. Soil Sci. 171: 893–899.

Sumihar Hutapea. " Waste Management with the Technology of Biopore Hole Absorption (LRB) Based On Biochar in Medan, Indonesia." IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT) 12.2 (2018): 77-82.