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The Application of UBS has to Reduce due to Influencerainfall Extreme in the A.Y Patty Street Ambon City

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Abstract— *In the last 20 years there is often an extreme climate phenomenon that causes high rainfall and flood impact in Maluku. A.Y Patty Street is one of the locations in Ambon, the capital city of Maluku that often experience the inundation. In facing this phenomenon, the extreme value theory becomes the right solution where based on the theory, the value of extreme rainfall is known asymptotically and it will converge following the distribution of GEV (Generalized Extreme Value) which is an extreme value in a certain period.To overcome the extreme climatic problems on urban drainage system, the under drain Box Storage (UBS) filling hole is used as an environmentally friendly drainage concept. With the implementation of UBS, the drainage system can reduce 43.36% the inundation that occurred on the area of A.Y Patty street for the 5th return period and 30.99% for 10th return period.,or51.25% of the volume of water capable of being impregnated into the soil.*

Keywords— extreme climate, GEV, UBS, drainage, Ambon city.

I. INTRODUCTION

In the past 20 years in Maluku, extreme climate phenomena often occur which cause high rainfall and flooding everywhere. Rain with high intensity will cause inundation at some locations in Ambon, one of them is at AY Patty Street. The inundation is caused by several factors; they are high rainfall, natural factors and human factors. People tend to discharge a lot ofgarbage into waterways, as the result the canal becomes shallow then the flow of water becomes obstructed, overflows and stagnates. One other reason besides above factors is the lack of absorption of soil against water because the soil has been covered by pavement (asphalt) and buildings that are clearly translucent, cause the increasingof surface volume water which entering the drainage canal.

Some problems that arise here are (1) how to determine rainfall, extreme distribution and return period ?, (2) how is the drainage system used?

To overcome extreme climate problems and city infrastructure in this case roads and buildings that cover waterways or water absorption, an environmentally sound drainage system is needed with the basic principle of controlling excess surface water so that it can be run in a controlled manner and have more opportunities to seep into the ground. This is intended so that groundwater conservation can well take place and the structure of the drainage building dimension can be more efficient. In contrast to the old principle of drainage, which is to drain rain water into the receiving water body as soon as possible, environmentally-friendly drainage works by attempting to slow down runoff flow.

The principle of filling holes under the drainage channel (under drain box storage) is to hold rainwater that falls and seeps into the ground. This is done considering the lack of groundwater supplies and the high rate of water extraction. Development of environmentally sound drainage is shown to manage surface runoff by developing facilities to withstand rainwater. This concept is what wants to change the old paradigm in the construction of drainage, especially in urban areas.

II. STUDY OF LITERATURE

2.1 Concept of Underdrain Box Storage (UBS)

Underdrain Box Storage (UBS) is an environmentally friendly drainage concept. The technical concept is that rainwater is flowed through open channels where the bottom is given holes arranged serially along the channel as a function to fill the storage space, where the bottom of the shelter is related to the ground. The UBS concept consists of rainwater drainage channels, vertical drain holes, storage boxes and domestic waste disposal channels (sewerage

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systems). Rainwater drainage channels function to receive surface runoff due to rainwater lighting. Vertical drain holes function to continue rainwater runoff into the storage box. Whereas the storage box which is functioned as a long storage which holds rainwater runoff then absorbs water naturally into the soil. In this system, domestic sewage channels are placed separately from rainwater channels. In general the requirements of the construction of the drainage concept are as follows:

1. Rainwater channels are placed separately from the sewage channel.
2. This construction is made of precast reinforced concrete or a combination of masonry and precast reinforced concrete.
3. The main channel is given a round hole at the bottom.
4. In its application, maintenance is needed on a scale to keep it functioning properly.

2.2 Extreme Value Theory

Based on the theory, it is known that asymptotically the extreme value of rainfall will converge the following distribution of GEV (Generalized Extreme Value) which is an extreme value in a given period. Suppose we have a free random variable x1, x2, ... xn each variable xi has the same distribution function, namely F (x) then consider the maximum value Mn = max (X1, X2, Xn) as written as the equation below;

$$F(x)=\begin{cases}\exp\left(-\left[1+\xi\left(\dfrac{x-\mu}{\sigma}\right)\right]^{\frac{1}{\xi}}\right), & \xi\neq 0\\[2ex] \exp\left(-\exp\left[-\left(\dfrac{x-\mu}{\sigma}\right)\right]\right), & \xi=0\end{cases}$$

The parameter form ξ determine characteristic of the distribution tip if $\xi < 0$ then the chance function has a finite right end and if $\xi \geq 0$ the chance function will have an infinite right end. The extreme value distribution introduced by Jenkinson, is a combination of three types of limited distribution for extreme values into one single form as derived by Fisher and Tippet, the three singular forms referred to are Gumbel distribution,

2.2.1 Determination of Extreme Values

Determination of extreme values can be done in two ways:

1. By taking maximum values in a period, for example weekly or monthly periods, observations of these values are considered extreme values.
2. By taking values that exceed a threshold value, all values that exceed the threshold are considered extreme values.

2.2.2 Return Level

In practice, the quantity that is concerned is not only directed at estimating the parameters themselves but in quintiles which are also referred to as return levels of the GEV. The estimated rate of returned on maximum rainfall.

$$x^k = F^{-1}\left(1-\frac{1}{k}\right)$$

If F is the distribution of the maximum value for observing the same period, then the rate of return will follow the following equation where $F^{-1}$is quintile function of the function of distribution$F$, $k$is the period of time and p is the period. The return period value is the maximum value that is expected to be exceed once in the period k with period p, or in other words in the time period k, the rainfall will reach the maximum value once after the expected parameter μ,σ dan ξ can be substituted with the equation below.

$$x^k=\begin{cases}\hat{\mu}-\dfrac{\hat{\sigma}}{\hat{\xi}}\left(1-\left[-\ln\left(1-\dfrac{1}{p}\right)\right]^{-\xi}\right) & ;\xi\neq 0\\[2ex] \hat{\mu}-\hat{\sigma}\ln\left[-\ln\left(1-\dfrac{1}{p}\right)\right] & ;\xi=0\end{cases}$$

III. RESEARCH METHODOLOGY

The research location is in Ambon with an elevation from the sea level 10.47 m at the coordinates 3°.41 'LS - 128°.31'BT. As seen at picture below.

The population and sample are all objects in this study which are located on the A.Y Patty street; geometry and channel dimensions, building infrastructure, soil type and rainfall data for 29 years. Meanwhile the research variable is used in the identification process based on the study of theory. Variables used in this study include: Existing conditions of drainage systems, land use, rainfall data and soil permeability

Data collection methods used in this study include; Observations include observation of catchment area, topography of the region, inundation area, land use and land permeability, meanwhile the data analysis method used is descriptive method which is classified as analysis of basic physical conditions including topographic analysis, rainfall analysis using extreme theory, permeability analysis soil and analysis of filling holes in the reservoir under the drainage canal.

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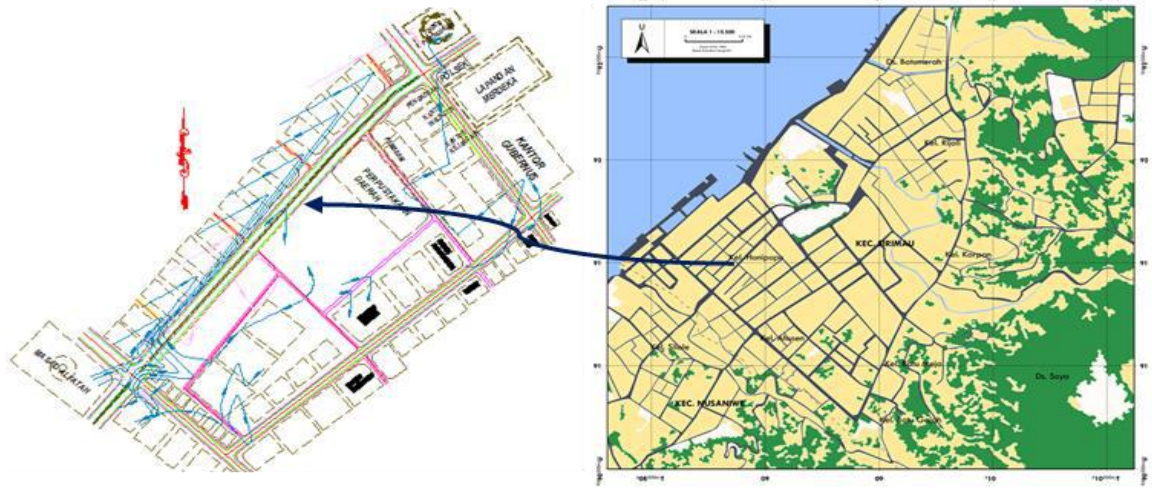

Fig1.Research Site

IV. RESULTS AND DISCUSSION

4.1 Descriptive Rainfall Statistics in Ambon City

Rainfall analysis in Ambon City uses the maximum daily rainfall data from 1989-2017 which consists of 324 data. Descriptive statistics of rainfall in Ambon City are presented in Table 1.

Table.1: Descriptive Statistics of Rainfall in Ambon City

Variable	N	Mean	Min	Max	SD	CV	CS	CK
CH	324	60.33	0	455	57.37	95.1	2.85	13.02

4.2 Selection of Distribution

From the rainfall phenomenon that occurred for 28 years (1989-2017) in Ambon, it can be concluded that the rainfall occurring in extreme categories. This pattern reads that most of the data is on the left side, while in others it is of extreme high value with the appearance of '*'. The characteristics of asymmetrical data with a greater proportion of data on the left side, it is assumed that rainfall data will follow the distribution of generalized extreme values such as Figure 2 and distribution analysis in table 2.

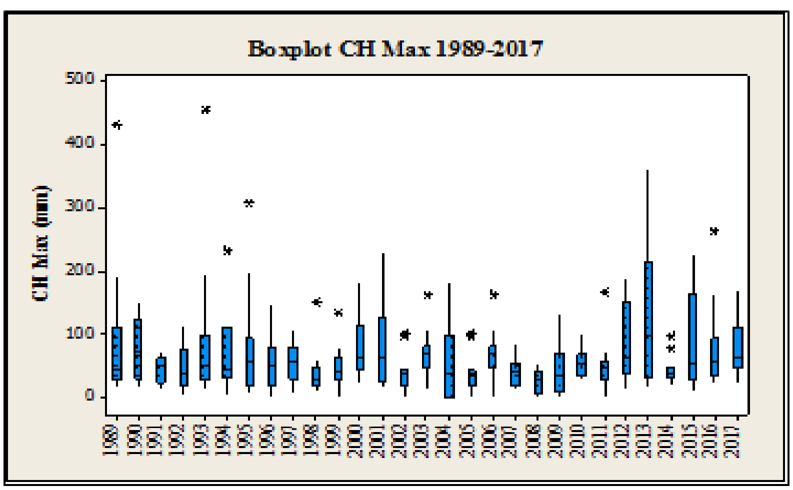

Fig 2. Boxplot Graph- data 29 year rainfall data

Table.2. Analysis of Distribution Models With Several Methods

Parameter	Distribution			
	GEV	Gumbel Max	Lognormal	Weibull
α				1.2224
β				66.776
σ	29.172	44.733	0.9608	
μ	34.199	34.505	3.7649	
ξ	0.2465			

In the Distribution Compatibility Test the Smirnov Kolmogorov test is used to test the horizontal direction deviation and the Chi-Square test to calculate the vertical direction deviation and Anderson-Darling used to measure the suitability of the data distribution shown in the table below.

Table.3: Distribution Compability Test

Disribution Test	Parameter	KS			AD			Chi Kuadrat		
		Sample	Probabilty	Rk	Sample	Probabilty	Rk	Sample	Probabilty	Rk
Distribution	**GEV**	324	0.035	1	324	0.417	1	324	3.291	1
	Gumbel Max	324	0.115	4	324	7.989	2	324	47.495	4
	Log Normal	324	0.073	2	324	23.383	4	324	21.173	3
	Weibull	324	0.086	3	324	20.187	3	324	12.169	2

From the results of the hydrological analyst, according to the hypothesis GEV distribution where the value of the parameter $\xi \neq 0$ is used as a rainfall plan with a certain return period to determine runoff discharge, which can be seen in table 4.

Table.4: Rainfall recurring period analysis

Parameter			Distribution Function		
			K	5	10
σ	μ	ξ	P	0.2	0.1
29.172	34.199	0.246	Xk	87.14	121.94

4.3 Analysis of the database with underdrain box storage (UBS)

Environmental-friendly drainage analysis with underdrain box storage (UBS) in the area of A.Y Patty street, Ambon city produces values:

1) The average slope of the channel (S) is 0,0036
2) Time of concentration (Tc) = $0.0195L^{0.77}*S^{-0385}$according to Kirpich produces a concentration time 30.84 minutes or 1850.49 seconds
3) The amount of rainfall intensity (I), using the Manono be equation, where the 5year return period is 78.19 mm/hour and for 10 years it is 101.30 mm/hour.
4) The mangnitude of the average land use cooficient($C_{rata-rata}$) at A.Y Patty street is 0,68
5) The channel storage coefficient (Cs) is 0.752
6) The magnitude of the design discharge (Q) for 5 years 1,06 m^3/second, 10 years 1,48 m^3/second.
7) Calculation of infiltration by using Horton method results in a soil permeability value of K $=6*10^{-6}$Cm/second.
8) Calculation of dimensions for draians using existing conditions (existing channels) because the existing dimensions are changed into rectangles with a semicircular base. The dimensional model can be seen as shown in Figure 3 below.

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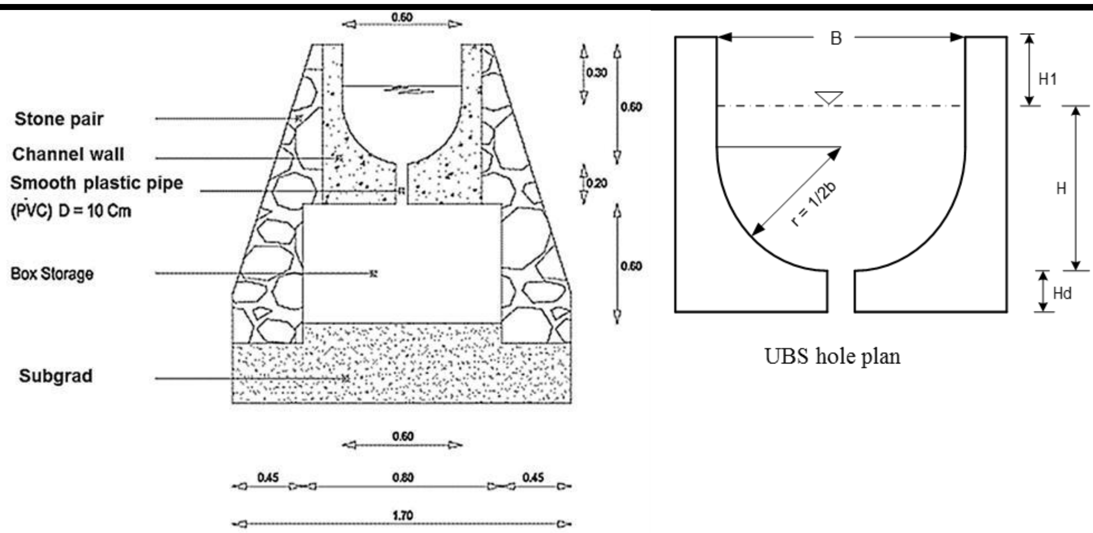

Fig3.Underdrain box storage design

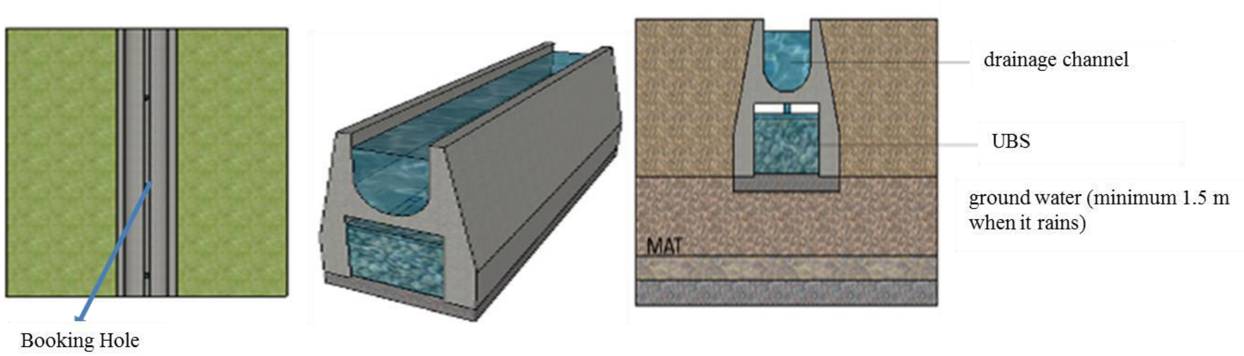

Fig 4. UBS plan details

From the results, the plan debit analysis which is using the rational equation is greater than the channel debit which results in runoff. Comparison of the two debits can be seen in table 5.

Table.5: Percentage of storage

Tr Thn	Qr m3/det	I mm/jam	Qdr m3/det	Qrunoff m3/det	Presentase	
5	1.06	78.20	0.89	0.17	8.72	91.28
10	1.48	101.72	1.15	0.33	12.55	87.45

4.4 The diameter planning of the filling storage

In this study using dimensionless variable parameters to determine the hole diameter of filling the pool using the Froude number.

$$Fr = \frac{v}{\sqrt{g.h}}$$

$$Fr = \frac{1,41}{\sqrt{9,81.0,6}} = 0,581$$

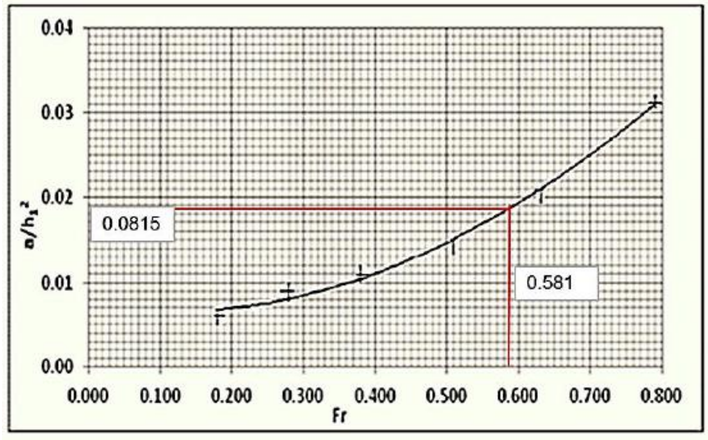

Fig.5. Relatiohship between Fr and a/h^2

For Fr = 0,581 produces a/h^2 =0,0185, IfFr = 0,581 it includes in sub critical flow A = 0,0067 00 0. 0,007 m^{2}after obtaining the UBS filling hole, found a hole diameter of 10 cm or 3 inches. With a total of 57 holes.

Table.6: Planning for a number of holes

Box	Distance (m)	Long (m)	Σhole (Pc)
1	15	258	17
2		165	11
3		164	11
4		270	18

4.5 Planning of Storage Space (Box Storage)

Besides absorbing rainwater in order to reduce runoff in the main drain, Box Storage also functioned to accommodate the volume of water to be absorbed slowly. The following are the dimensions of the storage box design::B=0,8 m ; H_2=0.6 mdan H_1=0.3 m

Table.7: Volume of storage space (box storage)

Box	b (m)	H2 (m)	L (m)	Volume UBS (m3)
1	0.8	0.6	258	123.84
2	0.8	0.6	165	79.2
3	0.8	0.6	164	78.72
4	0.8	0.6	270	129.6
Total				411.36

With the value of soil permeability (K) = 6 * 10^{-6} Cm / det and duration / peak time (t) = 30.84 minutes or 1850.49 seconds the recharge volume can be seen in Table.9

Table.8: Percentage of accommodation has been done by storage

Tr	Volume			(%)
	Channel	Runoff	Leftover	
(Year)	(m3)	(m3)	(m3)	
5	435.72	1960.68	1524.95	22.22
10		2743.76	2308.04	15.88

Table.9: Percentage of storage/shelter after there is a storage box

Tr	Qd	Tc	K	Volume					(%)
				Channel	UBS	Infiltraton	Runoff	Leftover	
(Year)	(m3/sec)	(Sec)	(cm/sec)	(m3)	(m3)	(m3)	(m3)	(m3)	
5	1.06	1850.49	6*10^-6	435.72	411.36	3.148	1960.67	1110.45	43.36
10	1.48						2743.76	1893.53	30.99

CONCLUSION

1. The phenomenon of rainfall in Ambon city includes extreme rainfall so that this problem can be solved by extreme value distribution. From several distribution methods used, the GEV method is a method that can provide solutions to extreme rainfall conditions.
2. With the UBS method in implementing environmentally friendly drainage systems, the drainage system can reduce waterlogging that occurs in A.Y Patty area for a 5 year return period of 43.36% and 10 years 30.99% or 51.25% of the volume of water that can be absorbed into the soil.

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