Development Zero Runoff Model in Palm Oil Plantation for Water Resources Conservation by Using Recharge Wells

Eri Gas Ekaputra*, Fadli Irsyad, Delvi Yanti

(Faculty of Agricultural Technology, Andalas University, Padang, 25163, Indonesia)

Abstract: Soil water conservation with how water infiltration through recharge wells is very important considering the land use changes in the earth's surface as a consequence of the growth in population and economy, society, decrease the rate of erosion runoff will decline. If the surface flow decreased, soils eroded and drift would be reduced. The impact of rainwater runoff and erosion too small to be small. This study aims to determine the number of recharge wells, dimensions, distribution of recharge wells and reduce the volume of runoff that occurs. The results of the analysis are obtained on Cambodgien. There were 21 water catchment areas with runoff volume, and the number of wells required catchment is different. So 21 catchment area takes 5200 recharge wells that can hold the runoff volume of 23,400 m^3 with areal extents section, 948.985 Ha, infiltration wells have dimension 1.5 m × 1.5 m and height 2 m.

Keywords: zero runoff, recharge wells, conservation, water resources management, water balance

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1 Introduction

Land use/land cover changes has become major issue for water resources management and conservation. It has impacted on run off, soil erosion, and biodiversity (Nega et al., 2019; Ahmed, 2016; Melese, 2016). Furthermore it also contributes to climate change (Hailemariam et al., 2016).

Nowadays the area of oil palm plantation in Indonesia is increasing, especially in Sumatera and Kalimantan islands. The plantation should manage runoff well, to avoid water resource problem such as floods in the rainy season and drought in the dry season (Murtilaksono et al., 2018; Devianti et al., 2019; Manoli et al., 2018). These problems are caused by decreasing infiltration and reduces water storage (Dislich et al., 2017) and that condition will increase surface runoff (Comte et al., 2012). The increase in runoff results in increased erosion on plantation land. Soil erosion in oil palm plantations has caused water pollution in local rivers where turbidity and total solids are suspended high in the area (Sahat et al., 2015).

In water resources management knowledge about climate variability and trends is important for many aspects. In addition, such predictions are also important for managing water supply and excess, reducing the impact of floods and drought, also for information of water availability (Mahmood et al., 2019; Feng et al., 2016; Sunday et al., 2014; Reyna et al., 2015). In estimating climate conditions, time series modeling is one of the main tools used when predicting short-term and long-term changes in climate time series.

Time series analysis is usually used for monitoring, forecasting, and feedback by adjusting the model that matches the long time series. It is also the basis for predicting the maximum rainfall conditions in an area (Oyerinde et al., 2015; Burn et al., 2004; Adeyeri et al., 2017).

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***Corresponding author: Eri Gas Ekaputra,** Agricultural Technology, Andalas University, Padang, 25163, Indonesia. Email: erigas@ae.unand.ac.id

Efforts are needed to reduce the runoff rate of one of the efforts namely the concept of zero runoff system (ZROS) (Wirasembada et al., 2017; Comte et al., 2012; Lestari et al., 2019). Conservation of ground water by water infiltration through infiltration wells is very important considering the land use changes in the earth's surface as a consequence of the growth in population and economy, society, decrease the rate of erosion runoff will decline.

This study aims to determine the number, size and distribution of recharge wells layout using geographic information systems and reduce the volume of runoff in the study site with zero run-off method.

2 Materials and methods

2.1 Time and place

This research was conducted during June to August 2016 at Oil Palm Plantation PTPN VI West Pasaman and Laboratory of Land and Water Resources Engineering.

2.2 Tools and material

The tools used in the implementation of this study, namely: a set of computers, Global Positioning System (GPS), and stationery, and a digital camera for documentation retrieval.

The materials used in this study, namely: software ArcGIS 10.3, Global Mapper, and Google Sketch Up 8, Data precipitation last 10 years from 2006 to 2015, Map the location of PTPN VI West Pasaman, and Data SRTM 1 Arc-Second.

2.3 Research procedure

The procedure was first performed in this study was to conduct a field survey to determine the condition of the field such as topography, land cover, and soil types. Once that is done the literature study to find ways of solving problems that occur in the field.

2.3.1 Data collection

Data that is required in the study as follows:

1. Data precipitation last 10 years
2. Map Administration / PTPN VI block map of West Pasaman
3. Data SRTM 1 Arc-Second

The data was obtained from the institutions and from PTPN VI itself, besides that there are also data downloaded from the Internet such as the SRTM data.

2.3.2 Siting research

The research location is in West Pasaman PTPN VI by selecting one section on the estate as a research location of the site will be in use as a reference for analyzing the design of infiltration wells in PTPN VI West Pasaman.

2.4 Data analysis

2.4.1 Calculation of Rainfall Plan (R24)

Rainfall estimates using rainfall data plan with a specific return period were calculated by four methods of frequency distribution, namely:

1. Normal distribution
2. Log Normal Distribution
3. Log Pearson III distribution
4. Gumbel distribution

Data analysis was performed on all four of these methods include the average, standard deviation, coefficient of variation, coefficient of skewness (heeling / skewness) and kurtosis coefficients.

The results obtained for the four methods, and then test the compatibility with Sminov-Kolmogorov method suitability or non-parametric tests. This compatibility test is used to determine the value of the design rainfall frequency distribution of the four methods most suitable for use at the sites. (Hazen, 1930; Haan, 2002; Linsley, 1982; Chow et al, 1988). Calculation of the draft rain every method of distribution for the period specified using the following equation:

Normal distribution

$$X_T = x + Kt \times S_x \quad (1)$$

Where:

X_T is is the rainfall in the plan year return period T (mm),

x is average rainfall (mm),

K_t is the frequency factor,

S_x is the standard deviation.

Log Normal Distribution

$$Log\ X_T = log\ x + K_t \times S_x \quad (2)$$

Log-Pearson III distribution

$$Log\ X_T = log\ x + K \times S_x \quad (3)$$

Where:

K is standard variable Xt whose magnitude depends on the skewness coefficient (Cs)

Gumbel distribution

$$X_T = x + \frac{Y_t - Y_n}{S_n} \times S_x \quad (4)$$

Where:

Y_t is the reduced variable, Gumbel parameters for the period T years,

Y_n is the reduced mean, the function of most of the data (n),

S_n is the reduced standard deviation, the function of most of the data (n).

Based on the above results can be seen the kurtosis coefficient (*Ck*) and skewness coefficient (*Cs*) parameter which qualifies presented below:

Gumbel distribution type I, has a price and *Ck* = 1.139, *Cs* = 5.402.

Harpers distribution, has a price *Cs* and *Ck* flexible

The normal distribution, has a price and the price *Cs* = 0, *Ck* = 0

log normal distribution, has a price *Cs* <0 and *Ck*> 0

Distribution person log type III, has a price *Cs* = 0 until 0.9

Skewness Coefficient / skewness (Cs)

$$Cs = \frac{\sum_{i=1}^{n}(x_i - x)^2}{(n-1)(n-2){S_x}^3} \quad (5)$$

Where:

x_i is value of a variant (mm),

n is number of data

Kurtosis coefficient (Ck)

$$C_k = \frac{n^2 \sum_{i=1}^{n}(x_i - x)^4}{(n-1)(n-2)(n-3){S_x}^4} \quad (6)$$

Rainfall intensity

Rainfall intensity is the amount of rainfall is expressed in high rainfall (mm hr^{-1}) per unit time, which occurs at a time duration, when rain is concentrated. One common formula for calculating the intensity of the rain is the formula Mononobe (Suharyanto, 2016; Pardian and Kumanan, 2014):

$$I = \frac{R_{24}}{24}\left(\frac{24}{Tc}\right)^{2/3} \quad (7)$$

Where:

I is the intensity of rainfall during the concentration time (mm h^{-1}),

R_{24} is the daily maximum rainfall in 24 hours (mm),

Tc is duration of rainfall / precipitation duration (hours).

2.4.2 Calculation of runoff coefficient

Runoff coefficient is the ratio between runoff and precipitation. The runoff coefficient values based on land use factor.

2.4.3 Analysis size directions runoff and catchment area

Directions runoff is determined by topography. Topographic maps can be created from SRTM data so that the resulting contours of the land and the water flow visible research location on the map with the help of ArcGIS 10.3 software by using the tools Flow Direction. The results of the flow direction has been obtained and then used as a reference for determining the amount of the water catchment area using Extension Basin Hydrology, then each catchment area is calculated areas processed using ArcGIS 10.3 software.

2.4.4 Calculation debit runoff

Rational method was developed based on the assumption that the rainfall has uniform intensity and evenly throughout the drainage area for at least equal to the time of concentration (tc), the mathematical equations Rational Method is as following:

$$Q = 0.278 \times C \times I \times A \quad (8)$$

Where:

Q is debit runoff (m^3 s^{-1}),

C is flow coefficient ($0 \le C \le 1$) see in the Table 1,

A is area of the drainage area (km^2).

Table 1 Runoff coefficient (C) for a rational method

Land Use	flow coefficient (C)
Secondary dry forest	0.03
Thicket	0.07
Primary Forest	0.02
Industrial Plantation Forest	0.05
Secondary swamp forest	0.15
plantation	0.4
Dryland Agriculture	0.1
Dryland Agriculture mixed shrub	0.1
Settlement	0.6
Paddy field	0.15
Tambak	0.05
Open land	0.2
Bodies water	0.05

2.4.5 Calculation of volume runoff and infiltration wells dimension

In the spatial analysis results obtained flow direction of water gathering point which later on the number of points the water associations will be used as the location for the placement of recharge wells (n), then for the runoff volume is obtained by the equation:

$$V = Q \times t_c \quad (9)$$

Where:

V is volume of rRunoff (m^3),

Q is debit Runoff (m^3 s^{-1}),

Tc is long rainfall (hours).

Having obtained the runoff volume, and then conducted to determine the dimensions of recharge wells to get the pitcher volume absorption wells using the Equation:

$$v = s \times t \quad (10)$$

Where:

s is the infiltration wells (m),

t is higher absorption wells (m).

2.4.6 Tutorial spread of absorption wells in afdeling 1 PTPN VI West Pasaman

Placement location of recharge wells used spatial analysis were analyzed using a contour map PTPN VI West Pasaman, from SRTM data will be processed on the Global Mapper software to obtain contour in each catchment area. The contour map is converted to raster data in ArcGIS 10.3 software using Topo extension to raster, raster then will be cut in accordance with the administrative boundaries PTPN VI West Pasaman and each catchment area in section 1 by using extension extract by mask. After that it will be made a map of the movement direction of the flow, using extension Flow Direction on Arc Hydro tools GW, having obtained the movement direction of flow layout planning is carried out infiltration wells. Infiltration wells will be placed at points bevy of water that can be seen by a map of the movement direction of flow of PTPN VI West Pasaman then recharge wells will spread all amounts have been calculated and analyzed.

3 Results and discussion

3.1 Overview Location Research

Ophir business unit is one of the sixteen existing business unit under the management of the PTPN VI (Persero). PTPN VI Business Unit Ophir has the areal extents 3549.16 hectares, and consists of four department. PTPN VI Ophir Business Unit located in the border area between the province of West Sumatra and North Sumatra Province, including West Pasaman area in District Luhak Nan Duo and Kinali. This area is low-lying western part of Mount Pasaman and Mount Talamau overlooking the west coast of West Sumatra northern part of the city of Padang distance ± 186 km, altitude ranges from 50-164 meters, the climate of 28°C-31°C, humidity 70%-80%, andosol soil types, with soil acidity (pH) 4-6, geographical position exactly on the equator and 100° east longitude, topographically flat and undulating with a slope of 1%-3%.

3.2 Calculation of rainfall plan (R_{24})

Determination of rainfall plans to use the study site's average precipitation last 10 years (2006-2015) were obtained from climatological station PTPN VI Business Unit Ophir, West Pasaman. Rainfall data were obtained and analyzed in order to extract statistical parameters to select the appropriate method of distribution of the rainfall, the results obtained from the Log Pearson III method that meets the requirements for analyzing the rain draft of the study sites. The value of the parameter and design rainfall were obtained in Table 2 and Table 3 below:

Table 2 Parameter analysis test statistic distribution log pearson III

Parameter	Value
The average CH	26.051
Average Log	1.410
The standard deviation	$Sx = 0.077$
The coefficient of variation	$Cv = 0.0029$
The coefficient of skewness	$Cs = 0.876$
Kurtosis coefficient	$Ck = 4.14$

Note: source from results analysis (2016)

Based on the analysis of statistical parameters of rainfall data of the past 10 years found the average value of precipitation 26.051, then the average value of logs obtained 1,410, the value of a standard deviation of 0.876 this shows the data more inclined to right because it is positive, then obtained standard deviation or standard deviation of 0.077, this value indicates the size of the statistical distribution of data or an average distance of deviations of data points measured from the average value of the data.

After analyzing the test of statistical parameters above, the calculation of rainfall in the period of the plan specified using the equation log Pearson III, namely: $Log\ X_T = log\ x + K \times Sx$, then the equation becomes $\text{Log}\ X_T = 1.410 + K \times 0.077$. K value obtained from interpolation between the highest and lowest value of Cs.

Based on the equation obtained above, then obtained the value of rainfall each specific return period.

Table 3 Rainy day plan period particular birthday (R_{24})

Repeat Period (years)	Plan Rainfall (mm)
1	23.381
2	25.030
5	29.418
10	32.510
25	36.611
50	39.812
100	43.130

Note: source from results analysis (2016)

In Table 3 above shows the calculation results obtained for precipitation plans with a certain return period, the return period (return period) is the hypothetical time where the rain or debit cards with a certain amount of (X_T) will be equaled or exceeded once in that time period. Based on rainfall data for a number of years of observation can be expected rainfall is expected to be equaled or exceeded once in T years, and is known as the rain with return period T years or annual rainfall. Based on the above data on the 1-year period, the value of 23.381 mm rainfall, meaning that the rain is expected to be equaled or exceeded in any one year. Later in the period of 2 years, the value of 25.009 mm rainfall, meaning that the rainfall will be equaled or exceeded once in 2 years, as well as the return period more, it is not means that rain in T years will only happen once in a period T in the sequence, but it is estimated that the rain if exceeded k times in a long period of years will have a value M k / M is approximately equal to 1 / T.

The probability that an event will be equal to or greater than a certain value (rain with return period T), or in other words the probability that an event or events will occur in a year, the return period of 2 years at the top of the chances can be calculated as follows: $1/2 = 0.5 \times 100\% = 50\%$, so the chance of rain with a return period of 2 years will be a 50% in one year, as well as the other return period.

3.3 Calculation of Intensity Rain

The calculation of rain intensity within the return period T years of daily rainfall data, then the intensity of rainfall can be calculated by using the formula Mononobe.

Table 4 Results analysis the rain intensity (mm h^{-1})

DTA	Repeat Period (years)						
	1	2	5	10	25	50	100
DTA 1	27.494	29.432	34.592	38.228	43.051	46.814	50.716
DTA 2	28.093	30.074	35.346	39.061	43.989	47.834	51.821
DTA 3	24.511	26.239	30.840	34.081	38.381	41.736	45.214
DTA 4	19.219	20.575	24.182	26.723	30.095	32.726	35.453
DTA 5	23.139	24.770	29.113	32.173	36.232	39.399	42.683
DTA 6	34.509	36.943	43.420	47.983	54.037	58.760	63.658
DTA 7	23.881	25.565	30.047	33.205	37.395	40.663	44.053
DTA 8	20.904	22.378	26.031	29.065	32.732	35.593	38.560
DTA 9	30.696	32.378	38.621	42.680	48.065	52.267	56.954
DTA 10	26.521	28.391	33.369	36.876	41.528	45.158	48.922
DTA 11	21.632	23.158	27.217	30.078	33.873	36.834	39.904
DTA 12	28.934	30.975	36.405	40.231	45.307	49.267	53.374
DTA 13	32.093	34.356	40.379	44.623	50.252	54.645	59.200
DTA 14	20.893	22.366	26.288	29.050	32.715	35.575	38.540
DTA 15	15.707	16.814	19.762	21.839	24.594	26.744	28.973
DTA 16	19.728	21.119	24.821	27.430	30.890	33.591	36.288
DTA 17	14.251	15.256	17.931	19.815	22.315	24.266	26.288
DTA 18	12.455	13.333	15.671	17.318	19.503	21.208	22.975
DTA 19	12.293	13.160	15.461	17.092	19.249	20.931	22.676
DTA 20	14.729	15.767	18.532	20.479	23.063	25.079	27.169
DTA 21	11.241	12.033	14.143	15.629	17.601	19.140	20.735

Note: Source from results analysis (2016)

In the table above can be seen the calculation results obtained for the intensity of the rain that took place in each catchment area (DTA), each DTA has a rainfall intensity is different, because it is influenced by the length of the flow that occurs in each catchment area (DTA).

Time of concentration (*tc*), is used to determine the length of the rain water flows from upstream to downstream flow. The length and slope flow DTA obtained by using Geographic Information System (GIS), based on the results obtained SRTM data processing flow that occurs in each DTA, so the length of the flow can be measured using a map.

Based on the results in Table 4 are the smallest rainfall intensity on DTA 21, this is due to the length of the flow that occurred in the DTA, causing streaming, a long time from a point upstream to downstream, and rainfall intensity obtained small. In the DTA 21 long stream measured on a map that is 2,343 km, the tilt of 1.7%, and the length of time streaming, 0.6 hours or 36 minutes, and the largest rainfall intensity contained in DTA 6, with a length of 0.417 km flow, with a slope of 4,3%, so time streaming, fast, ie 0.114 hours or 6.84 minutes.

3.4 Directions and Watershed Runoff (DTA)

Determining the direction of water runoff that occurs at the site of the research results from processing of data SRTM 1 arc-second which has a spatial resolution of 30 meters, the data is then carried out the process of the clip (cutting) by using software ArcGIS 10.3, after it and then made a topographic map by using software Global Mapper, so that the resulting map topography in research location.

Topographic maps that have been made visible topographical conditions in some parts of the corrugated region Afdeling 1, topographic high located towards the north or towards the mountain Pasaman. Topographic map is then used for processing with ArcGIS 10.3 software for the resulting map directions runoff, contour lines are used to determine the direction of the runoff. Runoff comes from the highest points and move toward the lower points in a direction perpendicular to the contour lines.

Map directions runoff that has been obtained can be seen toward the more dominant runoff moved south-west or seaward. Map directions runoff is then processed again by the software ArcGIS 10.3 for later obtained the distribution of water catchments in Afdeling 1.

Table 5 The cathment area

Catchment area / DTA	Large (Ha)
Cathment area 1	12.261
Cathment area 2	14.695
Cathment area 3	15.974
Cathment area 4	18.128
Cathment area 5	18.319
Cathment area 6	18.426
Cathment area 7	19.234
Cathment area 8	19.816
Cathment area 9	21.757
Cathment area 10	22.699
Cathment area 11	22.880
Cathment area 12	32.367
Cathment area 13	41.152
Cathment area 14	41.272
Cathment area 15	42.716
Cathment area 16	46.454
Cathment area 17	85.011
Cathment area 18	93.740
Cathment area 19	98.524
Cathment area 20	105.329
Cathment area 21	158.231

Note: Source from results analysis (2016)

Based on the results of processing map directions runoff generated 21 DTA in Afdeling1. The DTA is obtained with an area of 158.231 hectares i.e. DTA 21 for the smallest DTA DTA 1 with an area of 12.261 ha. Surface flow at Watershed occur in several forms: 1) the flow of runoff on the soil surface, 2) flow through the ditch / sewer, 3) flow through streams, and 4) the flow through the main river. The flow of the land surface runoff occurred during or after rain in the form of runoff on the soil surface. The flow went into the ditch / sewer which then flows into the streams further into the flow in the main river.

3.5 Runoff coefficient and debit

Rational method runoff coefficients for the location of research can be seen from land use, namely plantation. Runoff coefficient value is 0.4 for plantation areas, can be seen in Table 1.

Debit runoff that occurs in the location study were calculated using a rational method for estimating the peak discharge caused by heavy rains in the catchment is small. A small catchment area is considered uniform when the distribution of rainfall in space and time, and duration of rainfall normally exceeds the concentration time. After calculation, it can be seen in Table 6 runoff discharge that occurs in the respective DTA with a specific return period.

Table 6 Discharge of runoff (m^3 sec^{-1})

DTA	Repeat Period (years)						
	1	2	5	10	25	50	100
DTA 1	0.375	0.401	0.472	0.521	0.587	0.638	0.691
DTA 2	0.459	0.491	0.578	0.638	0.719	0.782	0.847
DTA 3	0.435	0.466	0.548	0.605	0.682	0.741	0.803
DTA 4	0.387	0.415	0.487	0.539	0.607	0.660	0.715
DTA 5	0.471	0.505	0.593	0.655	0.738	0.803	0.869
DTA 6	0.707	0.756	0.890	0.983	1.107	1.204	1.304
DTA 7	0.511	0.547	0.643	0.710	0.800	0.870	0.942
DTA 8	0.461	0.493	0.580	0.640	0.721	0.784	0.850
DTA 9	0.743	0.795	0.934	1.033	1.163	1.265	1.370
DTA 10	0.669	0.717	0.842	0.931	1.048	1.140	1.235
DTA 11	0.550	0.589	0.692	0.765	0.862	0.937	1.015
DTA 12	1.041	1.115	1.310	1.448	1.631	1.773	1.921
DTA 13	1.469	1.570	1.848	2.042	2.300	2.501	2.709
DTA 14	0.959	1.026	1.206	1.333	1.501	1.633	1.769
DTA 15	0.746	0.799	0.939	1.037	1.168	1.270	1.376
DTA 16	1.019	1.091	1.282	1.417	1.596	1.735	1.880
DTA 17	1.347	1.442	1.695	1.873	2.109	2.294	2.485
DTA 18	1.298	1.390	1.634	1.805	2.033	2.211	2.395
DTA 19	1.347	1.442	1.695	1.873	2.109	2.293	2.484
DTA 20	1.725	1.847	2.171	2.399	2.701	2.937	3.182
DTA 21	1.978	2.117	2.488	2.750	3.097	3.368	3.648

Note: Source from results analysis (2016)

Based on the calculation results table above can be seen runoff discharge, discharge runoff obtained is affected by 1) catchment area, 2) runoff coefficient, and 3) Intensity of Rain. Catchment area are the main parameters that influence the outcome of the discharge, the discharge of runoff largest found in DTA 21, it can be seen the influence of the area of comprehensive DTA 21 compared with the DTA other, the DTA 21 is the area's largest, while to discharge runoff smallest one is on DTA 1, which is the catchment area with the smallest area.

3.6 Calculation of volume runoff and recharge wells dimensions

3.6.1 The volume of runoff

The volume of runoff is the number of accommodated runoff catchment area that occurred during the drainage time (*tc*), then from the discharge runoff we can calculate the volume of runoff in the respective catchment areas, where each of the catchment area has a drainage time (*tc*) different. Here are the results of calculations each catchment runoff volume at a certain return period.

Based on the calculation results Table 7 can be seen the volume of runoff largest located in the region DTA 21, it can be seen from the large catchment areas in the region, causing the volume of runoff, if seen from the intensity of rain DTA 21, the rain intensity smallest, is caused by the length of time streaming but for the volume of runoff can be seen are the main factors influencing the magnitude of the extent of the catchment area and the length of time jetting, for the smallest runoff volume obtained in the area DTA 1, this results in accordance with an area DTA 1, which is the smallest catchment area of the region.

Table 7 The volume of runoff (m^3)

DTA	Repeat Period (years)						
	1	2	5	10	25	50	100
DTA 1	215.92	231.14	271.67	300.22	338.09	367.65	398.29
DTA 2	256.16	274.22	322.29	356.17	401.10	436.16	472.52
DTA 3	297.81	318.81	374.70	414.08	466.32	507.09	549.35
DTA 4	382.16	409.11	480.84	513.37	598.41	650.72	704.96
DTA 5	351.25	376.02	441.94	488.39	550.01	598.09	647.94
DTA 6	290.19	310.65	365.12	403.49	454.39	494.11	535.30
DTA 7	364.08	389.76	458.09	506.23	570.10	619.94	671.61
DTA 8	399.64	427.82	502.82	555.66	625.77	680.47	737.19
DTA 9	363.60	389.24	457.48	505.56	569.34	619.11	670.71

DTA 10	407.28	436.00	512.44	566.29	637.74	693.49	751.29
DTA 11	453.73	485.73	570.88	630.88	710.47	772.58	823.97
DTA 12	554.86	593.99	698.13	771.50	868.88	944.78	1023.53
DTA 13	671.44	718.79	844.80	933.39	1051.38	1143.28	1238.57
DTA 14	835.37	894.28	1051.06	1161.53	1308.07	1422.41	1540.97
DTA 15	996.45	1066.72	1253.74	1385.50	1560.30	1696.69	1838.11
DTA 16	964.85	1032.89	1213.97	1341.56	1510.81	1642.88	1779.81
DTA 17	2080.60	2227.32	2617.80	2892.92	3257.90	3542.69	3837.97
DTA 18	2453.80	2626.83	3087.36	3411.83	3842.28	4178.15	4526.40
DTA 19	2593.89	2776.80	3263.62	3606.62	4061.64	4416.69	4784.81
DTA 20	2533.85	2712.53	3188.08	3523.13	3967.62	4314.45	4674.06
DTA 21	4357.51	4664.80	5482.61	6058.82	6823.21	7419.67	8038.09

Note: Source from results analysis (2016)

3.6.2 Dimensional recharge wells

Design dimensional infiltration wells using the volume of runoff with a return period of 2 years, seeing an opportunity rains that occurred 50% and a prediction of rain events are not too short and too long, if using a return period of 1 year, the time is too short, if the return period of 5 years , the odds of a small 20% and the predicted long time. In this study dimensional diffusion well defined with a size of 1.5 meters × 1.5 meters high on its side and infiltration wells 2 meters, so that the storage volume that is generated for the recharge wells is 4.5 m^3. In the Table 8 below the results can be seen in the number and volume of each pitcher infiltration wells of water catchment areas.

In Table 8 above can be seen, the number and volume of catchment runoff each DTA vary, the DTA 1, the volume of runoff that occurs 231.143 m^3, so it takes 52 pieces of recharge wells to accommodate runoff that occurs, and the volume catchment runoff by recharge wells are 234 m^3, as well as other DTA, such as DTA 21, which is the largest runoff volume needed recharge wells on the acreage in 1037 with an area of 158.231 hectares to accommodate the runoff volume of 4664.795 m^3, when seen needs infiltration wells in an area of 1 Ha also varies every DTA no need 4, 5 and 6 of absorption wells in 1 Ha, even on DTA 21 extents are most in need of 7 infiltration wells in 1 Ha, on the volume of runoff that is in great need of recharge wells that are so much in keeping with the area large catchment area.

Table 8 Number and volume of runoff catchment

DTA	Volume of Runoff	Number of recharger wells	Volume catchment runoff	the number of recharge wells in 1 Ha
DTA 1	231.14	52	234	4
DTA 2	274.22	61	274.5	4
DTA 3	318.81	71	319.5	4
DTA 4	409.11	91	409.5	5
DTA 5	376.02	84	378	5
DTA 6	310.65	70	315	4
DTA 7	389.76	87	391.5	5
DTA 8	427.82	96	432	5
DTA 9	389.24	87	391.5	4
DTA 10	436.00	97	436.5	4
DTA 11	485.73	108	486	5
DTA 12	593.99	132	594	4
DTA 13	718.79	160	720	4
DTA 14	894.28	199	895.5	5
DTA 15	1066.72	238	1071	6
DTA 16	1032.89	230	1035	5
DTA 17	2227.32	495	2227.5	6
DTA 18	2626.83	584	2628	6
DTA 19	2776.80	618	2781	6
DTA 20	2712.53	603	2713.5	6
DTA 21	4664.80	1037	4666.5	7
Total	23363.44	5200	23400	

Note: Source from results analysis (2016)

Infiltration wells are designed with the type of square-shaped with dimensions that have been set, the square shape selected because it is easily made in the field and volume of reservoirs produced greater than a cylindrical shape, making it more suitable for the applied field, construction design recharge wells consisting of wall infiltration wells and around recharge wells on the surface of the ground made a small ditch filled with empty oil palm bunches, it serves as a filter so that water seeped into clean and can accommodate sediments due to sediment runoff so that it does not fit into the wells to reduce the volume of catchment it.

3.7 Distribution infiltration wells in location research

Based on the number and map directions runoff, can be determined placement of recharge wells, recharge wells would be made at the meeting point of water and in areas of ramps / flat (not steep), so that water flowing from the high point to the sloping area and can get into recharge wells optimally, Infiltration wells will be deployed on the DTA by considering the density of the contour lines in accordance with their respective amounts so as to absorb runoff that occurs every DTA. Figure 1 show cathment area 1 and distribution recharge wells.

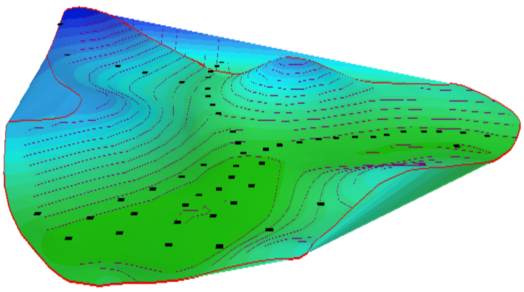

Figure 1. 3D Cathment area 1 and Distribution Recharge wells
Source: Spatial Analysis Results

4 Conclusions

On Afdeling 1 PTPN VI West Pasaman based on the direction of flow generated 21 Watershed each catchment area runoff discharge occurs different when it rains. In section 1 PTPN VI West Pasaman with areal extents 948.985 Ha be required 5200 recharge wells or 5 recharge wells per Ha to accommodate the volume of runoff that occurs at 23,363.437 m^3 based on the 2 year period used in the design. Based on the concept of zero run off pitcher volume resulting from 5200 recharge wells as 23,400 m^3 so it can accommodate the volume of runoff that occurs in section 1 PTPN VI.

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