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THE IMPACT OF LAND USE CHANGED AND CLIMATE CHANGED TO THE DISCHARGE ON KODINA WATERSHED – POSO, CENTRAL SULAWESI

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ABSTRACT

The river's flow is highly depend on climatology and soil conditions and the vegetation as well as land use changes have a direct impact to the river flow. NRECA's model used in this study was considered the parameters of soil moisture storage, ground water flow and climate changed. The method was involved calculation of evapotranspiration due to temperature rise and net rainfall which are used in the models.

In this model used coefficient NOM = 0.21; SMS = 351.55 mm (soil test results), GWF = 0.225 and PSUB = 0.815 for evapotranspiration adopted a increasing of 0.5 % of temperature. While rainfall correction used 9% net rainfall, which is strongly influenced by vegetation and land use in Kodina watershed. The results of models was found that the total discharges output due to climate and land use changed were 2443.38 m^3/s/year, the average discharge value = 15.66 m^3/s, whilst the total observed discharge = 2487.58 m^3/s/year and average debit = 15.95 m^3/s. The differences of model and observed discharge were – 1.78 %. So the climate and land use changed was should be considered in the models. Because it would be made the model are very close with the observed discharge.

Key words: Climatology, Net Rainfall, Land Use, and Physical Factor of Watershed.

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1. INTRODUCTION

Hydrological model is one way to estimate the river discharge approaching the condition of a catchment area. A good model is to pay attention to natural phenomena such as the impacts of climate change that lead to an increase of temperatures resulting in the increase of evapotranspiration. On the other hand land use changed result in changes in land infiltration capacity, soil surface capacity, and interception by plant canopy (net rainfall).

Knowing the impact of rainfall variability and land conversion on river flow discharge is essential to ensure the sustainability of water resources. Therefore modeling is rain-discharge unit to approach the values of hydrological processes that occur in the field are required. The availability of Flow data, rainfall data and climatological data is needed to determine the potential of water resources in a river basin. Rain-flow models can be used as a tool to monitor and evaluate the potential of river discharge through the approach of the existing surface water resources. (e.g, Ammann, Asdak, Bardsley) [2,3,5].

The sensitivity of hydrology system to changes in land use and climate change in a watershed can be evaluated by using models of hydrology that it concerned by the biophysical properties in the regions. Some parameter according to water balanced scheme was analyzed such a climate change, surface flow, base flow, percolation and evapotranspiration. Nreca's hydrological models are an approach models which is simulate and predict the hydrological events that occur by using specific hydrological data recording. (e.g, Asdak, Indarto, Rudi H) [3,12,15].

In response analysis of the watershed, the watershed is a hydrological system in which there is a very close relationship between every input in the form of rain, hydrological processes, and outputs such as the river discharge and sediment transported. Referred to hydrological processes in a watershed, it can be concluded that the distribution of rainfall into streams are influenced by the physical properties of the surface of the watershed are also influenced by the properties of the rain. (e.g, Indarto, Kesuma, Rahman,Syukur, S) [9, 12, 16, 20].

From several discharge models found by hydrological experts, in this study Nreca model (National Rural Electric Cooperative Association, 1985) was selected. This model is widely used by scientists, universities (hydrological analysis calculations). This is probably due to the practicality in its application and the parameters used are not too much. Considering those phenomena so that a debit model is needed taking into account changes in land use, soil type and soil characteristics. This study was made to analyze land use changes that directly impact on river discharge. The result of debit analysis will be compared to the observed discharge so that the model can be well validated.

2. RESEARCH METHODS

Aspects reviewed are factors that can be affected by land use change and climate change. Where the climate factors were include rainfall, temperature, air humidity, solar irradiance and wind speed. Location of the study is the upland of Kodina Watershed, the south of Lake Poso. The size of watershed is 28.800 ha and it is located at the coordinates 2°8'02 "- 2°14'52" South latitude and 120°40'18"- 120°51'16".

2.1. Data of the Research

Kodina Watershed is largely a protected forest with the status of state forests. The forest area is dominated by the natural vegetation and according to data from 2004 - 2014, during 10 years the density of vegetation on these lands increasingly reduced 3-6 % of the area. Land use in Kodina watershed was dominated by 69.5 % of forest and it was predicted will decrease in the future. The land use was shown in Table-1.

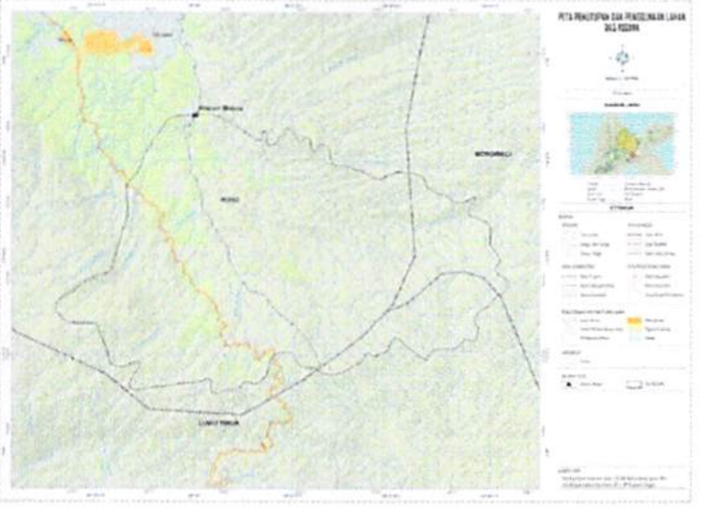

Figure 1 Kodina Catchment Area at Sout of Lake Poso

Based on the type of land use, the components of catchment area are grouped into several types of land use.

Table 1 Land Use in Kodina Watershed at 2014

No.	Penggunaan Lahan	Area in 2002 (ha)	Area in 2014 (ha)	%
1	Settlement	68.40	136.80	0.60
2	Open space land	91.20	228.00	1.00
3	Brushwood	1938.00	2280.00	10.00
4	Moor / Garden Field	1071.60	1390.80	6.10
5	Forest	17328.00	15846.00	69.50
6	Rice field	456.00	638.40	2.80
7	Plantation	1732.80	2166.00	9.50
8	Road	114.00	114.00	0.50
	Jumlah	**22800.00**	**22800.00**	**100.00**

The data used were obtained from BWS III Central Sulawesi which is specific to Kodina Watershed such are rainfall data, climatology data, observed discharge and temperature data from 2002 – 2014. The data was recorded at Mayoa Rainfall-Climatological Station.

Table 2 Data of Monthly Average Temperature

	Monthly Average Temperature (T °C)											
Year	Jan	Peb	Mar	Apr	May	Jun	Jul	Ags	Sep	Okt	Nov	Des
2002	24.76	25.54	25.85	25.47	25.61	24.54	26.06	26.23	27.41	27.65	27.65	26.98
2003	25.85	25.17	26.21	24.91	24.89	26.37	25.49	25.90	26.28	26.72	26.34	25.43
2004	25.54	25.37	25.35	25.10	26.01	25.21	23.85	26.10	26.24	27.29	27.11	25.79
2005	25.86	25.08	27.18	25.26	23.91	24.84	24.86	25.34	27.01	27.24	26.34	26.01
2006	26.85	26.63	26.04	25.99	25.90	24.84	26.01	25.79	26.69	27.60	26.82	25.65
2007	25.84	27.25	25.89	24.68	25.48	25.02	23.60	24.75	23.12	27.36	25.55	25.74
2008	25.95	25.51	25.52	25.19	24.52	24.88	23.60	23.48	25.30	26.09	25.79	25.34
2009	26.07	26.85	26.99	26.53	26.44	25.78	27.77	28.42	27.79	26.86	28.81	27.96
2010	28.46	30.64	29.89	31.31	30.37	29.77	30.98	29.43	30.02	28.52	27.31	26.27
2011	25.75	26.50	27.03	27.58	29.22	29.53	31.00	30.38	28.56	27.40	26.87	25.80
2012	27.35	28.04	28.50	29.23	28.50	28.95	28.34	30.26	27.28	24.22	24.94	24.73
2013	25.00	24.43	24.01	23.67	23.51	23.80	23.77	24.14	24.73	25.11	24.59	26.42
2014	26.63	25.30	24.39	25.09	23.58	22.82	23.64	23.45	25.69	26.99	25.32	25.91

Table 3 Data of Monthly Rainfall

Monthly Rainfall at Mayoa Rainfall Station (mm/month)													
Years	Jan	Peb	March	April	May	June	July	Agst	Sept	Okt	Nop	Des	Total
2002	334.7	199.5	854.5	493.3	413.3	559.1	68.8	32.2	46.0	16.6	386.5	321.0	3725.5
2003	151.8	322.2	796.5	571.4	236.3	60.1	117.0	307.0	177.6	94.7	357.7	320.0	3512.3
2004	323.8	381.3	416.4	404.9	397.9	230.1	214.9	3.9	128.7	18.8	245.9	28.0	2794.6
2005	453.2	553.2	361.2	376.3	371.1	209.6	433.6	137.3	97.3	297.9	431.0	452.3	4174.0
2006	211.1	223.4	308.8	480.4	349.3	325.9	43.2	111.5	28.2	29.4	210.9	384.3	2706.4
2007	212.6	605.9	353.1	690.3	348.1	437.4	164.5	172.4	169.6	217.3	306.8	253.9	3931.9
2008	279.8	236.5	477.7	472.9	407.1	259.4	216.8	451.1	215.8	369.6	826.7	514.6	4728.0
2009	484.1	369.9	604.6	597.0	441.2	179.2	165.6	75.5	49.3	92.5	343.5	298.4	3700.8
2010	485.1	337.3	934.7	577.0	580.2	224.5	149.2	490.4	289.3	536.7	346.1	567.9	5518.4
2011	198.9	251.6	269.8	425.5	462.9	184.7	213.5	105.6	203.8	282.3	383.7	404.0	3386.3
2012	104.5	110.0	74.2	146.9	497.4	292.8	90.4	17.7	26.8	71.7	258.9	257.6	1948.9
2013	80.1	419.8	326.7	554.9	525.9	445.7	708.1	126.3	214.0	95.6	517.3	528.0	4542.4
2014	203.2	173.0	360.0	306.3	250.8	388.2	375.1	190.6	41.0	21.6	246.7	602.1	3158.6

Table 4 Data of Average Climatology

Average Climatology Data at Mayoa Station (2002-2014)													
Description	Units	Month											
		Jan	Peb	Mar	Apr	May	June	July	Ags	Sept	Okt	Nop	Des
Relative Humidity (RH)	%	91.86	92.93	93.82	94.93	94.66	95.71	96.91	93.67	90.21	88.81	92.72	93.77
Temperature, T	°C	26.15	26.33	26.37	26.15	26.00	25.87	26.07	26.44	26.62	26.85	26.43	26.00
Wind Velocity, u	m/s	0.34	0.34	0.35	0.32	0.30	0.30	0.32	0.34	0.35	0.34	0.33	0.29
Solar Radiation (SR)	%	43.37	45.11	45.32	46.49	44.28	36.24	36.83	40.76	50.04	54.79	49.88	41.96

Table 5 Discharge Recorded at Sta.Mayoa

Discharge Recorded at Mayoa Rainfall Station (m^3/s)												
Month	Jan	Peb	Mar	Apr	May	Jun	Jul	Ags	Sep	Okt	Nov	Des
2002	12.56	15.76	16.04	27.85	25.75	11.63	5.68	5.29	3.98	4.55	8.72	22.08
2003	15.86	17.64	22.33	31.15	11.70	5.90	6.25	13.73	9.75	4.65	10.17	15.94
2004	15.63	15.95	20.41	20.97	18.09	13.17	15.86	12.97	11.04	8.82	10.60	7.47
2005	12.89	28.40	15.78	23.28	25.01	12.64	12.69	11.22	6.92	10.01	15.27	21.88
2006	10.54	11.73	13.18	32.20	19.57	12.99	5.17	4.30	5.06	3.29	3.52	9.78
2007	8.38	17.15	16.54	28.54	20.62	23.22	16.55	19.90	14.71	13.29	15.62	13.88
2008	14.19	14.44	18.21	19.68	19.16	20.61	15.80	21.81	19.14	29.10	25.68	27.28
2009	17.76	16.02	27.68	29.62	26.15	22.16	23.16	21.05	18.82	20.68	20.71	11.81
2010	16.62	18.21	32.96	22.01	25.10	16.80	17.18	18.71	20.22	26.71	24.40	25.59
2011	23.80	15.81	15.88	17.51	19.65	18.22	11.21	10.32	10.86	11.37	14.57	17.28
2012	9.94	9.33	6.45	6.22	12.38	13.32	7.93	6.79	5.76	4.43	10.62	7.38
2013	8.82	13.99	14.05	18.77	16.27	20.98	20.30	20.30	21.81	13.92	20.62	27.39
2014	10.47	8.73	9.35	12.74	8.98	12.62	16.81	12.02	10.31	5.28	7.09	14.63

2.2. Research Stage

Following Nreca models which are using the result of calculation evapotranspiration, rainfall and soil condition as follows water balance equations. Therefore it stage of research is calculating of evapotranspiration (using Penmann formula), calculating the net rainfall by adopting Dunne and Leopold formula), testing ground water content, and the impact of climate changed. The water balance is specifically formulated with (e.g. Festy R.A) [7]

$$P = Q + E \pm \Delta S \tag{1}$$

where: P = Precipitation (mm); Q = Discharge (m^3/s);

E = Evapotranspiration (mm) ; ΔS = Delta Storage (mm)

2.2.1. *Evapotranspiration*

Evapotranspiration is the total amount of water that is returned to the atmosphere from the surface of the ground, bodies of water and vegetation by the influence of climatic factors and physiological vegetation. The Calculation of potential evapotranspiration using Penman Method received a recommendation from the UN Food and Agriculture Organization. The general principle of the calculation of potential evapotranspiration in accordance with the following formula:

$$E = C*(W*Rn + (1-W)*f(u)*(e_a-e_d)) \tag{2}$$

where: E = daily potential evapotranspiration (mm/day) ; C = correction factor ; W = weighting factor ; R_n = net radiation (R_{nl} - R_{NS}) ; f(u) = function of wind speed ; ea = saturated vapor pressure ; ed = actual vapor pressure

From the climatology data then it was calculated the evapotranspiration and the results are follows:

Table 6 The Calculation of Monthly Evapotranspiration

Calculation of Monthly Evapotranspiration												
Month	Jan	Peb	Mar	Apr	May	Jun	Jul	Ags	Sep	Okt	Nov	Des
2002	109.32	93.27	114.83	110.80	102.33	75.24	85.20	102.23	117.84	134.84	125.50	126.53
2003	106.42	99.82	116.44	101.87	92.13	72.24	89.13	108.74	110.33	123.80	114.69	98.73
2004	107.71	98.99	111.14	105.53	101.12	72.99	81.77	106.25	110.85	126.79	115.26	100.79
2005	107.00	99.19	135.33	98.22	82.80	91.86	88.75	93.71	103.82	110.71	103.90	94.66
2006	98.99	96.54	110.67	107.47	94.40	83.13	91.08	90.14	103.94	123.54	123.25	100.92
2007	97.03	103.28	109.33	110.75	100.23	89.24	82.73	95.07	98.22	116.22	92.24	110.49
2008	111.07	115.17	116.69	102.35	89.13	88.62	104.99	84.64	103.90	114.18	106.93	106.50
2009	113.05	103.74	115.08	107.28	113.92	87.91	102.15	100.67	119.65	115.62	111.94	109.77
2010	112.88	134.87	130.72	131.87	127.78	100.25	107.38	113.02	126.29	121.18	116.79	103.44
2011	105.67	97.11	108.25	113.20	102.74	89.71	100.62	105.82	112.20	128.20	113.15	100.35
2012	110.85	119.09	122.62	126.75	113.76	96.44	97.67	111.58	102.26	115.31	116.05	108.86
2013	97.12	91.47	97.82	91.89	91.05	83.51	79.58	93.54	100.09	113.94	106.79	102.39
2014	111.58	100.14	111.93	107.03	97.52	79.72	83.35	91.68	108.44	110.14	111.28	108.39

Climate change causes uncertainty in water availability. The change may include annual rainfall and evapotranspiration hence it affects hydrological response in the region. Following the temperature increase in a decade, therefore it would affect to the evapotranspiration in the watershed. The impact would be influence to the discharge, therefore the evapotranspiration that used in the model are:

Table 7 Evapotranspiration as impact of Temperature Rise in Decade

Evapotranspirations as Impact of Temperature												
Month	Jan	Peb	Mar	Apr	May	Jun	Jul	Ags	Sep	Okt	Nov	Des
2002	110.91	94.62	116.50	112.41	103.82	76.33	86.44	103.71	119.55	136.79	127.32	128.36
2003	107.97	101.27	118.13	103.35	93.47	73.28	90.42	110.32	111.93	125.59	116.36	100.16
2004	109.27	100.43	112.75	107.06	102.58	74.05	82.96	107.79	112.46	128.63	116.93	102.25
2005	108.55	100.62	137.29	99.65	84.00	93.19	90.03	95.06	105.33	112.31	105.41	96.03
2006	100.42	97.94	112.28	109.03	95.77	84.33	92.40	91.45	105.45	125.33	125.04	102.38
2007	98.44	104.77	110.92	112.35	101.68	90.53	83.93	96.45	99.64	117.91	93.58	112.09
2008	112.68	116.84	118.38	103.84	90.42	89.91	106.51	85.87	105.40	115.83	108.48	108.04
2009	114.69	105.24	116.75	108.84	115.57	89.19	103.63	102.13	121.38	117.30	113.56	111.36
2010	114.52	136.82	132.62	133.78	129.63	101.70	108.94	114.66	128.12	122.94	118.48	104.94
2011	107.20	98.52	109.82	114.84	104.23	91.01	102.08	107.35	113.82	130.06	114.79	101.80
2012	112.46	120.82	124.40	128.59	115.41	97.84	99.09	113.20	103.74	116.98	117.74	110.44
2013	98.53	92.80	99.24	93.22	92.37	84.72	80.73	94.90	101.54	115.59	108.34	103.88
2014	113.19	101.59	113.55	108.58	98.93	80.88	84.56	93.01	110.01	111.74	112.89	109.96

2.2.2 Net Rainfall in Catchment Area

Land use changes such as the conversion of forest to agricultural land, agricultural land to residential areas and others will have an impact on the environment, especially on surface watersheds. Land use has impact to the net rainfall due to interception of canopy crops in the watershed. This equation is used to obtain net rainfall on each land use (Dunne and Leopold, 1978).

- Net rainfall for area excepting forest $Y = 0{,}925\ x + 0{,}333$ and $R2 = 0{,}996$
- Net rainfall for forest used the formula: $Y = 0{,}886\ x + 0{,}088$ and $R2 = 0{,}996$

Furthermore, the area of land cover in Kodina catchment area based on 2014 data can be developed a net rainfall regression equation used for calculation in this research model as shown on table.

Table 8 The Result of Calculation Net Rainfall in The Cathment Area

Monthly Net Rainfall due to Interception												
Tahun	Jan	Peb	Mar	April	May	June	July	Agst	Sept	Okt	Nop	Des
2002	304.61	181.55	777.60	448.90	376.10	508.78	62.61	29.30	41.86	15.11	351.72	292.11
2003	138.14	293.20	724.82	519.97	215.03	54.69	106.47	279.37	161.62	86.18	325.51	291.20
2004	294.66	346.98	378.92	368.46	362.09	209.39	195.56	3.55	117.12	17.11	223.77	25.48
2005	412.41	503.41	328.69	342.43	337.70	190.74	394.58	124.94	88.54	271.09	392.21	411.59
2006	192.10	203.29	281.01	437.16	317.86	296.57	39.31	101.47	25.70	26.75	191.92	349.71
2007	193.47	551.37	321.35	628.17	316.77	398.03	149.70	156.88	154.34	197.74	279.19	231.05
2008	254.60	215.25	434.68	430.34	370.50	236.02	197.32	410.50	196.38	336.34	752.30	468.29
2009	440.53	336.61	550.19	543.27	401.49	163.07	150.70	68.71	44.86	84.18	312.59	271.54
2010	441.44	306.94	850.58	525.07	527.98	204.30	135.77	446.26	263.26	488.40	314.95	516.79
2011	181.00	228.96	245.52	387.21	421.24	168.08	194.29	96.10	185.46	256.89	349.17	367.64
2012	95.10	100.10	67.52	133.68	452.63	266.45	82.26	16.11	24.39	65.25	235.60	234.42
2013	72.89	382.02	297.30	504.96	478.57	405.59	644.37	114.93	194.74	87.00	470.74	480.48
2014	184.91	157.43	327.60	278.73	228.23	353.26	341.34	173.45	37.31	19.66	224.50	547.91

2.2.3. Nreca Methods

The amount of discharge is calculated using simulation models Nreca. Nreca principle is to estimate the amount of river flow due to the rain that fell in the Catchment Area taking into account the soil conditions and topography of the catchment. In the model Nreca there are two (2) types of reservoirs, namely the storage humidity (moisture storage) and soil water storage (groundwater storage). Humidity storage is determined by rainfall and actual evapotranspiration, while the soil water storage is determined by the excess moisture (excess moisture).

$$RO = R - ET_a + \Delta S \qquad 3)$$

Input is needed from the model of rain - runoff are as follows; The average rainfall (P); Potential evapotranspiration (PET); The capacity of the storage moisture (NOM); PSUB (values ranging from 0.3 - 0.9); GWF (ranged from 0.2 - 0.8); The initial value of the storage soil moisture (SMSTOR); The initial value of the ground water reservoir (GWSTOR); and Crop factor (Cf).

Table 9 Parameter Value Used in the Model

No.	Parameter	Initial Parameter	Calibration Parameter	Final Nreca Parameter	Note
1	NOMINAL	3679.1 mm			NOM = 100 + C* (avg annual rainfall)
	c	0.25	0.22	0.22	
2	PSUB	0.9	0.815	0.825	
3	GWF	0.25	0.22	0.21	
4	SMS (mm)	200 mm	295	315.55	Soil test results
5	GWS (mm)	150 mm	200	200	

3. RESULTS AND DISCUSSION

3.1. Discharge with Initial Parameter and Calibration in Nreca Model

Determining the influence of climate components to stream flow on Kodina watershed needed the parameters associated with the discharge of the river. The climate data used ranging from 2002 – 2014 as well as the data of river discharge. Therefore the monthly evapotranspiration results were apply to Nreca models.

Table 10 The Result of Discharge with Initial Parameters

Discharge Nreca Model on Kodina Watershed												
Month	Jan	Peb	Mar	Apr	May	Jun	Jul	Ags	Sep	Okt	Nov	Des
2002	15.46	18.83	34.64	32.44	33.21	26.83	10.60	8.69	7.36	5.84	9.19	10.57
2003	11.23	14.00	18.82	21.32	17.11	12.57	11.38	12.92	11.14	8.47	11.90	12.31
2004	12.99	16.45	16.49	18.19	18.51	17.12	15.29	11.78	10.34	8.10	9.37	6.73
2005	11.80	17.99	15.13	16.98	17.44	15.46	18.24	13.87	11.50	12.74	16.25	18.01
2006	14.94	15.60	14.71	18.85	17.85	18.56	13.34	11.35	9.50	7.54	8.09	11.29
2007	9.90	18.89	15.90	23.64	20.33	22.80	17.72	15.58	14.19	12.84	18.72	15.21
2008	16.23	15.62	16.57	22.67	21.71	22.21	19.30	19.52	16.65	22.82	28.26	26.41
2009	25.45	26.32	28.82	31.62	28.81	24.33	20.05	16.07	16.34	14.81	13.90	10.44
2010	17.33	17.82	28.04	24.79	28.76	26.80	21.39	25.63	22.94	26.37	24.83	28.54
2011	22.47	19.88	20.03	23.07	24.30	20.37	18.06	14.08	14.04	13.98	17.04	18.54
2012	13.23	12.01	8.90	8.00	14.73	14.42	10.18	8.35	7.07	5.61	7.94	7.63
2013	6.13	13.39	12.16	16.57	15.88	19.11	18.23	18.91	19.47	15.81	22.68	23.54
2014	9.14	9.28	11.24	12.14	11.55	16.74	17.84	14.97	10.97	8.70	10.12	17.03

From Initial off Nreca models then it was calibrated and validated regarding to the biophysical oh the Kodina watershed. After obtained the parameters then it was calibrated and validated. So the calculation results can be seen on table below.

Table 11 The Result of Nreca Calibration models

Discharge Calibratrion of Nreca Model on Kodina Watershed												
Month	Jan	Peb	Mar	Apr	May	Jun	Jul	Ags	Sep	Okt	Nov	Des
2002	14.79	16.83	30.43	29.23	28.57	18.43	11.47	7.46	6.21	5.44	10.65	12.52
2003	11.34	15.96	24.13	25.78	18.65	11.48	10.95	13.73	10.87	7.50	12.98	13.43
2004	14.20	18.52	18.68	20.48	20.71	18.05	15.74	11.85	9.26	6.80	9.44	5.57
2005	13.53	21.46	16.72	19.02	19.51	16.01	20.55	13.61	10.49	13.21	18.17	20.14
2006	15.30	15.90	15.51	25.36	19.43	20.05	12.50	10.36	8.11	6.12	7.43	12.52
2007	10.04	22.85	17.69	28.53	22.44	25.62	17.94	16.33	14.61	12.41	16.25	14.82
2008	15.20	14.69	18.55	21.15	20.91	19.20	17.88	21.12	16.82	25.91	34.05	29.74
2009	29.57	29.65	32.31	35.32	30.87	23.92	18.91	14.05	14.78	15.55	15.83	10.40
2010	19.21	18.61	34.33	32.01	29.51	24.82	18.59	25.10	20.88	26.16	23.30	28.12
2011	20.00	18.16	17.95	22.12	23.85	17.99	15.86	11.12	11.75	12.40	16.47	18.39
2012	10.98	9.48	6.68	5.99	15.56	14.13	8.49	6.63	5.34	4.03	8.42	7.34
2013	7.22	14.58	13.30	17.88	24.03	22.31	19.35	19.13	19.83	13.30	23.01	25.25
2014	8.72	8.62	11.73	12.38	11.45	16.18	17.04	13.03	9.44	7.13	9.38	18.73

The result of the calibration of discharge Nreca models shown in figure-2. The hydrograph was compared with observed discharge data. The result of the computation are shows the graph below.

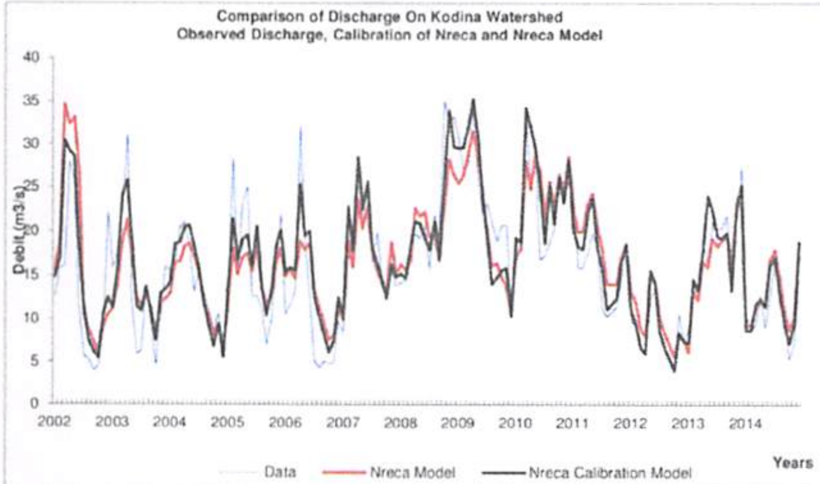

Figure 2 The Graph of observed discharge, Nreca model and Nreca calibration

The calibration and verification in the calculation Nreca models need to be calibrated against the parameters of the Soil Moisture Capacity (SMC), the coefficient of infiltration, recession coefficient, Initial Soil Moisture (ISM), and Initial Ground Water Storage (IGWS) in order to obtain the optimal parameter values then used statistical test for correlation coefficient, volume and t-test error.

The calibration results are shown in table 11. It shows that results of the discharge are more closely to the observed discharge data. The average observed data is 15.58 m^3/s while the Nreca calibration models had a result of 16.12 m^3/s. From the Figure 2. Nreca calibration models could be assure to predict the distribution of availability of water with good accuracy. This is caused by the correlation value R2 of 0,826. Correlation value is greater so it can be trusted.

with comparing the mean and variance between discharge data on the calculation and observed data.

3.2. Discharge with Final Nreca model and Adopting Land Use and Climate Changed

Effects of changes in land covers increase of temperature has direct impact to the flow rate in the rivers. Following the Dunne and Leopold (1978) that the impact of land used are direct to net rainfall. Also it would influence to recharge the ground water. The Phenomena of temperature rise and reducing of vegetation has an effect to the discharge. Therefore calculation of Net rainfall was considered in the simulation.

Effects of changes in land cover and rainfall to recharge the ground water and in showing a similar pattern, for groundwater recharge in a part of the shallow groundwater recharge and the amount was comparable even with a much smaller percentage. The best results by following the test shows the Nreca calibration model is closed to observed data. It can be concluded that the calibration model gives best results.

It is seen from the results of the correlation value (R) Nreca calibration model is best compared to the other methods. The Simulation results show that the vegetation changes from 2002 to 2014 as the year for the same rainfall will produce more water runoff, while decreasing the amount of rainfall on the same land cover by itself will reduced runoff.

Regarding to result of evapotranspiration due to temperature rise (table-7) and calculation of net rainfall in Kodina Watershed (table-8), the it was calculated the discharge as an impact of both parameters. The result of discharge was shown on table below.

Table 12 The Result of Discharge by Using Net Rainfall and Temperature rise

Discharge Nreca Model on Kodina/Mayoa Watershed												
Month	Jan	Peb	Mar	Apr	May	Jun	Jul	Ags	Sep	Okt	Nov	Des
2002	14.42	17.63	28.25	26.99	27.89	16.39	11.43	5.89	4.87	4.62	10.27	14.03
2003	13.55	16.52	23.11	26.28	16.69	8.72	10.10	12.95	10.05	5.09	13.18	14.79
2004	14.49	16.52	17.85	19.96	17.70	14.91	12.63	12.15	9.23	8.46	10.38	6.58
2005	11.13	21.76	15.94	19.13	20.68	12.90	14.58	10.45	7.73	10.26	15.22	20.20
2006	11.79	14.09	17.38	26.23	16.38	16.90	9.76	5.73	5.57	3.99	4.84	10.09
2007	7.61	18.12	15.04	25.69	19.41	22.38	16.56	16.82	15.40	13.91	15.71	13.10
2008	14.06	14.54	18.75	19.14	18.99	18.00	15.68	20.77	16.39	27.59	32.67	29.48
2009	27.00	26.42	28.96	31.87	26.64	23.34	20.38	17.18	17.92	18.57	16.65	11.39
2010	16.32	17.12	31.41	26.57	27.57	21.16	17.32	20.04	19.51	26.65	23.08	25.87
2011	17.89	16.69	15.96	18.19	20.23	14.16	12.13	9.99	10.28	11.08	13.29	15.97
2012	10.43	9.91	7.62	6.53	13.28	11.72	8.54	6.84	5.70	5.65	8.93	7.61
2013	7.62	12.66	13.60	17.94	18.45	21.11	21.29	19.64	20.43	13.08	20.46	24.23
2014	11.43	8.02	10.26	11.58	9.20	13.61	16.15	11.84	8.79	6.28	7.88	17.14

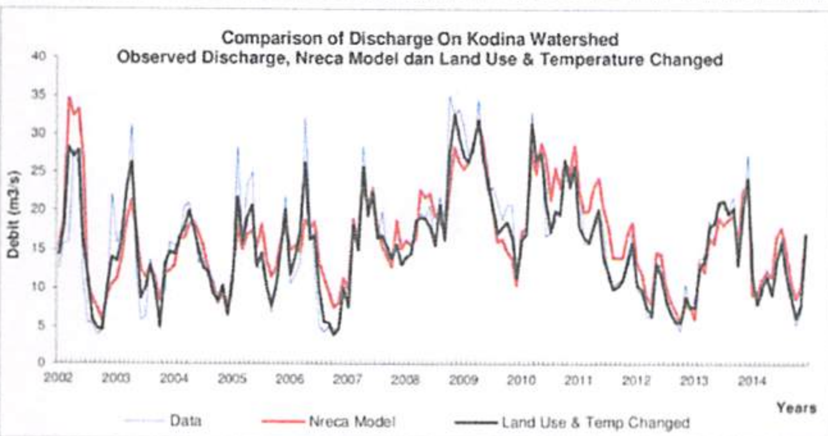

Figure 3 The graph of observed discharge, Nreca model, and Model LU&TC

The hydrologic processes simulated in the basin as shown by the influence of land use change (net rainfall) and climate changed (temperature rise) has a similar and closed result compared with observed discharge. Considering the land use change and climate change in the Kodina watershed, it was the obtained results are better and very close to measured data.

4. CONCLUSIONS

To obtain better results on Nreca model it was concluded that the model should engage the net rainfall (due to changes in land use) and evapotranspiration due to climate changed. The influence of land use changed caused the net rainfall was less about 9 % from rainfall data. While the increase of temperature effect to the rise of evapotranspiration. Both of parameters had significant impact to the models. By applying of these two parameters, the results obtained are very close to the observed discharge on Kodina Watershed. There was the difference -1.78 % of the model compared with observed discharge. However, the database should have an adequate level of accuracy.

Soil moisture content test are needed to obtain parameter of SMS (SMS= 315.55 mm). Regarding to model by reducing of forest area it would reducing some parameters such as Nominal = 809.4 mm; PSUB = 0.815 and GWF = 0.21. While a temperature rise has an impact to evapotranspiration (increase about 0.5 %/month). From the models it was concluded that land use and climate has a big impact to the catchment area therefore it was needed a good control to reduce deforestation.

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