THE CALIBRATION OF DISCHARGE MODEL AS AN IMPACT OF LAND USE AND CLIMATE CHANGED IN KODINA WATERSHED, THE SOUTH OF LAKE POSO

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Abstract— Changes in land use and climate changed had a direct impact to the flow characteristics and the availability of water in a watershed. In terms of utilization of water resources of a river or surface water, the design will be based on historical data (time history) debits. By knowing the river discharge data in the time period, it can be foreseen the magnitude of the discharge at the future. The mistakes which implied in data of rain and discharge, parameter yielded become less optimum of the models. Therefore it was required a phase calibrate to evaluate the model. Data of rain, climatology and discharge in Kodina River were enough to run the models. From two methods were applied in the calculation, It was shows the Nreca models are more similar with observed data. Therefore the calibration model was only tested the Nreca Models. The result of the calibration models shows the errors is 4.81%, coefficient correlation is 0.736, Initial SMS is 200 mm, and Nominal is 835.8 mm. After running the Nreca model, the it was calibrated and validated concerning to land use changed the model are tested again. The result of calibration shown, the maximum discharge is 33.33 m^3/s while the observed data is 32.96 m3/s. The minimum debit is 2.55 m^3/s and observed discharge is 3.29 m^3/s. The average of discharge for the model is 6.12 m^3/s while the observed data is 15.58 m^3/s.
Rainfall and discharge model of hydrology stream used Nreca method, with three especial parameter. Result calibrate to indicate that value of parameter to: make an index to soil moisture storage capacity (Nominal) = 835.8 mm ; PSUB = 0,91 ; Percentage of the pool of groundwater flowing into the river as the base flow (GWF) = 0.18. While correlation coefficient value (r) = 73.59 %, and number of error is 4.81. The results shows the relation of observed discharge and the model result are very close. Assess the parameter serve the purpose of assess characteristic of catchment area having an effect on to occurence of stream in DAS Kodina.

Keywords— Land use, evapotranspitation, Nreca Model and Calibrations, Discharge.

I. INTRODUCTION

Water resource development activities could not be separated from the evaluation and analysis of hydrological phenomena which are always consider the local conditions such as land cover and climatology. Important step in this study will provide an overview of the output water discharge (inflow) to the river so that water availability is expected to be able to meet human needs (outflow), and indirectly also will help determine the direction of the development strategy of water resources in a comprehensive manner.
Changes in land use and climate changed had a direct impact to the flow characteristics and the availability of water in a watershed. The pattern of land use changed are generally converted the forests to agriculture, plantations, and continues to settlements referred to the development of the region. Such a change obviously affects to the water balance of the area and watershed hydrology regimes concerned. 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. In the case of Kodina/Mayoa Watersheds would be simulated by Mock's Model, Nreca's models and models calibration.
Mock's and Nreca's hydrological models is an approach models which is simulate and predict the hydrological events that occur by using specific hydrological data recording. The main input data in the hydrological model are referred to precipitation, climatology (the calculation of evapotranspiration), watershed areas and related parameters while output in the form of flow models. Then the models will be calibrate, verification and validated until it obtained the optimal parameters of a hydrological model.
The Components of water balanced is analyzed surface flow, base flow, percolation and evapotranspiration. In some of the literature describes the narrower of the watershed the more significant effects of the percentage changes in runoff components. In general, the existence of forest cover affect the water balance in regions which are reducing surface runoff however it affected the raise of base flow, percolation and evapotranspiration. While the broader watershed's had the declining impact on water balanced regarding to the presence forest cover. Characteristics of river discharge generated from the model will be validated and calibrated by the flow measured at the study sites, so the trend will be obtained from the model to the actual discharge. The ratio of discharge should be observed that the accuracy of the model can be compared against the average monthly discharged. The important indicator to assess the hydrological characteristics of a river is a specific discharge per unit area.

The Land use pattern in the upland Kodina's watershed in 2014 was still dominated by forests and plantations partially shown in Table-1.

Table-1. Land Use in the Study Area at 2014

No.	Land Use	Area (Ha)	%	Run off Coef.
1	Settlement	576.00	1.98	0.3
2	Land Open Space	172.80	0.82	0.2
3	Shrubbery	3168.00	11.00	0.45
4	Moor / Lea	864.00	3.08	0.45
5	Forest	20160.00	69.33	0.35
6	Rice Field	1440.00	5.12	0.45
7	Plantation	2304.00	8.25	0.35
8	Road	86.40	0.30	0.7
9	Public Facility	28.80	0.12	0.6
	Jumlah	**28800.00**	**100.00**	0.368

The vegetation impact on watershed hydrology mainly affected to the forest role. That was could be holding / storing rainwater, and avoid the occurrence of floods and drought, which seems to be explained by the laws of causality. The Assessment of sensitivity of hydrology system in the watershed due to changes in land use can be done in three stages: (i) development of land use change scenarios; (ii) simulation of the hydrologic region; and (iii) evaluation of the impact of hydrological variations produced water resources system that includes aspects of the development and management as well as assessing system performance due to disasters such as floods and droughts, the operation of rivers, canals, water quality, and environmental issues

Pawitan (1999) stated that the changing of land use has an impact to the declined on availability of water regions due to increased seasonal fluctuations with symptoms of floods and droughts, and the watershed dimensions as well as the storage capacity either on the surface (plants, rice paddies, swamps, lakes / rivers, and streams) and subsurface (soil and water in the earth), will be the dominant factor in determining vulnerability and the carrying capacity of water resources system to climate change in the regions. Regard to the new paradigm from the management of the water resources of blue water into green water to be relevant today.

One of the watershed management planning programs is needed to know in advance the local hydrological conditions. However, most of the watershed that will be manage has not available the sufficient hydrological data, so that to solve this problem it was required an approach through hydrological modeling in accordance with biophysical conditions sub watershed / watershed. The results of the model are expected to be applied to the Watershed which has some similarities biophysical conditions. With the appropriate hydrological model the evaluation of watershed characterization can be easily done.

Hydrological modeling has been applied for a long time. Hydrological models are mostly developed in temperate regions, and a few are developed in the tropics. Whereas the tropical regions was also needed their hydrological model. Hydrological model developed in temperate regions is not necessarily appropriate when applied in the tropics because in addition to climatic differences are also differences in soil and vegetation cover.

A model of watershed hydrology generally used the unit as a whole area of research. 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 directly instead are influenced by the physical properties of the surface of the watershed are also influenced by the properties of the rain. Rainfall that occurred in the wet tropical climate have considerable variation in space and time, the study of rainfall and runoff relationship and how their influence on the response of a watershed is very necessary, given the measurement of hydrological phenomena, especially areas without hydrological data recording either because of limited funds or human resources, we need a model of correlation between variables, so that the existence of a model, it can be reduced measurement of the hydrological phenomenon.

II. LITERATURE REVIEW AND METHODS.

2.1. Data of the Research

To create the models it is necessary to have a completed and accurate data, so that the model can be applied to the area which has some similarities both biophysical and socio-economic conditions. In this study will only be tested on an empirical model that is one part of a model deterministic. This model is generally presented the relationship between two or more factors hydrology based on observations in the Automatic Water Level Records (AWLR) and field. The empirical model is usually a mathematical equation based on information obtained from research.

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^{o} 8'02 "- 2°14'52" South latitude and 120^{o}40'18"- 120^{o}51'16" East Longitude.

The materials needed to support this study include:
- Map of land use 1: 50,000 scale,
- geological map scale of 1: 500,000,
- soil maps scale of 1: 100,000,
- Landsat Imagery

The data used were obtained from BWS III Central Sulawesi which is specific to Kodina Watershed such

are:
1. Rainfall data from 2002 – 2014
2. Climatology data
3. Discharge Data Recorded

Table 3: Monthly Rainfall Data Sta.Mayoa

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: 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

Table 2: Average Climatology Data at Sta.Mayoa

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

2.2. Literature Review and Procedure

Watershed is an area where all the water flows into a river. This area is generally restricted by topography, which means determined based on the flow of surface water. This limit is not set based on underground water because the water table is always changing with the seasons and the level of user activity. Aside from watershed functions, the flow of water in the watershed is also greatly influenced by the shape of the watershed, watershed characteristics, rainfall and runoff areas that become unitary flow that passes through a river body per unit time.

Water balance is a balancing system of water in one place at a certain period, so that the information excess (surplus) or shortage (deficit) of water can be easily to know. The concept of water balance basically shows the balance between the amount of water if flow, available, and outflow from the specific system. In general, the water balance equation

$$I = O \pm \Delta S \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where:

I = input (inflow)
O = output (outflow)
ΔS = Changes in soil moisture content.

The water balance is specifically formulated with (Handayani, 2010)

$$P = Q + E \pm \Delta S \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

where :

P = Precipitation (mm)
Q = Discharge (m^3 / s)
E = Evapotranspiration (mm)
ΔS = Delta Storage (mm)

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 (Adsak, 2007). Evapotranspiration is closely related to water requirements of plants. Crop water needs is a certain amount of water needed to replace the water lost through evaporation. Evaporation in this case is the evaporation of surface water and the leaves of the plant (Montarcih, 2010). There are several ways of calculation and measurement or evapotranpirasi among others (Adsak, 2007):

a) Pan evaporation
c) Measuring tools *lysimeter*
d) *Thornthwaite methods*
e) *Blaney-Criddle methods*
f) Penman methods

Generally potential parameters for evapotranspiration calculation as follows (Montarcih, 2010):

- The average monthly temperature
- monthly relative humidity average (RH)
- The montly sun brightness (n/N in percent)
- monthly wind speed average (U in m/s)
- Location of latitude regions
- The number of correction (C)

The Calculation of potential evapotranspiration using Penman Method received a recommendation from the UN Food and Agriculture Organisation. The general principle of the calculation of potential evapotranspiration in accordance with the following formulation:

$E = C *(W*Rn + (1-W)*f(u)*(e_a-e_d))$ ..... (3)

where:

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

Based on the formula of Penman Modification and the data from Mayoa Climatology station, therefore it calculated the evapotranspiration, so that the results are follows:

Table 4: The Calculation of Monthly Et

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

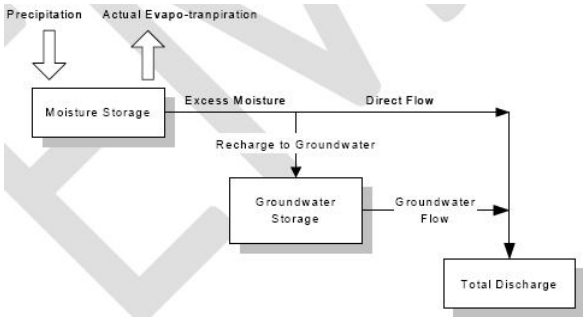
2.2.1. Nreca Methods

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).

$$RO = R - ET_a + \Delta S \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

Input is needed from the model of rain - lmpasan Nreca are as follows:

- The average rainfall (P)
- Potential evapotranspiration (PET)
- The capacity of the storage moisture (NOM); can be estimated: NOM = 100 + 0.2 x average annual rainfall.
- PSUB, with values ranging from 0.3 - 0.9.
- GWF that ranged from 0.2 - 0.8
- The initial value of the storage soil moisture (SMSTOR)
- The initial value of the ground water reservoir (GWSTOR)
- crop factor (Cf),



NRECA models carried out in phases:

- Calibration of model parameters with discharge data that existed at an expected post water
- Verification of the model parameters on several posts had expected existing water in the study area,
- Generation of a synthetic discharge data for each cacthment area that is not on the measurement data or the data amount is less.
- NOMINAL = 100 + C * (average annual rainfall), where C = 0.2, for areas with rain throughout the year, C ≤ 0.2, for areas with seasonal rains.

NOMINAL can be reduced up to 25% to areas with limited vegetation and ground cover is thin.

2.2.2. F.J Mock Methods

In principle, the Mock method is considering the inflow and outflow and soil storage. The volume of incoming water are rainfall, otherwise the most dominant of the water that comes out is infiltration, percolation and evapotranspiration. Overall, the computation of availability of discharge by Mock models refers to water balance, where the total volume of water on earth is fixed, only the circulation and distribution varies (Bappenas 2007).

Mock models are mainly considered the calculation of the actual evapotranspiration, water balance, run-off and groundwater, total stored volume and surface runoff.

Criteria calculations and assumptions are sorted as follows.

a) meteorological data
b) Monthly rainfall data (R) for each year Data on the number of monthly rain days (n)
c) m = Percentage of open field
d) K = Catchment Area resession Factor)
e) Vn-1 = the initial storage (initial storage).
f) Calculation of evapotranspiration, the method of Penman Modification were used.
g) Soil Moisture Capacity

$ET_a = ET_p - ET_p(m/20) \cdot (18 - n)$
ER = P - ET_a
ΔSM = SMC – ISM
WS = ER - ΔSM
I = Cds * WS ; I = Cws . WS
GWS = 0,50 * (1 + k) . I + k
ΔS = GWS – IGWS
BF = I - ΔS
DRO = WS – I ; TRO = DRO + BF
QRO = A * TRO ..... (5)

2.2.3. Calibration and Validation

Calibration parameters of the model performed in order to find the parameters that best fit the characteristics of the watershed basin concerned, so hydrograph simulation approach observation. Phase calibration is highly dependent on rainfall data and discharge, because the main input is the data model of rainfall and discharge data for calibration. There are two parameters that need to be calibrated such as PSUB and GWF. In addition there are other parameters beyond structure models such as the crop factor (crop factor) and the weighting factor rainfall station.

The benchmarks closeness between hydrograph simulations with observations determined by:

$$r = \frac{1}{n}\sum(Q_{obs} - Q_{sim}) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

Where,

n = number of data

Q_obs = discharge observation, m^3 / s

Q_sim = discharge simulation, m^3 / s

The reliability of the calibration results can be seen through the chart, and depends on:

- Data validity rainfall and discharge
- The range of the calibration data (minimum 5 years)

Validation of the results is done by comparing the total flowing water monthly / yearly results of the calculation of the total flow (high flow) is separated from the hydrograph curve recorded at the Mayoa rainfall station. The difference between the calculation results and measurement results for each month will be considered. The difference (error = (observed data – counted result) / (amount of observed + count)). Differences monthly average and an annual for observed and computing results also counted in the simulations.

III. RESULTS AND DISCUSSION

In this study the climate components include temperature (T), rainfall (R), evapotranspiration (ETo) was analyzed. Determining the influence of climate components to stream flow discharge data 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. The calculation of evapotranspiration by using the table 2 related climatology in the study area. The results of evapotranspiration shows in table 4. So that monthly evapotranspirantion will be apply in the calculation of discharge concerned to Mock Models.

The data of flow rate (Q observed) and topographic data was analyzed and processing by using the Microsoft Excel program. Water Availability are shown on the table below;

Table 5: The Result of Discharge by Mock models

Discharge FJ. Mock Model on Kodina/Mayoa Watershed - Poso (m^3/s)												
Month	Jan	Peb	Mar	Apr	May	June	July	Ags	Sep	Okt	Nov	Des
2002	7.71	10.46	12.48	16.61	17.77	20.41	20.27	19.21	19.36	18.47	19.66	19.77
2003	19.58	21.92	22.01	25.36	24.78	24.26	21.92	21.38	22.14	20.83	21.50	21.44
2004	21.73	24.95	23.75	25.02	24.65	25.66	23.98	22.88	22.83	21.40	21.39	19.37
2005	18.63	22.36	21.91	23.27	22.77	23.23	22.66	22.68	22.48	21.61	23.24	23.77
2006	24.20	26.48	23.85	25.27	24.89	25.54	24.00	22.82	22.54	21.14	21.71	21.32
2007	21.56	25.30	24.34	26.59	26.61	27.32	26.00	24.49	24.02	22.67	23.19	22.29
2008	22.31	25.05	23.29	25.10	25.15	26.05	24.22	23.82	24.43	23.28	26.40	28.22
2009	29.35	33.36	30.99	33.26	32.76	32.99	30.28	28.59	28.11	26.01	26.12	25.34
2010	26.22	29.97	29.25	32.86	32.47	32.76	29.35	28.26	28.89	28.03	29.25	28.50
2011	28.42	30.29	26.66	27.55	27.27	27.94	26.17	25.24	25.03	24.00	24.97	24.38
2012	23.76	25.01	21.52	20.68	19.77	20.60	18.73	17.16	16.65	15.15	14.90	14.17
2013	14.33	17.55	17.53	19.69	21.17	23.67	25.17	26.04	25.89	24.43	25.97	27.07
2014	27.81	30.49	27.36	28.24	27.17	28.15	27.56	27.32	27.41	25.48	25.71	25.90

region, shows the dependable water on region has some differences compared to observed data. And the result is shows in figure-1.

For NRECA method, in addition to data evapotranspiration, also required monthly rainfall, the coefficient of P_1 and P_2. P_1 value used in this study is 0.5 because the land in the Kodina watershed likely able to detained the flow of groundwater. For P_2, the value used is 0.4 for the same consideration when choosing the value of the coefficient P_1. The final result of the calculation still needs to be multiplied by Kodina watershed area to obtain the final result of the discharge in the unit m^3/sec.

Table 6: The Result of Discharge by Nreca models

Discharge Nreca Model on Kodina/Mayoa Watershed												
Bulan	Jan	Peb	Mar	Apr	Mei	Jun	Jul	Ags	Sep	Okt	Nov	Des
2002	1.80	1.96	3.65	7.39	8.44	12.94	7.97	7.17	6.67	5.81	8.76	8.68
2003	7.24	10.46	17.05	18.39	14.84	12.70	11.50	13.23	11.88	9.85	13.04	13.02
2004	13.72	17.02	16.71	18.21	18.45	17.44	16.16	13.50	12.85	11.06	12.37	9.82
2005	12.04	16.12	13.63	15.17	15.50	14.19	16.62	13.20	11.96	13.22	16.03	17.09
2006	14.98	16.43	15.88	19.92	18.63	19.48	14.98	13.84	12.70	11.06	11.76	14.18
2007	11.98	18.19	15.22	21.10	18.15	20.52	16.62	15.56	15.02	14.13	15.81	14.43
2008	14.19	14.79	16.26	18.18	18.00	17.08	15.35	18.57	16.32	17.33	25.68	23.49
2009	24.43	25.44	26.81	29.11	26.91	23.82	21.09	18.52	17.22	15.00	17.78	16.92
2010	18.08	18.60	24.54	24.29	24.82	21.73	18.67	22.24	20.46	23.03	21.96	24.67
2011	21.15	23.72	20.93	24.10	24.70	21.49	19.91	16.98	17.45	17.13	19.47	19.97
2012	15.49	15.44	12.55	12.02	16.79	15.86	12.25	11.02	10.25	8.93	10.67	10.59
2013	8.40	14.17	12.70	17.68	18.86	20.14	24.90	18.15	18.51	15.26	20.99	22.00
2014	18.03	18.49	18.47	18.54	17.09	19.83	19.62	17.02	15.05	13.11	14.31	19.00

The result of the calculation of the overall discharge Nreca models an FJ Mock models are shown in figure-1. The figure was compared the results of discharge models and observed discharge data. The graph shows that Nreca models are quite similar with observed data.

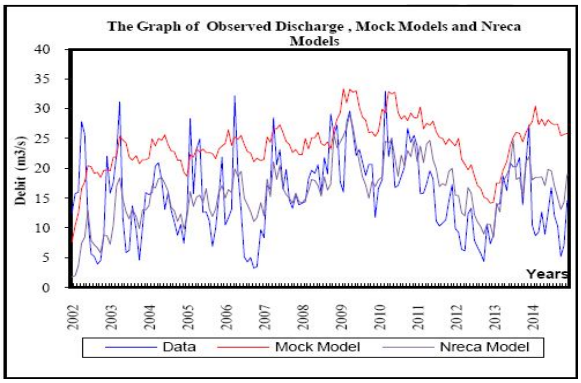


Figure-1. The Observed data, Mocks model and Nreca models

From the figure above it seems the result of Nreca almost similar to the pattern of observed flow. Therefore the next step, the only nreca models will be tested by calibration and validation regarding to the biophysical oh the Kodina watershed. Phase calibration and verification in the calculation nreca method 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). To get optimal parameter values then used statistical test for correlation coefficient, volume and t-test error. After obtained parameters then the next optimal calibration results do the verification phase models with comparing the mean and variance between discharge data on the calculation and observed data. The validation phase is carried out to see the enforceability of a model to be applied in a region based on a statistical test. The calibration results are shown in table 7. Itshows 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 0,736. Correlation value is greater so it can be trusted.

Table 7: The Result of Nreca Calibration models

Discharge Calibratrion of Nreca Model on Kodina/Mayoa Watershed												
Bulan	Jan	Peb	Mar	Apr	Mei	Jun	Jul	Ags	Sep	Okt	Nov	Des
2002	2.86	2.87	5.98	11.80	13.48	19.98	12.49	9.99	8.26	6.39	10.41	10.53
2003	8.24	12.07	21.70	24.34	19.11	14.85	12.12	13.93	11.76	8.68	12.74	13.26
2004	14.04	17.94	18.05	19.90	20.22	18.43	16.29	12.16	10.47	7.99	9.51	6.56
2005	12.51	19.58	16.31	18.37	18.88	16.44	19.72	14.55	11.73	13.31	17.40	19.48
2006	15.82	16.41	15.56	20.35	19.17	19.89	13.80	11.53	9.39	7.27	7.98	11.82
2007	10.24	20.57	17.15	26.04	22.06	24.76	18.78	16.26	14.60	13.15	15.27	13.71
2008	13.90	14.18	17.75	21.06	21.21	19.45	16.52	20.96	17.51	18.74	31.02	28.74
2009	28.93	29.76	31.16	34.21	30.88	25.47	20.59	16.05	13.27	10.27	14.01	13.68
2010	18.30	18.68	30.79	30.65	31.30	25.76	20.09	24.59	21.66	25.39	23.66	27.65
2011	21.20	22.09	18.71	21.91	23.31	19.08	16.78	12.67	12.69	12.83	16.09	17.77
2012	12.18	10.79	7.80	6.93	14.18	13.82	9.39	7.51	6.21	4.81	7.29	8.08
2013	5.50	13.05	12.49	19.64	22.12	23.93	30.58	21.10	19.93	14.68	21.89	24.07
2014	9.19	9.21	11.39	12.26	11.57	15.49	16.48	13.55	10.55	8.17	9.67	17.07

From the test of nreca calibration it was shown the impact of rainfall changes was more significant than that caused by changes in land cover. Due to the area change is not significant, so that the effect of a change in the type of cover to other types hydrological was less. Of the two types of factors that changed, keep in mind that changes in rainfall occur more dynamic and repetition occurs more frequently, such as always there is a repeat of wet and dry years caused by the El nino and La nina phenomenon, while the land-cover change are generally more latent.

Another thing to note is that the land cover changes in general has always evolved from dense vegetation cover, such as forests became sparse vegetation. Meeting with vegetation cover types are generally identical to the good hydrological functions, such as forests and plantation, while species with low vegetation cover is generally synonymous with bad hydrological function as well as the clearing or settlement.

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 reduce runoff. 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.

With the above results it appears that the rate of error calculation will be even greater if the precipitation that falls is getting smaller.

The results above are figure below;

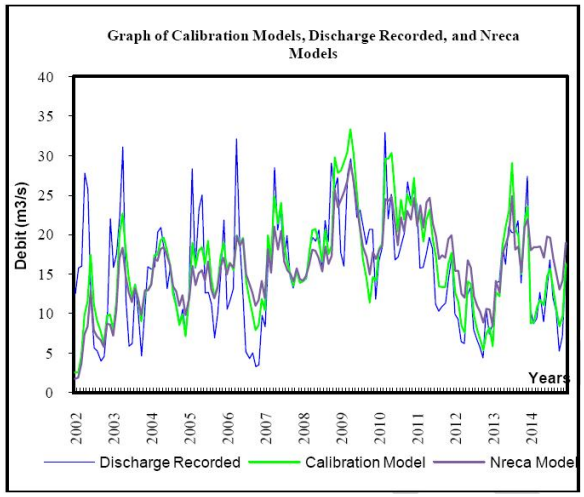


Figure 2. The observed discharge, results of nreca model and Nreca calibration models.

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.

CONCLUSIONS

The empirical Penman modification equation (EPM) used in this study has a much simpler form than the Penman-Monteith equation. And the result which is apply to model are good to models. Also several fewer intermediate calculation steps are required to estimate daily reference Based on the results of the qualitative evaluation can be seen that the pattern of the average monthly flow simulation results have similarities with observed discharge measurement results. So it can be said that the model is reasonable and logical.

The above results indicate that the results of the calculation give a small error for the annual average and the error was varied for each month. However, for the information in this database have an adequate level of accuracy. On the other hand, for the purpose of using more detail, such as for the engineering design, it will take a more detailed study of locally around the site to be developed.

Regarding on the data generated, it is known that both modeling scenarios the discharge may affect the value. Large discharge observed January – March 2006 with increasing open space, plantation dan settlement with a percentage rise to 7.45 %. However, both scenarios are made, the Scenario 1 discharge data obtained at 2552.18 m^3/s average 16,23 m^3/s, while for scenario 2, discharge generated at 2514.01 m^3/s. The observed discharge data shows 2430 m^3/s and the average is 15,578 m^3/s. Based on the data obtained, it appears that both the scenario results in a differences debit is not significant, especially in scenario 2. So it can be said that scenario 2 is most effectively decrease the amount of discharge, ie by changing land cover to 7.45% in the form of previous land cover in the areas. The calibration model in Kodina watershed discharge can be reduced by changing land cover other than forests to forested land.

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