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# Small Islands Water Availability Analysis In Groundwater Basin (Gwb) And Non-Groundwater Basin (Non-Gwb) Using Modified Mock Calculation Method

Happy Mulya[1], Prof. Ir. Jutata Hadihardadja[2], DR. Ir. Robert Kodoatie[3], Msc
*Doctoral Student Department of Civil Engineering of Diponegoro University, Semarang, Indonesia.*

**Abstact:-** one aspect that needs to be known before analysing water balance for a certain region is the amount of water availability. One way of doing it is to calculate the water availability by using mock method, which are developed by Dr. F. J. Mock (1973). Principally, Mock Method refer to water balance, where the amount of volume of water in earth are constant, only in circulation and distribution varies. Mainlands in Indonesia consist of GWB and Non-GWB area (KepPres 26 Year 2011). Both areas have different characteristic on producing water availability. In Non-GWB ground, water flows only on soil water zone layer, while in GWB area, water are capable to flow until the groundwater zone layer (kodoatie, 2012). For GWB area, Mock Methods calculation needs to be modified, because there is an addition of groundwater from GWB in the form of base flow from other watershed. Analysis result from Modified Mock Method calculation produce water availability in GWB area are greater than in Non-GWB.

**Keywords**:- Small Islands – GWB Area – Non-GWB Area – Mock Method Calculation (Modified) – Water Availability.

## I PRELIMINARY

One aspect that needs to be known before analysing water balance for a certain regoin is the amount of water availability. Water availability in the meaning of water resoures, principally comes from precipitation, surface water and groundwater. Precipitation falling to the surface of a watershed or river basin partially will vaporize back according to the climate processes, partially will flow via surface and sub surface into a drainage, river or lake and partially will infiltrate to the ground as a recharge to the existing groundwater contents (Bappenas, 2006)

Water availability which is part of the natural phenomena, are hard to control and predict. This is because water availability consist of high spatial and temporal variability elements. Therefore, quantitative and qualitative analysis must be done as carefully, so that accurate information can be obtained for planning and maintaining water resourcess (Bappenas, 2006).

Ambon Island is a small island with an area of 761 km² ≤ 2.000 km² (Hehanussa and Bhakti, 2005). Its mainland consist of GWB and Non-GWB area, are taken as a study case for analysing water availability with modified Mock Modeling calculation.

## II MOCK METHOD WATER AVAILABILITY

F. J. Mock (1973) propose a simulation model for monthly water balance for drainage area in Indonesia, this method is called Mock Discharge Simulation. This model is specifically are used for rivers in Indonesia (Bappenas, 2006).

Principally, Mock Method refers to water balance, where the amount of volume of water in earth is constant, only in circulation and distribution varies. Mock Method consider inflows, outflows and groundwater storage. Inflows are precipitaion, outflows are infiltration, percolation and those dominants caused by evapotranspiration.

Mock Model is a simple simulation model. In its development, this model is used in the application of water resources development such as irrigation and raw water supply. Mock Method is used to calculate the amount of discharge from a watershed.

Flow Chart of Mock Method rainfall-runoff is shown in the figure below.

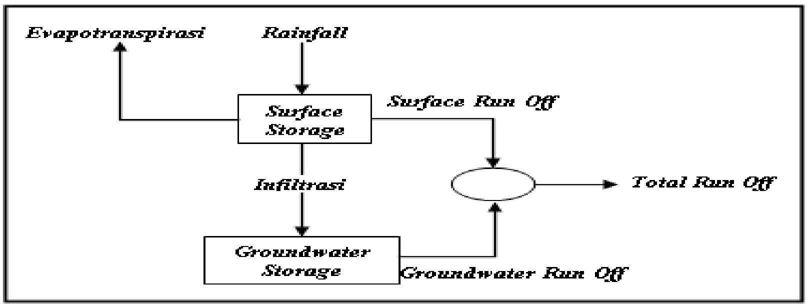



**Figure 1** Flow chart of Mock Method Rainfall-Runoff (Bappenas, 2006)

Calculation process performed in Mock Method is generally described in figure below.

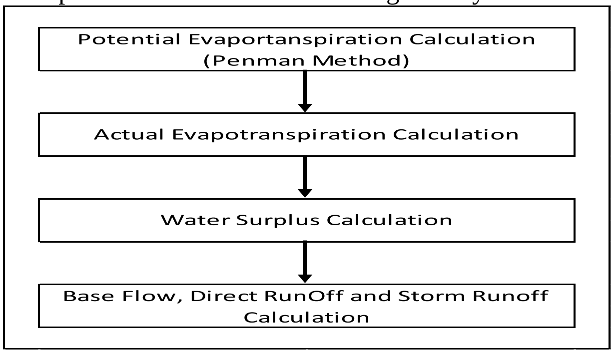



**Figure 2** Flow Chart of Mock Method Discharge Calculation (Bappenas, 2006)

**Water Balance**

On hydrology cycle, description regarding the relationship of inflow and outflow in an area for a certain period is called water balance. This relationship, clearly will be shown on figure below.

General equation of water balance is

$$P = Ea + \Delta GS + TRO \quad (1)$$

where:

P = precipitation.
Ea = actual evapotranspiration
ΔGS = groundwater storage changes
TRO = total runoff.

Water balance is a closed cycle which occur for a certain period of annual observations, where no changes in groundwater storage or ΔGS=0. Which means, groundwater storage determination is based on the previous month within the annual period of review, therefore the water balance equation is:

$$P = Ea + TRO \quad (2)$$

Transportation of precipitation forms into discharge will be shown on figure below.

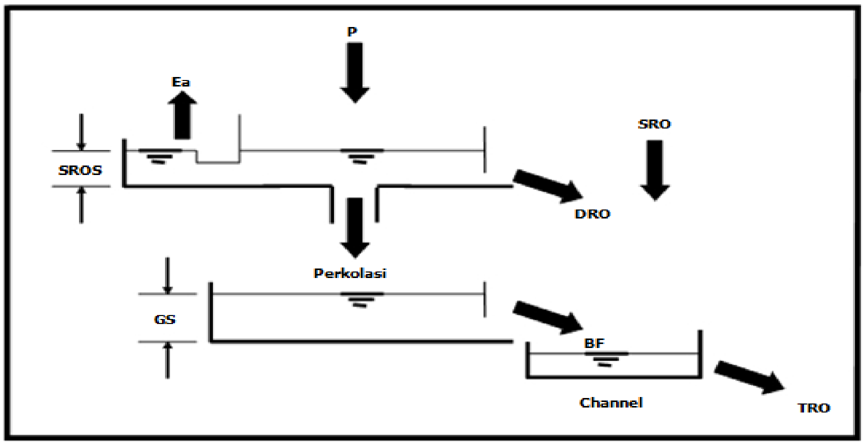



**Figure 3** Transportation of precipitation forms into discharge (Bappenas, 2006)

Where:

P = Precipitation
Ea = Actual evapotranspiration

GS = groundwater storage
SRO = surface run-off
DRO = direct run-off
TRO = Total run-off
BF = base flow

## III WATER AVAILABILITY IN GWB AND NON-GWB

In land: in land surface, gravitationally, water flows from high places (mountains, high lands) to the low places (low lands, coastal areas) and disembogue to the water storage (ocean, lake), water infiltrates and flow gravitationally inside the ground from a high to low elevation. This water, furthermore, will flow to vadoze zone (soil zone) as soil water flow and to the phreatic zone (groundwater zone or saturated zone) as groundwater flow (Kodoatie, 2012).

In GWB, water flows inside the ground, wether in soil water zone or groundwater zone. In groundwater zone, water flows wether in unconfined aquifer or confined aquifer. In Discharge area from unconfined aquifer, which is where water comes out in one groundwater system formation in some condition may become one with soil zone. In other words, in a certain topographical condition, soil water becomes one with groundwater (Kodoatie, 2012).

This groundwater zone is called Groundwater Basin (GWB). Water also flows in the Non-GWB wether inside the ground or in the surface. Inside th ground of Non-GWB, water flows only in soil water zone, because groundwater zone does not exist. In the surface, GWB or Non-GWB, water flows as a runoff in the watershed or the river system (Kodoatie, 2012)

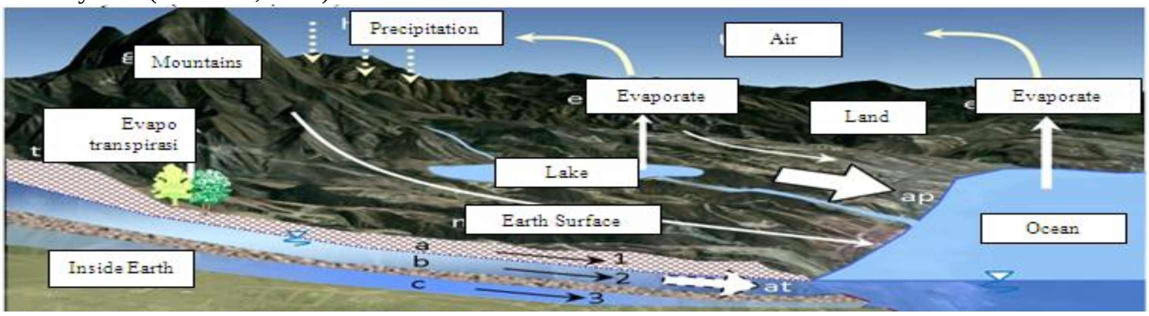



**Figure 4** Simple illustration of water transportation process (Hydrology cycle) (Kodoatie, 2012)

Note: ap = surface runoff (total), at = groundwater (total)
a = soil zone, b = unconfined aquifer, c = confined aquifer
1 = interflow, 2 = groundwater (baseflow) in unconfined aquifer,
3 = groundwater flow in confined aquifer

Generally, water availability phenomenon is divided into two types, which is water on vadose zone and water on phreatic zone. In vadoze zone, water is divided into three types: soil water, intermediate vadoze zone and capillary water. In phreatic zone or saturated zone, groundwater exist. The division of these zone will be shown on figure below, which shows a cross section of the earth's water availability wether groundwater or soil water (Kodoatie, 2012)

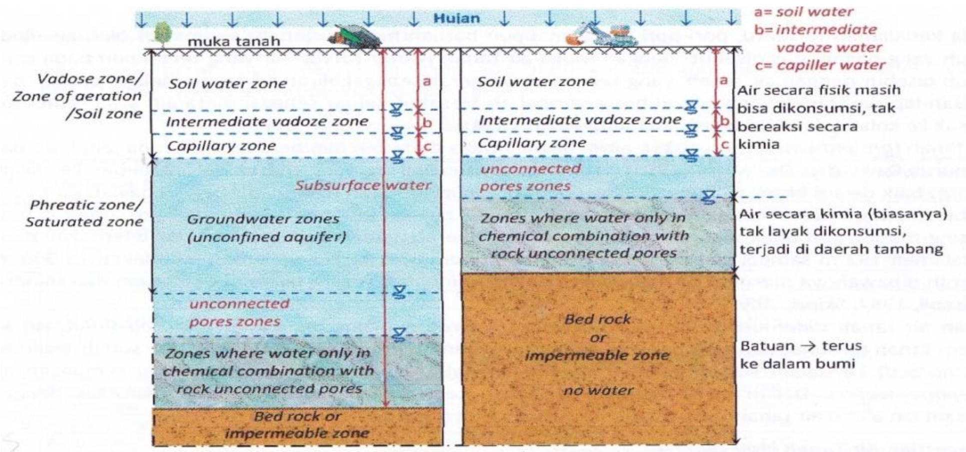
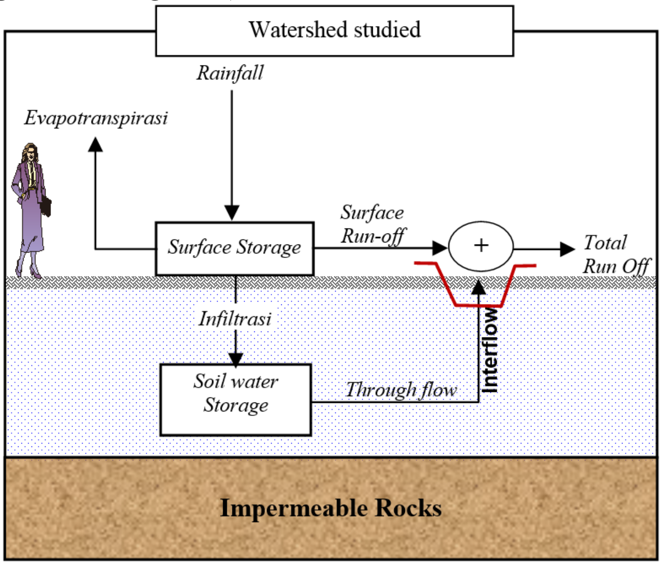
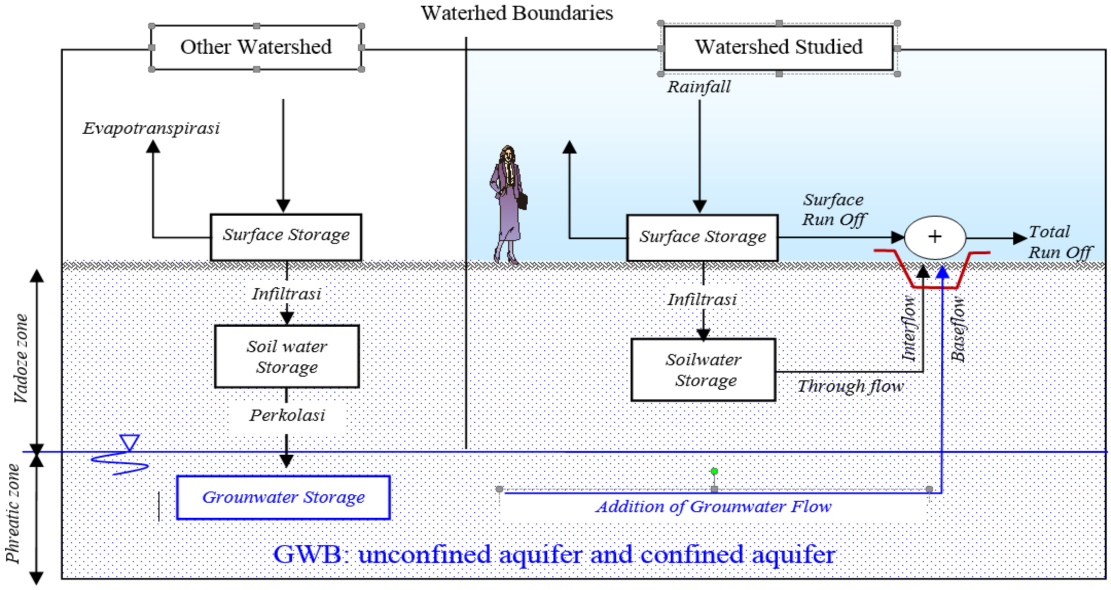



**Figure 5** Cross section of the earth's water availability in GWB and Non-GWB (Kodoatie, 2012)

In GWB, throughflow and interflow occur. While in Non-GWB only throughflow occur, because after soil water zone is an impermeable layer.
Mock Method rainfall-runoff flow chart model are shown in Figure 1, where water flow follows hydrological cycle, generally from precipitation, partially store in the surface becomes surface runoff, partially infiltrate groundwater storage becomes groundwater runoff and furthermore addition of surface runoff becomes total runoff. But based on hydrology cycle on Non-GWB describe flows from precipitation are partially stored in the surface, partially infiltrate the root zone / vadoze zone / unsaturated zone and becomes soil water. With the existance of impermeable rock under root zone, therefore water flows changes into interflow. For GWB calculation of Mock Method needs to be modified, because there is an addition of GWB in the form of base flow from other watershed (Figure 6a and Figure 6b)




a. Modified Mock Method in Non-GWB




b. Modified Mock Method in GWB

**Figure 6** Flow chart of Mock Method Rainfall-runoff in Non-GWB and GWB (Modified)

Modified Mock Method calculation in GWB and Non-GWB can be seen on Table 1.

**Table 1** Modified Mock Method Calculation in GWB and Non-GWB

| Non-GWB | GWB |
|---|---|
| ***Actual Evapotranspiration*** | ***Actual Evapotranspiration*** |
| ΔE / Ep = ( m / 20 ) x ( 18 – n ) | ΔE / Ep = ( m / 20 ) x ( 18 – n ) |
| ΔE = ( m / 20 ) x ( 18 – n ) x Ep | ΔE = ( m / 20 ) x ( 18 – n ) x Ep |
| Eta = Ep – ΔE | Eta = Ep – ΔE |
| ***Water Surplus*** | ***Water Surplus*** |
| SMS = ISMS + (P – Eta) | SMS = ISMS + (P – Eta) |
| WS = (P – Eta) + SS | WS = (P – Eta) + SS |
| ***Soilwater Storage*** | ***Soilwater Storage*** |
| Infiltrasi (I) = WS x if | Infiltrasi (I) = WS x if |
| V (n) = k.V (n-1) + 0,5.(1 + k). I (n) | V (n) = k.V (n-1) + 0,5.(1 + k). I (n) |
| ΔVn = V (n) – V (n-1) | ΔVn = V (n) – V (n-1) |
| *Interflow*= I – ΔV (n) | *Interflow*= I – ΔV (n) |
| ***Water Available*** | ***Ground Water Storage*** |
| DRO = WS – I | Perkolasi (P) = WS x if |
| WA = *Interflow* + DRO | V (n) = k.V (n-1) + 0,5.(1 + k). I (n) |
| | ΔVn = V (n) – V (n-1) |
| | *Baseflow*= P – ΔV (n) |
| | ***Water Available*** |
| | DRO = WS – P |
| | WA = *Interflow* + *Baseflow*+ DRO |

Where:

| | | |
|---|---|---|
| ΔE | = | Potential and actual evapotranspiration difference |
| Ep | = | Potential evapotranspiration |
| Eta | = | Actual evapotranspiration |
| m | = | Percentage of uncoverd vegetation |
| ISMS | = | initial soil moisture storage (constitute of soil moisture capacity (SMC) previous month) |
| P – Eta | = | Precipitation which experience evapotranspiration |

There are two condition to determine SMC

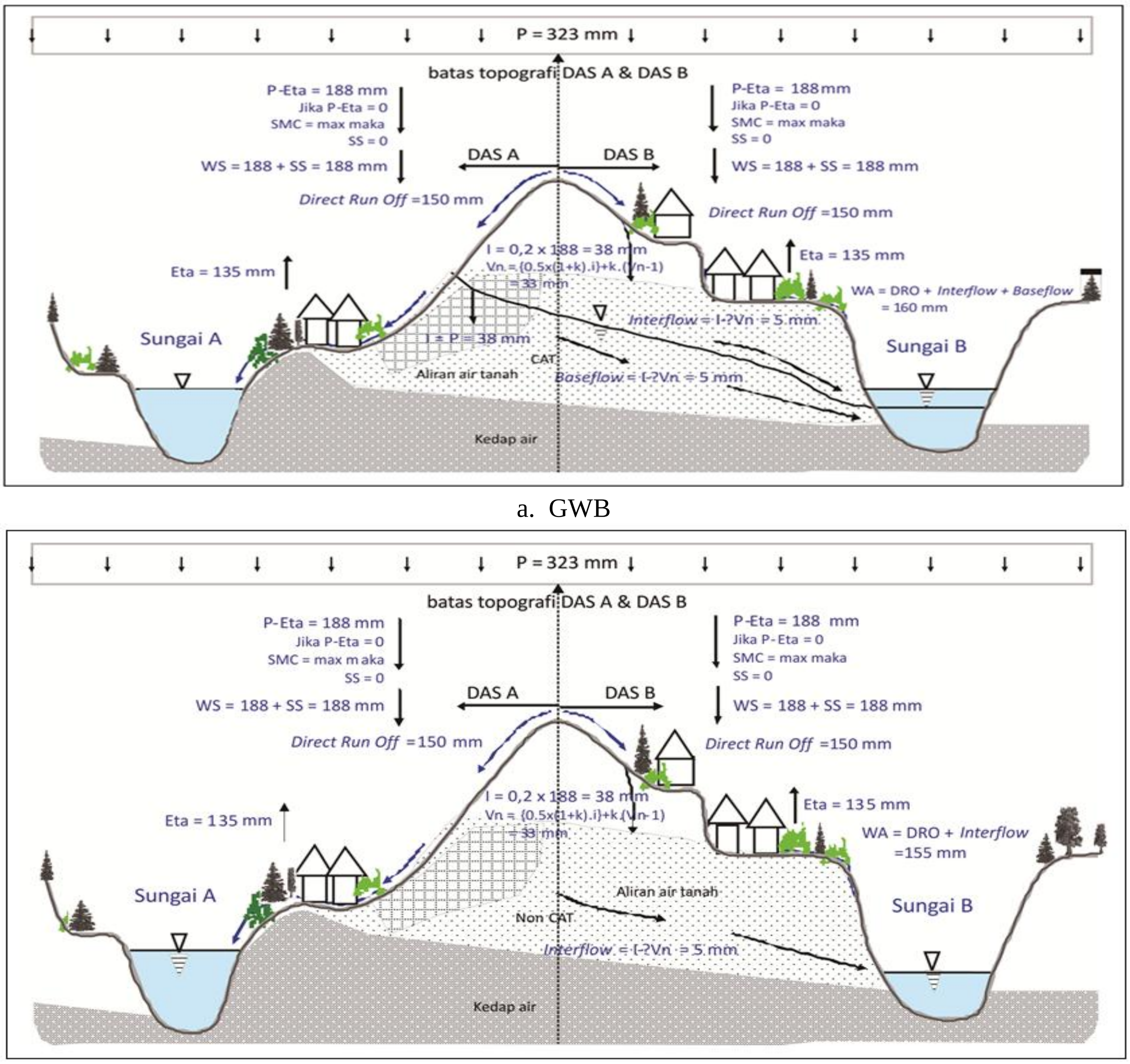
| | | | | | |
|---|---|---|---|---|---|
| 1. SMC | = | 200 mm/month, if P – Eta ≥ 0 | | | |
| 2. SMC | = | SMC previous month + (P – Eta), if P – Eta < 0 | | | |
| V (n) | = | Groundwater volume n month | | | |
| V (n-1) | = | Groundwater volume (n-1) month | | | |
| k | = | Groundwaterflow recesion factor (0,4 – 0,7) | | | |
| WS | = | Water surplus | SS | = | Soil Storage |
| I | = | Infiltration | If | = | Infiltration Coefficient |
| P | = | Percolation | DRO | = | Direct Run Off |
| WA | = | Water Available | | | |

**Calibration Data**

Calibration to Mock Parameter must be done so that the discharge calculation with this method may represent the actual condition in the field (compare to the discharge from the hydrometric measurment which obtained from the secondary data). By using Mock Method discharge runoff calculation, monthly discharge data from the compilement of secondary data are used to calibrate.

## IV RESULT AND DISCUSSION

Mock Method calculation simulation on GWB and Non-GWB in Ambon Island are shown in the figure below:




b. Non-GWB

**Figure 7** Example of Method Mock Calculation in GWB and Non-GWB

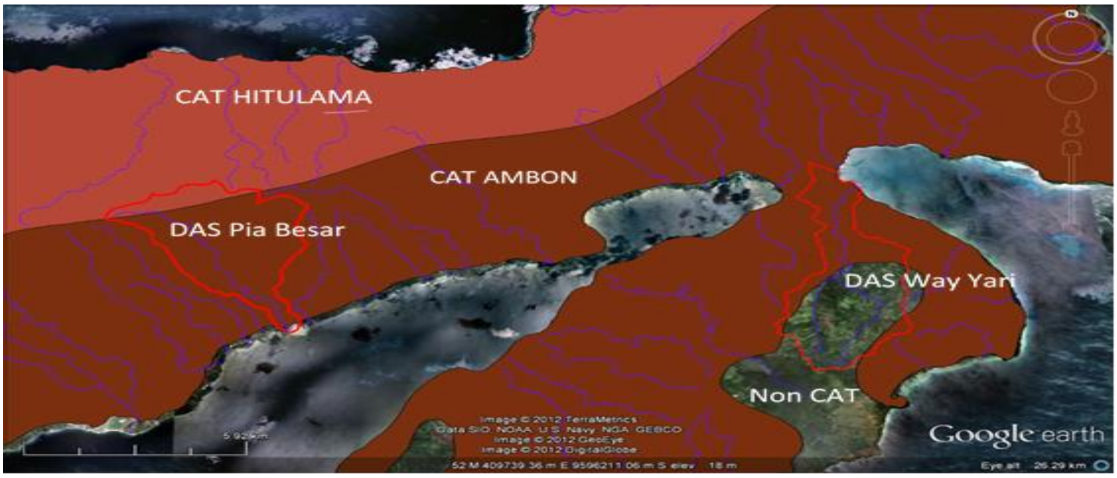



**Figure 8** Map Location of GWB and Non-GWB in Ambon Island

**Table 2** Example of Water Availability calculation in GWB Ambon Island in 2011

| No | Uraian | | Satuan | Jan | Feb | Mar | Apr | Mei | Jun | Jul | Agt | Sep | Okt | Nop | Des |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly Recession Constant | | | | 0,7 | 0,7 | 0,7 | 0,7 | 0,95 | 0,95 | 0,95 | 0,75 | 0,75 | 0,7 | 0,6 | 0,7 |
| [1] | Curah Hujan (P) | | mm | 228 | 201 | 126 | 237 | 1468 | 692 | 694 | 323 | 304 | 143 | 44 | 147 |
| [2] | Jumlah Hari Hujan (n) | | Hari | 17 | 18 | 15 | 19 | 25 | 23 | 27 | 24 | 22 | 15 | 10 | 19 |
| Actual Evapotranspiration | | | | | | | | | | | | | | | |
| [3] | Evapotranspiration (Eto) | | mm | 150 | 137 | 154 | 135 | 123 | 96 | 97 | 117 | 126 | 163 | 159 | 149 |
| [4] | Exposed Surface (m) | | % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % |
| [5] | (m/20) x (18-n) | | | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| [6] | ΔE= ((m/20)x(18-n)) x Eto | [5] x [3] | mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| [7] | Eta = Eto –ΔE | [3] - [6] | mm | 150 | 137 | 154 | 135 | 123 | 96 | 97 | 117 | 126 | 163 | 159 | 149 |
| Water Balance | | | | | | | | | | | | | | | |
| [8] | P – Eta | [1] - [7] | mm | 78 | 64 | -28 | 102 | 1345 | 596 | 597 | 206 | 178 | -21 | -114 | -2 |
| [9] | SMS = ISMS + (P - Eta ), SMC = | 150,00 | mm | 228 | 214 | 122 | 252 | 1495 | 746 | 747 | 356 | 328 | 129 | 36 | 148 |
| [10] | Soil Storage (SS), if P -Eta >=0 , SS = 0 | | mm | 0 | 0 | 28 | 0 | 0 | 0 | 0 | 0 | 0 | 21 | 114 | 2 |
| [11] | Soil Moisture Capacity (SMC) | | mm | 150 | 150 | 122 | 150 | 150 | 150 | 150 | 150 | 150 | 129 | 36 | 148 |
| [12] | Water Surplus (WS) = (P-Eta)+SS | [8] + [10] | mm | 78 | 64 | 0 | 102 | 1345 | 596 | 597 | 206 | 178 | 0 | 0 | 0 |
| Run Off and Soilwater Storage | | | | | | | | | | | | | | | |
| | | | | Unsaturated Zone | | | | | | | | | | | |
| [13] | Infiltration (i) = If x WS | If = 0,20 | mm | 16 | 13 | 0 | 20 | 269 | 119 | 119 | 41 | 36 | 0 | 0 | 0 |
| [14] | {0.5 x (1+k) x i} | | mm | 13 | 11 | 0 | 17 | 262 | 116 | 116 | 36 | 31 | 0 | 0 | 0 |
| [15] | k x (V n-1) | | mm | 85 | 69 | 56 | 39 | 54 | 300 | 395 | 384 | 315 | 242 | 145 | 102 |
| [16] | Soilwater Storage Volume | [14] + [15] | mm | 98 | 80 | 56 | 56 | 316 | 416 | 512 | 420 | 346 | 242 | 145 | 102 |
| [17] | ΔVn = Vn - Vn-1 | | mm | -23 | -19 | -24 | 1 | 259 | 100 | 96 | -92 | -74 | -104 | -97 | -44 |
| [18] | Interflow | [13] - [17] | mm | 39 | 31 | 24 | 20 | 10 | 19 | 24 | 133 | 109 | 104 | 97 | 44 |
| Groundwater Storage | | | | | | | | | | | | | | | |
| | | | | Saturated Zone | | | | | | | | | | | |
| [19] | Percolation (p) = If x WS | If = 0,20 | mm | 16 | 13 | 0 | 20 | 269 | 119 | 119 | 41 | 36 | 0 | 0 | 0 |
| [20] | {0.5 x (1+k) x i} | | mm | 13 | 11 | 0 | 17 | 262 | 116 | 116 | 36 | 31 | 0 | 0 | 0 |
| [21] | k x (V n-1) | | mm | 85 | 69 | 56 | 39 | 54 | 300 | 395 | 384 | 315 | 242 | 145 | 102 |
| [22] | Groundwater Storage Volume | [14] + [15] | mm | 98 | 80 | 56 | 56 | 316 | 416 | 512 | 420 | 346 | 242 | 145 | 102 |
| [23] | ΔVn = Vn - Vn-1 | | mm | -23 | -19 | -24 | 1 | 259 | 100 | 96 | -92 | -74 | -104 | -97 | -44 |
| [24] | Baseflow | [19] - [23] | mm | 39 | 31 | 24 | 20 | 10 | 19 | 24 | 133 | 109 | 104 | 97 | 44 |
| Water Available | | | | | | | | | | | | | | | |
| [25] | Interflow | [18] | mm | 39 | 31 | 24 | 20 | 10 | 19 | 24 | 133 | 109 | 104 | 97 | 44 |
| [26] | Baseflow | [24] | mm | 39 | 31 | 24 | 20 | 10 | 19 | 24 | 133 | 109 | 104 | 97 | 44 |
| [27] | Direct Runoff | [12] - [13] | mm | 63 | 51 | 0 | 82 | 1076 | 477 | 477 | 165 | 142 | 0 | 0 | 0 |

| Monthly Recession Constant | | | | 0,7 | 0,7 | 0,7 | 0,7 | 0,95 | 0,95 | 0,95 | 0,75 | 0,75 | 0,7 | 0,6 | 0,7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No | Uraian | | Satuan | Bulan | | | | | | | | | | | |
| | | | | Jan | Feb | Mar | Apr | Mei | Jun | Jul | Agt | Sep | Okt | Nop | Des |
| [28] | Water Available | [25] + [26] + [27] | mm | 140 | 114 | 48 | 122 | 1095 | 514 | 525 | 431 | 361 | 208 | 194 | 87 |

**Table 3** Example of Water Availability calculation in Non-GWB Ambon Island in 2011

| Monthly Recession Constant | | | | 0,7 | 0,7 | 0,7 | 0,7 | 0,95 | 0,95 | 0,95 | 0,75 | 0,75 | 0,7 | 0,6 | 0,7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No | Uraian | | Satuan | Bulan | | | | | | | | | | | |
| | | | | Jan | Feb | Mar | Apr | Mei | Jun | Jul | Agt | Sep | Okt | Nop | Des |
| [1] | Curah Hujan (P) | | mm | 228 | 201 | 126 | 237 | 1468 | 692 | 694 | 323 | 304 | 143 | 44 | 147 |
| [2] | Jumlah Hari Hujan (n) | | Hari | 17 | 18 | 15 | 19 | 25 | 23 | 27 | 24 | 22 | 15 | 10 | 19 |
| Actual Evapotranspiration | | | | | | | | | | | | | | | |
| [3] | Evapotranspiration (Eto) | | mm | 150 | 137 | 154 | 135 | 123 | 96 | 97 | 117 | 126 | 163 | 159 | 149 |
| [4] | Exposed Surface (m) | | % | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| [5] | (m/20) x (18-n) | | | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| [6] | ΔE= ((m/20)x(18-n)) x Eto | [5] x [3] | mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| [7] | Eta = Eto –ΔE | [3] - [6] | mm | 150 | 137 | 154 | 135 | 123 | 96 | 97 | 117 | 126 | 163 | 159 | 149 |
| Water Balance | | | | | | | | | | | | | | | |
| [8] | P – Eta | [1] - [7] | mm | 78 | 64 | -28 | 102 | 1345 | 596 | 597 | 206 | 178 | -21 | -114 | -2 |
| [9] | SMS = ISMS + (P - Eta ), SMC = | 150,00 | mm | 228 | 214 | 122 | 252 | 1495 | 746 | 747 | 356 | 328 | 129 | 36 | 148 |
| [10] | Soil Storage (SS), if P -Eta >=0 , SS = 0 | | mm | 0 | 0 | 28 | 0 | 0 | 0 | 0 | 0 | 0 | 21 | 114 | 2 |
| [11] | Soil Moisture Capacity (SMC) | | mm | 150 | 150 | 122 | 150 | 150 | 150 | 150 | 150 | 150 | 129 | 36 | 148 |
| [12] | Water Surplus (WS) = (P-Eta)+SS | [8] + [10] | mm | 78 | 64 | 0 | 102 | 1345 | 596 | 597 | 206 | 178 | 0 | 0 | 0 |
| Run Off and Soilwater Storage | | | | | | | | | | | | | | | |
| [13] | Infiltration (i) = If x WS | If = 0,20 | mm | 16 | 13 | 0 | 20 | 269 | 119 | 119 | 41 | 36 | 0 | 0 | 0 |
| [14] | {0.5 x (1+k) x i} | | mm | 13 | 11 | 0 | 17 | 262 | 116 | 116 | 36 | 31 | 0 | 0 | 0 |
| [15] | k x (V n-1) | | mm | 85 | 69 | 56 | 39 | 54 | 300 | 395 | 384 | 315 | 242 | 145 | 102 |
| [16] | Soilwater Storage Volume | [14] + [15] | mm | 98 | 80 | 56 | 56 | 316 | 416 | 512 | 420 | 346 | 242 | 145 | 102 |
| [17] | ΔVn = Vn - Vn-1 | | mm | -23 | -19 | -24 | 1 | 259 | 100 | 96 | -92 | -74 | -104 | -97 | -44 |
| [18] | Interflow | [13] - [17] | mm | 39 | 31 | 24 | 20 | 10 | 19 | 24 | 133 | 109 | 104 | 97 | 44 |
| Water Available | | | | | | | | | | | | | | | |
| [19] | Interflow | [18] | mm | 39 | 31 | 24 | 20 | 10 | 19 | 24 | 133 | 109 | 104 | 97 | 44 |
| [20] | Direct Runoff | [12] - [13] | mm | 63 | 51 | 0 | 82 | 1076 | 477 | 477 | 165 | 142 | 0 | 0 | 0 |
| [21] | Water Available | [19] + [20] | mm | 101 | 82 | 24 | 102 | 1085 | 496 | 501 | 298 | 252 | 104 | 97 | 44 |

**Note**: The result of the Calculation (WA) on table above are using millimeter (mm) units, therefore if WA are multiplied with the area of catchment in $km^2$ with a certain conversion rate, discharge unit of $m^3$/sec are obtained.

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**Table 4** Water Availability comparison in GWB and Non-GWB

| **Commentary** | **Month** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Des |
| **Water Availability (mm)** | **GWB** | | | | | | | | | | | |
| | 4 | 3 | 2 | 53 | 159 | 137 | 158 | 69 | 46 | 34 | 21 | 11 |
| | **Non-GWB** | | | | | | | | | | | |
| | 3 | 1 | 1 | 37 | 150 | 119 | 117 | 35 | 27 | 17 | 10 | 5 |

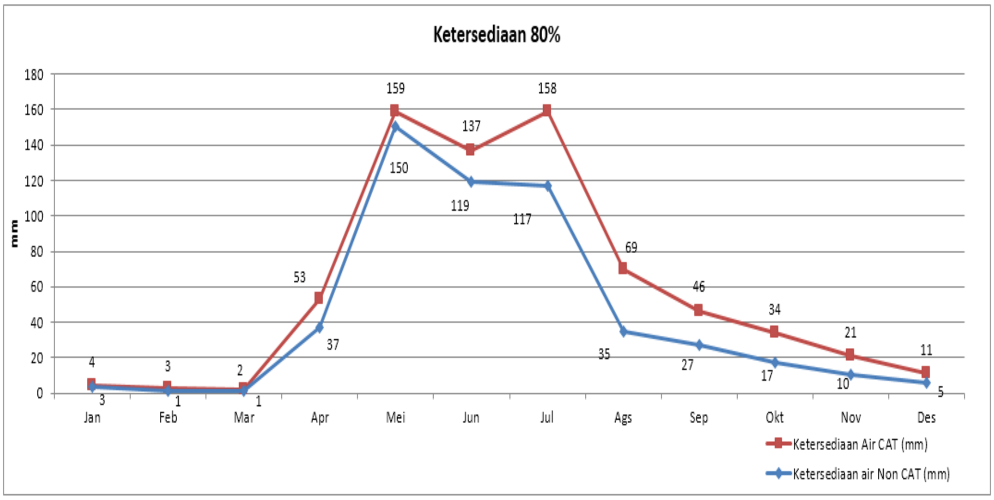



**Figure 9** Comparison Graphic of Water Availability in GWB and Non-GWB in Ambon Island

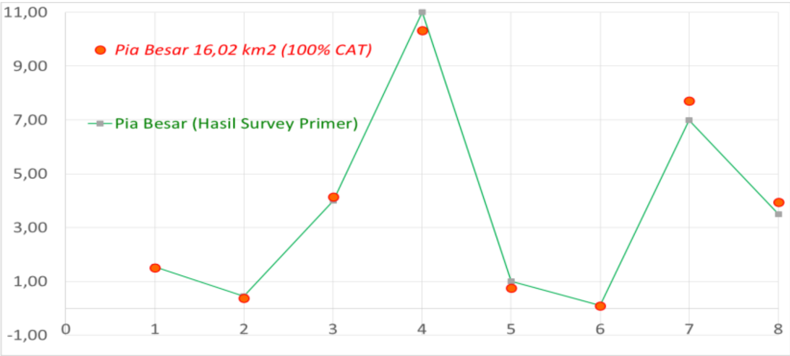
From Figure 8, two Watershed in GWB and Non-GWB are chosen which is Pia Besar Watershed which consist of GWB and Yari Watershed which consist of GWB and Non-GWB. Other than that, these rivers has the same watershed width. Comparison of calculation with Modified Mock Method and Primary Discharge measurement for Pia Besar River and Way Yari River. Primary and Secondary data are shown below:

- Primary Data: Dischare measurement in 2011 and 2012, 4 times of measurement each year. Detail of measurement are shown below.

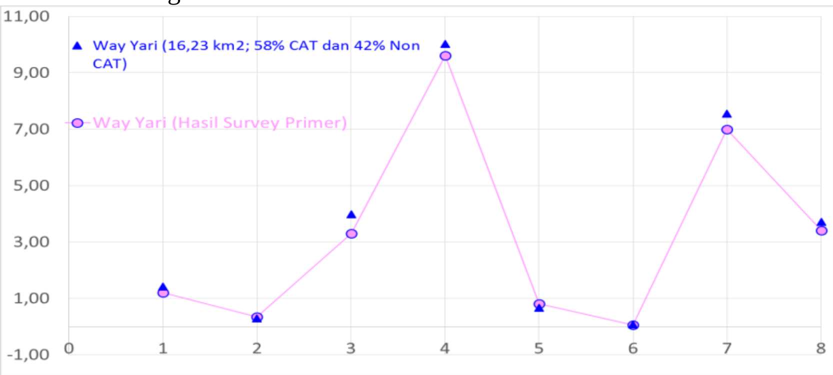
**Table 5** Discharge measurement of two rivers in Ambon Island

| **No.** | **Date of Measurement** | **Discharge (m3/det)** | |
|---|---|---|---|
| | | **Pia Besar Watershed** | **Way Yari Watershed** |
| 1 | January 12, 2011 | 1,55 | 1,2 |
| 2 | February 2, 2011 | 0,45 | 0,35 |
| 3 | June 19, 2011 | 4 | 3,3 |
| 4 | July 4, 2011 | 11 | 9,6 |
| 5 | January 1, 2012 | 1 | 0,8 |
| 6 | February 14, 2012 | 0,1 | 0,05 |
| 7 | June 16, 2012 | 7 | 7 |
| 8 | July 1, 2012 | 3,5 | 3,4 |

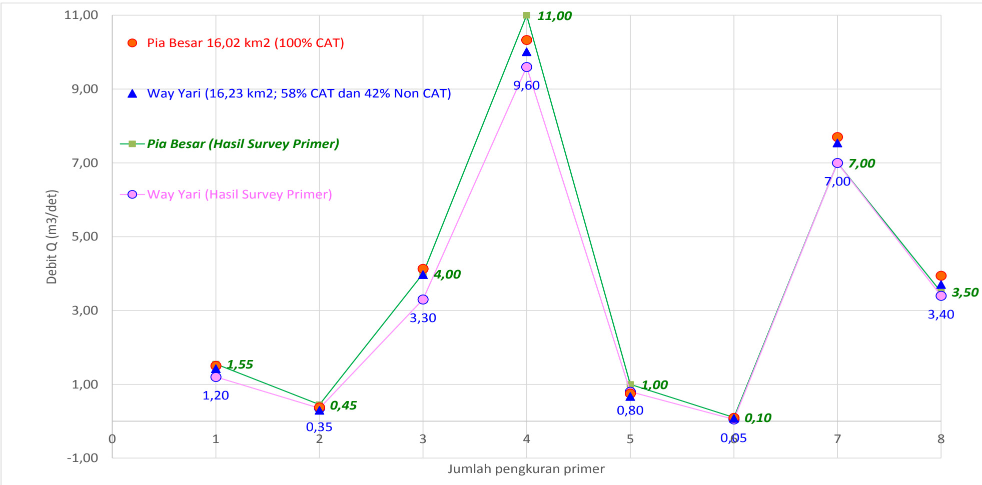
- Secondary Data: Climatology data taken from Pattimura Station for daily data according to the primary measurement. Pia Besar Watershed Area = 16 $km^2$ (All are GWB), Way Yari Watershed are = 16,23 $km^2$ (100%) with 9,35 $km^2$ (58%) are GWB and 6,88 $km^2$ (42%) are Non-GWB.
- The result of comparing Modified Mock calculation with direct measurement in the field are shown in the figure below. Notes for the exact previous comparison has been modified with equated area scale.




a. Comparison of discharge calculation of water availability using Modified Mock Method and the resul of direct measurement of Discharge for Pia Besar Watershed




b. Comparison of discharge calculation of water availability using Modified Mock Method and the resul of direct measurement of Discharge for Way Yari Watershed (58 % GWB, 42 Non-GWB)




c. Merged comparison between calculation result with modified mock and direct measurement of the two rivers.

Figure 10 Comparison of Modifed Mock calculation result and direct measurement for the two rivers.

## V CONCLUSION

1. Water Availability calculation with Mock Method for GWB and Non-GWB are different.
2. For Non-GWB, water flows as soil water flow in soil zone or known as interflow, therefore Mock may be used directly.
3. For GWB, additional groundwater flow which becomes base flows from other watershed, therefore flow chart and calculation of Mock Method needs to be modified
4. From the result of water availability analysis in GWB are always bigger than water availability in Non-GWB.
5. In Non-GWB, existing rivers are intermittent rivers, therefore on dry season river discharge measurement cannot be applied, calibration from the result of Mock Model Modification are only applied on rain season.

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