

**A COMPARATIVE STUDY OF RESERVOIR INFLOW ESTIMATION
USING MOCK METHOD AND NRECA (CASE STUDY IN BATUJAI
RESERVOIR)**

Final Project

Submitted in partial fulfillment of the requirement
for the bachelor's degree in civil engineering



Submitted by :

LALU MUH. A'ISY AZIZAN

NIM : D 100 164 014

**CIVIL ENGINEERING DEPARTMENT
ENGINEERING FACULTY
UNIVERSITAS MUHAMMADIYAH SURAKARTA
2023**

APPROVAL SHEET

**A COMPARATIVE STUDY OF RESERVOIR INFLOW ESTIMATION
USING MOCK METHOD AND NRECA (CASE STUDY IN BATUJAI
RESERVOIR)**

Final Project

Submitted and Maintained on at the Final Project Examination
In front of the Board of Examiners
At the date of : 14 January 2023

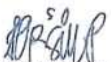
Submitted by :

LALU MUH. A'ISY AZIZAN

NIM : D100 164 014

Structural of the Board of Examiners,

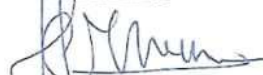
Supervisor Lecturer,


Purwanti Sri Pudyastuti, S.T., M.Sc.
NIDN : 0608117002

1st Examiner


Ir. Isnugroho, CES
NIP : 1955.03.06.1982.02.1.001

2nd Examiner


Ir. Hermono S Budinetro, M. Eng
NIP : 110.032.522

This Final Project is accepted as one of the requirements
To achieve the Bachelor's degree in Civil Engineering
Surakarta, 14 January 2023


Dean of Engineering Faculty,
Beis Fatmahan, S.T., M.Sc., Ph.D.
NIDN : 0603027401


Head of Civil Engineering Department,
Agus Edhi Istiyawan, S.T., M.Sc.
NIP : 0622036101

VALIDITION SHEET

**A Comparative Study of Reservoir Inflow Estimation Using Mock Method And
NRECA (Case Study In Batujai Reservoir)
Final Project**

Submitted and Maintained at the Examination Final Project

Final Project in front of the Board of Examiners

On January 14th 2022

Submitted by :

LALU MUH. A'ISY AZIZAN
ID STUDENT : D100164014

Supervisor Lecturer



Purwanti Sri Pudyastuti S.T.,M.Sc.

NIDN. 0608117002

STATEMENT OF FINAL PROJECT AUTHENTICITY

I am the underdesigned below:

Name : Lalu Muh. A'isy Azizan
Student ID : D 100 164 014
Faculty/Department : Engineering/Civil Engineering
Judul : A Comparative Study of Reservoir Inflow Estimation Using
Mock Method and NRECA (Case Study In Batujai Reservoir)

State that the final project I create and submitted is my own work, except for the quotations and summaries, that I have explained the source. If in the future can be proven that this final project is the result of plagiarism, then I am willing to accept any sanctions from the Civil Engineering Department, Faculty of Engineering and/or the degrees and diplomas granted by Universitas Muhammadiyah Surakarta, I will cancel my receipt.

That I make this statement properly and hopefully can be used as it should.

Surakarta, 20 Januari 2023



Lalu Muh. A'isy Azizan

MOTTO

**“And when the prayer has been concluded, disperse within the land
and seek from the bounty of Allāh, and remember Allāh often that you
may succeed ”**

(QS. AL JUMU’AH : 10)

PREFACE

Assalamu 'alaikum warahmatullahi wabarakatuh

Alhamdulillah, all praise and gratetitude to Allah SWT because His mercies, the final project with the title “A Comparative Study of Reservoir Inflow Estimation Using Mock Method and NRECA (Case Study In Batujai Reservoir)” can be finished properly. So that the author can fulfill the partial requirement to achieve Bachelor’s Degree in Civil Engineering. In the process of completion, the author does not do it by himself. Gratefull Acknowledgement given to those who supported the author in completing his task. With the completion of this final project, the author would like to thank :

1. Author’s family, Abah, Ibu, brothers (Vian, Irfan, Abid) and anothers family that cannot be mentioned one by one, who always cares, loving and giving endless support until author can finished and get the Bachelor’s Degree in Universitas Muhammadiyah Surakarta. Thank you for everything.
2. Mr. Rois Fatoni, S.T., M.Sc., Ph.D. as the Dean of the Engineering Faculty of Universitas Muhammadiyah Surakarta.
3. Mr. Anto Budi Listyawan, S.T., M.Sc., as Head of the Civil Engineering Department of Universitas Muhammadiyah Surakarta.
4. Mrs Purwanti Sri Pudyastuti as the author’s supervisor lecturer, who was willing to share the knowladge and provide guidance to author patiently, support and provide feedback to the author in preparing the Final Project report.
5. Mr. Ir. Isnugroho, CES. and Mr. Hermono S Budinetrio, M.Eng. as the author examiners who give the constructive criticisms and positive suggestion to faced the next step after graduation from Universitas Muhammadiyah Surakarta.

6. Lecturer of Civil Engineering Study Program Universitas Muhammadiyah Surakarta who has provided useful knowledge to the author.
7. All the staff of the Civil Engineering Study Program Universitas Muhammadiyah Surakarta who have served and assisted the author during the study until the completion of this Final Project.
8. All friends from Civil Engineering International. Thank you for the togetherness, support also twist and turn experience during study in Universitas Muhammadiyah Surakarta.
9. All friends from Civil Engineering 2016' generation, one struggle friends. Thank you for sharing the knowledge and togetherness.
10. Author's sharing home friends, another family from stranger and one of the most comfortable place after home. Thank you for sharing many valuable things.
11. Vava, one of the author's friend who give the support and want to lend his house while working on final project.
12. And the last one is author's special person, Gladys Windatari Yasmin, who always giving the support in any condition.

The author believe that this report is far from perfection. Therefore, the author expect criticism and suggestion to enhance this report. Last, the author hopes that this Final Project can be useful for author himself and for all readrs.

Wassalamu'alaikum warahmatullahi wabarakatuh

Surakarta, 2023
Author,

Lalu Muh. A'isy Azizan

TABLE OF CONTENTS

APPROVAL SHEET	i
VALIDATION SHEET	ii
STATEMENT OF FINAL PROJECT AUTHENTICITY	iii
MOTTO	iv
PREFACE	v
TABLE OF CONTENTS	vii
LIST OF FIGURE	xi
LIST OF TABLE	xiii
ABSTRACT	xvi
CHAPTER I.....	1
A. Background	1
B. Problem statement	2
C. Reseach objective	2
D. Benefit.....	3
E. Research Limitation	3
F. Originality of research.....	3
CHAPTER II	4
A. Previous Research.....	4
CHAPTER III.....	6
A. Basic Theory	6
1. Reservoir	6
2. Catchment Area (DAS).....	6
3. Hidrology Cycle	7
4. Discharge	8
B. Theoritical Analysis.....	8

1. Rainfall Data Consistency Analysis	8
2. Collecting of missing rainfall data	9
3. Determine Average Rainfall Area	10
4. Evapotranspiration.....	11
5. Rating Curve	16
6. Determine the discharge	16
7. Validation Test	23
CHAPTER IV	26
A. Location and time of research	26
B. Step of research	26
C. Data collection.....	27
1. Hidrology data.....	27
2. Climatology data	27
3. Topograph data.....	27
4. Technical Data.....	27
D. Analysis Method.....	28
1. Collecting the missing data of rainfall.....	28
2. Rainfall data consistency	28
3. Calculate average rainfall area	28
4. Evapotranspiration.....	28
5. Rating Curve of Discharge.....	28
6. Discharge	28
7. Validity Test.....	28
8. Calibration Parameter	29
E. Flow Chart	35
CHAPTER V.....	36
A. Geographic Condition.....	36

B.	Land use Condition.....	37
C.	Hidrology Data	38
1.	Catchment Area	38
2.	Rainfall Data	39
3.	Number of rainfall day data	40
4.	Average Discharge from AWLR Petitik (2014-2020).....	40
D.	Climatology Data.....	41
E.	Analysis Calculation	42
1.	Collecting the missing data of rainfall and number of rainfall days analysis	42
2.	Rainfall Data Consistency Analysis	46
3.	Calculate Average Rainfall Area.....	49
4.	Number of rainfall days	49
5.	Determine evapotranspiration	50
6.	Rating Curve	56
7.	Determine the inflow discharge	60
8.	Validity Test.....	72
9.	Determine the inflow discharge (with parameter calibration)	76
10.	Validity Test (calibration parameter).....	88
F.	Discussion Analysis	92
1.	Rainfall Data Analysis	92
2.	Potential Evapotranspiration	94
3.	Inflow Discharge	94
CHAPTER VI.....		102
A.	Conclusion.....	102
B.	Suggestion.....	102

REFERENCES

ATTACHMENT

LIST OF FIGURE

Figure III- 1 Example of inconsistency rainfall data	9
Figure III- 2 Example of Polygon Thiesen	11
Figure III- 3 Example of rating curve	16
Figure III- 4 Graph to determine value of AET/PET.....	23
Figure IV- 1 Administrative Map of Dodokan Catchment Area.....	26
Figure IV- 2 Step 1 and 2 of calibration parameter	29
Figure IV- 3 Step 3 of calibration parameter	30
Figure IV- 4 Step 4 for calibration parameter	30
Figure IV- 5 Step 5 of calibration parameter	31
Figure IV- 6 Step 6 of calibration parameter	32
Figure IV- 7 Step 7 of calibration parameter	32
Figure IV- 8 Step 8 of calibration parameter	33
Figure IV- 9 Result after calibration parameter (a)	33
Figure IV- 10 Result after calibration parameter (b)	34
Figure IV- 11 Flow Chart of Research	35
Figure V- 1 Map of Dodokan catchment area.....	36
Figure V- 2 Map of Dodokan sub-catchment area	37
Figure V- 3 Land use condition of Dodokan catchment area	37
Figure V- 4 Map of Polygon Thiesen in Dodokan sub-catchment area	38
Figure V- 5 Graph of rainfall data in ARR Pengadang	44
Figure V- 6 Graph of rainfall data in ARR Batujai	44
Figure V- 7 Graph of rainfall data in ARR Dasan Cermen.....	45
Figure V- 8 Graph of rainfall data consistency in ARR Pengadang with ARR Dasan Cermen and ARR Batujai.....	47
Figure V- 9 Graph of rainfall data consistency in ARR Batujai with ARR Dasan Cermen and ARR Pengadang	48
Figure V- 10 Graph of rainfall data consistency in ARR Dasan Cermen with ARR Pengadang and ARR Batujai.....	48

Figure V- 11 Rating curve of discharge with Polynomial Regression	58
Figure V- 12 Rating curve of discharge with Linear Regression.....	58
Figure V- 13 Rating curve of discharge with Exponential Regression	59
Figure V- 14 Graph comparison between Q Mock and Q observation before calibration parameter	65
Figure V- 15 Graph correlation between P/PET and Storage Ratio (Sr) to determine AET/PET.....	67
Figure V- 16 Graph comparison between Q NRECA and Q observation before calibration parameter	71
Figure V- 17 Graph comparison between Q Mock with Q observation after calibration parameter	81
Figure V- 18 Graph correlation between P/PET and Storage Ratio (Sr) to determine AET/PET.....	83
Figure V- 19 Graph comparison between Q NRECA and Q observation after calibration.....	87
Figure V- 20 Histogram relationship between monthly rainfall and frequency in ARR Pengadang	93
Figure V- 21 Histogram relationship between monthly rainfall and frequency in ARR Batujai	93
Figure V- 22 Histogram relationship between monthly rainfall and frequency in ARR Dasan Cermen	94
Figure V- 23 Graph comparison of Q Mock and Q NRECA with Q observation before calibration parameter.....	96
Figure V- 24 Graph comparison of Q Mock and Q NRECA with Q observation after calibration parameter	100

LIST OF TABLE

Table III- 1 Saturated vapor pressure (ea) by average air temperature	12
Table III- 2 <i>Extra Terrestrial Radiation</i> (Ra).....	13
Table III- 3 Effect of air temperature f(T) on wave radiation.....	14
Table III- 4 Weighting factor values (W) for radiation effects	14
Table III- 5 Monthly adjusment factor (c)	15
Table III- 6 Expose surface indicator	17
Table III- 7 Criteria of <i>Coefficien Correlation</i> value	24
Table III- 8 <i>Nash-Sutcliffe Efficiency</i> value	25
Table V- 1 Monthly rainfall data in ARR Pengadang.....	39
Table V- 2 Monthly rainfall data in ARR Batujai	39
Table V- 3 Monthly rainfall data in ARR Dasan Cermen	39
Table V- 4 Monthly number of rainfall day in ARR Pengadang	40
Table V- 5 Monthly number of rainfall day in ARR Batujai	40
Table V- 6 Monthly number of rainfall day in ARR Dasan Cermen	40
Table V- 7 Monthly average discharge from AWLR Petitik.....	41
Table V- 8 Monthly average temperature	41
Table V- 9 Monthly average air humidity.....	41
Table V- 10 Monthly average wind velocity	41
Table V- 11 Monthly intensity of sunshine.....	42
Table V- 12 Analysis result of collecting the missing data of rainfall in ARR Pengadang	43
Table V- 13 Analysis result of collecting the missing data of rainfall in ARR Batujai	44
Table V- 14 Analysis result of collecting the missing data of rainfall in ARR Dasan Cermen	45
Table V- 15 Analysis result of collecting the missing data of number of rainfall days in ARR Pengadang.....	45

Table V- 16 Analysis result of collecting the missing data of number of rainfall days in ARR Batujai	46
Table V- 17 Analysis result of collecting the missing data of number of rainfall days in ARR Dasan Cermen.....	46
Table V- 18 Calculation of rainfall data consistency test of ARR Pengadang with ARR Dasan Cermen and ARR Batujai.	47
Table V- 19 Result of calculating monthly rainfall area.....	49
Table V- 20 Result of calculating monthly number of rainfall day.....	50
Table V- 21 Analysis result of evapotranspiration in 2017	55
Table V- 22 Data of high water level and discharge in AWLR Petitik (2014-2020). 56	
Table V- 23 Analysis result of discharge in 2016 with Mock method before calibration parameter (beginning parameter)	64
Table V- 24 Analysis result of discharge with Mock method before calibration parameter (beginning parameter) (2014-2020)	65
Table V- 25 Analysis result of discharge with NRECA method in 2018 before calibration parameter (beginning parameter)	70
Table V- 26 Analysis result of discharge with NRECA method before calibration parameter (2014-2020).....	71
Table V- 27 Calculation of validity test for F.J Mock method	72
Table V- 28 Calculation of validity test for NRECA method.....	74
Table V- 29 Analysis result of discharge in 2016 with Mock method after calibration parameter.....	80
Table V- 30 Analysis result of discharge with Mock method after calibration parameter (2014-2020).....	81
Table V- 31 Analysis result of discharge with NRECA method in 2018 after calibration parameter	86
Table V- 32 Analysis Result of Discharge with NRECA after calibration parameter (2014-2020).....	87
Table V- 33 Calculation of validity test for F.J. Mock method after calibration.....	88

Table V- 34 Calculation of validity test for NRECA method after.....	90
Table V- 35 Calculating result of missing the rainfall data	92
Table V- 36 Calculating result of missing the number of rainfall day data.....	92
Table V- 37 Begining parameter for Mock method (2016)	95
Table V- 38 Begining parameter for NRECA method (2018)	95
Table V- 39 Recapitulation result of validity test of Mock and NRECA method with begining parameter	96
Table V- 40 Parameter for mock method after calibration parameter (2016).....	98
Table V- 41 Parameter for NRECA method after calibration parameter (2018)	98
Table V- 42 Recapitulation result of validity test of Mock and NRECA method with calibration parameter	99

A COMPARATIVE STUDY OF RESERVOIR INFLOW ESTIMATION USING MOCK METHOD AND NRECA (CASE STUDY IN BATUJAI RESERVOIR)

ABSTRACT

Majority of surface on earth is covered of water and make the water resource on earth is abundance and cannot be separated from hydrological cycle process. With the process of hydrological cycle, data collection is carried out for measuring the rainfall and discharge in the field. However, data in the field is not fully available due to several factors which is difficult to predicted. So the data cannot be collected and make the data in the field is not fully available. This what makes this research is carried out, because it is use an emprirical approach method, which is method that conduct by calculating process of the available data in the field, not conduct the measurement in the field lively. The main objective of this research is to determine the discharge inflow in Batujai reservoir using Mock and NRECA method and then compared to find which result method is closest with inflow data in the field. Based on the validity test and graph of comparation result, the value of Q simulation with Mock method give the better result than the NRECA method. So the simulation method which closest with observation data is Mock method. Result of validity test using parameter which has been calibrated for Mock method give the value of Root Mean Square Error (RMSE) = 0,893, Coefficient of Correlation (R) = 0,950 and Nash-Sutcliffe Efficiency (NSE) = 0,900 while NRECA method give the value of Root Mean Square Error (RMSE) = 2,821, Coefficient of Correlation (R) = 0,753 and Nash-Sutcliffe Efficiency (NSE) = 0,005.

Keywords : Mock, NRECA, Discharge Inflow, Validity Test.