



**BUSITEMA  
UNIVERSITY**  
*Pursuing Excellence*

**FACULTY OF ENGINEERING  
DEPARTMENT OF WATER RESOURCES AND MINING  
ENGINEERING**

**WATER RESOURCES ENGINEERING PROGRAMME**

**FINAL YEAR PROJECT**

**DESIGN AND SIMULATION OF AN AUTOMATIC WASHOUT SLUICE  
GATE SYSTEM FOR BUDUDA-NABWEYA GRAVITY FLOW SCHEME**

**WATER INTAKE**

**BY**

**KALAJJA BAZIRIO**

**BU/UP/2013/278**

**TEL: +256-782095101/+256-703711182**

**Email: bazimanrio@gmail.com**

**MAIN SUPERVISOR: MR. OKETCHO YORONIMO**

**CO-SUPERVISOR: MR. BAGAALA BRIAN**



A final year project report submitted to the Department of Water Resources and Mining Engineering as a partial fulfillment of the requirements for the award of a Bachelor of Science degree in Water Resources Engineering

**MAY 2017**

## ABSTRACT

Washout sluice gate is a point at which water exists to a space enclosed by walls. Its is widely being used for controlling discharge and flow depth in irrigation channels, large sewers, and in hydraulic structures like water intakes. Due to delays in manual opening and closing of the gate, sediment is left to raise to the height of the weir where its washed to the intake pipes that are used for distributing water from the intake to the treatment plant. This leads to too much sediment loading which is a point source pollutant in the treatment plant, high rate of corrosion and bursting of the pipes as the intake where the gate is located is on one of the hills of mountain Elgon national park a gazette and highly place, the person responsible for operating it is expected to walk on foot for 2.5kmwork

An automated washout sluice gate (WSG) system was designed using Solidworks software and its simulation was carried out using Arduino software

It all starts after sediment accumulating in the sedimentation chamber to 0.29m thickness, the ultrasonic sensor senses it when the distance between it and sediment is zero and it sends an impluse to the micro-controller to start the servo motor through its shaft and bevel gears to rotate at 50 rpm in an anti-clockwise direction for 47 seconds hence opening the gate to height of 0.67m. The motor stops to rotate for 1 second to allow sediment to be washedout the it again starts to rotate for 47 seconds to close the gate in a clockwise direction. Bevel gears are used to reduce and transfer the horizontal motion to vertical of the motor. Messages are sent to three different people using GSM when the WSG is being opened and when closed, this is to enable monitoring of the performance of the system at a distance. Solar power is the source of power to be used for the system

**DECLARATION**

I **KALAJJA BAZIRIO**, declare that the information in this report is a true work of my hands and has never been presented by any person or institution for an academic award.

Signature:  .....

Date: 24/05/2017



**APPROVAL**

I **KALAJJA BAZIRIO**, submit this final year project report to the Faculty of Engineering for examination with approval of my;

**MAIN SUPERVISOR: MR.OKETCHO YORONIMO**

Signature..... Date...../...../.....

**CO-SUPERVISOR: MR.BAGAALA BRIAN**

Signature..... Date...../...../.....

## **ACKNOWLEDGEMENTS**

First and foremost, I would like to extend my sincere gratitude to the Almighty God for His unconditional love shown to me in my academic life

In a special way, I would like also to thank my family members for the financial, social and spiritual support given to me.

Special thanks go to Mr. Oketcho Yoronimo, Mr. Bagaala Brian and KOL Company for their advice, guidance and encouragement offered towards my final year project

Last but not least I express my appreciation to Busitema University Main Campus students for their valuable assistance given to me at the different stages in the preparation of this final year project report

May the Almighty God bless them abundantly

## **DEDICATION**

This piece of work is dedicated to Mr. Kagaire Debi family

## **LIST OF ABBREVIATIONS**

DWD -	Directorate of Water Development
UNEP -	United Nations Environment Programme
BSN -	British Standards
GSM -	Global System for Mobile communication
Mt. -	Mountain
NP -	National Park
UWA -	Uganda Wild life Authority
WSG -	Washout Sluice Gate

## Table of Contents

ABSTRACT.....	i
DECLARATION.....	ii
APPROVAL.....	iii
ACKNOWLEDGEMENTS.....	iv
DEDICATION.....	v
LIST OF ABBREVIATIONS.....	vi
LIST OF FIGURES.....	x
LIST OF TABLES.....	xi
1 CHAPTER ONE: INTRODUCTION.....	1
1.1 Background of the study.....	1
1.2 Problem statement.....	2
1.3 Purpose of the study.....	2
1.4 Objectives of the study.....	2
1.4.1 Main objective.....	2
1.4.2 Specific objectives.....	3
1.5 Scope of the project.....	3
1.6 Justification.....	3
2 CHAPTER TWO: LITERATURE REVIEW.....	4
2.1 Introduction.....	4
2.2 Sluice gates.....	4
2.2.1 Classification of the sluice gates.....	4
2.2.2 Types of sluice gates.....	5
2.2.3 Types of material used for sluice gates.....	5
2.3 Expansive soils.....	7
2.3.1 Erosion and Deposition of sediment by Flowing Water.....	7
2.4 Sensors.....	8
2.4.1 Sediment level sensors.....	9
2.4.2 Ultrasonic sensors.....	9



2.5	Motors .....	10
2.5.1	Servo motors .....	10
2.6	Bevel gears .....	13
2.7	Solar Energy .....	14
2.7.1	Solar Electricity .....	14
2.8	Simulation of an automatic washout sluice gate system .....	14
2.8.1	Automation .....	15
2.8.2	Microcontroller .....	16
2.9	Economic evaluation .....	16
2.9.1	Methods of Economic evaluation .....	17
3	CHAPTER THREE: MATERIALS AND METHODOLOGY .....	19
3.1	Introduction .....	19
3.2	Data collection techniques .....	19
3.2.1	Discussions and consultations .....	19
3.2.2	Field visits .....	19
3.2.3	Using Float method to Measure Velocity of water into the water intake .....	20
3.2.4	Determining the suitable maximum height at which the sediment is to be washed out .....	22
3.2.5	Determining the suitable maximum height at which the WSG is to be opened for the sediment to be washout from the sediment chamber .....	23
3.3	Design of a WSG system .....	25
3.3.1	Components of the WSG system .....	25
3.3.2	Selection of materials and components used .....	25
3.3.3	Determining the number and shape of teeth for bevel gears .....	25
3.3.4	Software used in designing of the WSG .....	26
3.3.5	Gate .....	27
3.3.6	Spindle .....	29
3.3.7	Gate frame .....	31
3.3.8	Seals .....	31
3.3.9	Guide .....	31
3.3.10	Drive unit .....	32

3.4	Automation of the washout sluice gate.....	33
3.4.1	Simulation software used.....	34
3.4.2	Determining the time taken in opening and closing of the WSG.....	35
3.4.3	Global System for Mobile communication.....	35
3.4.4	Selecting and locating the controller.....	35
3.5	Economic Evaluation.....	36
3.5.1	Discounting.....	36
3.5.2	Using the benefit cost ratio:.....	37
4	CHAPTER FOUR: RESULT AND DISCUSSIONS.....	38
5	CHAPTER FIVE: DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS.....	49
	<i>Conclusion</i> .....	49
	<i>Recommendations</i> .....	49
	<b>References</b> .....	50
	<b>APPENDIX</b> .....	52

## LIST OF FIGURES

Figure 2-1 classification of sluice gates.....	5
Figure 2-2 ultrasonic sensor.....	9
Figure 2-3 ultrasonic radiations.....	10
Figure 2-4 servo motor.....	11
Figure 2-5 open loop.....	12
Figure 2-6 closed loop.....	12
Figure 2-7 straight bevel gears.....	13
Figure 3-1 stream flow using float to measure velocity and stadia rod.....	22
Figure 3-2 variation of specific energy and discharge with depth.....	23
Figure 3-3 flow below a sluice gate.....	24
Figure 3-4 threaded spindle.....	29
Figure 3-5 connection of a motor control on arduino.....	34

## LIST OF TABLES

Table 3-1 plate thickness coefficient .....	28
Table 3-2 threaded parts .....	30
Table 4-1 results from float method .....	38
Table 4-2 costs of the system .....	45
Table 4-3 benefits for the project .....	46
Table 4-4 summary of total costs and benefits .....	47

## **1 CHAPTER ONE: INTRODUCTION**

This chapter entails relevant information about the project, problem statement for the intended design while showing how automation of the sluice washout gate will reduce the existing problems through fulfillment of the stated objectives of the study and the scope of the study.

### **1.1 Background of the study**

A washout sluice gate (WSG) is a point at which water exists to a space enclosed by walls. WSG may prevent or control entry and exit, or they may be merely decorative. They are widely being used for controlling discharge and flow depth in irrigation channels, large sewers, and in hydraulic structures like water intakes.

The Environmental Protection Agency lists sediment as the most common pollutant in rivers, streams, lakes and reservoirs (Chapman, 1996).

While natural erosion produces nearly 30 percent of the total sediment in Uganda, accelerated erosion from human use of land accounts for the remaining 70 percent.

Sediment pollution causes \$16 billion in environmental damage annually.

In 2015, a Bududa-Nabweya gravity flow scheme water intake was constructed on one of the hills of Mt. Elgon within the Mt. Elgon NP by KOL and CEMIC Companies where water of high pressure is directed to the water intake pipes that direct it to the treatment plant. On this intake, a WSG was also constructed in the sides which is opened manually for sediment to be washed away that will have accumulated within the intake sediment chambers

Rate of sediment accumulation within the intake chambers varies with a given season as opening of the gate is done after a period of one week in a rainy season and two weeks in a dry season

Amidst the challenges faced in operating of the WSG such as the hilly long distance of 2.5km to be travelled on foot by the persons responsible, the water intake being located in a gazetted place by UWA and possible attacks from wild animals, delays in opening have been observed which has led to sediment accumulation in the water intake to the level of the weir. This sediment is later washed by the flowing waters to the intake pipes that has led to pipe blockages, leakages, too much sediment loading in the treatment plant

## References

- Abdalgader, H. A., 2016. *Microcontroller logger Design for Water Distribution Network Via GSM*, s.l.: s.n.
- Abdalgader, H. A., 2016. *Microcontroller logger Design for Water Distribution Network Via GSM*, s.l.: s.n.
- adler, P., 1999. *The influence of hiatuses on sediment accumulation rates*. s.l., s.n.
- Anon., 2666. *dgfhfjhgh. kampvx*: s.n.
- Ashraf, M. A. M. M. J. Y. I. W. A. M. K., 2011. Sand mining effects, causes and concerns: a case study from Bestari Jaya, Selangor, Peninsular Malaysia. *Scientific Research and Essays*, 6(Academic Journals), pp. 1216-1231.
- Cassan, L., 2011. %T Experimental and numerical investigation of flow under sluice gates. *Journal of Hydraulic Engineering*, 138(American Society of Civil Engineers), pp. 367-373.
- Cassan, L., 2011. Experimental and numerical investigation of flow under sluice gates. *Journal of Hydraulic Engineering*, 138(American Society of Civil Engineers), pp. 367-373.
- Chapman, D. V., 1996. *Water quality assessments: a guide to the use of biota, sediments, and water in environmental monitoring*. Issue E & Fn Spon London.
- Church, M., 1975. *Proglacial fluvial and lacustrine environments*. Issue Special Publications of SEPM.
- Greenleaf, R. K. S. L. C., 2002. *Servant leadership: A journey into the nature of legitimate power and greatness*. s.l.:Paulist Press.
- Horcas, I. F. R. G.-R. J. C. J. G.-H. J. A., 2007. WSXM: a software for scanning probe microscopy and a tool for nanotechnology. *Review of Scientific Instruments*, 78(AIP Publishing), p. 013705.
- Iron, C. S. S., n.d. *Types of sluice gates Flap sluice gate*.
- Jones, L. D. J. I., 2012. *Expansive soils*. s.l.:ICE Publishing.