



**BUSITEMA
UNIVERSITY**
Pursuing Excellence

FACULTY OF ENGINEERING

DEPARTMENT OF MINING AND WATER RESOURCES ENGINEERING

FINAL YEAR PROJECT REPORT

APPLICATION OF GIS IN WATER BALANCE ESTIMATION

CASE STUDY: BUSITEMA SUB CATCHMENT

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ABSTRACT

The demand for water is increasing with growing population and industrialization. Water supply is considered to be one of the key factors for rapid development and urbanization. However, the overexploitation of water resources has resulted in a condition of unsustainability and environmental degradation. Hence, the information on water balance studies will be helpful for the optimum utilization of water resources. The water balance was used for computing patterns of water availability to facilitate better management of available water resources. This was achieved through determining the net change in storage of water taking into account losses of runoff and evapotranspiration.


Rates of evapotranspiration were determined using the Penman_Monteith model to determine rates of ET_c for maize grain as it is one of the major crops grown in the area. Remote sensing and GIS were used in formulating thematic maps of slope, landuse, soil types and rainfall as factors that affect runoff. Runoff was determined using the USDA_SCS_CN loss method and a transform method of SCS_Unit Hydrograph through running a simulation in HEC_HMS.

The study was helpful indicating periods of surplus and deficit after calculation of the change in storage. This study indicates that there is a maximum monthly deficit of 128 mm in February which could be attributed to high rates of evapotranspiration and runoff and an average surplus of 36.99 mm in July. The surplus indicated an increase in ground water storage. Periods of surplus and deficit are essential in assessing and evaluating the status and trends in water resources availability. Water balance studies are essential to the local people as this will determine when to adjust their crop calendar basing on periods of surplus or deficit.

DECLARATION

I NANTAMBI ALLEN NAMUKASA declare that the content presented in this report during my project research belongs to me and it has not been presented anywhere else.

Signature


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Date

26th/05/2016
.....

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DEDICATION

I dedicate this report to my parents: Mr. Mutagwanya John and Mrs. Nassali Rose, who advised and counselled me. They contributed the little they had to see that I successfully complete my research.

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APPROVAL

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REFERENCES

- California's ground water update, 2003, *Basic Groundwater Concepts*, Chapter 6.
- Colin Pain, Laura Gow, John Wilford and Penny Kilgour, 2011. *Mapping Approaches to Recharge and Discharge Estimation and associated input datasets*, Geoscience Australia Professional Opinion No. 2011/01.
- Creating SCS Curve Number Grid using HEC-GeoHMS*. School of Civil Engineering, Purdue University.
- Douglas S. Cherkauer, 2004. *Quantifying ground water recharge at multiple scales using PRMS and GIS*, vol. 42. Department of Geosciences, University of Wisconsin.
- FAO Corporate Document Repository, Crop evapotranspiration - *Guidelines for computing crop water requirements...* Natural Resources Management and Environment Department.
- Frank van Steenburgen and Anthony Luutu on behalf of GWMATE, 2009. *Managed Groundwater Development in Uganda*, Ministry of Water and Environment, Strategic Sector Investment Plan for the Water and Sanitation Sector in Uganda.
- Hsin-Fu Yeh, Cheng Haw Lee, Kuo-Chin Hsu, Po-Hsun Chang, 2008. *GIS for the assessment of the groundwater recharge potential zone*, Department of Resources Engineering.
- Hydrogeological journal 10:91-109, The Kampala statement, *Groundwater and Climate in Africa*, from 24-27 June 2008.
- Jeffrey Swingly, Frans Sumarauw and Koichiro Ohgushi, 2012. *Analysis of Curve Number, Land Use and Land Cover Changes and the Impact to the Peak Flow in the Jobaru River Basin*, Japan. Department of Civil Engineering and Architecture, Faculty of Science and Engineering, Saga University. *International Journal of Civil & Environmental Engineering IJCEE-IJENS* Vol: 12 No: 02, Venkatesh Merwade, 2012.

Jenifa Latha.C, Saravanan.S, Palanichamy.K, 2010. *A Semi – Distributed Water Balance Model for Amaravathi River Basin using Remote Sensing and GIS*, International journal of geomatics and geosciences volume 1, no 2.

Lincoln Zotarelli, Michael D. Dukes, Consuelo C. Romero, Kati W. Migliaccio, and Kelly T. Morgan. *Step by Step Calculation of the Penman-Monteith Evapotranspiration (FAO-56 Method)*. Lynn E. Johnson, 2009. *Geographic Information Systems in Water Resources Engineering*.

Mingbin Huang, Jacques Gallichand, Cuiyun Dong, Zhanli Wang and Mingan Shao, 2006. *Use of soil moisture data and curve number method for estimating runoff in the Loess Plateau of China*. Institute of Soil and Water Conservation, Northwest A&F University.

Mudher N. Abdulla, 2011. *Catchment Area Delineation Using GIS technique for Bekhma Dam*. National Cheng Kung University.

R. K. Singh, V. Hari Prasad & C. M. Bhatt, 2012. *Remote sensing and GIS approach for assessment of the water balance of a watershed / Evaluation*, Hydrological Sciences Journal, Water Resources Division, Indian Institute of Remote Sensing.

Richard W. Healy, Peter G. Cook, 2002. *Using ground water levels to estimate recharge*.

Shereif H. Mahmoud* and A. A. Alazba, 2015. *Hydrological Response to Land Cover Changes and Human Activities in Arid Regions Using a Geographic Information System and Remote Sensing*.

Tirusew Asefa¹, Z. Wang¹, O.Batelaan¹ and F. De Smedt. *Open integration of a spatial water balance model and GIS to study the response of a catchment*.

Venkatesh Merwade, 2012. *Watershed and Stream Network Delineation using ArcHydro Tools*, School of Civil Engineering, Purdue University.

Venkatesh Merwade, September 2011, *Watershed and stream Network Delineation*, school of Civil Engineering, Purdue University.