Assessment of the potential for irrigation development in Albert Nile basin: A case study of Nebbi

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Introduction

- In Sub-Sahara Africa, agriculture plays a vital role in providing food and income (Sheffield, 2014; Rockstro, 2009).

- Crop production is however faced with the challenge of water shortage (Gowing, 2015; Adesina and Elasha, 2007).

- Albert Nile basin is mainly characterized by agricultural activities with 85% of the population engaged in farming and livestock rearing (UBOS, 2018).

- In spite of the wet rainfall months, rains are rather inconsistent and unreliable (MWE, 2011).

Introduction cont.

- Irrigation has the potential to boost production by more than 50% (MAAIF and MWE, 2017).
- Therefore, this calls for the need to assess the potential for irrigation development to guide planning and investment in the subsector.

Statement of the problem

- The importance of developing an irrigation master plan for Uganda to aid planning and investment in irrigation has long been recognized.
- However, a number of existing studies provide a wide number of estimates of irrigation potential for Uganda (MWE, 2013).
- These values are questionable and thus constrain reliable medium term planning and investment in the subsector.
- This calls for the need to harmonize information on the irrigation potential of Uganda (Wanyama et al., 2017).

Statement of the problem cont'

- The statistics and the approaches used also lack thorough and dependable information to guide planning for irrigation in Uganda (Wanyama et al., 2017).
- Available information emphasizes more on large scale systems yet majority of the population are small holder farmers.
- This implies that the estimates in the previous studies are likely to be low hence the need for a re-assessment at basin level (Droogers et al., 2012; Ayella et al, 2019) .
- This research therefore focused on providing specific analysis and assessment of irrigation potential in Nebbi District.

Objectives

Main Objectives

- To assess the potential for irrigation development in Nebbi District in the Albert Nile of Uganda with a view of guiding planning and strategic investment in irrigation.

Specific Objectives

- To assess the suitability of land for irrigation development in Nebbi district;
- To assess the irrigation water requirements in Nebbi district;
- To carry out a water resources assessment in Nebbi district.

Research Questions

1. To what extent are the soils and land terrain in Nebbi district suitable for Irrigation and what irrigation systems can be developed and their area of coverage?

2. What is the total Irrigation water requirement if irrigation is to be developed in Nebbi district?

3. Is there enough water to sustain irrigated agriculture in Nebbi district and what is the maximum command area that can be irrigated?

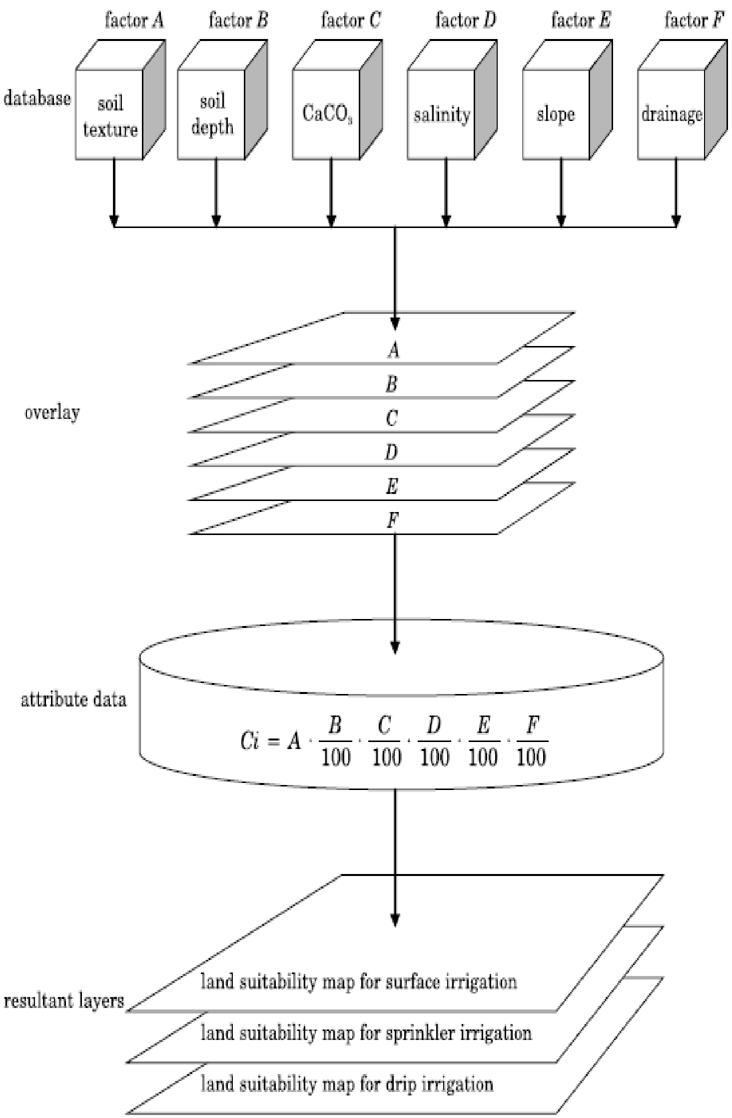
Materials and Methods

Irrigation Suitability Assessment

- For the evaluation of land suitability for surface, sprinkler and drip irrigation, the parametric evaluation system was used (Albajiel et al., 2014).
- This method is based on morphology, physical and chemical properties of soil.
- The land was evaluated according to numerical indexes (0 to 100) which were given to land characteristic through comparison with soil requirements.
- The chemical and physical soil proprieties were determined from Harmonized World Soil Data (HWSD).

SO1: Land Suitability for Irrigation

- Suitability index for irrigation was calculated considering some factors influencing the soil suitability. (Soil Texture, Soil Depth, CaCO3,Salinity(Electrical Conductivity), Slope and Drainage)
- In order to verify the possible effects of different management practices, the land suitability for sprinkler and drip irrigation was evaluated



SO2: Assessment of irrigation water

- Based on the terrain suitability, elevation and the soil suitability, potential cropping patterns were derived for at least two main commodity crop classes.
- The crops and their varieties were selected basing on the prevailing climatic conditions, soil properties, water availability, farmer preference and marketing potentials.

Net irrigation requirements

- The FAO CROPWAT program (FAO, 2009) was used to the determine the crop water requirement. The program was used to calculate the crop evapotranspiration using the reference evapotranspiration and the crop coefficients (Kc).

Overview

- Profitable irrigation requires excess rainfall beyond evapotranspiration and sufficient runoff that can be channeled or stream flow that can be stored for later use by crops.

Rainfall Analysis

Daily rainfall data was extracted from https://power.larc.nasa.gov/data-access-viewer/ which utilizes the virtual rainfall stations.

- Rainfall Trend Analysis.
- Aerial rainfall estimation; Thessien polygon approach was used.
- Frequency Analysis for annual totals.

Catchment Delineation

- ArcMap10.1. was used for delineated contributing catchments for the various sites under considerations.
- Catchment parameters derived included: Area, Longest flow path, slope, centroid and shape.
- Analysis was done to identify areas with the highest catchment area and runoff generation.
- Derivation of curve numbers values for the respective catchments

SO3: Water resources assessment cont’

Flow analysis

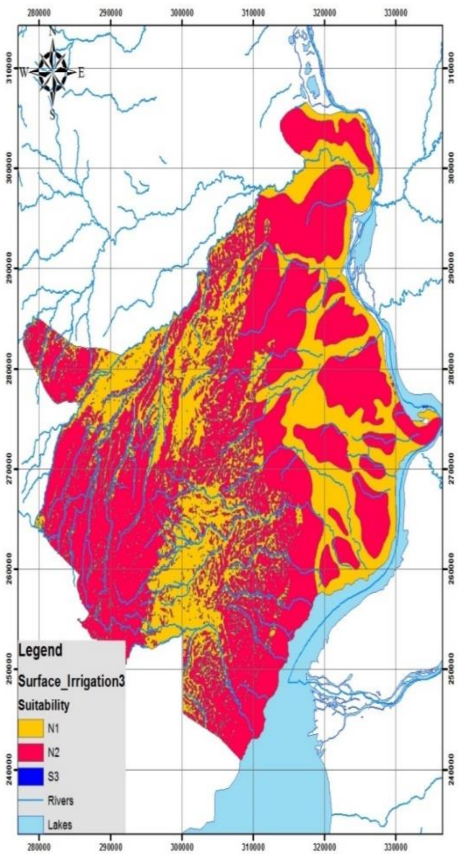
- Flow duration curve and low flow analysis.
- Stream flow records were used to establish historical maximum, minimum flows, and mean flows.
- The flow duration curve were segmented into five zones representing high flows (0-10%), moist conditions (10-40%), mid-range flows (40-60%), dry conditions (60-90%) and low flows (90-100%).

Low flow analysis

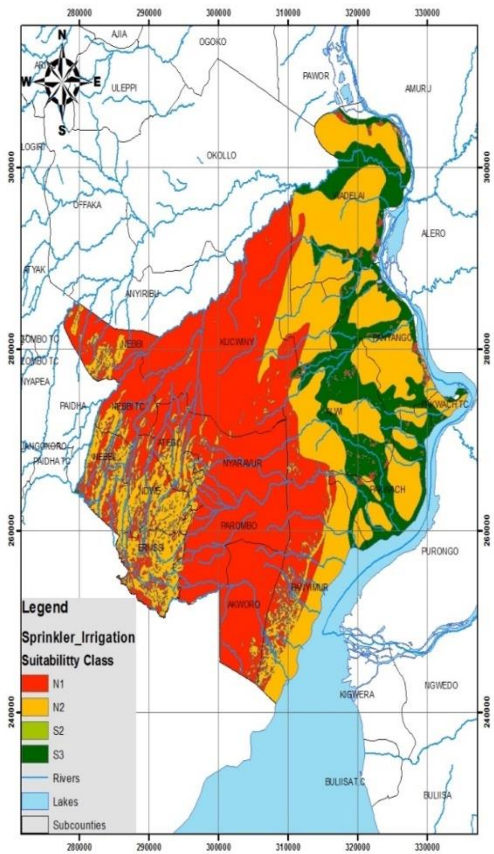
- Annual minimum N-day moving averages for N=3, 5, 7, 10, 15, 30 and 90 aggregated days exceeded for different times were applied.
- This is important in designing storage facilities.

Results and Discussion

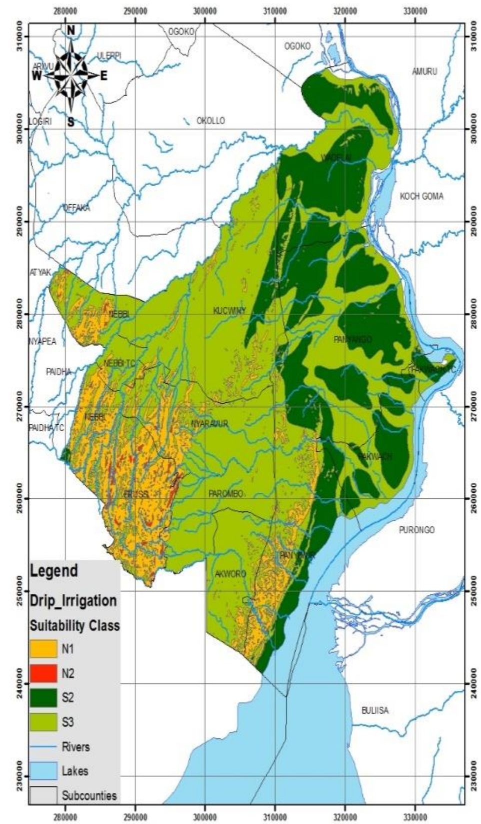
Irrigation Suitability Maps



Surface irrigation



Sprinkler irrigation



Drip irrigation

Results and Discussion cont'

Irrigation suitability Analysis

Suitability Class	Surface Irrigation		Sprinkler Irrigation		Drip Irrigation	
	Area(ha)	**Ratio**	**Area(ha)**	**Ratio**	**Area**	**Ratio**
N1	736	0.37%	90291	47%	28,492	15%
S1	153,676	77%	72987	38%	988	1%
S2	38,952	19%	48	0%	49,083	26%
S3	6,622	3%	26815	14%	111,590	59%
	199,987	100%	190142	100%	190,155	100%

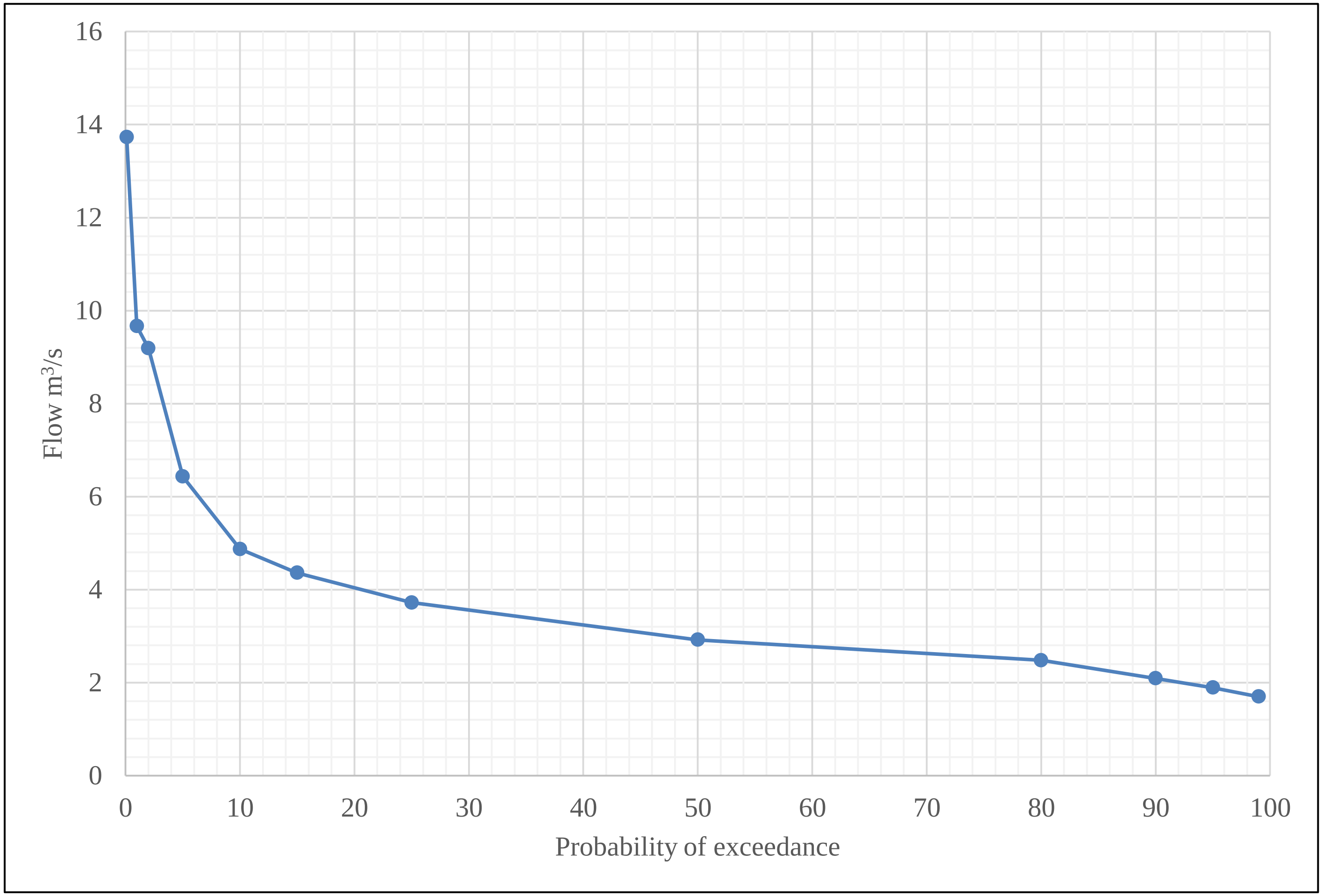
Results and Discussion cont’

- Crop water requirements-FAO cropwat

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation deficit												
1. Small vegetables	0	0	0	0	0	0	0	0	5.7	5.2	45.1	36.7
2. Tomato	153.9	0	0	0	0	0	0	0	4.9	0	51	132.1
3. Cabagge Crucifers	167.5	97.4	0	0	0	0	0	0	5.7	0	23.1	115.3
Net scheme irr.req.												
in mm/day	2.6	1	0	0	0	0	0	0	0.2	0.1	1.2	2.4
in mm/month	81	29.2	0	0	0	0	0	0	5	2.1	35.2	75.7
in l/s/h	0.3	0.12	0	0	0	0	0	0	0.02	0.01	0.14	0.28
Irrigated area (% of total area)	50	30	0	0	0	0	0	0	90	40	90	90
Irr. req. for actual area (l/s/h)	0.61	0.4	0	0	0	0	0	0	0.02	0.02	0.15	0.31

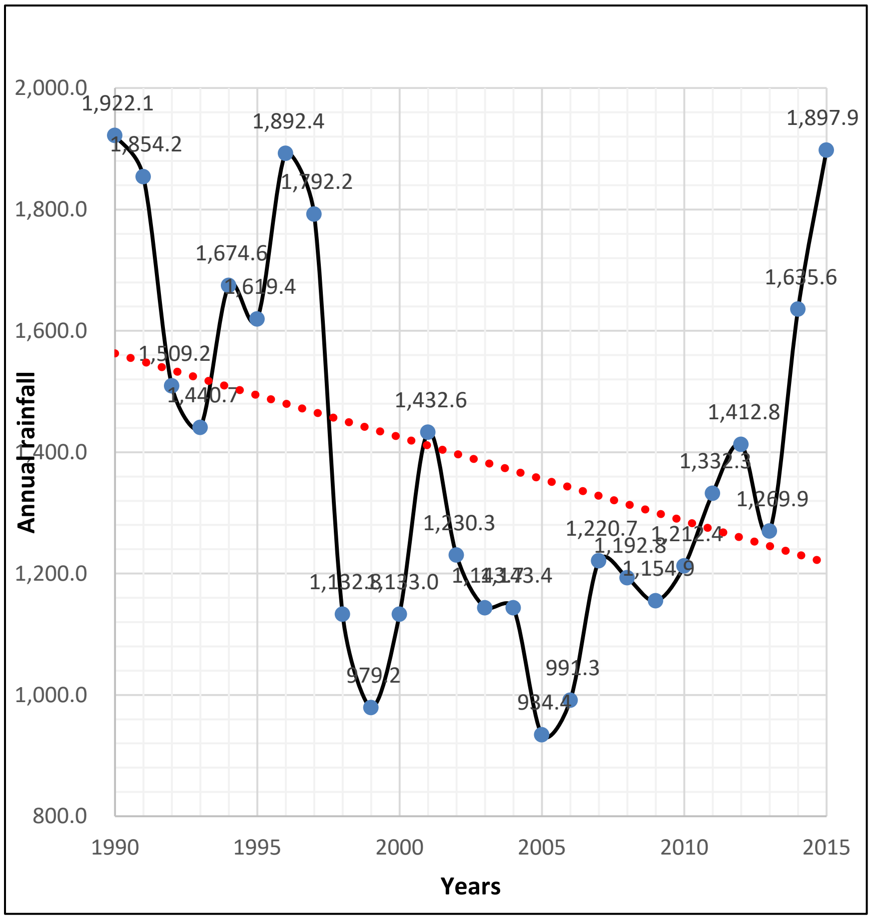
Results and Discussion cont’

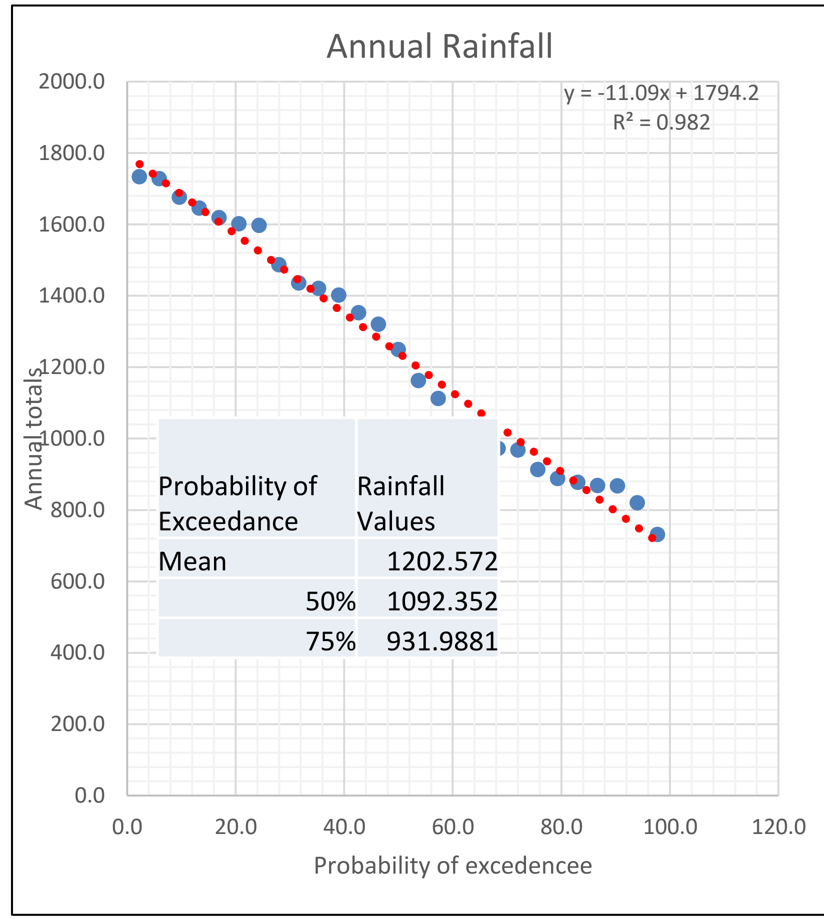
Flow duration curve- river Nyarwodho



Results and Discussion cont’

Rainfall trend analysis





Probability of Exceedance	Rainfall Values
Mean	1202.572
50%	1092.352
75%	931.9881

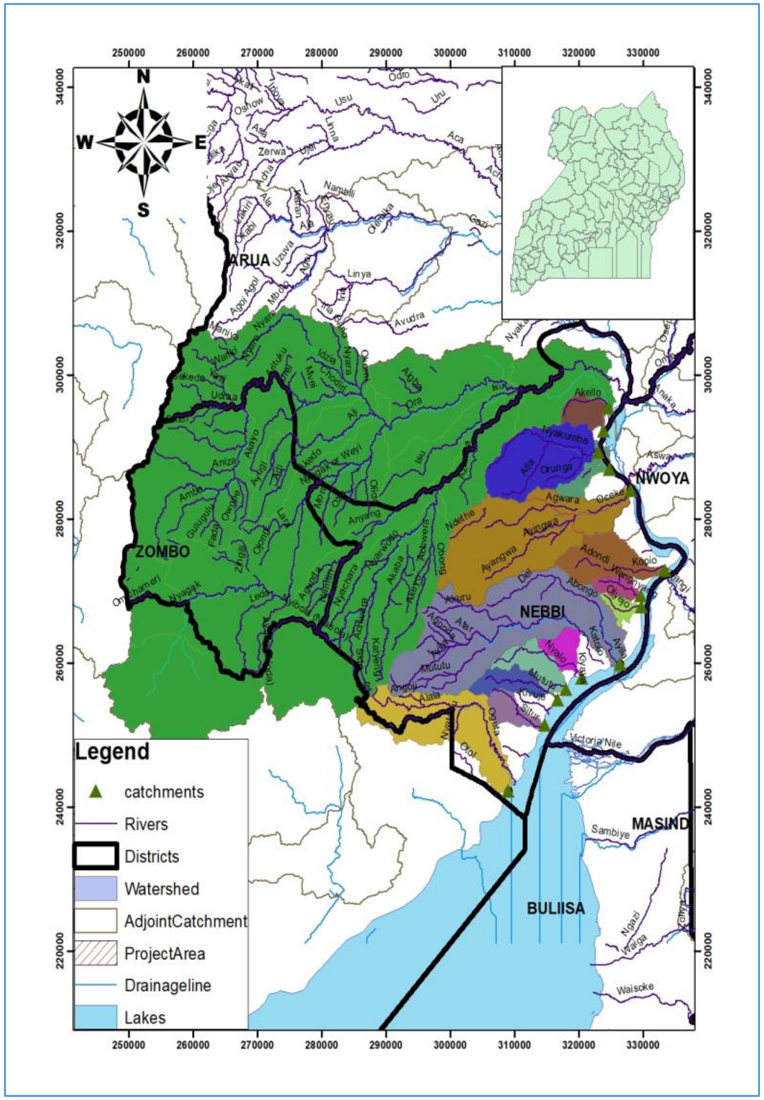
Results and Discussion cont’

Catchment yield analysis

Catchment Name	Catchment area, A (sq.km)	Mean Annual Catchment Yield (cubic. m)	Annual Catchment Yield (cubic. m)-Based on 50% Dependable Rainfall	Annual Catchment Yield (cubic. m)-Based on 75% Dependable Rainfall
Nyakumba	128.7	104,213,246	92,732,898	76,146,737
Kopio	69.98	62,400,383	55,872,742	46,410,466
Wangyang	17.17	14,680,855	14,964,957	11,282,807
Oceke	258	206,453,016	184,245,458	152,107,895
Kiyaya	24.8	21,612,555	19,237,341	15,805,163
Mututu	40.8	33,739,946	29,934,769	24,447,352
Ayila	339	319,963,397	288,041,541	248,319,545
Mututu2	33	28,925,907	25,755,582	21,173,567
Situr	25.9	21,980,022	19,520,180	15,970,643
Nyawrodo	2,289.50	1,709,185,436	1,535,832,645	1,320,286,611
Oguta	121.7	109,812,369	98,695,698	82,555,715
Akello	26	23,402,491	20,889,765	17,253,052
Ojobodagi	24.6	20,607,334	18,274,319	14,910,966
Olyejo	13.9	13,133,630	11,759,731	9,768,168

Results and Discussion cont’

Major water catchments in Nebbi



Conclusions

- The maximum area that was suitable for irrigation was 332,348.87 ha taking into account both soil and terrain suitability.
- This area requires 6.304BCM for irrigation from the catchment however the total catchment yield was 2.69BCM
- The catchment yield only permits irrigation for an area of only 141,817.65 ha (1,418.2km^2)
- The potential can be enhanced by promoting drip irrigation technology since relatively big acreage (64%) can be moderately suitable with drip from (0.03%) marginally suitable under surface irrigation
- The results therefore show that drip irrigation system is more suitable for the study area than the surface irrigation

Recommendations

Policy makers

- Should promote drip irrigation systems by lobbying for tax exemptions and subsidies to offset the initial investment cost.
- Should also advocate for construction of dams, valley tanks and bulk water transfer systems to impound runoff water and create storage.

Beneficiaries

- Make use of the irrigation potential identified in this study to invest in drip irrigation technology to earn more and diversify their sources of income.

Future research direction

- For further suitability studies, consideration other factors likes system management, marketing infrastructure and socio-economic issues should be proposed.

Thank you