Every Drop of Water Counts

Assessing Rainwater Harvesting Suitability in Rwanda using GIS

Background

Fresh water is one of the abundant natural resources the world has today. Yet, due to urbanization, industrialization, and groundwater exploitation, this natural resource is depleting. Between 2000-2050, water demand is projected to go up by 55% where agriculture will account for 70% of global water use. Rainwater harvesting is among potential techniques that could help the world suffice this water demand as it is useful for livestock, groundwater recharge, and irrigation purposes. Rwanda, a country located in East Africa at latitude and longitude of 1.9403° S and 29.8739° E respectively with total area of 26, 338 km^2, could benefit from rainwater harvesting. Rwanda's agricultural factor is rain-fed, and the water requirement for agriculture in 2020 will skyrocket whereby eastern region of the country itself is going to require 406 million m^3 per year compared to 150 million m^3/year of the total national water withdrawal for agriculture in 2000. Therefore, this project aims at using GIS analysis to assess rainwater harvesting suitability for domestic and agricultural use in Rwanda. Different datasets such as land use, slope, lithology, soil type, precipitation, geomorphology, drainage, and road buffers were used in this project.

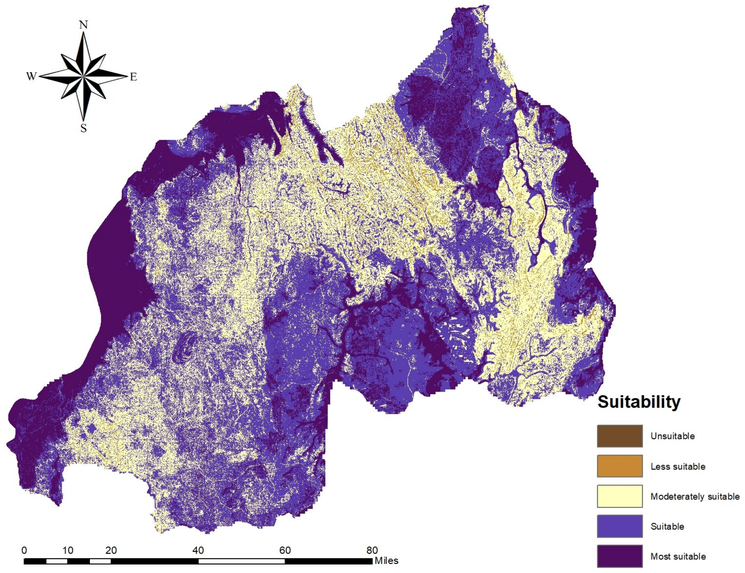
Methodology

Suitability Analysis: Factors that influence rainwater harvesting were identified from peer reviewed literature. GIS spatial analyst tools were deployed to perform a weighted overlay analysis.

Factor	Weight (%)	Suitability score 1 (least suitable)	Suitability score 2	Suitability score 3	Suitability score 4	Suitability score 5	Suitability score 6	Suitability score 7	Suitability score 8	Suitability score 9 (Most suitable)
Precipitation (m)	25	N/A	N/A	850 - 953	953 - 1085	1085 - 1216	1216 - 1340	1340 - 1485	1485 - 1643	1643 - 2258
Slope (in degrees)	20	36.20 - 74.14	30.12 - 36.20	25.2 - 30.12	20.85 - 25.20	16.51 - 20.85	12.16 - 16.51	7.82- 12.16	3.48 - 7.82	0 - 3.48
Clay content (mass fraction in % at 30 cm)	13	N/A	N/A	14 - 30	N/A	30 - 36	N/A	36 - 41	N/A	41 - 56
Geomorphology	12	Waterbody	Mountains Volcanic shield	Hills and mountain foot-	Plateau	Footslope	N/A	Valley Depression	N/A	Alluvial plain Plain
Lithology	12	N/A	Schist	N/A	Quartzite	Volcanic ash	Colluvial Granite	N/A	Water	Fluvial Organic
Land use	10	Built-up areas	N/A	N/A	Tree cover areas Shrubs cover areas	Vegetation aquatic Lichen Moses	N/A	N/A	Grassland	Cropland Bare areas Open water
Road buffers	8	Within 100 m of roads	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Beyond 100 m away from roads

Results

After performing a weighted overlay analysis, a suitability map was produced after integrating geomorphology, clay content, land use, slope, lithology, road buffers, and precipitation. On a 1-9 scale, the analysis resulted into a highest score of 8 and a lowest score of 3



(not shown on this map). Suitability was ranked into five classes unsuitable (it occupied 0.01% of the total country), less suitable (2.81%) , moderately suitable (32.11%), suitable (45.07%), and most suitable (20.00%).

Conclusions and Limitations

The process of rainwater harvesting suitability using GIS provides an advantage to other conventional survey techniques because GIS combines different layers of parameters such as rainfall, land use, slope, clay content, and more. This analysis indicates that northwestern, western, southern, northeastern, and eastern regions proved to be more suitable for rainwater harvesting. The central regions did not depict much suitability due to steep slopes, low rainfalls, unfavorable lithology, and geomorphology. If rainwater harvesting were encouraged, it would increase water availability and thus fight against water scarcity.

One limitation from this analysis is the need to rely on outside tools/techniques. Peer reviewed studies have, for instance, used HEC-HMS to generate curve numbers. Thus, curve numbers were not used due to not having this program. Also, drainage density and lineaments which required advanced techniques were not used. However, factors considered in this study provide a good starting point for determining where to implement water management techniques in the country.

Information

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CEE 187: Geographic Information Systems
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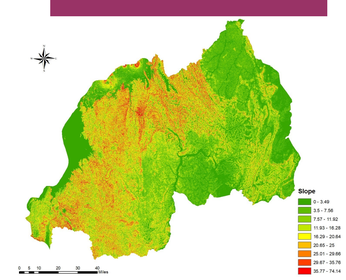
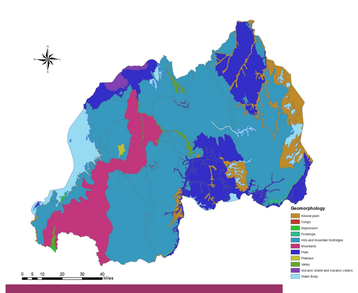
Projection: WGS_1984_World_Mercator
Data sources: ISRIC, RCMRD Geoportal, Stanford Earthworks, and HDX

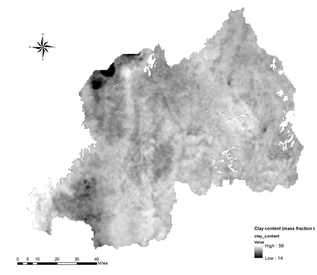
Slope



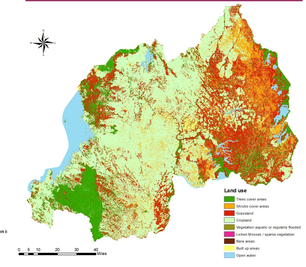
Geomorphology



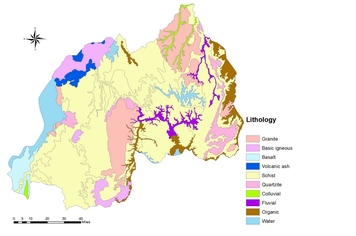
Clay content



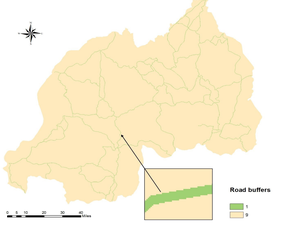
Land use



Lithology



Road buffers



Precipitation