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Review Paper

A review of peat deposits in Rwanda

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Abstract

The peat deposits in Rwanda are distributed over an area of 50,000 ha. The studies show that Rwanda has one hundred fifty five (155) million tone of dry peat, which can produce electrical energy, and this deposit is sufficient for Rwanda to achieve energy target. These deposits maybe used for about 30 years. Hereafter, it was felt crucial to do mapping to identify probable locations of peats and find out respective energy potential. The result of the study and assessment of peat to power in Rwanda shows that the average in-situ ash content, in-situ moisture content and in-situ bulk density of the collected peat samples are 36% wt, 70.8% wt and 1112kg/m^3 respectively. Their average thickness ranges from 0.9 to 7.8m. In Finland, peat was used as fuel in 1996 and produce 10% of total installed capacity. Rwanda has the same operational power plant in Gishoma; Rusizi District generating 15MW connected to the national electrical grid. A peat-fuelled power plant is under construction and is expected to generate 80 MW. This plant, once completed, is expected to connect 50% more household into national grid before the end of 2018. Thus, this effort along with other projects will increase electrical power from 208 MW to 563 MW in 2024. Peat deposit is expected to generate 500 Mega watt electrical powers during 30 years. Although an effort was done to use peat as fuel, the power plant is still vulnerable to the lack of good quality of dry peat to operate and thus efforts are on to develop suitable technology for exploitation.

Keywords: Peat, electricity, power, energy, Rwanda.

Introduction

Peat has been used as energy about 2000 years as substitute to firewood and heating. The consumption of hydrocarbon (gas & oil) in 20th has hindered the usage of peat[1] but high increase of demand of electrical power has motivated the construction of electrical power plant fueled by peat. It was used as fuel in four countries namely former Soviet Union, Sweden, Ireland and Finland in the world in 1996[2]. In Ireland for example, peat has been used for electricity generation since 1950, and it is estimated at 10% of the total installed capacity[3]. Rwanda has approximately 155 million tones of dry peat over an area of 50,000 ha of peat[4] and most of which is located in South and South west of the Country. These deposits were formed about the end of last glaciations period and this imply that they are less than 10,000 years old[1,5]. However, peat deposit in Akanyaru is of 20,000 years old and thus it contains peat of glacial and postglacial period[5]. These deposits were formed as result of the formation of East Africa lift Valley which caused the Precambrian rocks of Lake Tanganyinka to sink in 700m below sea level and Ruwenzori area to elevate to more than 5000m above sea level and therefore it has changed the East Africa plateau. The stratigraphic framework of Rwamiko peat deposits is presented on the Figure-3. This period has triggered the formation of new lakes and flow direction of rivers.

The topographical and hydrological architect of tropical swamps in Rwanda is basically influenced by recent volcanism. Because the lava flow blocked the valley, the age of these peat deposits are more likely to be influenced by volcanic activity than climate change[1]. Rwanda has the operational peat power plant in Gishoma; Rusizi District generating 15MW connected to the national electrical grid however, it is still vulnerable to its limited capacity to sustain large-scale peat production during rainy season that could handle up to 50 MW of power[6,7]. Hence, it was felt essential to do mapping of all probable locations of peat and their energy reserves for future exploitation.

Under the aegis of the Energy division, Rwanda Ministry of Infrastructures, a comprehensive research-oriented peat program has been launched, emphasizing on quality, quantity and technology development with the following objectives: i. Understanding the nature and distribution of peat in Rwanda, ii. Finding out favorable sites and estimating peat resource in Rwanda, iii. Quantifying peat resources in Rwanda, iv. Recommending suitable sites for peat exploitation.

In recent times, peat deposits has given intention geoscientists as possible models for certain coal deposits. Due to their distribution, low ash content, low sulfur and thickness has attracted coal geologist to study these peat bogs along with some brown coal deposits[8,9]. The scientific research is only way to justify if the recent peat deposit can be provided as models for certain coal basin.

Geological settings

Rwanda falls into Kibaran belt (KIB) of the Central Africa which is a belt of Mezoproterozoic supracrustal units composed of metasedimentary rocks and minor metavolcanic rocks. It has been intruded by S-types granitoid and mafic rocks[10,11]. The NE Kibaran Belt as it is known as Karagwe-Ankole Belt (KAB) consists of two different structural domains namely WD (Western Domain) and ED (Eastern Domain) (Figure-1) and each domain has a specific sedimentary sub basins and depositional conditions[12]. The WD is referred as Akanyaru Super group while the ED is Kagera Super group. WD is composed of Rwanda, part of Katanga in DRC up to Ankole region of SW Uganda. This super group is underlain by Palaeoproterozoic basement. The older granites and gneisses dominate the eastern province while the northwestern is made up of neogene volcanics. The young alluvium and lakes sediments dominate the southwestern part of the country (Figure-2). The sedimentary sequences indicate the influence of shallow marine and high energy environment due to stratification, conglomerates and symmetric ripple marks found within the layers. The western rift of western part of Rwanda is filled with tertiary and quaternary clastic sediments[13].

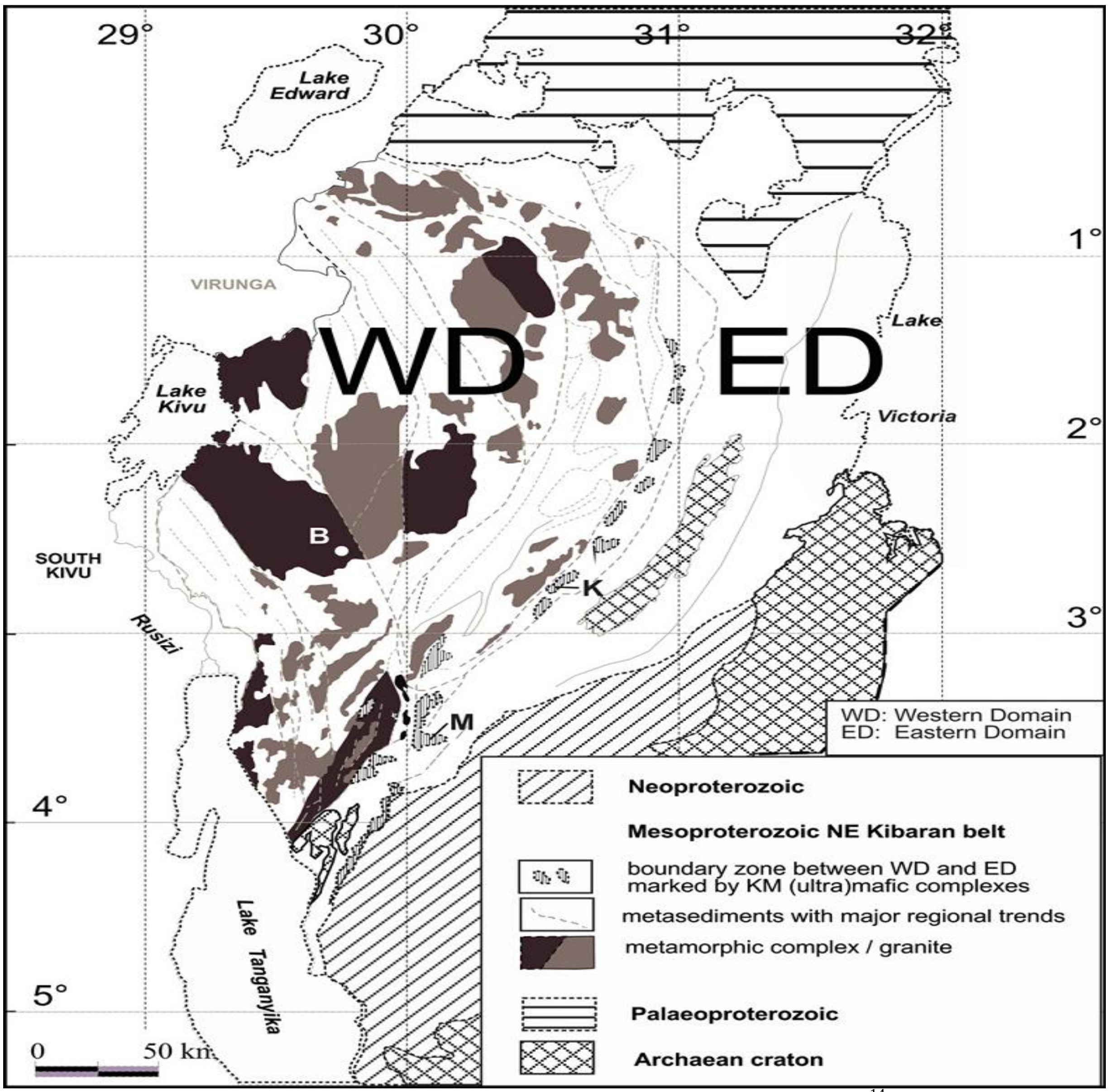

Figure-1: Regional framework of the Karagwe-Ankole Belt (KAB)[14].

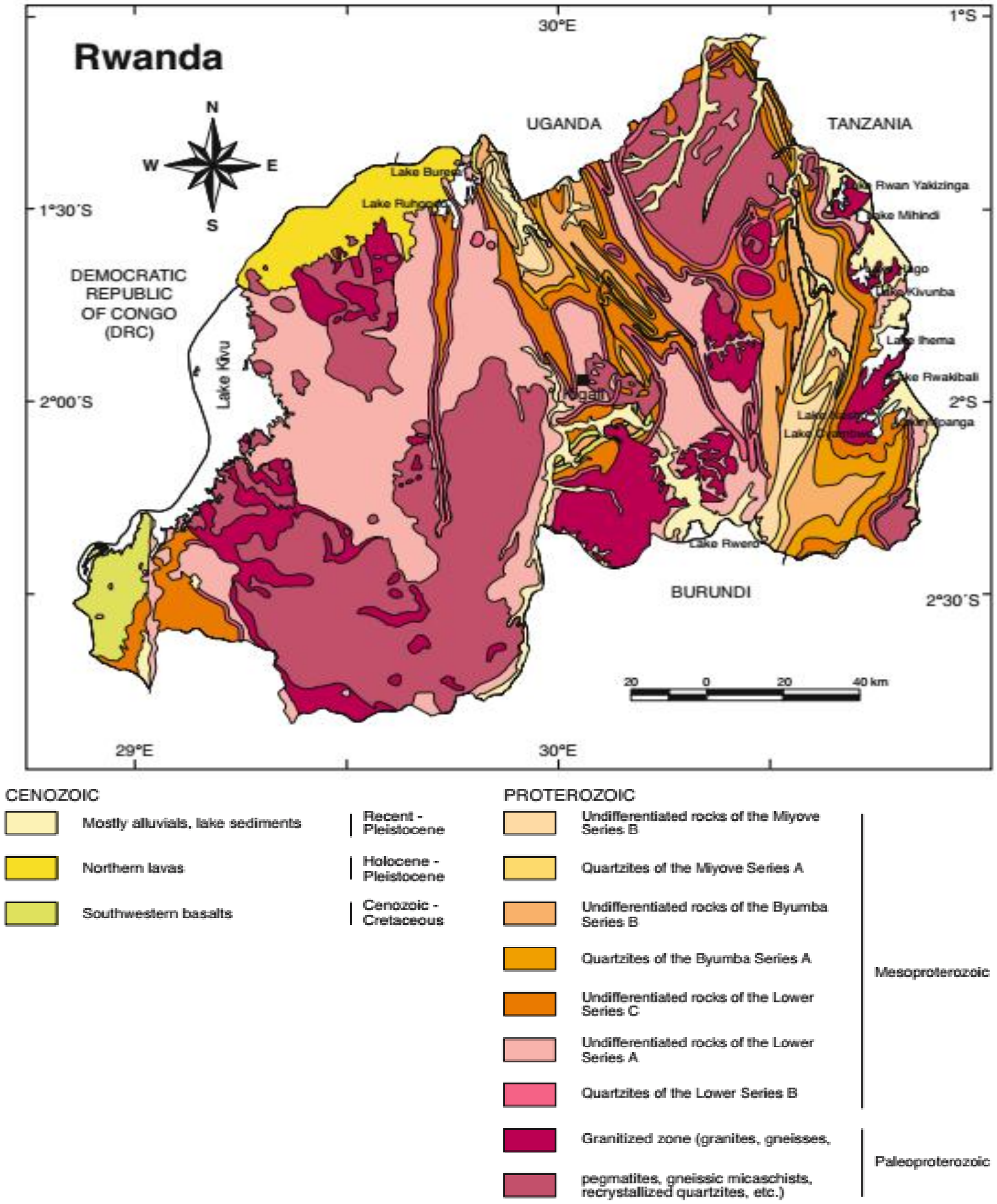

Figure-2: Geological overview of Rwanda[15].

Qualitative and quantitative analysis of peat deposits in Rwanda

Peat has been used as energy about 2000 years as substitute to firewood. Peat is organic sediments from plants and seldom from inorganic substances deposited *in situ* or transported. It is subjected to different processes such as coalification to become coal[16]. The usage of coal /peat is related to its geochemical properties. For example, coal/peat with high sulfur and high ash content is not suitable for energy production. The high sulfur content is environmental harmful whereas the high ash yield reduces the heating value of the peat. The coal with 70% of organic matters in dry basis is considered as good coal[17]. The evaluation of peat for fuel usage is based on its chemical characteristics (Table-1). The researchers have appraised one hundred fifty five million tons of peat on dry basis across the country[4,20] and these deposits could be converted into energy[19].

Table-1: General chemical and fuel properties of a range of fossil fuels (modified by Theophile Mugerwa)[18].

Chemical composition			Coal	Lignite	Peat	Wood
Carbon (C)		weight %	76-87	65-75	50-60	48-55
Hydrogen (H)		weight %	3.5-5.0	4.5-5.5	5-7	6-7
Oxygen (O)		weight %	3-11	20-30	30-40	38-43
Nitrogen (N)		weight %	0.8-1.2	1-2	0.5-2.5	<0.6
Sulphur (S)		weight %	1-3	1-3	0.1-0.4	0.02-0.06
Fuel properties	Volatile matter	weight %	10-50	50-60	60-70	75-85
	Ash	weight %	4-10	6-10	2-15	0.1-2.0
Bulk density		kg/m^3	728-880	650-780	300-400	320-420
Effective calorific value of dry substance		MJ/kg^1	28-33	20-24	20-23	17-20
1 MJ/kg = 239 Kcal/kg						

Table-2: Reserves peats in Rwanda (Sampled locations) [21].

Peat deposit location	Area (ha)	Approved peat reserves, dry basis (tonnes)	
		sod peat application	milled peat application
Rucyahabi	925	813 973	687 998
Akanyaru North-North part	1 321	501 291	68 753
Akanyaru North-Middle part	1 994	3 572 375	2 026 147
Akanyaru North-South part	3 208	15 740 346	11 517 536
Akanyaru south	2 108	7 797 785	6 763 219
Mukindo	959	1 323 573	698 581
Kaguhu	195	69 712	64 942
Gishoma	423	171 880	88 305
Gihitasi	90	12 168	12 168
Mashya	36	89 821	78 191

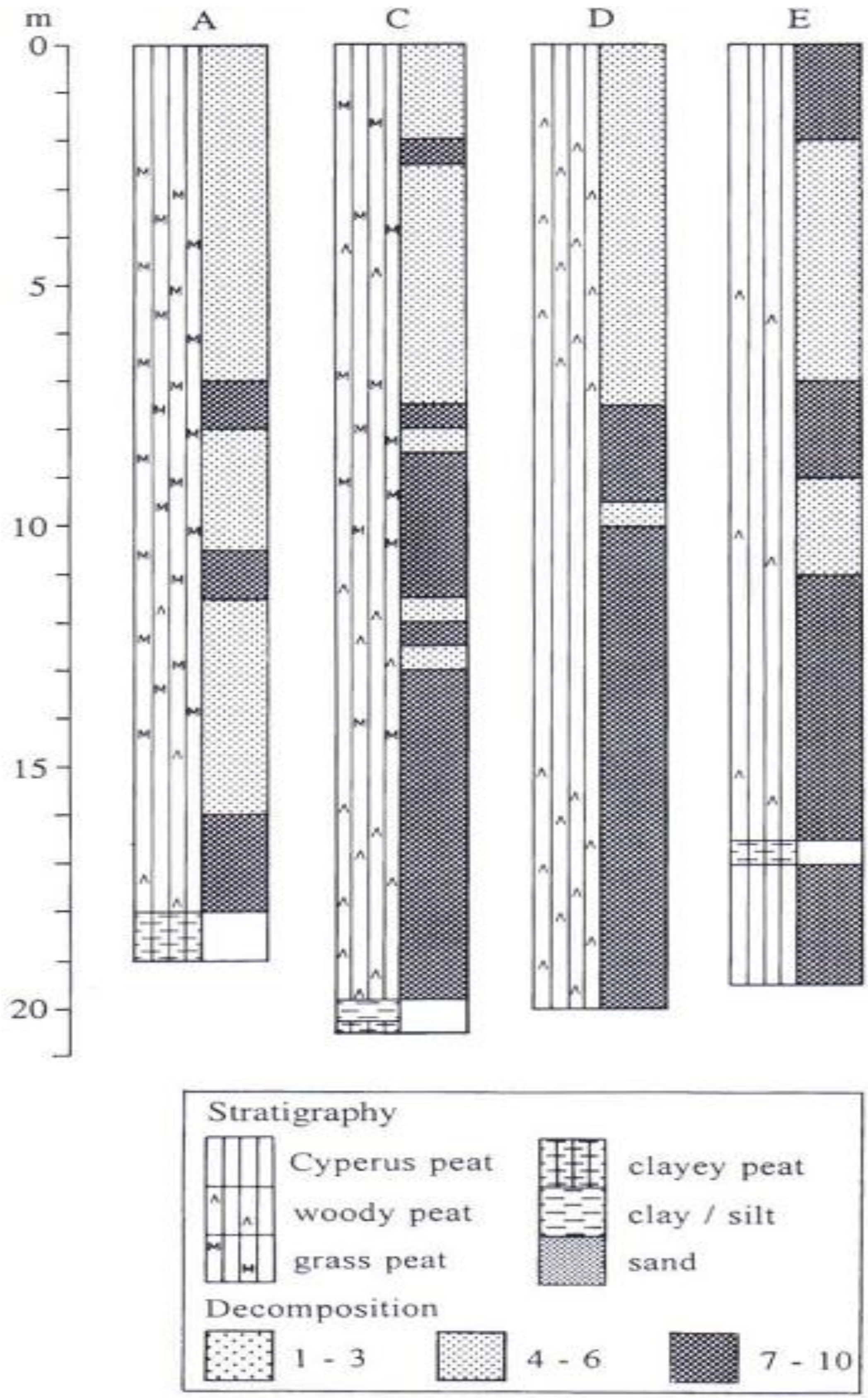

Figure-3: Peat stratigraphy in Rwamiko peat bogs[5].

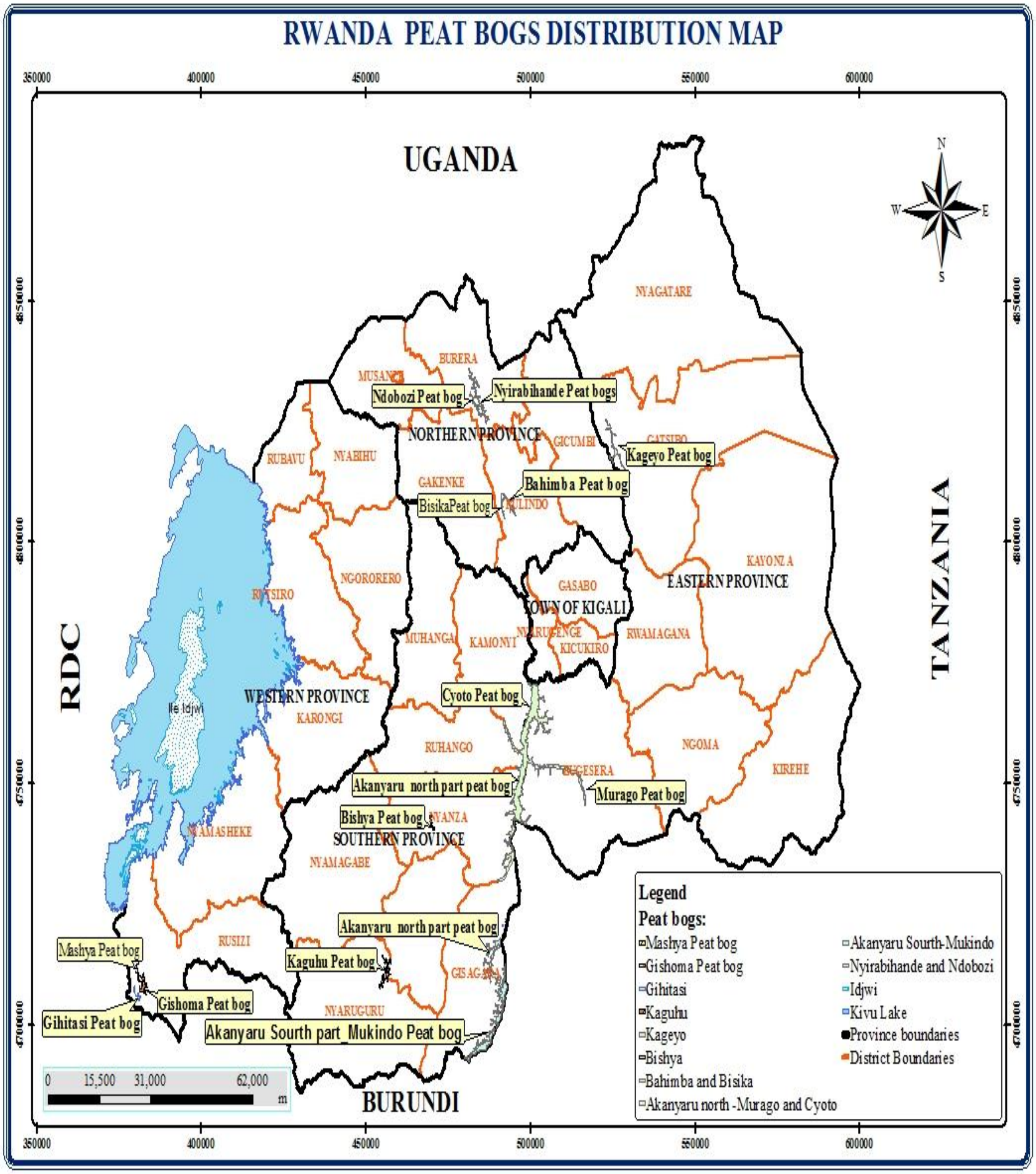

Figure-4: Peat distribution map_Rwanda.

The procedures outlined by Bureau of Indian Standards[22] were followed to determine total moisture, volatile matter, ash, fixed carbon, total sulfur and calorific and some of the results are presented in Table-3. The high moisture content (average 70.88%) is typical of peats (70–90%). The total S% values (average 0.84%) are generally medium for all samples. The gross calorific values of peat samples ranged from 3107 to 5258 Kcal/kg, with an average value of 4302Kcal/kg. These values are moderately very high because typical dry peat has calorific values of 2000Kcal/kg[23].

Table-3: Characteristics of peat samples taken from Rwanda in 2015[21].

Name of peat bog	Top soil depth (m)	Peat layer thickness (m)	*In-situ* moisture content (% wt)	*In-situ* bulk density (kg/m^3)	Average ash content in-situ peat, dry basis (% wt)	
Average values of all samples taken						Top soil layer not included
Cyato	2.5	2.4	74	1138	49	40
Murago	0.8	5.7	83	1056	42	31
Rucyahabi	1.8	3.7	80	1086	48	29
Akanyaru North (other), North	2.4	2.1	68	1180	66	46
Akanyaru North (other), Middle	0.8	4.6	78	1094	51	42
Akanyaru North (other, South)	0.3	7.6	85	1037	31	28
Bishya	1.2	2.4	70	1162	54	39
Akanyaru south (other)	0.3	7.8	83	1061	30	20
Mukindo	0.7	3.0	65	1207	64	43
Gishoma	0.7	2.2	73	1139	53	31
Gihitasi	0.6	2.0	73	1108	56	28
Mashya	0.0	3.5	86	1016	20	9
Kaguhu	0.9	0.9	53	1262	71	28
Bahimba	0.7	1.3	55	1297	75	42
Bisika	0.7	1.4	54	1278	77	73
Kageyo	1.3	1.0	53	1287	80	45
Ndongozi	0.1	2.9	76	1057	41	33
Nyirabirande	0.9	2.4	67	1162	57	32

Based on average ash content values determined from different peat deposits, Mashya peat deposit has low value of ash content (20%) while Kageyo has high ash peat (80%). In general, the content of ash for all location is equivalent to 36% (av.). The moisture content in all locations is slightly high ranging from 53% to 85%. Kaguhu and Kageyo display the lowest moisture content (53%) while Akanyaru North (other, South) is featured with highest value (85%). The ash content of less than 40% in soda peat dried up to 30% moisture content and less than 30% in milled peat dried to 40% is suitable for electrical power generation[18].

Conclusion

The peat resources are playing a crucial role in the development of Rwanda but its quality in doubt. The quality is not enough good for electrical power plant to run for many years and thus there is a need to develop a possible way to increase quality of harvested peat is important to ensure long term use for electrical generation. The analysis of earlier and new data depicts the most prospective bogs which are Murago, Rucyahabi, Akanyaru, Mukindo, Ndongozi and Nyirabirande. Besides evaluating the peat resources potential, the geochemical analysis can provide inputs such as peat forming vegetation, chemical characteristics and biogeochemical processes, which may affect the use of peat as fuel.

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