ISSN: 2186-8476, ISSN: 2186-8468 Print
Vol. 1. No. 1. March 2012

HYDROPOWER POTENTIAL MAPPING OF NIGER STATE

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ABSTRACT

The paper provides an evaluation and mapping of hydropower potentials in Niger State. The aim of the study was to evaluate and map the renewable energy potentials in Niger State with the objective of assessing the hydro energy that can be harnessed for national development. An automated interpolation computer program (Surge) was used to produce hydropower potential maps. The Hydro power potential data were obtained from Nigeria Hydrological Service Agency (NIHSA), Abuja. The analysis of the data indicates that the existing large Dams in the state have a total capacity of 22,880 Mm^3 and total output power of 1840 MW. The proposed large dams in the state have a total capacity of 30,232 Mm^3 with output power of about 2431MW, while the proposed medium and small Dams indicate a total capacity of 750 million Mm^3 and output of 60 MW. The hydro potential map produced using the software shows the locations of the prospective medium and small dams.

Significance: Mapping the hydropower potentials of Niger state will serve as a guide to energy experts and policy makers on effective exploitation and conservation of alternative energy resources in Nigeria.

Keywords: Hydropower; Dam; River; Renewable energy; Mapping.

INTRODUCTION

Energy is inevitable for human life and a secure accessible supply of energy is crucial for the sustainability of modern societies. Continuation of the use of fossil fuels is set to face multiple challenges that include: depletion of fossil fuel reserves, global warming and other environmental concerns, geopolitical and military conflicts as well as instability in fuel prices. These problems create a fragile and unsustainable economy, especially in developing countries like Nigeria. Renewable energy is the solution to the aforementioned energy challenges. Renewable energy resources such as solar, wind, biomass, wave and tidal, as well as hydro energy are abundant, inexhaustible and environmentally friendly (Asif, 2005).

Essentially, hydropower system rely on the potential energy difference between the levels of water in reservoirs, dams or lake and their discharge tail water levels down stream. The water turbines which convert the potential energy of water to shaft rotation are coupled to suitable

generators. Hydropower is by far the most established renewable resource for electricity generation and commercial investment.

Hydro installations and plants are long lasting, for example turbines last for about 50 years due to continuous steady operation with high temperatures or other stresses. Hydro turbines have a rapid response for power generation and so the power may be said to supply both base load and peak demand requirements on a grid supply. Power generation efficiencies may be as high as 90%. The main disadvantages of hydropower are associated with effects other than the generating equipment particularly for larger systems. There are the difficult problems of environmental impact, silting of dams, corrosion of turbines in certain water conditions and relatively high capital cost compared with those of fossil power stations (John *et al.,* 1990).

The hydropower potential of Nigeria is very high and currently accounts for about 29% of the total electrical power supply. The first hydropower plant in Nigeria was installed at Kainji on river Niger having an installed capacity of 836 MW with provisions for expansion up to 1156 MW. A second hydropower plant, also on River Niger, is at Jebba with an installed capacity of 540 MW. An estimate for rivers Kaduna, Benue and Cross River (at Shiroro, Makurdi and Ikom, respectively) indicates their total capacity to stand at about 4,650 MW (Aliyu *et al.,* 1990). Estimates of the hydropower potentials for the rivers on the Mambila Plateau are put at 2,330 MW. Sambo (2005) reported that the overall hydropower resources potential exploitable in Nigeria is in excess of 11,000 MW.

Since the energy crisis of the 1970s, many developed and developing countries have opted for small scale hydropower with appreciable savings made in comparison to the use of crude oil. It should be noted that hydropower plants that supply electrical energy between 15 kW and 15 MW are mini-hydro while those supplying below 15 kW are normally referred to as micro-hydro plants (Cotton, 1972).

Indeed small-scale (both micro and mini) hydropower systems possess the advantage over large-scale hydro systems, because the problems associated with topography are not excessive. In effect, small hydropower systems can be set up in all parts of the country so that potential energy in the large network of rivers can be tapped and converted to electrical energy. In this way the national rural electrification projects can be greatly enhanced (Sambo *et al.,* 2009).

The aim of the current study is to evaluate and map the renewable energy potentials in Niger State with the objective of assessing the available hydro energy that can be harnessed for national development.

MATERIALS AND METHODS

Hydropower Potentials Data

The data for the existing large, small, mini and micro hydro potentials were obtained from Niger upper River Basin Authority Minna and Nigerian Hydrological Services Agency (NIHSA) Abuja. From the Analysis of the data, a number of large dams identified can be utilized for hydro-electric power stations while the small dams can be utilized for mini or micro power stations.

Data on existing large dams in Niger State

The existing large dams in Niger State are Kainji, Jebba and Shiroro dams presently generating the hydroelectricity power for Nigeria. The data for the existing hydro-power producing stations are presented in Table 1.

Data on proposed large dams in Niger State

These dams have been identified with the capacity to support hydro-electricity power stations. There are eleven of these potential hydro power stations shown in Table 2.

Data on Proposed Medium and Small Dams in Niger State.

Fourteen earth dams were identified as medium and small dams with the capacity for mini/micro hydro potentials across the state (Table 3).

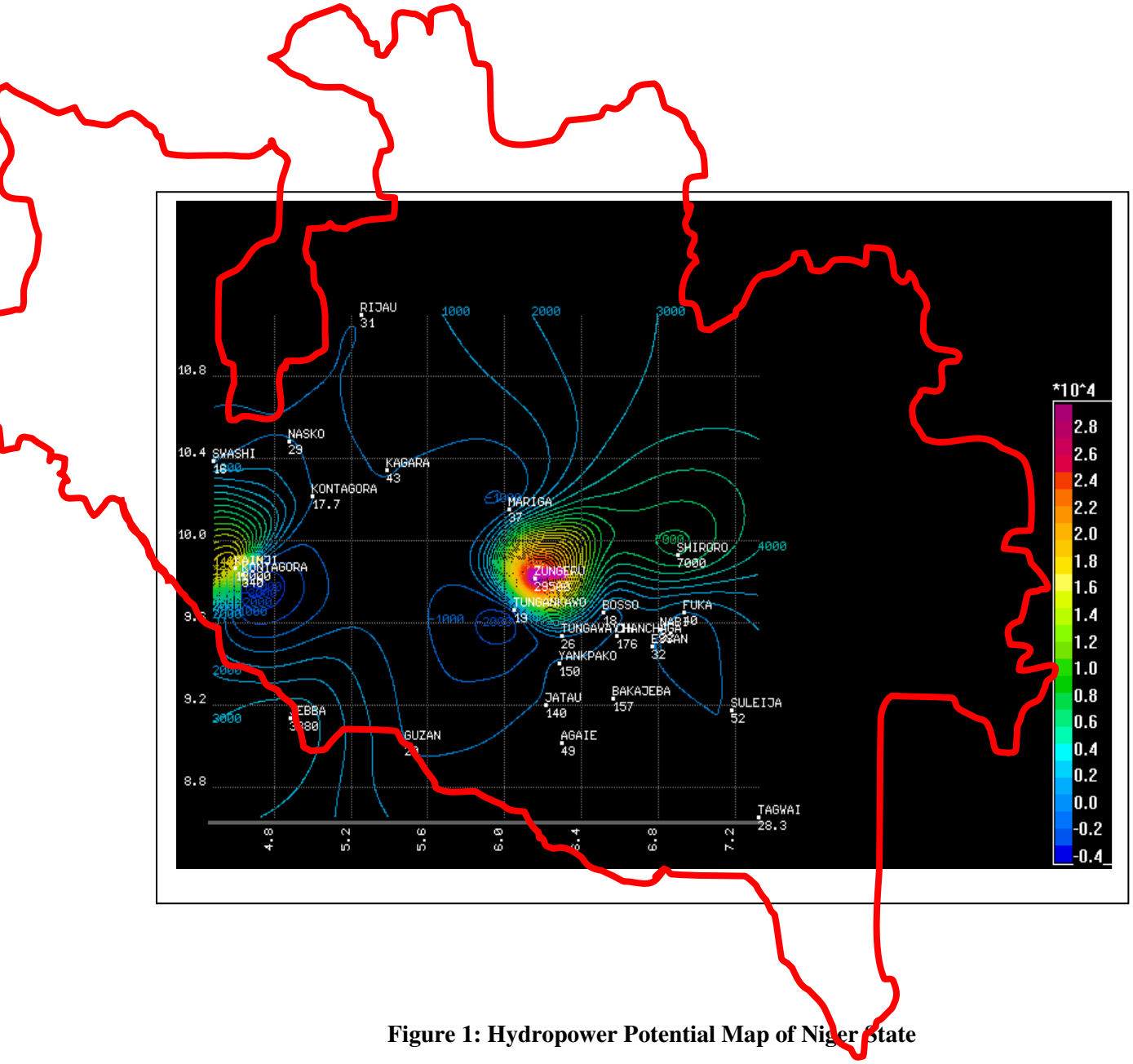

Figure 1: Hydropower Potential Map of Niger State

RESULTS AND DISCUSSION

Locations of Hydro-Potential Dams in Niger State

The latitudes and longitudes of all the dams found in Niger State are tabulated in Table 4 with their potentials for large mini and micro hydro electricity generations. The Niger State hydro power and Mini/Micro hydro power potentials map was obtained using the interpolation software (Figure 1).

DISCUSSION OF RESULTS

The Hydro power potential data were obtained from NIHSA Abuja. The analysis of the data indicates that the existing large Dams in the state have the total capacity of 22,880 Mm^3 and total output power of 1840 MW. The proposed large dams in the state have a total capacity of 30,232 Mm^3 with output power estimated at 2431MW. The proposed medium and small Dams indicate a total capacity of 750 Mm^3 and output power of 60 MW. The hydro potential map produced (Figure 1) shows the locations of these dams. In addition to the existing hydropower stations across the state that are operating below capacity, the results show that there is hydropower potential of about 2491 MW in Niger state yet untapped.

CONCLUSION

Hydropower potentials in Niger state have been estimated and mapped. Niger state has about 28 dams that have the potential for electricity generation. Though the state has existing hydropower generating stations which are providing the nation with electricity, there exist other hydropower potentials from small, medium and micro dams. The findings of the current research indicate that the existing large dams in the state have the total capacity of 22,880 Mm^3 and total output power of 1840 MW. The proposed large dams in the state have a total capacity of 30,232 Mm^3 with output power estimated at 2431MW. The proposed medium and small dams indicate a total capacity of 750 Mm^3 and output power of 60 MW. In addition to the existing hydropower stations across the state that are operating below capacity, the results show that there is an untapped hydropower potential of about 2491 MW in Niger state. The electricity generation in Nigeria may be improved if all the proposed small, medium and micro dams are constructed and their hydropower potentials harnessed appropriately.

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Table 1: Data on existing large dams in Niger state

S/N	Name	Type	River`	Height (m)	Length (m)	Volume (1,000m^3)	Area km^2	Total capacity (Mm^3)	Active Capacity (Mm^3)	Dead Capacity (Mm^3)	Outlet(M^3/S)	Sillorary (mm)	Rainful (mm)	Intion (Mm^3)	Power output (MW)
1	Kanji	Concrete	Niger	55.5	5,300	6.1	1,270.0	12,000.0	9,140.0	2,860.0	-	7,900	950	22,400	680
2	Jebba	Concrete	Niger	40.0	2,279	4.1	316.0	3,880.0	1,000.0	2,880.0	-	13,300	1,150	24,300	560
3	Shiroro	Rock fill	Kaduna	105.0	700	3.4	312.0	7,000.0	6,050.0	950.0	-	7,500	1,200	7,200	600
Total						13.6		22880.0	16190.0	6,690					1,840

Source: NIHSA, 1995

Table 2: Data on proposed large dams in Niger state

S/N	Name	Type	River	Height (m)	Length (m)	Volume (1,000m^3)	Area km^2	Total capacity (Mm^3)	Active Capacity (Mm^3)	Dead Capacity (Mm^3)	Outlet (M^3/S)	Sillorary (mm)	Rainfal (mm)	Intion (Mm^3)	Power output (MW)
1	Kubil	Concrete	Svasei	23.0	128	-	9.4	75.0	62.0	13.0	13.0	522	950	160	-
2	Swashi	Earth	Swashi	17.6	800	0.3	-	16.0	12.6	3.4	6.0	375	950	170	-
3	Kontagora 1	Earth	K/gora	20.0	1,000	0.9	3.7	17.7	15.7	2.0	-	-	1,050	36	-
4	Kontagora 2	Earth	K/gora	32.0	1,400	1.4	39.0	340.0	200.0	145.0	18.0	240	1,150	270	-
5	Kagara	Earth	Kagara	31.0	1,721	0.9	5.8	43.0	38.0	5.0	-	1970	1,150	40	-
6	Guzan	Earth	Yiko	-	-	-	-	20.0	18.0	-	17.0	385	1,200	-	-
7	Tagwai	Earth	Tagwai	25.0	1,770	0.9	5.5	28.3	26.5	1.8	-	-	1,200	33	-
8	Bosso	Earth	Karuko	17.0	132	-	-	-	-	-	-	-	1,300	-	-
9	Suleja	Earth	Iku	27.8	512	-	7.4	52.0	48.5	3.5	-	-	1,150	42	-
10	Zungeru	Rock	Kaduna	113.0	2,800	-	974.0	29,500.0	24,500.0	-	-	-	1,200	-	950
11	Jatau	Earth	Jatau	55.0	1,600	-	5.8	140.0	640	-	-	-		-	-
Total						**4.4**		**30,232**	**24,985,3**	**173.7**					**950**

Source: NIHSA, 1995

Table 3: Data on proposed medium and small dams in Niger state

S/N	Name	Type	River	Height (m)	Length	Area (km^2)	Total Capacity (Mm^3)	Active capacity (m^3)	Rainful (mm)
1	Yankpako	Earth	Chanchaga	32	-	27.5	150.0	14.0	1,150
2	Essan	Earth	Lami	24.0	600	-	32.0	38.0	1,200
3	Eniko	Earth	Eniko	16.0	1,000	-	22.0	19.0	1,150
4	Chanchaga	Earth	Chanchaga	33.5	2,400	22.2	176.0	140.0	1,200
5	Agaie	Earth	Bakogi	17.3	1,400	12.0	49.0	44.0	1,200
6	Bakajeba	Earth	Jatau	22.0	-	24.0	157.0	147.0	1,250
7	Tunbawayin	Earth	Wayin	22.4	1,400	-	26.0	23.0	1.150
8	Sanakpan	Earth	Bako	16.4	1,300	6.8	29.0	26.0	1,150
9	Nabi	Earth	Gora	29.0	1,200	-	32.0	26.0	1,250
10	Fuka	Earth	Kemi	16.0	1,600	15.0	40.0	37.0	1,250
11	Mariga	Earth	Jattau	27.0	800	-	37.0	32.0	1,250
12	Rijau	Earth	Butulu	-	-	-	-	-	850
13	Nasko	Earth	Shadaoulbi	-	-	-	-	-	900
14	Tungan kawo	Earth	Ubandawaki	-	-	-	-	-	1,150
Total							**750**	**672**	

Source: NIHSA, 1995.

Table 4: Location of Dams in Niger State

S/N	Dam	Latitude	Longitude	Remark
1.	Kainji	9.866	4.600	Hydro
2.	Jebba	9.133	4.883	Hydro
3.	Shiroro	9.933	6.900	Hydro
4.	Swashi	10.390	4.483	Hydro/mini
5.	Kontagora 1	10.214	4.999	Hydro/mini
6.	Kontagora 2	9.833	4.633	Hydro/mini
7.	Kagara	10.346	5.384	Hydro/mini
8.	Guzan	9.017	5.483	Hydro/mini
9.	Tagwai	8.651	7.325	Hydro/mini
10.	Bosso	9.653	6.516	Hydro/mini
11.	Suleija	9.176	7.181	Hydro/mini
12.	Zungeru	9.813	6.156	Hydro
13.	Jatau	9.200	6.216	Hydro
14.	Yankpako	9.400	6.283	Hydro/mini
15.	Essan	9.483	6.766	Hydro/mini
16.	Chanachaga	9.533	6.583	Hydro/mini
17.	Agaie	9.016	6.300	Hydro/mini
18.	Bakajeba	9.233	6.566	Hydro/mini
19.	Tunbawayin	9.533	6.298	Hydro/mini
20.	Nabi	9.566	6.816	Hydro/mini
21.	Fuka	9.650	6.933	Hydro/mini
22.	Mariga	10.154	6.025	Hydro/mini
23.	Rijau	11.102	5.251	Hydro/mini
24.	Nasko	10.487	4.879	Hydro/mini
25.	Tungan kawo	9.666	6.050	Hydro/mini

Source. w.w.w geonames.nga.mil