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Hydropower Resources as Target of Terrorism: Case Study of Selected Water Bodies In Northern Nigeria.

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----------ABSTRACT ----------

Energy demand is a major issue facing both the developed and developing nations and is always at the front bunning of government policy at all levels. Part of the current consideration by governments in terms of energy security is the factor of supply stability and infrastructural safety; especially in the wake of post September 11 attacks on the United States. As the level of terrorism is increasing, so is with the attention to energy security. This paper is therefore on attempt to analyze a sector of Nigeria's energy source-Hydropower, within the current security challenge facing the northern part of the country. After a through background on the issues surrounding hydro-terrorism at the global level. The paper had explored the Nigeria's hydropower asset and actimately assessed its vulnerability to insurgent attacks of especially the Boko Haram terrorist that dominated the study area. The evaluation consist of target attractiveness, vulnerability assessment, Risk assessment and the assessment of consequences which were evaluated on the four major river-basins that hold over 90% of the hydropower resources in the region. The study indicated the highest risks on the Hadeja-Jama'are and Kamadugu Yobe basins. This was attributed to their geographical locations, socio-economy of the residents and porocity of the boarders that warrants the smuggle of small arms and light weapons. Recommendations were made on both physical and small measures to safeguard the hydropower assets involved.

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I. INTRODUCTION

Nigerian's Hydro potential is high and hydropower currently accounts for about 32% of the total installed commercial electric power capacity. The average large scale potential is in excess of 11,000MW. Nigeria has considerable hydropower potential sources exemplified by her large rivers, small rivers, and streams. Nigerian rivers are distributed all over the country with potential sites for hydropower schemes which can serve the urban, rural and isolated communities. In order to realize these said potentials, there is the need to carefully review these sites within the spectacle of terrorism risks, going by the current escalation of violence particularly in the Northern part of Nigeria.There is a long history of water related violence and conflicts, including what must be categorized as environmental terrorism targeting water resources and infrastructure. The threat of future attack is real, but the plans for responding to such attacks appear to be inadequate especially in the northern states of Nigeria; which is recently plagued by the Boko-Haram insurgency.It must be noted that water as a fundamental resource for human and economic welfare and modern society depends on complex, interconnected water infrastructure for domestic water supply as well as for generation of hydropower. It is therefore imperative to articulate effective measures towards protecting these critical infrastructures from the attack of terrorist in what is commonly known as environmental terrorism.Environmental terrorism as defined by Gleck (2006) as the unlawful use of force against environmental resource or systems with benefits in the name of a political or social objective.Some important water facilities, such as dams, reservoirs, power equipment and transmission facilities (including flow values, turbines, generators, transformers etc) are open to the public, for recreational visits. 65% of Nigeria's dams and reservoirs are located in the northern part of the country, where the activities of insurgents are at its highest ebb in recent times. The new move of government to exploit its power generation through utilizing these water bodies makes them a clear and susceptible target for terror.

This chapter reviews history of past attacks on water bodies across the world. It then attempted to identify the vulnerability and risks of some selected water-bodies that are planned for hydropower generation. The purpose is to identify where productive and protective efforts are needed to reduce the risks. The chapter also ended with recommendations on proper and appropriate safeguards to reduce the identified risks, as well as to reduce the consequences should an event occur.

II. HISTORY OF HYDRO-TERRORISM

There is a long history of the use of water resources as both a target and tool of war and terrorism (Gleck, 1993, 2004.) Water supplies can be poisoned; dams can be destroyed to harm downstream population or to sabotage power generation. The recorded history of attacks on water systems goes back to 4,500 years ago, when Ulama, king of Agos from 2,450 to 2,400 BC, diverted water from his region to boundary canals, drying up boundary ditches to deprive the neighboring city-state of Umma of water. Similarly, in an early example of bio-terrorism, solon of Athens besieged Cirrha around 600BC for a wrong done to the temple of Apollo and put the poision hellebore roots into the local water supply. This reportedly caused the cirrhaens to become violently ill and facilitated the subsequent capture of the city (Eitzen and Takafuji, 1997). Many of the recorded instances of violence by individuals and non-state groups concerning water focused perceived inequities associated with water development projects or controversial decisions about allocations of water, often marginalized groups faced with the construction of water systems that appropriate local water resources have responded by threatening or attacking those systems.

This violence may be related to both absolute deprivation, where access to the most basic needs is denied to a group or region, and to relative deprivation, where basic needs are met, but water allocations or control are perceived to be unfair or in equitable.In one f the earliest reported acts, an angry mob in New York in 1748 burned down a ferry house on the Brooklyn shore of the East River, reportedly as revenge for unfair allocation of East River water rights. Similarly, in 1840s and 1850s, groups attacked small dams and reservoirs in the Eastern and Central USA because of concerns about threats to health and to local water supplies. Likewise, between 1907 and 1913, farmers in the Owens valley of California repeatedly dynamited the aqueduct system being built to divert their water to the growing city of Los Angelos (Reisner, 1993).The first reported attack by the Palestinian National Libration Movement, Al-Fatah, was in 1965 on the diversion pumps of the Israeli national water carrier (Naff and Matsm, 1984) and the region has seen many more examples. In 2001, Palestinians accused Israel of destroying a water cistern, blocking water deliveries and attacking materials for waste water treatment project (Kraelline, 2001; ENS, 2001)

Rivers and water infrastructures such as reservoirs can be easily vulnerable to this type of terrorism, since they are publically accessible in many places. In July 1999, engineers discovered an unexploded bomb in a water reservoir near Pretoria, South Africa. The bomb which had malfunctioned, would have been powerful enough to destabilize a nearby military base, and a hydrological research facility from the possible rapture of the dam's embarkment.Motive for such attacks can be economic as well as political. In July 2000, workers at the cellatex chemical plant in northern France dumped 5000 liters of sulfuric acid into Meuse River; when they were denied worker benefits. More recently, a series of events in India, Pakistan, the Persian Gulf and the Middle East have reaffirmed the attractiveness of water and water systems as targets for terrorists in a wide range of unrelated conflicts and disputes; but with similar undertone to that of Boko Haram in northern part of Nigeria.

III. REVIEW OF HYDROPOWER DEVELOPMENT IN NIGERIA

The country's topography ranges from lowlands along the coast and in the lower Niger valley to high Plateau in the north and Mountain along the eastern boarder. Most part of the country is linked with productive rivers which are scattered virtually all over the country. About two-third of Nigeria falls within the watershed of the Niger River, which empties into the Atlantic at the Niger Delta, with its major tributaries. Benue in the Northeast, the Kaduna in the North Central, the Sokoto in the Northwest, and the Anambra in the Southeast.
There are also several rivers of Northeastern Nigeria, including the Komadugu Gana and its tributaries which flow into Lake Chad. The lake Chad rests in the centre of a major drainage basin at the point where Nigeria, Niger, Chad and Cameroon meet. Similarly, there is the Kainji Lake created in the late 1960s by the construction of the Kainji Dam on the River in Nigeria. The first major work to identify potential hydropower sites was carried out by Motor Columbus in the 1970s as shown on Table 1 below:

Table 1: Potential Hydro Power Sites in Nigeria

Location	River	Average Discharge (m3/s)	Max. Head	Installed Capacity (pf=0.5) MW
Donko	Niger	1650	17	225
Jebba	Niger	1767	27.10	500
Zungeru II	Kaduna	343	97.50	450
Zungeru I	Kaduna	343	100.60	500
Shiroro	Kaduna	294	95.00	300
Zurubu	Kaduna	55	40.0	20
Gwaram	Jamaare	75	50	30
Izom	Gurara	55	30	10
Gudi	Mada	14.5	100	40
Kafanchan	Kongum	2.2	100	5
Kurra II	Sanga	5.5	430	25
Kurra I	Sanga	5.0	290	15
Richa II	Daffo	4.0	480	25
Richa I	Mosari	6.5	400	36
Mistakuku	Kurra	2.0	670	20
Kombo	Gongola	128	37	35
Kiri	Gongola	154	30.50	40
Kramti	Kam	80	100	115
Beli	Taraba	266	79.2	240
Garin Dali	Taraba	323	36.60	135
Sarkin	Suntai	20	180	46
Danko	Donga	45	200	130
Gembu	Katsina Ala	170	45	30
Kasimbila	Katsina Ala	740	49	260
Katsina	Benue	3185	25.90	600
Ala	Niger	6253	31.40	1950
Makurdi	Niger	6635	15.25	750
Lokaja	Osse	80	50	30
Onitsha	Cross	759	47	400
Ifon	Cross	1621	15.5	180
Ikom	Cross	1704	10	180
Afikpo				

Source: ECN 2007.

The potential hydroelectric schemes recommended for the country as at that time are shown in TABLE 2 below

Table 2: Potential Hydroelectric Schemes in Nigeria

			(ENERGY)	**GENERATION**	**Gwh/h)**	
Scheme	**Proposed station capacity**	**Head (m)**	**Firm**	**Secondary**	**Total Average**	**Remark**
Kainji[4]	700	142	2226	1676	3902	In operation
Shiroro[5]	600	375	2300	406	2080	Under const.
Jebba[4]	560	103	1828	816	2644	Out to tender
Ikom[6]	400	65			2300	Under study

Lokoja[6]	1950 1000 550 1950	64 57 50 64	9050 8000	1550 1770	10600 9770	Under study Including advantage of Makurdi project Excluding Makurdi
Makurdi[6]	600 180 80	91.5 85 70	2300	870	3170 960 430	Under study Excluding regulating Advantages of upstream project
Mambilla[7]	1000	103	4470		4470	Suggested

Source: ECN 2009

The first generating plant was built in Lagos in 1898 by the colonial government and was managed by the Public Works Department (PWD). The federal government established electricity corporation of Nigeria (ECN) through the instrument of ordinance No.15 of 1950, which was vested with the responsibility of running the generating station, subsequently in 1962 the Niger Dam Authority (NDA) was established to built dam.
However, the first large scale hydro power station in Nigeria was built in Kainji on the river Niger with an installed capacity of 760MW and with expansion to 1.150MW in 1968, then followed by Jebba in 1984 and Shiroro in 1990 with installed capacity of 570MW and 600MW respectively. Table 3 below show the proposed commissioning dates of hydroelectric schemes in Nigeria.

Table 3: Commissioned Hydroelectric Schemes

Location	**Capacity (MW)**	**Commissioning date**
Shiroro	600	1990
Kainji	760	1968
Jebba	570	1984

Source:

As the population grew and demand for energy increased, the Federal Government in the period 1982 to 2002 projected for some hydropower station for the plan period 1982-2002 to meet the increasing growth of power requirement in the country which was then put at 20% per year. These hydro power stations are shown in Table

4**.** Below

Table 4: Planned Hydro Power Station (1982-2002)

Location	**Capacity (MW)**
Ikom	730
Lokoja	1050
Zungeru	450
Mambilla Hydro	3960
Makurdi Hydro	1062
Onitsha Hydro	1050
Gurara (Abuja Hydro)	300

Source : ECN 2011.

IV. OVERVIEW OF SMALL HYDRO POWER (SHP) RESOURCES IN NIGERIA

Hydropower potential sites are distributed in 12 States and in the four river basins. However, SHP potential sites exist in virtually all parts of Nigeria. There are over 278 unexploited sites with total potentials of 734.3 MW (4). So far about eight (8) small hydropower station with aggregate capacity of 37.0 MW has been installed in Nigeria by private company and the government as shown in TABLE 5. Some around Jos Plateau, where there is 2MW Station at Kwall fall on N'Gell river (river Kaduna) and 8MW station at Kurra at Kura fall, which was developed by a private company (NESCO).

Table 5: Existing Small Hydro Schemes in Nigeria

S/No.	River	State	Installed Capacity [mw]
1.	Bagel (I) (II)	Plateau	1.0 2.0
2.	Kura	Plateau	8.0
3.	Lere (I) (II)	Plateau	4.0 4.0
4.	Bakalor i	Sokoto	3.0
5.	Tiga	Kano	6.0
6.	Oyan	Ogun	9.0

Source: Aliyu 1990.

Table 6 below shows the small hydropower potentials in some states.

Table 6: Small Hydro Potentials in Surveyed States in Nigeria

S/No.	State	River Basin	Total Sites	Potential Capacity (mw)
1.	Sokoto	Sokoto-Rima	22	30.6
2.	Katsina	Sokoto-Rima	11	8.0
3.	Niger	Niger	30	117.6
4.	Kaduna	Niger	19	59.2
5.	Kwara	Niger	12	38.8
6.	Kano	Hadeja	20	46.2
7.	Borno	Jama'are	29	20.8
8.	Bauchi	Chad	20	42.6
9.	Gongola	Upper-Benue	38	162.7
10.	Plateau	Upper-Benue	32	110.4
11.	Benue	Lower-Benue	19	69.2
12.	Cross River	Lower-Benue Cross River	18	28.1

Source: ECN 2011

The next table however, shows the hydropower potentials of Nigeria based on some selected river basins.

TABLE 8: RIVER BASINS IDENTIFIED HYDRO POTENTIAL

Organization	Potential site	Status	Capacity
Upper Benue River Basins Development Authority	Jada Dam Monkin Dam Kiri Dam Waya Dam Dandin kowa Dam	Pre-feasibility level	5MW 500Kw 1083Kw 61.8KW 33KW
Owena Benin River Basin Development Authority	River OWENA Ele River River Okhuanwan	Pre-feasibility level	1.3MW 1.29MW 600Kw
Anambra-Imo River Development Authority	River Igwu Imo River Ivo River	Identified	7.55KW
Chad Basin Development Authority	Biu site Janga Dole Dam site Majeekin Dam site	Identified	
Ogun-Oshun River Basin Development Authority	Oyan River Dam Ikero Gorge Dam Lekan Are Dam Oke-Odan Eniosa Ofiki I Ofiki II Sepeteri I Sepeteri II Okuku Igbojaiye	Pre-feasibility level	9MW

Source: Asif 2005.

V. TERRORISM VULNERABILITY OF SELECTED HYDROPOWER RESOURCES.

There are four major River basins in the northern part of Nigeria, which have a lot of potentials for hydropower. These river basins are assessed based on certain factors in order to classify them on risk scales for vulnerability to the attacks of insurgents.The first factor considered is the rate of escalation of insurgent activities in the communities where the hydropower asset is located, then followed by the potent of ideological and economic consideration around the river basin. The other issues factored are the closeness of the river basin to any Nigerian boarder that could be infiltrated by illegal alliance. The last factor considered was that of unemployment and poverty which were agreed to be push factors of indigent people into the unfortunate crime of terrorism.Those five factors were ranked form 1 to 10 and evaluated at the studied river basins in order to find the risks with which such hydro potentials are subjected to. The figure of 1 represents the least of risks and 10 represents highest level of risk. Table 9 below give a summary of the assessment.

S/No	River Basin	States covered	Terrorism record factor	Socio-ideological factor	Boarder proximity factor	Poverty & unemployment factor	Aggregate
1.	Sokoto –Rima R.Basin	Kebbi Sokoto zamfara Katsina, Kaduna	6	5	5	6	22
2.	Hadeja-Jama'a	Kano, Jigawa, Yobe, Bauchi	8	7	8	7	30
3.	Komadugu-Yobe	Yobe, Borno	8	8	9	7	32
4.	Upper-Benue	Adamawa, Gombe, Taraba	6	4	4	5	19

Source: Field work 2013

There are several factors that could be considered in evaluating the vulnerability of the hydropower resources to insurgency attacks. The choice of the factors to be considered are dependent upon the site specific it is located. To this extent, terrorism record and proximity to boarder is considered as the site specific factors, while socio-ideological and poverty/unemployment were considered as the most important factors of the socio economy.

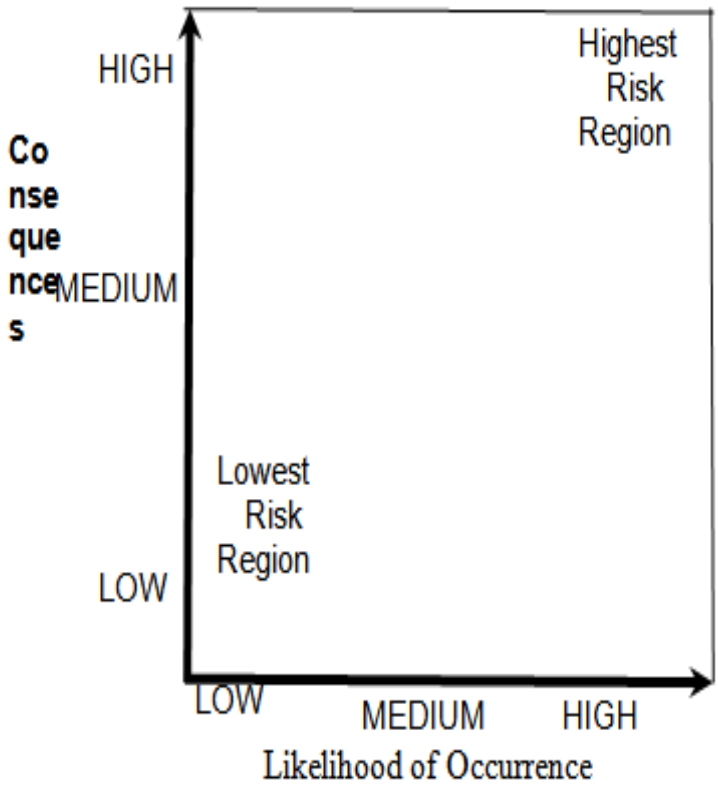
5.1 Target Attractiveness: This is an estimate of the real or perceived valued of target to insurgents.

Hydropower resources in communities were associated based on its individual attractiveness to insurgent's attacks. It is noteworthy to mention that not all target are of equal value to adversaries, however target attractiveness is one factor that influences the likelihood of security event. Therefore, the target attractiveness as shown on table ….. is having Komadugu Yobe basin with the highest risk assessment of 32/40, then followed by Hadeja-Jama'are river basin with 30/40 and the least of which is the upper Benue basin with 19/40. This clearly shows that even the hydropower resources of the least vulnerable basin of the upper Benue represent a risk factor of about 50%, while the vulnerability factor of the Komadugu basin staggered around 75%.

5.2 Vulnerability Assessment: This refers to any weakness that can be exploited by an adversary to gain unauthorized access and subsequent destruction of the particular facility or asset. Vulnerability can result from, but are not limited to weakness in current management practices, physical security or operational practices. The result of our investigation on selected hydropower sites in the four river basins of this northern states of Nigeria revealed that Sokoto-Rima basin has an aggregate vulnerability level of 50%, the Hadeja-Jama'are river basin is assessed as having a vulnerability value of 70%, Kamadugu-Yobe 80% and the least came from the upper Benue basin with a value of 40%.

5.3 Risks Assessment: Risk is an expression of the likelihood that defined threat will target an successful exploit a specific vulnerability of a facility or asset and cause a given set of consequences. In order to determine of Nigeria, several variables were used to compose an estimate. This include target attractiveness, the depress of threat and the degree of vulnerability. This is depicted in the matrix provided below.

Fig. 5: Hydropower Risk Matrix



The risk indicators showed that Komadugu-Yobe basin has 90% value risk of attract from the insurgents, which is the highest in the while of the northern states of Nigeria. The least risk value is recorded from the upper Benue river basin with a risk value of 40%. There seems to be a relationship between distance to the boarder and the risk value of studied hydropower resources of the studied river basin.

5.4 **Assessment of Consequences:** The severity of the consequences of a security event is generally expressed in terms of the degree of damage that would result of there was a successful attack on a particular hydro resources. This may involve effects that are more severe than expected with accidental risks. In order to have a clear and precise evaluation of the possible consequences of insurgent attacks in the selected hydropower resources, the following parameters were used to evaluate the outcome i, injuries to workers and the public ii, severe environmental damage iii, Economic loss to the community, state, region and the nation.The result of the study indicated that both Hadeja-Jama'are and Kamadugu Yobe river basin have 70% of severe consequences. The other four basins of Sokoto-Rima and upper-Benue were assessed as having moderate of consequences. The severity in Kamadugu Yobe and Hadeja-Jama'are is likely to be connected with the already fragility of the two ecosystems, together with the high population density of the community.

VI. CONCLUSIONS AND RECOMMENDATIONS.

Regarding physical security of a hydropower resource, a key question is whether protective measures should be focused on the largest hydro systems and facilities, where risks to the public are greatest, or on all, since small facilities may be more vulnerable. A related question is responsibility for additional steps, because the federal government has direct control over only a limited portion of the water infrastructure sector. The distributed and diverse nature of ownership (federal, non-federal government, and private) complicates managing risks, as does the reality of limited resources. The adequacy of physical and operational security safeguards is an issue for all in this sector. One possible option for federal facilities (dams and reservoirs maintained by the River Basins Development Authorities) is to restrict visitor access, although such actions could raise objections from the public.

Closure dams and reservoirs indefinitely to all fishing, hiking, and boating and blocked access to some roads are some vital recommendations.Measures that could improve coordination and exchange of information on vulnerabilities, risks, threats, and responses must be articulated in response to the outcomes of especially the assessment of Komadugu-Yobe and the Hadeja-Jemaare river basins. This should be a key objective, and an issue to relevant Ministries, Departments and Agencies in the ongoing security efforts by other federal government and non-federal entities that operate water infrastructure systems.Another identified issue is that of duplication of roles and responsibilities.

The growing potential for duplication and overlap among agencies must be checked to allow for proper responsibility sharing and a hitch-free coordination. Currently, for example, policies are being developed both by federal and state governments, and both agencies are being assisted by separate advisory groups. In order to ease this there should be a Water Sector Coordinating Council. Similarly, information sharing and dissemination even in this one sector are occurring through several different mechanisms. Some have questioned the multiple authorities that exist and in particular the potential that the several mechanisms for sharing Nigerian security information could transmit inconsistent information and make the exchange of information more complicated, not less. Others are optimistic that the systems and agencies must be sorted clearly into compatible and complementary networks of information sharing.

The cost of additional protections and how to pay for them are issues of interest, and policymakers continue to consider resource needs and how to direct them at public and private sector priorities. An issue of great interest to hydropower resources protection is how to pay for physical security improvements, since currently there are no federal funds dedicated to these purposes. Notwithstanding, government must consider a special funding mechanism to finance The vast Hydropower resources that are scattered across the whole country and particularly those in the northern part; where the Boko Haram insurgency is more pronounced.

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Confronting the Terrorism of Boko Haram in Nigeria James J.F. Forest JSOU Report 12-5 The JSOU Press MacDill Air Force Base, Florida 2012 This monograph and other JSOU publications can be found at https://jsou.socom. mil. Click on Publications.Â This study is offered as a resource for those engaged in policy or strategic deliberations about how to assist Nigeria in confronting the threat of Boko Haram.Â Further, Muslims in Northern Nigeria at one point in history enjoyed considerably more power relative to others in West Africa, but they have witnessed the fall of the Sokoto Caliphate, the rise of Western European colonization followed by successive military regimes, and now a secular democracy. 3. Installing hydropower in existing water conveyance infrastructure, such as conduits and canals; 4. Developing hydropower projects on new stream-reaches (NSD); and.Â Future hydropower must integrate environmental stewardship, economic performance, and availability of critical water resources for production of clean energy. Chapter 2, State of Hydropower in the United States, summarizes the status of hydropower in the United States as of year-end 2015 within eight important topic areas: history, contributions, and context; role in the grid; markets and project development economics; opportunities for development; design, infrastructure, and technology; operations and maintenance; pumped storage; and economic impact.