Evaluation of the Environmental Mitigation and Area Development (EMAD) component of the Bumbuna Hydroelectric Project (BHP) in Sierra Leone.

Alhaji Brima Gogra [a, d], Jun Yao [a, *], Edward Hinga Sandy [a], Gyula Zaray [b], Solomon Peter Gbanie [a], Celeste Tjobe [a], Tamba Samuel Bandagba [c]

[a] State Key Laboratory of Biogeology and Environmental Geology of Chinese Ministry of Education, School of Environmental Studies and Sino-Hungarian Joint Laboratory of Environmental Science and Health, China University of Geosciences, 430074 Wuhan, PR China.
[b] Department of Chemical Technology and Environmental Chemistry, Eötvös University, H-1518 Budapest, P.O. Box 32, Hungary.
[c] Department of Hydrology and Water Resources, School of Environmental Science, China University of Geosciences, 430074 Wuhan, PR China.
[d] Department of Chemistry, School of Environmental Sciences, Njala University, Private Mail Bag, Freetown, Sierra Leone.

* Corresponding author. E-mail address: yaojun@cug.edu.cn (J. Yao) or abgogra@yahoo.co.uk (A. B. Gogra)

Abstract: The most important development goals from the completion of the Bumbuna Hydroelectric Project (BHP) will be to accelerate economic growth, and poverty reduction, through the development of affordable power generation for domestic use in an environmentally sustainable, and efficient manner. Besides mobilizing private capital, the proposed Project will promote private sector involvement in the management of the power sector, and sustainable sector reform. The first component includes Hydroelectric and Transmission Infrastructure; and the second component is the funding of the implementation of the Dam/Reservoir, and the Transmission Line Resettlement Action Plan, with livelihood restoration and agriculture stabilization subcomponents, in addition to a comprehensive Environmental Management and Mitigation Plan (EMP). And the Technical Assistance component will fund the management and supervision of activities under the second component, and in addition, provide support to the Project Implementation Unit (PIU), the Dam Review Panel (DRP), and the Environmental and Social Advisory Panel (ESAP). This paper discusses environmental sustainability vis-à-vis regulatory compliance and environmental policy issues as related to the challenges and benefits being experienced by the Bumbuna Hydroelectric Project (BHP) in Sierra Leone. Its goal is to present strategies by applying established theoretical concepts and frameworks to the BHP case and examines some critical success factors that could be integrated into best practice management, especially in the face of future environmental and socio-economic challenges. The paper focuses on the Environmental Mitigation and Area Development (EMAD) component of the project as opposed to project contracts and technical assistance. We (the authors) believe that the EMAD component has a direct influence on the livelihood of the people, and as such, it could be used to gain further insights into BHP. If effectively implemented, the EMAD component may become one of the most important strategic management initiatives taken by BHP in complying with environmental regulations, in reaping potential benefits, and in putting the project in a better position for future financial assistance. As such, this paper's main focus is on EMAD's activities and recommends the adoption of a competitive strategy like a focused low-cost strategy that will provide the project with a strategic advantage whilst capitalizing on the World Bank's Dam Planning/Management Action Plan (DAMAP). [Journal of American Science 2010;6(6):51-64]. (ISSN: 1545-1003).

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1. Introduction

The Bumbuna hydroelectric dam, a creation of the Bumbuna Hydroelectric Project (BHP), is found in the valleys of the Sula Mountains in Sierra Leone on the river Seli. The main objective of BHP, which was initiated in 1970, was to provide least-cost and sustainable electricity supply within the country, especially the capital city of Freetown. This objective is in line with that of the New Partnership for Africa's Development (NEPAD) which aims at the integration of Africa into the global energy economy and the reduction of poverty. However, for the past thirty-six years, BHP has still not achieved its objective, as the dam is yet to be operational. The delay in project completion has mainly been due to inadequate

finances, environmental constraints, and a ten year old civil strife (1991-2001) in the country.

Analysis revealed that the development of the Bumbuna Falls offered the most attractive option to expand and diversify power supply for the country including the capital, Freetown. A feasibility study prepared in 1980 and funded by the World Bank (WB) recommended though, a down-scale of the original design to match Sierra Leone's ability to absorb the generated capacity and therefore, repays the investors. Subsequent studies by the donor community throughout the late 1980s and 1990s have confirmed the present scaled-down version of Bumbuna as least-cost for hydroelectric development to supply the Freetown peninsula served by the Western grid as well as provincial centres along the transmission route. The delay in financing the project after the redesign of the scaled-down version in 1984 however, rendered the project impossible to start, not until 1990 on the one hand. The project was to be commissioned in 1998 but because of the civil war all works were abandoned in May 1997 but not before the project was 85 percent (%) completed, on the other hand. Discussions for the resumption of the project resumed after the 2002 national elections, and in 2003, the donor community pledged resources to complete the project.

Since then many stops have been pulled down on the way of the project with the view to completing the remaining 15 % of the entire project: Panels of experts or consultants including geologists, geological engineers, and water resource engineers, civil engineer specialist in hydraulics and hydraulic structures and dam engineer specialists continue to work overtime to conclude the project. There are environmental and social advisory experts both local and expatriate engaged in the project affected areas stretching from Freetown to the valleys and the Sula Mountains of Bumbuna and have been holding consultative meetings with the Project Affected People (PAP) other stakeholders including officials of government and non-governmental organizations, etc.

The project's initial plan was financed by the United Nations Development Program (UNDP). In 1984, after the completion of a feasibility study, the World Bank decided to invest in the project on the basis of its Dam Planning and Management Action Plan (DAMAP). Within the project's chequered history, the government of Italy also made substantial investment, and in 1993, the African Development Bank (ADB) joined forces with the other partners in view of providing funds to BHP. Other major international stakeholders include Salini Costruttori (Salcost), ABB Italia, and Studio Pietrangeli.

BHP is divided into three components, namely: Hydropower Project Contracts, Environmental Mitigation/Area Development (EMAD), and the Technical Assistance component. Although there would not have been the EMAD component without project contracts and technical assistance, yet the EMAD component is of great importance in relation to environmental sustainability vis-à-vis regulatory compliance and environmental policy issues. EMAD (comprising of community development initiatives and issues relating to land acquisition, compensation and rehabilitation) deals mainly with the effects of BHP on the environment, the economy, and society.

The project is envisioned as the first phase of the Bumbuna-Yiben hydropower development scheme with an ultimate potential of 270 MW. The subsequent phases of this development foresee the construction of a multi-annual regulation dam at Yiben, 28 kilometer (km) upstream of the existing Bumbuna dam, and the extension of the Bumbuna powerhouse with two additional turbine units to raise its output to 100 megawatts (MW) and further options include construction of additional powerhouses at the Yiben dam and downstream of Bumbuna falls. The completed project will consist of the 88m high asphalt faced rockfill dam and a crest-length of 440 meters (m) now in place (Figure 2); two freestanding bell-mouth spillways upstream of the dam, one leading to the primary spillway tunnel on the left bank of the dam and one to a combined power and auxiliary spillway tunnel on the right bank; a single inlet tower intake (Figure 3; giving an idea of how high the water will rise in the valley before the water level is high enough to power the turbines); a 50 MW surface power station and associated works; and 200 km of 161 kV transmission line linking the power station to the Western Area grid network at a substation in Freetown. The shield wires above the 161 kilovolts (kV) conductors will be energized at 35.5 kV to supply loads up to 5 MW at the provincial towns of Makeni and Lunsar along the transmission route. A narrow Y-shaped reservoir (Figure 4) 30 km long with width between 0.2 and 1 km, a surface area at the maximum operating level of 21 km^2, and a water volume of 445 x 10^6 m^3, with two upstream branches will be created at full impoundment.

The above-ground powerhouse set at the base of the dam will house 2 x 25 MW turbo-generator units. The hydro power plant will have a maximum operating capacity of 50 MW. The water level of the reservoir will be controlled by two “morning glory” spillways. Apart from power generation, the BHP will be capable of 35 x 10^6 m^3 regulation for downstream flood control. The

spillways discharging through left and right bank tunnels have a total design discharge of 3,000 $m^3 s^{-1}$.

Power and energy production from the Project is estimated as presented in Table 1.

Table 1. Certain characteristics of the BHP project.

Characters	Estimated potential
Installed Power	50 MW
Firm Power	18 MW
Total Average Annual Energy Production	315 GWh
Annual Firm Energy Production	158 GWh
Annual Average Secondary Energy Production	157 GWh

(Source: Mansaray and Khare, 2007)

Currently, the country's unreliable electricity supply, thermal in nature, is provided by the government-subsidized National Power Authority (NPA) upon which BHP is dependent. In effect, in order for BHP to succeed, NPA, like the Government of Sierra Leone (GoSL), will not only have to provide a clear sense of direction but also be more proactive in determining demand and supply features of sources of energy.

2. Description of study area.

The Bumbuna dam site is located on the upper reaches of the Seli (or Rokel) River, in the valleys of the Sula Mountains about 200 km northeast of the capital city Freetown (Figure 1). The dam site is 2.5 km upstream of Bumbuna Falls close to the town of Bumbuna (population of about 3,000) in the Kalansogia Chiefdom in Tonkolili District. The Seli River is the third largest of nine major river systems in Sierra Leone and has a drainage area of 10,620 km^2. A regional road from Freetown provides access to Bumbuna Town and the dam site.

2.1 Hydroelectric Component

Hydrology: The Bumbuna project is a run-of-river facility with a drainage area of 3,240 km^2 (2,635 mm average annual precipitation at Bumbuna). The Seli River has its sources in the northeast of Sierra Leone. For about 100 km, it flows across the Interior Plateau in a southwestern direction. About 30 km upstream of Bumbuna near the village of Yiben, the Seli river flows out of the interior plateau cutting through the Sula Mountains (Figure 3). After a fall of about 40m over Bumbuna Falls and the adjoining rapids it reaches the interior lowland floodplains and subsequently flows to a second fall, about 30km upstream of the estuary north of Freetown.

Figure 1 – A Map of Sierra Leone showing the Location of Bumbuna (in blue colour circle) (Source: Encyclopaedia Britannica, Inc.).

The hydrology reflects the seasonal rainfall pattern characterized by very wet periods followed by 4-5 months of markedly dry periods. Since 1970, the stages of the Seli River have been recorded at Badela and Bumbuna by two gauges installed under a UNDP Program. The intake flow regime of the Seli River recorded at Bumbuna for the period 1970 - 1979 shows a mean annual discharge o f 122.8 $m^3 s^{-1}$, with a maximum of 331 $m^3 s^{-1}$ in September and a minimum of 6.1 $m^3 s^{-1}$ in March and the highest peak flows are reached between August and October and normally range between 600 and 1200 $m^3 s^{-1}$, with the maximum-flow recorded in September 1970 at 1,052 $m^3 s^{-1}$. The design flood determined in the feasibility study through analysis of precipitation records for stations south of the catchment area and by infiltration measurements corresponds to a probable maximum flood with a peak flow of 2,970 $m^3 s^{-1}$.

Geology: The Seli River runs north to south through a relatively deep, narrow valley in the Sula Mountains, cut into pre-Cambrian, crystalline basement rock. The region is characterized primarily by gneissose granite and granodiorite of the West African Craton. The Bumbuna dam site itself lies on the western edge of a Precambrian curvilinear greenstone belt locally referred to as the Sula Group, which is surrounded by basement granitoids and late kinematic granites. Residues of weathered granite overlie most of the Precambrian rock formations.

Figure 2 – Illustration of the 88m high asphalt faced rockfill dam (Source: author's visit in 2006).

A comprehensive investigation was made of the geological and geotechnical conditions at the Yiben and Bumbuna dam sites for one and two years from 1972 and 1977, respectively. The Bumbuna dam site has firm bedrock at the surface in the center of the riverbed and at depths varying to 30m in the extremes of the flanks. On the right side, the rock is mainly granite and granodorite and the overburden is weathered granite. On the left side, the rock is mainly amphibolite with an overburden of weathered rock.

Figure 3 - One of the two towers where water will spill down over two-hundred feet onto turbines which will power the generators. (Source: author's visit in 2006).

Alluvium is nearly absent in the riverbed at the dam site, where bedrock outcrops are fresh and sound. A hard granodiorite shelf crosses the river about 2 km downstream of the dam site forming Bumbuna Falls. Most of the potential geotechnical risks associated with construction have been mitigated as the dam and the main civil works are in place.

Seismicity: The project area is considered to have very low natural seismicity. The crystalline rock of the West African Craton on which the Bumbuna project is located, have been geologically stable since the Pre-Cambrian, Faults identified in this basement complex are not considered to be planes of weakness that could reactivate due to seismic forces and there is no evidence of movement of any faults within the craton since the Cretaceous Period some 65 million years ago. There is a slight risk of induced seismicity. Considering experience of reservoirs impounded on Pre-Cambrian Cratons around the world an earthquake of 4.5 magnitude on the Richter scale with a hypocenter at a distance of 5 km from the site was incorporated in Project design criteria.

Sedimentation: There hasn't been any comprehensive, nationwide sediment survey of Sierra Leone's river systems. Sediment loads in the Seli River at the dam site, as determined by measurements taken from 1978 to 1979 as part of the 1980 Feasibility Study activities (World Bank, 2005), indicated monthly suspended concentrations, as at that time, varied from 1.1 milligram per liter (mg l^{-1}) in the dry season to 105.3 mg l^{-1} in the wet season. The mean annual transport was estimated at about 90,000 m^3. Recent measurements (Cemmats Group Limited, 2004) suggest that the amount of suspended sediment in the river may be increasing (over 100 mg l^{-1} was recorded in 2004 near the end of the wet season). The indication of higher levels in the recent survey likely reflects land use changes after 30 years a result of the slash and burn agriculture, where trees and shrubs are replaced by shallow-rooted crops (or grasses in areas left fallow).

The analysis of the International Hydropower Association (IHA)-supported Dam Review Panel (2004) indicates that a conservative estimate of bed load could be about 20 % of the suspended load, about 18,000 m^3. The total sediment inflow was thus estimated at about 108,000 m^3 (suspended plus bed load). As most of the suspended sediment would pass through the Dam the Review Panel (DRP) concluded that deposited sediment would be small compared to the reservoirs inactive storage of 95 million m^3. To address the potential risk accelerated soil erosion, a watershed management plan has been proposed as a component of the Project to improve vegetation and land management practices. The downstream channel consists of boulders, cobbles and gravel but its generally coarse superficial materials have produced a natural armored layer reducing erosion.

2.2 Project Description

2.2.1 Instruments

Two IDA instruments are used to finance the BHP:

(a) A US$ 38 million Partial Risk Guarantee (PRG), to mobilize a commercial loan for the completion of the BHP (two major physical

components of the project: (I) Contract A2/B comprising the BHP civil works and hydraulic structures; and (11) Contract C comprising the electromechanical equipment); and

(b) A technical assistance grant to finance the other project components including the Environmental Management Plan (EMP); the Resettlement Action Plans (RAPs) for the dam reservoir and the transmission line; supervision of the EMP and the RAPs; support for the Bumbuna Project Implementation Unit (PIU); the Dam Review Panel (DRP) of Experts; the Environment and Social Advisory Panel (ESAP) of Experts; Upper Seli Community Development Initiative (USCDI), the Communication Action Plan (CAP); and capacity building for relevant ministries and agencies for sustainable implementation of the project's safeguard measures.

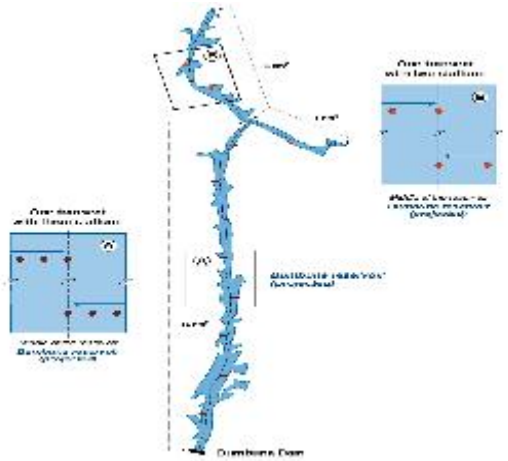

Figure 4 – Illustration of the Y-shaped Reservoir of the Bumbuna Hydroelectric Project dam. (Source: Encyclopaedia Britannica, Inc.).

2.2.2 Project Development Objective (PDO) and Key Indicators The PDO assumes that all energy generated by the BHP is sold to NPA and that NPA functions properly.

The main development objective of the proposed Project is to expand the capacity of Sierra Leone to increase the supply of electricity services at least-cost, and in an efficient and environmentally and socially sustainable manner. This would enable Sierra Leone to overcome one of the key constraints on growth, as well as on the effective delivery of social services.

The key outcome indicators include:

- Increase in electricity sales from 68.9 gigawatts per hour (GWh) in 2003 to 230 GWh in 2008;
- Percentage reduction of average electricity tariffs;
- A bio-diversity index to be established under the Additional Environmental Studies, acceptable to the Association, does not reduce by the end of the Project;
- 60 % increase of the targeted watershed area under improved agricultural conservation practice by the end of the Project;
- Sustainable fishery practices in 60 % of the reservoir and downstream of the dam;
- 100 % of Affected Persons resettled, as per definition in World Bank 2001 Operational Policy (OP) 4.12, by the end of the Project;
- Eighty percent increase of income of involved households with new income generating activities (forestry, fisheries, agriculture, soap making, carpentry, etc.) by the end of the Project;
- The Bumbuna Watershed Management Plan (BWMP) was to be developed by March 1,2007;
- Establishment of Environmental and Social Management Unit in the Ministry of Energy and Power (MoEP) and was to be operational by December 1, 2008;
- The Bumbuna Conservation Area was to be established by October 31, 2006 and management plan adopted by March 1, 2007; and Environmental management monitoring system developed by the date of effectiveness of the Grant.

3. Project Components, Environmental Sustainability, the Major Environmental and Social Impacts, etc.

3.1 Project Components

The three components of BHP are briefly described below:

3.1.1 Hydroelectric and Transmission Infrastructure (Component A)

The completed BHP will consist of an 88 m high rockfill dam with an asphalted concrete upstream face with a crest-length of 440 meters, two "morning glory" spillway intakes leading to a spillway tunnel and combined power/auxiliary spillway tunnel, a gated power intake incorporated in the spillway tower for the combined tunnel, and an above-ground powerhouse with two 25 MW turbo-generator units. A narrow Y-shaped reservoir between 0.2 and 1 km wide (Figure 4) and 30 km in length will form in the river behind the dam. It will have a capacity of 445 million m^3 and a surface area at the maximum operating level of 21 km^2. The energy from the hydroplant will be stepped up with a

13.4 kV/161 kV switchyard and transmitted to Freetown through a single-circuit 200 km-long transmission line on self-supporting steel towers (poles). In Freetown, the energy will be stepped down with a 161 kV/34.5 kV/11 kV substation, for distribution in the Western Area. Power service to Makeni, Lunsar, and Port Loko (all along the transmission line) will be provided by means of an insulated shield wire above the 161 kV line conductors that will be energized at 34.5 kV.

Although preliminary works have been undertaken as early as in the 80s, construction of the project began in the early 90s. Before the inception of the civil war, the major civil structures were in place (spillways, intake, tunnel, gates) and the rockfill dam had been finished. When the dam was about 85 % complete in May 1997, construction had to be suspended as a result of the ten-year old civil-armed conflict. The existing pre-civil war contracts cover the completion of civil works (Contract A2), the hydraulic steel structures (Contract B), the electro-mechanical equipment (Contract C), and the transmission line (Contract D).

3.1.2 Environmental Mitigation, Resettlement, Watershed Management and Benefit Sharing Environmental Management Plan, EMP (Component B)

The EMP and the RAP were prepared, approved and disclosed, both in-country and at the World Bank's Infoshop. The oversight arrangement for ensuring the implementation of these plans rests with the Bumbuna PIU. The PIU supervises the transmission and the main civil contractors, who are contractually obligated to implement and report on environmental and social mitigation measures for their respective construction activities. In parallel, the PIU is also responsible for coordinating with local government councils, traditional authorities and with line Ministries and agencies who are involved in specific EMP studies and activities funded by the project (particularly the Environment and Agriculture Departments), and for the hiring and supervision of consultants, non-governmental organizations (NGOs) and contractors for their implementation. Throughout the life of the project, this component provides assistance to develop an Environmental and Social Management Unit, within the Ministry of Energy and Power to take over the oversight function from the PIU upon completion of the BHP.

The PIU initiates all the legal and administrative activities needed to establish the Bumbuna Watershed Management Authority (BWMA) and the Bumbuna Conservation Area (BCA) as a Conservation Offset, which organizations will be established shortly after the test reservoir impoundment, and will undertake implementation of the EMP; and the RAPs will be implemented by the PIU under a separate contract. The BWMA will be responsible for the BWMP that aims to protect the reservoir from excessive sedimentation through improving agricultural practices in the Bumbuna catchment area, improving the livelihood of farmers, and protecting the remaining animal and plant biodiversity in the catchment, which includes the chimpanzee and other primate communities (World Bank, 2005).

The BWMP has several sub-programs for: (i) community awareness; (ii) land and soil management; (iii) agro-forestry and forestry; (iv) agricultural development; and (v) downstream and reservoir fisheries management. The PIU will also initiate and gradually transfer to the BWMA other EMP activities funded by the project, including actions for: (i) monitoring of public health impacts on diseases such as bilharzia and malaria; (ii) establishment of an environmental and social amenity flow; (iii) management of water quality in the reservoir area; and (iv) preparation and implementation of a comprehensive environmental monitoring program. All of these actions are necessary to protect the Bumbuna Reservoir from sedimentation, improve the livelihood of farmers in the catchment area, increase economic opportunities for communities in the area, protect biodiversity, ensure adequate water quality for users of the reservoir and downstream users, ensure sufficient water quantity for downstream uses, and protect the downstream environment. After commissioning of the BHP, a special-purpose project company, the Bumbuna Hydropower Company (BHC) will be contractually responsible for, among other obligations, and, pursuant to an Operations and Maintenance (O&M) management contract to be entered into between BHC and an operator ("the Operator") maintaining ongoing environment and management programs for the operation of the dam and reservoir and the transmission facilities and right-of-way (ROW). These responsibilities will be specified in the O&M management contract for the international operator for the dam/reservoir and the transmission facilities.

3.1.2.1 Land Acquisition, Compensation and Rehabilitation.

Reservoir Area: Laser images, GPS positioning and socio-economic impact surveys have determined varying degrees of impact in the dam/reservoir area. The Dam/Reservoir Resettlement Action Plan includes resettlement and compensation measures for: one village, which will be physically relocated; one village, which will lose almost all its farmland; and 31 villages which will lose a

substantial part of their farmland (approximately 40 %). In addition, four villages will be compensated, through community development compensation, for losses that occurred during the construction of the dam, the camp, access roads and the quarry in the 1980's and 1990's. Almost all project-affected people have started receiving appropriate compensation as per impact category, i.e. new houses and other structures, new farmland, assistance to move and to prepare new farmland, and compensation for other property such as shrines.

Technical assistance and funding will be provided under this project to ensure: (a) that farmers are able to reinstall themselves on their new farms and with better agricultural techniques, through the Stabilized Agriculture Program; and (b) that individual household incomes are restored to at least pre-resettlement levels through the Livelihood Assessment and Income Restoration Program.

Transmission Line: A Transmission Line Resettlement Action Plan has been developed, even though only very limited land acquisition and resettlement was required. In line with public consultations which expressed an unwillingness to resettle and conforming to accepted utility practice in many developed and developing countries, an approach was adopted which retains existing land use and permits transmission lines to overpass existing building and houses, provided that there was a minimum clearance between structures and the lowest conductor of 7.0 meters. Otherwise houses have to be moved and people compensated and resettled. One school near Makeni needed to be moved to an area adjacent to the present building. In addition, five dwellings also needed to be moved out of the ROW to adjacent areas. Provisions were made to control future building and land use in the ROW, with the guiding principle of maintaining the minimum clearance. The transmission line RAP will be implemented prior to the energizing of the transmission line.

Implementation of the Two RAPS: There is a common resettlement plan implementation arrangement for both parts of the project. The Dam/Reservoir RAP and the Transmission Line RAP is to be implemented by the PIU, by a unit of international and national resettlement consultants. The Resettlement Unit also provides continuous legal assistance to the project affected people and therefore included a legal counsel in the form of a local NGO – The Lawyers Centre for Legal Assistance (LAWCLA). The project-affected people are participating fully in the process and each village formed a Village Resettlement Committee (VRC). The overseeing and monitoring function is ensured by a Resettlement Advisory Group (RAG) in which all stakeholders at all levels are represented, and by an independent observer in the form of a Witness NGO.

Benefit Sharing: USCDI developed and tested an innovative institutional model for the proposed Bumbuna Trust, with the aim of sharing benefits with the indirectly affected population in the area around the reservoir and downstream of the dam. It consists of two activities:

(a) Ward and Community Sub-projects. Affected communities continue to receive development benefits, based on their demands for improved public services, through sub-projects implemented by them in collaboration with ward development committees and in harmony with overall district development plans. Public services include clearing and rehabilitation of smaller access/feeder roads, hand dug community wells and construction of latrines, management of organic waste, rehabilitation of existing school buildings and health centers, etc.

(b) Youth Capacity Building. Young women and men have been receiving training in marketable trade skills as well as business and life skills, and small grants given to community-based youth organizations. A Catchment Stakeholder Forum will enable a wider group of stakeholders to have a say in the formation of the Trust, and an Advisory Group will provide overall strategic direction for the Trust. USCDI is expected to provide technical assistance for the establishment of the Bumbuna Trust, in addition to its role in helping it develop approached and processes for benefit sharing.

3.1.3 Technical Assistance (Component C)

Component C is composed of management and supervision of the activities under Component B; and support for the Bumbuna PIU, the Dam Review Panel of Experts, the Environmental and Social Advisory Panel of Experts (ESAP), the RAP Implementation Team and the Communications Action Program. An international and national Environmental Management Technical Assistance (EMTA) team assist the PIU in implementing the EMP, in collaboration with the Department of Environment and other Sierra Leonean agencies. The PIU also expected to establish its own environmental management structure to oversee implementation of EMPs prepared by the contractors for the dam and transmission line.

3.2 Environmental Sustainability - Environmental Management and Mitigation Plan (EMP)

BHP's EMAD component, an overall EMP, is the major environmental sustainability initiative to

be funded by the World Bank. It ranges from land and soil management to agricultural development and fisheries management programs. Also, it is partly in the form of a trust fund, a community development initiative or safeguard measures revolving around capacity building and benefit sharing. Its financial sources will come from sales of electricity, and from funds provided to developing countries by the Organisation for Economic Co-operation and Development (OECD) through its carbon finance program. The EMAD component was established in response to the global demand for project-based greenhouse gas emission (GHG) reductions in the energy sector in relation to the rationale for environmental regulation, which initiative is an embodiment of innovative management practices based on environmental performance measures. It also serves to monitor social responsibility whilst capitalizing on business opportunities within the framework of the Kyoto Protocol's Clean Development Mechanism (CDM). Piasecki et al. (1999) observed that environmental performance measures are not only evaluative in nature, but they are also goals based on cost quantification and activity driver identification wherein environmental activities are divided into the following five cost pools:

- Strategic/tactical positioning
- Business risk management
- Program administration
- Impact minimization
- Penalty and injury

Using these cost pools, an attempt has been made below to evaluate the environmental sustainability of BHP's Environmental Mitigation/Area Development component.

3.2.1 Strategic or tactical positioning

Strategic positioning as a cost pool could be seen in the recommendation made in a study (sponsored by the United Nations Economic Commission for Africa, UNECA, on behalf of the Government of Sierra Leone, GoSL) done by Cemmats Group Ltd. (2004) which called for the need to enforce a governmental or non-governmental intervention policy in view of dealing with the environmental impacts of BHP; and it also came up with a strategic energy policy for the country. It called for government intervention in enforcing regulations so that fair play and consumer protectionism could be maintained and private investments and competition could be encouraged. The study, which was convincing in portraying strategic positioning as a cost pool wherein strategic policy statements are stated for implementation, was however, although short- and medium-term policy priority actions are mentioned, yet the study's Action Plan is not detailed enough to state specific actions to be taken in the long-term. Overall, it provides an understanding of the necessity to achieve environmental compliance through the enforcement of regulations in the hydropower sector of Sierra Leone and also encourages the GoSL to reaffirm its strategic commitment of addressing environmental issues and leads to the 2005 World Bank pledge to fund an EMP for Bumbuna Hydro within the framework of the Bank's-managed Public or Private Infrastructure Advisory Facility (PPIAF).

3.2.2 Business risk management

Business risk management as a cost pool is considered by BHP as partnership and contractual arrangements. The BHP became a private public partnership in 2003 with participatory bodies as the World Bank (WB), the IDA, the African Development Bank (ADB), the Government of Italy (GoI), and the Oil Producing Exporting Countries (OPEC) Fund. The project appraisal document of WB, report no. 31844-SL (World Bank, 2005) states that about 64% of the business risk will be borne by the public sector, mainly the GoSL, and 36% by the private sector.

Under an operations and maintenance agreement, the BHP will be incorporated as the Bumbuna Hydro Company (BHC) with the Italian firm, Salcost, holding 95% of its shares and the GoSL 5%.

According to the WB Report no. 31844-SL (World Bank, 2005), total project costs for BHP's Environmental Mitigation Area Development component was estimated at US$7.693 million to local investors and US$0.603 million to foreign investors, indicating that much more effort was needed from the public sector, especially the government in terms of good governance and security. Moreover, it also points to the fact that the government should not only rely on debt cancellations and donations from other countries, but to provide its people a sense of direction through wise leadership.

3.2.3 Program administration

In terms of identifying program administration as a cost pool for evaluating the cost effectiveness of BHP's EMAD component, it is observed that a Cabinet Sub-Committee has been serving as a policymaking body, consisting of the nation's vice-president and five other ministers, notably those for finance, energy and power, and works. The others are lands, and local government.

Under the Technical Assistance component, there is a technical committee which provides general

project coordination and supervises the PIU; which committee is constituted of a chief environmental officer, a member of the Professional Engineers Association, other professional heads, and government ministerial secretaries. In addition to the supervision of the Wrap up Agreement with Salcost, the PIU also serves as a communication link between both local and international stakeholders.

3.2.4 Impact minimization

The Azimut Consultants (2005) report prepared for the government of Sierra Leone discussed impact minimization as a cost pool for evaluating cost effectiveness of BHP'S EMAD, in terms of satisfying donors, and addressing public expectations. The methodology used to compare the legislations on involuntary resettlement in Sierra Leone and those found in the World Bank's Operation Manual OP 4.12 (World Bank, 2001) is descriptive. This report highlights two approaches in relation to resolving the issue of resettlement; the first was to disallow any land use within a 30-metre wide ROW of the electrical transmission line and the second, which was chosen, was to reduce the ROW to 7 metres thereby minimizing resettlements of people and making it more cost effective for the project.

Also the report convincingly addressed valuation methods for compensation, including the presentation of a clear perspective for calculated values of land, land improvement, and building construction. The least convincing though is the future implementation of the RAP. The report provided tools, in the form of valuation methods, to achieve its objective of providing a fair and equitable resettlement and compensation package to BHP affected people. This does not mean that the objective is already achieved, but it's entirely up to the implementation unit of the project to execute the necessary recommendations of the RAP. The report contributed to the general understanding of emerging environmental and social issues in the hydropower business in Sierra Leone.

3.2.5 Penalties and injury

Structures have been put in place by BHP that will adequately compensate project affected people (PAP) by addressing penalties and injury to human health and the environment as a cost pool. The Stabilized Agriculture Program (SAP), and the Livelihood Assessment and Income Restoration Program (LAIRP) are two social initiatives (World Bank, 2005) that will make sure that farmers are provided with the necessary technical assistance and that their incomes are restored appropriately. Hopefully, that part of the activities of the EMP will be to monitor public health within the project affected area for minimizing the spread of water-borne diseases such as malaria and bilharzias. In general, BHP's technical committee will be responsible for compensation of PAP, communications, and watershed and wildlife management issues. Another area in which penalties may arise is in the case of default by the NPA in terms of making timely Power Purchase Agreement (PPA) payments. Although measures are being taken to prevent default, yet it is seen that unpaid and overdue payments will endanger BHP's operations. To address potential risks of the project to human health and the environment in an attempt to mitigate penalties and injury, a great deal of preventive measures has being taken by BHP. For instance, it is expected that the endangered chimpanzee population will be protected, and an Emergency Preparedness Plan (EPP) has been put in place in terms of a warning and protection system for people downstream in case of emergency.

In conclusion, it could be said that by using the above-stated cost pools or environmental performance measures (Piasecki et al., 1999), it is found that BHP's Environmental Mitigation/Area Development program has made significant strife to address the issue of environmental sustainability.

3.3 The Major Environmental and Social Impacts of the BHP

Below are the summaries of the major environmental and social impacts. Both the 1996 and the 2005 EIAs identified the presence of some chimpanzee (considered an endangered species) communities in the wider reservoir area. There are no indications at present that the area to be inundated contains any other endemic or endangered plant or animal species. The area to be inundated has not been considered a critical natural habitat, according to the Natural Habitat Policy OP 4.04 (World Bank, 2001). The project is financing mitigation measures to protect the remaining chimpanzee communities, other primates, and other biodiversity in the Bumbuna catchment. Further biodiversity studies are underway, and reservoir filling was to start when recommendations of these studies are known. Impacts on fish as a consequence of the closure of the dam and the impoundment of the reservoir are expected to be minimal, as fish surveys were carried out during the 1996 and 2005 EIAs preparations; the results of which surveys indicate that the Seli River does not contain any endemic or endangered fish species.

Some changes in the hydrological regime of the Seli River downstream of the dam shall result from the annual filling of the reservoir, as reservoir

operation will regulate flow in the river, which will alter the hydrological regime downstream; an amenity or environmental flow will be maintained during all phases (pre-impoundment, impoundment, and operation). The amenity flow during the dry and rainy seasons will be greater than or equal to 6 m^3 and 100 m^3, respectively, and the operation of the reservoir will result in an increase in dry season flow.

The prevalence of bilharzia and malaria might increase; and the prevalence of river blindness (onchocerciasis) will likely decrease as a result of the inundation of a number of rapids in the reservoir area.

People and chimpanzees will likely be squeezed into a smaller area because of the impoundment of the reservoir. This habitat squeeze will further decrease the sustainability of the present agricultural-shifting cultivation system, and thereby increasing pressure on the chimpanzee habitat. The project's EMP includes appropriate mitigation measures, partly financed from the electricity tariff.

To warn and protect people downstream in case of an emergency, an EPP was to be prepared and operational before reservoir filling. And a benefit sharing mechanism will be provided with the establishment of the USCDI (World Bank, 2005), through which indirectly affected communities around the reservoir can benefit from social and economic development activities.

The GoSL is dedicated to implementing these mitigation measures.

3.4 Safeguard Policies

The project has got considerable environmental and social impacts, therefore, designated a category "A" project with safeguard classification of S2. The following safeguard policies (World Bank, 2001) are triggered by the BHP: Environmental Assessment (OPBP 4-01), Natural Habitats (OPBP 4-04), Forests (OPBP 4.36), Cultural Property (OPN 11-03), Involuntary Resettlement (OP/BP 4.12) and Safety of Dams (OPBP 4.37). The environmental impacts and resettlement issues raised by the BHP have been addressed in the 1996 and 2005 EIAs, in the Dam and Reservoir RAP, in the Transmission Line RAP, and by instituting a DRP and an ESAP. Since the Seli River is not an international river, the Safeguard Policy on Projects in International Waterways OPBP 7.50 is never activated.

The Safeguard Policy issues raised by the project are briefly discussed below:

Environmental Assessment. The GoSL's 2005 EIA includes a comprehensive EMP, which is been implemented during project construction and operation.

Analysis of Alternatives. The 2005 EL4 includes a comprehensive Retrospective Analysis of Alternatives (or Options Assessment/scoping). This analysis indicates clearly that the BHP was the preferred option to provide electricity to Freetown and intermediate towns at the least cost.

Natural Habitat. The 2005 EIA, the ESAP, and qualified Bank Safeguard Policy staff concluded that the area to be inundated was not a critical natural habitat under the definition in the Bank's Natural Habitat Policy OP 4.04 (World Bank, 2005) and that the reservoir area to be inundated fell under the definition of natural habitat in OP 4.04. The Bank can only finance projects that involve the significant conversion of natural habitat under certain conditions. In such cases, an environmental offset will be required.

Cultural Property. The 2005 EIA (which investigated the Cultural Property aspects of the Bumbuna reservoir area, as did that of the 1996) included an archeological survey (which did not reveal any evidence of cultural property in the area to be inundated) and interviews with the local population. An additional survey was to be carried out once the reservoir area was cleared, but before reservoir filling. Cultural property (including sacred sites, that belong to "secret societies"; and graveyards) in the dam/reservoir area may disappear due to the impoundment. The dam/reservoir RAP includes provision for relocation of and compensation for sacred sites.

Resettlement. The two RAPs prepared in 2005 include, one for the dam and reservoir area and one for the transmission line. Both RAPs have been approved by the Bank Safeguard Policy staff and were disclosed in country and in the Infoshop in Washington DC on January 26, 2005 (World Bank, 2005).

RAP for the Transmission Line. Practices in countries such as Canada, New Zealand, Spain, and Mexico have demonstrated that from a safety and public health point of view, it is an acceptable standard to build a high voltage power line over houses, as long as the required safety clearance is observed. An international expert has verified the acceptability of this practice in regard to safety and Electromagnetic Field (EMF) guidelines. Therefore, the resettlement along the transmission line was then minimized to include only six structures, which is in line with the results of public consultation, which demonstrated that PAP was unwilling to relocate.

3.5 Legacy Issues (Background and Approach)

About 450 households were affected by loss of land and property when the transmission line foundations were constructed in 1994-1995; the

impact was documented and a resettlement plan was prepared by the construction contractor (ABB). The resettlement plan, which included individual compensation contracts for each affected household, was been implemented by the PIU within a five-year period, effective 2007. Revenues from the project (3%), allocated to a special account, will be for the purpose of RAP implementation. The total cost, including escalation, was approximated to US$1.2 million.

Implementation of the RAPS. Both the RAPs for the Dam/reservoir and for the Transmission Line will be implemented by the Resettlement Unit (RU), which has been a unit under the responsibility of the PIU **(**composed of international and national consultants). The RU has been implementing the RAPS in close collaboration with the Village Resettlement Committees (VRCs). It's also been using the services of a legal association in Sierra Leone for the purpose of providing legal assistance to the PAP. A Witness NGO has ensured independent monitoring and evaluation and the Resettlement Advisory Group (RAG), composed of representatives from all stakeholder categories, has a general oversight function.

Forests. The riparian forest patches (which are under increasing human pressure in West Africa) in the reservoir area has to be cleared before the inundation of the reservoir and these patches in the reservoir area were not considered critical natural habitat areas by the 2005 EM (World Bank, 2005). The remaining riparian forests in the Bumbuna watershed are to be protected as described in the EMP (World Bank, 2005).

Safety of Dams. The GoSL constituted a DRP in 2004 to comply with the World Bank Dam Safety Policy OP/BP 4.37. Although the findings of the DRP indicated that the dam is safe, the review of the consultant's report, (World Bank, 2005), recommended that the Emergency Preparedness Plan (EPP) needed significant improvement. The findings of this panel indicated that the dam is safe and also indicated that the hydrology in the Seli River had not changed in the past decades, but recommended the collection of additional hydrological data. It (the panel) also indicated that at present the sediment loads in the Seli River do not pose a risk to the lifetime of the Bumbuna reservoir.

Borrower Capacity. Though the borrower capacity to implement the safeguard policy recommendations has been insufficient, the project has been financing environmental management and resettlement implementation as well as capacity building through technical assistance (TA). The TA, handled by the PIU, consists of on-the-job training and capacity building in environmental management and monitoring by international consultants and national experts within the responsible Sierra Leonean institution, the Department of Environment.

Implementation of the EMP. The TA is been financed through an IDA TA Grant and implemented in close collaboration with Sierra Leonean partners such as the Department of Environment, a team of international and national experts in the Bumbuna PIU, the Bumbuna Watershed Management Authority (BWMA) and others satisfactory to IDA, is engaged in monitoring the implementation of the EMP, the contractors EMP, and provide legal aid to PAPS.

Public Consultations. The terms of reference (TOR) for the 2005 EIA was submitted through public scoping sessions with primary and secondary stakeholders, to ensure that all relevant stakeholder concerns have been addressed in the 2005 EIA. Extensive stakeholder consultations have been carried out on the Draft Final 2005 EIA. The minutes of these public meetings have been included in the Final 2005 EL4 report. Public consultations carried out for the 1996 EIA influenced the design of the EMP, and elements from the 1996 EMP have been carried over into the 2005 EMP (World Bank, 2005).

Disclosure of the 2005 EIA Report. The Final 2005 EIA and EMP, including a budget, have been approved by the World Bank and subsequently disclosed in the project areas, nationally and in the above-mentioned Infoshop in Washington. The main findings of the EIA are presented in World Bank 2005.

3.6 Political and Other Risks

Large dam projects involving resettlement are very sensitive due to their possible negative social and environmental impacts, which may hinder multi-stakeholder support for the project if disclosure of information and transparency is not properly ensured. Given this potential risk, a communications needs assessment was carried out through extensive one-on-one meetings, interviews, and focus groups with the national media, NGOs operating in Sierra Leone, opinion leaders, and the general public. The assessment established that overall there was broad political support for the project among all groups interviewed. A smaller risk was associated with the lack of government communications, as well as adequate and timely information dissemination.

The assessment concluded that the political and other risks associated with the project could be mitigated through a communication program aimed at ensuring interaction with national and international NGOs and national media. The program explains the project's commitment to fair, transparent, and

proactive initiatives aimed at promoting the high standards of social inclusion, environmental protection, and poverty alleviation attached to the project objectives.

3.7 Policy Exceptions and Readiness

The exception to World Bank 2001 Operational Policy (OP) 4.12 (a World Bank policy on involuntary resettlement, which requires that, if adverse indirect social or economic impacts might result, a social assessment should be done and measures to minimize or mitigate such impacts implemented.) was approved by the chairman of the Operations Committee and also instructed that this decision be fully disclosed in the PAD. The threefold rationale for seeking the exception to OP 4.12 includes:

(a) Because the loss of property and farmland occurred when the transmission line foundations were constructed during the civil war, the situation is very different from the normal situation where involuntary resettlement occurs. The affected people have moved and are not in immediate need of compensation.

(b) Since Government is normally responsible for payment of compensation related to resettlement and the unique circumstances prevailing in Sierra Leone (post conflict), use of project revenues is appropriate to enable the compensation be paid over five years. Very similar procedures have been followed to pay the legacy compensation as are considered for the payment of compensation of people affected by the filling of the reservoir; which procedures included the hiring of a 'witness NGO' to verify that compensation has, in fact, been paid to the affected people.

(c) Given the unique nature of the project and country circumstances, the region feels that an exception to OP 4.12 was justifiable and that the proposed compensation structure for the legacy issue discussed in this work eventually met the objectives of OP 4.12.

Otherwise the project is said to be in full compliance with the requirements of all other triggered World Bank Safeguards.

3.8 Challenges and Benefits

The debates on the long-term sustainability of hydropower projects are becoming increasingly more significant, especially with regard to the challenges and benefits for developing countries like Sierra Leone. In the midst of all the tremendous socioeconomic benefits to be realized from BHP, the sustainability of the project is apparently plagued with an excess of environmental and socioeconomic challenges (not only linked to the nature of the project and the disruption of the environment, but also to the displacement, compensation/rehabilitation of PAP, and the difficulty in acquiring funds for project completion) that might have more adverse effects on the country. This might mainly be due to the inadequacy or lack of necessary resources, skills, and infrastructures to sustain the hydropower project. In effect, the maximum benefits of the project might not be realized.

In terms of environmental degradation, compensation/rehabilitation, conflicts with some local communities are common. The construction of the BHP dam has diverted the flow of the river Seli from its natural course thereby disrupting surrounding ecosystems, which effect has been felt upstream and downstream of the river system by both flora and fauna. While ecosystems upstream are flooded with water, those downstream are deprived of an essential for livelihood. Dams, such as the BHP, are known to change water quality in terms of increase in river water temperature and dissolved gases, consequently, negatively affecting aquatic habitats, ecosystems, and human communities. Fish migration, particularly, is hampered by the slow-flowing dam water and hydropower turbines; which effect might result in the decline of fish population and food shortage for humans. Similarly, there is a high possibility for the BHP dam to accumulate contaminated sediments which affect fish spawning and deprive downstream ecosystems from receiving sediments.

Moreover, the country's post-civil war environment is not conducive enough to attract private investments thereby failing to fill the gap left by dwindling public sources of finance. The short-term financially uncompetitive nature of the project is not only a challenge in accessing long-term finance, but also in bringing about delay in donor remittances. Under normal circumstance, the cash flow of the project is expected to be a source of revenue. The Bumbuna Hydropower Company (BHC) and the NPA will set tariffs in favour of BHC as a risk mitigation measure. Finally, the high construction risk and time, the lack of an effective regulatory framework and bad media exposure are also compounding the challenges of the capital and local cost-intensive BHP.

The benefits from the BHP are promising even though the challenges of the project are seemingly formidable; including the facts that a well-proven and simple technology was used to provide electricity supply to a country that has been deprived for decades of a reliable source of energy. This means that an increased impetus would be added to agriculture, trade and industry thereby creating and improving secondary economic opportunities like

youth capacity building, tourism, culture and sports. With anticipated carbon finance benefits associated with its greenhouse gas (GHG) emissions reduction, its low operating/maintenance (O&M) costs, and its long project life years, the BHP will be in a position to strengthen its link to Sierra Leone's development vision for 2025 and its participation in regional development programs of the Economic Committee of West African States (ECOWAS) and the New Partnership for Africa's Development (NEPAD).

The goal of Sierra Leone's energy policy is not only to produce and use energy efficiently but also to add value to sustainable social and economic development (Cemmats Group Ltd., 2004). It is hoped that this will help reduce poverty as reflected in the objectives of NEPAD (New Partnership for Africa's Development, 2006), and the Millennium Development Goals (MDGs).

In the April 28, 2006 edition of Awareness Times newspaper (Munu, 2006), a BHP consultant was quoted as saying that the project will need US$93.8 million for final completion. In comparison with the 2005 financing plan of estimated project cost it is crystal clear that the possibility of an increase in cost could not be unfounded. In this case, there has been a change in the amount of project cost; an increase in cost of US$2 million between 2005 and 2006. In terms of debt servicing and the time value of money, otherwise known as discounting, it could be calculated that if US$91.8 million were borrowed to finance BHP, and if for instance the investors require a rate of return of 10 percent per year, then the project should be generating US$9.18 million yearly in order to repay the debt. Most of these economic costs include total costs to complete hydropower and transmission structures, operations and maintenance costs (O&M), environmental and development costs, and costs emanating from technical assistance (World Bank, 2005). In effect, the economic benefits are mainly revenues from sale of electricity, and carbon credits. From the ongoing analysis, it could be observed that the project costs of Bumbuna Hydro are significantly influenced by the concept of innovation and change.

Poor access to electricity is a major challenge for West Africa (Davidson, 2006), suggesting the need to integrate both urban and rural electricity development programs within the context of the West African Power Pool (WAPP), which is especially true for a war-torn country like Sierra Leone where poverty reigns and the challenge is the lack of "affordability" by the people to purchase electricity when available.

Head (2000) made mention of the current trends in private financing based on the drive for run-of-river projects and avoidance of large dams that tend to be costly, plagued by lengthy construction time, and poor publicity. The second major trend in private financing is that towards smaller hydropower projects like BHP (50MW). This trend arises in view of mitigating the effects of environmental degradation caused by larger projects, although according to the author it might not be a best practice.

As stated earlier the report prepared by Azimut Consultants (2005) for the government of Sierra Leone is in response to a World Bank requirement related to involuntary resettlement and the corporate responsibility of BHP for providing a fair and equitable resettlement and compensation package. The challenge was to develop and use a cost-effective and an appropriate valuation method for compensation of PAP. A solution might be to perpetually maintain a balance between the interrelated challenges and benefits, entailing a series of changes like policy reforms, energy production, distribution and consumption, reflecting the shift towards the era of the sustainable energy economy.

In summary, the environmental and socio-economic challenges and benefits of BHP to PAP and the industry are based on its long-term sustainability, including, the restoration of the livelihood of PAP through youth capacity building, benefit sharing, and compliance to the power purchase agreement (PPA). In effect, BHP is forced to be socially responsible and environmentally accountable if it is to survive in today's competitive corporate world.

In recent times, key players in hydropower-production are becoming more concerned with the long-term sustainability of the hydropower business, especially where companies could combine sustainable practices with profit-making. In such cases, alternative intervention strategies are needed to address each situation in its own sense.

4. Concluding Remarks

The research study's problem was to identify the potential environmental challenges and benefits associated with BHP and to evaluate its Environmental Mitigation and Area Development (EMAD) component.

The findings were that in identifying challenges and benefits and determining strategies, BHP has the overall internal strength to capitalize on external opportunities in view of combating threats. Also, that BHP is faced with alternative strategies, albeit irreversible strategic commitments in the midst of innovation and change, making access to private finance more critical in achieving the goals of the project. Moreover, it was also discovered that because of a possible Power Purchase Agreement-default, and the country risks (poor infrastructures,

post-war environment, and improper governance) involved, the project might be ineffective and unviable for long-term private financing. And, because of some or all of these risks and challenges, BHP, at one time or the other, has been denied funding by some private financiers. In effect, these risks and challenges have made executing best practices, completion of BHP, and effective implementation a difficult task.

As a concluding remark, it should be stressed that apart from the WB-related documents on BHP, research information about the project is scanty. Among other issues, the future of energy and the environment is relatively bleak in this part of the world. However, Sierra Leone's population is still hoping to see the completion of BHP.

This study is limited to an analysis of the dimensions of the problems revolving around the uncompleted BHP in view of evaluating its Environmental Mitigation and Area Development (EMAD) component. Recommendations for further study may include an application of a set of sustainability guidelines developed by the International Hydropower Association (IHA), (2004) to the case of BHP. A potential objective might be to evaluate BHP on the basis of these guidelines as they aim to promote an awareness of the environmental, social and economic aspects of sustainability assessment in hydropower projects.

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Corresponding Author:
Alhaji Brima Gogra
State Key Laboratory of Biogeology and Environmental Geology of Chinese Ministry of Education,
School of Environmental Studies and Sino-Hungarian Joint Laboratory of Environmental Science and Health,
China University of Geosciences, 430074,
Wuhan, PR China.
E-mail: abgogra@yahoo.co.uk

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