Background Paper for
The Multi-stakeholder consultation process for dams development in Ghana

Prepared by

Prof Chris Gordon
Volta Basin Research Project
University of Ghana

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Executive Summary

One of the main objectives of the Dam and Development Project is to support country-level, regional and global dialogues on the World Commission on Dams report and the issues it addresses with the aim of engaging all stakeholders with emphasis on those not currently involved. One of the key reasons why stakeholder involvement is not as complete as it should is the lack of easily assessable information, presented in a format that most can understand. This document presents an inventory of existing and future dams for 16 major dams in Ghana including the challenges concerning the dams. A comprehensive analysis of stakeholders in the "dams and development discussion" in Ghana is presented to identify both, the crucial and the comprehensive list of potential stakeholder groups in the process and their respective roles. The document also presents a review of both the positive and negative impacts of dam development projects in Ghana. These impacts include effects on communities, water bodies and biodiversity. A review of corrective measures to mitigate negative impacts taken in the past as well as an assessment of future measures in the case of dams in the pipeline. Legal framework and the decision-process for planning and implementing dam projects in Ghana is presented and the strengths and weaknesses highlighted. The document calls for a the creation of a Ghana Dams and Development Forum with a specific role to;

- Act as a platform for National multi-stakeholder dialogue on dams-related issues,
- Exchange experiences and lessons,
- Act as a consultative body.

There is also a need for a smaller Coordinating body which would have the role of:

- Provide advice to stakeholders, including Government
- Ensure that the multi-stakeholder consultative character is maintained
- Convene meetings of the Ghana Dams and Development Forum
- Provide reports/information to the Ghana and Development Forum members

Finally the document warns against the reinvention of established procedures and suggests the use of industry standards of good practice to guide Ghana

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1. Introduction

1.1. Background

The webpage of the Dams and Development Project (DDP) (http://www.unep.org/dams/About_DDP/) presents the following information on the project which has been paraphrased below. Established in November 2001, the Dams and Development Project is a time bound project hosted by UNEP financed with contributions of donor countries following a request of the Third Forum meeting of the World Commission on Dams (WCD). The Dams and Development Project whose mandate excludes it from taking positions or making judgements on individual projects or associated practices is **a neutral entity to take forward the consideration of the WCD recommendations into local contexts.** This was to be achieved through promoting inclusive multi-stakeholder dialogue and, widely disseminating the WCD materials. The first phase, which ended in July 2004, promoted dialogue at all levels. The outcomes and experience of Phase I set the starting point for Phase II (launched in February 2005) to **promoting improved decision making, planning and management of dams**.

The Vision of the Dams and Development Project is: ***The development and management of water and energy resources address the full range of options and are attained through institutionalised participatory and transparent decision-making processes to achieve sustainable outcomes that benefit all.***

The Mission is to: ***Promote improved decision-making, planning and management of dams and their alternatives building on the World Commission on Dams core values and strategic priorities and other relevant reference materials through promoting multi-stakeholder dialogue at national, regional and global levels and producing non-prescriptive tools to help decision-makers***.

The objectives of the DDP (Phase I and II) are to:

- Support country-level, regional and global dialogues on the WCD report and the issues it addresses with the aim of engaging all stakeholders with emphasis on those not currently involved;
- Strengthen interaction and networking among participants in the dams debate;
- Support the widespread dissemination of the WCD report and the report of the Third WCD Forum and make available other stakeholders' responses; and
- Facilitate the flow of information and advice concerning initiatives relevant to dams and development.
- Further strengthen interaction and networking among participants in the dams debate.
- Further disseminate information on activities, processes and outcomes of national, regional and global dialogues on dams and development.
- Further disseminate, tailored to a country and regional basis, the WCD report and the report of the Third WCD Forum, and make available other stakeholders' responses.
- Further facilitate the flow of information and advice concerning initiatives relevant to dams and development in partnership with other appropriate organisations.

1.2. Purpose

The purpose of this document is to provide background materials and a preliminary analysis of key issues to feed into the Multi-Stakeholder Platform (MSP) debate in Ghana. The document contributes to the two main elements and the three supporting elements of the DDP work programme for phase II. The document is required due to the imminent plans for major dam projects in Ghana.

It has now been realised that dam planning and management should involve a wider circle than

experts only to realise democratic and integrated management, 'dialogue' and 'partnership' approaches are seriously on the rise. Inter-sectoral partnerships have seen a steady increase in the course of the past decade in Ghana.

Multi-Stakeholder Platforms for dam and water management take the partnership and participation ideas one step further by including a diversity of interests. MSPs are not just about bringing management to the grassroots level, they are also about broadening the basis of representation. This document presents a strategy on how MSPs can add in terms of content, context and process in making decisions on dams.

In the past, national dialogue on dams was limited by the availability of information, which limited participation just to "experts". By making the basic information on the issues surrounding dams available, this document supports the national dialogue and supports the implementation of multi-stakeholder processes in Ghana. This document also raised awareness on the call for and wide concurrence on how to improve national regulatory frameworks so as to successfully take into account socio-cultural and ecological aspects and integrate appropriate participatory approaches in decision-making at all levels.

1.3. Scope and Terms of Reference

1.3.1. The Scope of the work

This document attempts to cover all the major issues for Ghana as given in the Mission and Vision of the Dams and Development Project.

1.3.2. Specific Terms of Reference

The Specific Terms of Reference as given on the 23rd of November 2006 were as follows:

> The Consultant will undertake the following tasks and deliver a first draft of the report for discussion not later than 8th December 2006. Comments and suggestions will then be incorporated and the final report should be available not later than the 31 of December 2006.
>
> The report will address the following aspects:
>
> Inventory of existing and future dams: A detailed facts sheet will be prepared for the major 10 dams in Ghana. The format of the fact sheet will address besides location and technical specifications also issues and challenges concerning the dam.
>
> Analysis of stakeholders and their potential roles: based on available information, a comprehensive analysis of stakeholders in the "dams and development discussion" in Ghana. This information will be utilised to identify both, the crucial and the comprehensive list of potential stakeholder groups in the process and their respective roles.
>
> Review of dam impacts using examples of the identified dams. This chapter will review both the positive and negative impacts of dam development projects in Ghana, substantiated with case studies and facts and figures. Effects on communities, water bodies (environmental flows, hydrology) and aquatic/biological stakeholders will be discussed drawing also from other cases elsewhere in the world
>
> Review of corrective measures (e.g. by VRA) to mitigate negative impacts: these may be for existing or future dams. In the case of existing dams a critical review of suggested measures, whether they were implemented and how successful these were will be presented. In the case of dams in the pipeline, the possible corrective measures will be discussed.
>
> The laws, regulations and the decision-process for planning and implementing dam projects in Ghana will be presented and the strengths and weaknesses highlighted. This section will also discuss the institutional and legal framework within which the process operates. The current Bui dam EIA could be used as one example.

On the basis of the above analysis, conclusions should highlight elements and recommendations to be used in a national strategic plan on dam planning and operating and the need for a multi-stakeholder discussion.

All reference materials quoted will be listed.

The consultant will present the findings at the first multi-stakeholder National Consultative Committee which will be the forerunner to the Dams and Development Forum for Ghana.

In the discussions before initiation of work, it was agreed that additional deliverables and/or additions to the Terms of Reference would be made by the Consultant. The main addition is providing a compilation CD-ROM with most of the key reference materials used in the study.

1.4. Approach to the Preparation of the Document

The basic approach to the preparation of the document consisted of three ***main phases***, encompassing ***four methodological components.*** The main phases were (i) Desk Phase setting out main issues (ii) Field Phase and (iii) Final Report-Writing Phase.

The methodological components were (i) Structuring of the document, (ii) Data Collection, including interviews, (iii) Compilation and Analysis of Data and (iv) Judgments leading to conclusions and recommendations.

Field work was mainly carried out in December 2006 regarding water supply and irrigation dams where visits to various dam sites around Accra, were made by two assistants to gather information for the report. In general, the operations manager or supervisor for each of the sites was consulted for information, in the case of the Ghana Irrigation development Authority and the Ghana Water Company Limited additional information was collected from their respective Head Offices.

The field assistants managed to contact about 10 key informants who provided some of the information used to fill the sheets used for the dam inventory and answers to questions in relation to people displaced by the dam. A structured interview approach rather than a questionnaire was used on the visits. This approach was based on the time available, and the very busy schedules of the staff contacted. Telephone contact was made with staff of the Volta River Authority, the Ministry of Energy and the Energy Commission.

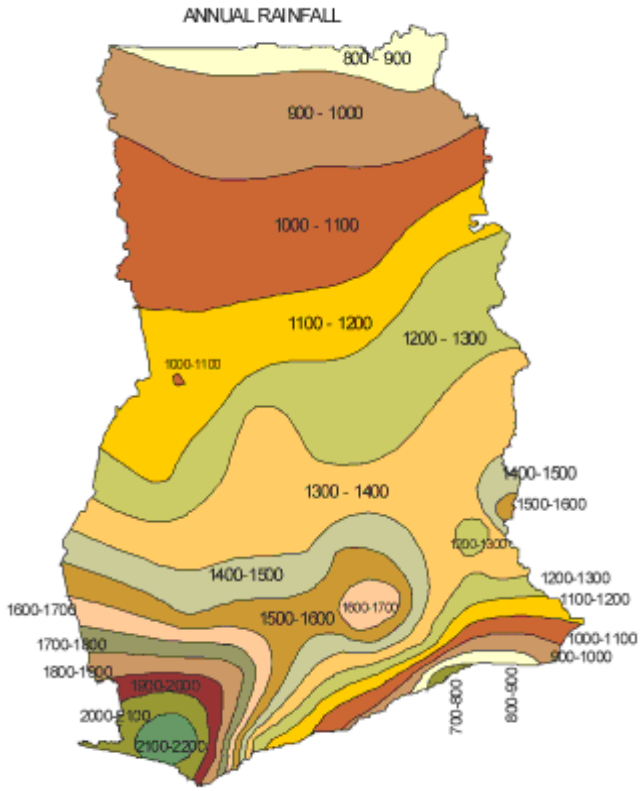
1.5. Overview of Climate and the Surface Water resources of Ghana

Ghana has a warm, humid climate with an annual mean temperature between 26°C and 29°C. Variations in the principal elements of temperature, rainfall, and humidity that govern the climate are influenced by the movement and interaction of two air masses, the dry tropical continental air mass, which blows from the northeast across the Sahara, and an opposing tropical maritime or moist equatorial system.

During the northern 'summer', the warm and moist maritime air mass intensifies and pushes northward across the country (South West Monsoon). A low-pressure belt, or inter-tropical front, in the air mass brings warm air, rain, and prevailing winds from the southwest. As the sun returns south across the equator, the dry, dusty, tropical continental air mass, or harmattan, prevails. The most active weather systems are at the Inter Tropical Convergence Zone (ITCZ).

Climatic conditions across the country are not uniform. The Kwahu Plateau, which marks the northernmost extent of the forest area, also serves as an important climatic divide. To its north, two distinct seasons occur. The harmattan season with its dry, hot days and relatively cool nights from November to late March or April, is followed by a wet period that reaches its peak in late August or September. To the south and southwest of the Kwahu Plateau, where the annual mean rainfall from north to south ranges from 1,250 mm to 2,150 mm, four separate seasons occur. Heavy rains fall from about April through late June. After a relatively short dry period in August, another rainy season begins in September and lasts through November, before the longer harmattan season sets in to

complete the cycle.



The extent of rainfall varies across the country, to the south of the Kwahu Plateau, the heaviest rains occur in the Axim area in the southwest corner of Ghana. Farther to the north, Kumasi receives an average annual rainfall of about 1,400 mm, while Tamale in the drier northern savanna receives rainfall of 1,100 mm per year. From Takoradi eastward to the Accra Plains, including the lower Volta region, rainfall averages only 750 mm to 1,000 mm a year.

In the wetter south and southwest areas of Ghana, the river and stream pattern is denser, but in the area north of the Kwahu Plateau, the pattern is much more open. The run-off from the various basins generally follow rainfall trends Several streams and rivers also dry up or experience reduced flow during the dry seasons of the year, while flooding during the rainy seasons is common.. A majority of the smaller order streams are temporary and ephemeral flowing only in the rainy season.

Ghana is drained by a large number of streams and rivers. The major drainage divide runs from the southwest part of the Akwapim-Togo Ranges northwest through the Kwahu Plateau and then irregularly westward to the Côte d'Ivoire border. Almost all the rivers and streams north of this divide form part of the Volta system. Extending about 1,600 kilometres in length and draining an area of about 388,000 square kilometres, of which about 158,000 square kilometres lie within Ghana, the Volta and its tributaries, such as the Afram River and the Oti River, drain more than two thirds of the country.

To the south of the divide are several smaller, independent rivers. The most important of these are the White Volta, the Black Volta, the Main or Lower Volta, the Oti, the Pra, the Tano, the Ankobra, the Bia, Todzie-Aka and the coastal basins between the Pra and the Lower Volta.

In addition to the river network, there are over 100 lagoons with water areas ranging in size from the 250 km^2 Keta lagoon complex to 0.010 km^2 bodies. The total lagoon water area is 36,596 ha which represents 0.15% of the total land area of Ghana. The largest lotic body is the man-made Lake Volta (8,400 km^2), and the land locked Lake Bosumtwi, 50 km^2 in surface area which is southeast of Kumasi.

There are 17 water bodies which can be classified as large dams in Ghana. These are made up of two multipurpose (power) supply dams, nine irrigation dams and six water supply dams. The total volume of all these dams is about 165.5 km^3, of which 165 km^3 is held by the Volta lake.

Ghana's total actual renewable water resources are estimated to be 53.2 km^3/yr, of which 30.3 km^3/yr are internally produced. Internally produced surface water amounts to 29 km^3/yr, while groundwater is estimated at 26.3 km^3/yr. The overlap between surface water and groundwater is estimated at 25 km^3/yr. About 22.9 km^3 of surface water enter the country annually, of which 8.7 km^3 come from Burkina Faso, 6.2 km^3 from Côte d'Ivoire and 8 km^3 from Togo.

Table 1.1. Major River Systems and Hydrological Zones - Ghana
(Sources: Govt. of Ghana, 1966; Welcomme, 1972; Nerguaye-Tetteh et al., 1984)

Major River Systems			Flow Range (Annual mean) $m^3/S \times 10^3$
Name	Length km	Catchment km^2	
Volta and tributaries		165 700	0.1–1.41
Bia	200	6 470	0.13
Tano	625	1 490	0.03–0.78
Ankobra		8 460	0.11
Pra	445	23 200	0.03–0.92 (0.24)
Ochi (Amissa & Nakwa)		2 870	0.05
Ayensu		1 700	0.001–0.06
Densu		2 550	
Subri-Amansuri		840	
Butre		460	
Kakum-Saruwi		980	
Todzie		1 860	0.06
Aka (Keta Lagoon)		1 720	
Minor Coastal Streams		6 150	

1.6. Overview of the Energy Sector in Ghana

While urban rates of electrification in Ghana, at 78 percent, are relatively high compared to the overall rate for the rest of sub-Saharan Africa (23 percent) see Table 2, rural access (24 percent) remains comparatively limited. The vast majority of Ghana's rural population depends on inefficient and relatively low luminosity fuels, such as kerosene, for lighting. In addition, only a very small proportion of the population has access to modern fuels for thermal energy: in urban areas, although LPG has made inroads, charcoal is the most widespread cooking fuel. In rural areas, unprocessed biomass dominates. Recent droughts in Ghana have caused significant power shortages that underscored the need for additional power sources. Currently, electricity is mainly produced from hydro sources. Households are now consuming and increasing amount of all electricity generated in the country.

Applying the Millennium Development Goal targets to Ghana requires the country to increase electrification rates to 82 percent in urban areas, and 28 percent in rural areas reaching an additional 0.6 million households in total between 2005 and 2015. On the cooking side, the proportion of the population with access to cleaner cooking methods will increase by 2 million households. Increased demand for electricity from households, educational and healthcare facilities, and industry will require a 45 percent increase in annual power supply.

Ghana's Resource Centre for Energy Economics and Regulation (RCEER) now estimates that thermal facilities will account for 50% of the country's generation mix by 2010. Given that Ghana is currently forced to import power and demand for electricity is rising at around 6% a year, it seems that there will be a market for all the power projects currently under development or on the drawing board. The government has plans to provide electricity to the entire country by 2020, but the pace of the electrification programme will have to be greatly stepped up if this is to be achieved. However, the emergence of the West African Power Pool (WAPP) should ensure that the VRA and other investors can develop any economically viable hydro schemes in the knowledge that excess generating capacity can be exported.

Table 1.2. Percentages of house hold that use grid electricity and stand alone Solar systems for lighting in Ghana, rural and urban

Year	**2000**[1]		**2003**[22]	
Locality	Grid.	Solar	Grid	Solar
	43.6	0.1	48.9	0.1
Rural	16.1	0.1	23.8	0.1
Urban	74.6	0.1	78.7	0.1

Table 1.3. Existing and Proposed Generation Stations in Ghana

	MW
Existing	
Takoradi-1 (thermal)	330.0
Takoradi-2 (thermal)	220.0
Akosombo (hydropower)	1020.0
Kpong (hydropower)	160.0
Proposed	
Takoradi-3 (combined cycle)	330.0
Tema (combined cycle)	1980.0
Bui (hydropower)	400.0
Juale (hydropower)	87.0
Pwalugu (hydropower)	48.0
Hemang (hydropower)	93.0

Table 1.4. Energy Supply 2005 in Ghana

Energy Supply 2005	
Domestic Energy Supply	
Electricity Generation	6787.91 GWh
Hydro generation	87.5 %
Thermal generation	12.5 %
Energy Imports	
Electricity	814.62 GWh
Crude oil and Petroleum Products	2.2 million tonnes
Import dependency for Commercial Energy Supply	83 %
Import dependency for Electricity Supply	10.8%

Table 1.4. Energy Consumption 2005 in Ghana

Energy Consumption 2005	
Total Energy Consumption	6.03 MTOE
Electricity	8.0 %
Petroleum Products	32.4 %
Wood fuel	59.6 %
Commercial Energy Consumption	2.44 MTOE
Electricity	19.6 %
Petroleum Products	80.4 %
Commercial Energy Cons/capita	113 kgOE
Electricity consumption/capita	274 kWh

[1] Ghana Population Data Analysis Report, Volume 2: Policy Implications of Population Trends, GSS (2005)

[2] Ghana 2003 Core Welfare Indicators Questionnaire (CWIQ II) Survey Report, GSS (2006

1.7. Overview of the Irrigation Sector in Ghana

This section is based on a document authored by B. S. Owusu and L. Kuwornu of the Ghana Irrigation Development Authority Accra and Adjei Lomo Department of Fisheries Accra. It is available from the FAO Corporate Document Repository. [3] Poor rainfall distribution and its erratic nature make the achievement of all-year cropping difficult. Supplementary irrigation therefore reduces the risks of crop failure. Furthermore, irrigation in the dry months between October and April allows all-year round cropping and increases productivity.

Ghana has a potential area of 500 000 ha for irrigation. Only 2 per cent of this potential or 10 000 ha has been developed so far. Types of irrigation practised are the gravity flow and the sprinkler systems. Gravity flow accounts for 80 per cent of all types of irrigation. Rice has been the principal crop grown on almost all existing government-financed irrigation schemes. Unfortunately the cropping of irrigated rice under the prevailing micro-economic climate has proved to be non-competitive. It is clear that the only economic option left for the promotion of rice production is to crop this cereal on the flood plains, using simple engineering methods for effective water control, through the construction of structures such as bunds.

It has also been proven that the cropping of high value exportable vegetables, fruits, banana and cut flowers presents economic advantages on irrigation schemes compared to rice. In addition to the low investment in irrigation, the drought of 1983 brought to the fore the need for the continuation, and where possible, the acceleration of irrigation development. At the same time, positive attempts will be made to meet the challenges posed by the efficient management of existing and new irrigation schemes. It is projected that the current total area of irrigation facilities will be increased from about 10 000 ha to 100 000 ha by the year 2020.

Since the 1960s, attempts by Government to introduce and promote irrigation through the settlement of a number of small-scale farmers on irrigation facilities constructed with public funds have been limited by the following constraints:
- high capital investment required for putting up any form of irrigation infrastructure;
- socio-cultural factors militating against the efficient management of existing government-funded irrigation schemes.

Strategies have been laid down for irrigation development in the future, as follows:

- For existing irrigation schemes, funds are being sought for their rehabilitation to attract private sector management. Such privatization of the management of existing Government/IDA irrigation schemes will be ensured through leasing to nucleus-outgrower farmers, groups of small-scale farmers and cooperative societies, ensuring a smooth take-over of the operation and maintenance of the facilities.
- On new projects, preferably grants are being sought to update available feasibility reports. Planning and development of future irrigation projects will include a canalization system for irrigation, the development of shallow aquifers wherever possible, water harvesting for dry season gardening, and the use of ponds, contour ridges or small narrow terraces for improved moisture retention.

[3] Moehl, J.F.; Beernaerts, I.; Coche, A.G.; Halwart, M; Sagua, V.O. Proposal for an African network on integrated irrigation and aquaculture. Proceedings of a Workshop held in Accra, Ghana, 20-21 September 1999. Rome, FAO. 2001. 75p.

2. Inventory of dams in Ghana

2.1. Background to the Inventory

Compiling the attributes of existing dams in Ghana is not a straight forward task. This is due to the fact that the information is scattered, outdated and in some cases of doubtful reliability. The Volta River Authority has the best and most complete set of records, though it can be argued that they have only two (albeit large dams to manage). The other two primary institutions with responsibility for operation of dams are the Ghana Water Company and the Ghana Irrigation Development Authority. The purposes to which they put their dams are very different, as such the way that information is recorded (in some cases still in acre-feet) and the types of information that have been captured in their monitoring systems is very different. In the tables that follow N/A stands for Not Available, in some cases figures are available but they are so out of date or in error that it was decided not to present them here. As far as possible the information presented here has been based on the most recent information; however it should be noted that primary data collect was not carried out and the accuracy of the information presented here is as good as the data sources that were taken from. The precise geo-reference for the dams was usually missing from documentation, or suspect. The dams were located with Google Earth and map coordinates derived from this source. The centre of the dam was used as the reference point.

The main sources of information for the inventory were Environmental, Resettlement and Dam Safety Studies for Ghana WSRP. 2004a Ghana Water Sector Restructuring Project Dam Safety Assessment. Draft final Report. Royal Haskoning. Netherlands and an undated excerpt of a report produced by FAPIM: The Project for Promotion of Farmers' Participation in Irrigation Management Inventory of Irrigation and Drainage Facilities. The comments in the inventory tables are from these two reports, WSRP for water supply dams and FAPIM for irrigation dams.

The power generation schemes considered for initial assessment covered:

Akosombo Dam
Kpong Dam

The water supply schemes considered for initial assessment covered:

Axim Dam
Barikese Dam
Brimsu Dam
Inchaban Dam
Owabi Dam
Weija Dam
Kwanyaku Dam

The irrigation schemes considered for initial assessment covered:

Ashaiman Irrigation Scheme
Kpong Irrigation Project (KIP)
Afife Irrigation Scheme
Kpando-Torkor Irrigation Scheme
Okyereko Irrigation Scheme
Dedeso Irrigation Scheme
Akumadan Irrigation Scheme
Sata Irrigation Scheme
Tanoso Irrigation Scheme
Golinga Irrigation Scheme
Tono Irrigation Project
Dawhenya Irrigation Scheme
Weija Irrigation Scheme
Aveyime Irrigation Scheme
Mankessim Irrigation Scheme
Amate Irrigation Scheme
Kikam Irrigation Scheme
Anum Valley Irrigation Scheme
Subinja Irrigation Scheme
Bontanga Irrigation Project
Libga Irrigation Scheme
Vea Irrigation Project

All the irrigation schemes were associated with different dam structures. Several of the irrigation schemes had been upgraded and enlarged over the years.

The terms of reference specified and inventory of existing and future dams and a detailed facts sheet will be prepared for the major 10 dams in Ghana. Due to the opportunities that this data gathering exercise gave and the general difficulty in getting access to information in one document, it was

decided that information for the16 dams are presented rather than for 10 as requested. The ICOLD classification scheme was used to select dams which by their size of reservoir or by dam height would qualify as large or medium dams[4]. The ICOLD database was consulted as a cross check to establish the fact that no major dam in Ghana had been ignored.

In the tables that follow, "volume" refers to the **planned** total reservoir storage for normal operation. Live storage data and the ratio of live storage to mean annual runoff at the dam site were not available for most of the dam structures.

The figures given for irrigated area refer to the current values of area under active irrigation. In several cases, the irrigated area is very small as compared with the size of the dam. The reason for this is in the breakdown/lack of irrigation infrastructure and the high cost of inputs which make irrigation farming expensive and unable to compete with subsidized imports.

Table 2.1. Major, Large and Medium Dams in Ghana

Hydro-development Project	Main Purpose	Dam Height* (m)	Storage Volume 10^6 m^3
Major			
Akosombo	Power	114	165,000.0
Large			
Golinga	Irrigation	26	12.3
Kpong	Power	19	190.0
Tono	Irrigation	19	92.6
Barikese	Water supply	19	35.3
Kplikpa	Irrigation	19	31.5
Okyereko	Irrigation	19	3.0
Weija	Water supply	17	19.5
Kwanyaku	Water supply	16	1.4
Dawhenya	Irrigation	15	5.8
Medium			
Inchaban	Water supply	12	1.7
Ashaiman	Irrigation	12	5.6
Vea	Irrigation	12	17.0
Bontanga	Irrigation	12	25.0
Brimsu	Water supply	10	2.3
Mankessim	Irrigation	10	5.7

* to the nearest metre

[4] Definition of large dams

The International Commission on Large Dams (ICOLD) defines a large dam as one with a 'wall equal to or higher than 15 metres from base to crest'. Clearly however, 15 m high embankments in small narrow valleys create relatively small impoundments with possibly small environmental consequences. ICOLD also categorizes major dams as those with 150m high dam walls or with a water storage capacity equal to or greater than 25km^3.

Source: http://www.dams.org/kbase/submissions/showsub.php?rec=ENV203

2.2. Hydropower dams

The two hydropower dams provide much of the material for discussion in this document; as such the basic information on these dams is presented here.

General Information			
Name of Dam:	Akosombo	Year of Construction	
Major Town:	Akosombo	Name of River:	Volta
Latitude:	6^{o} 17' 58.28" N	Longitude:	0^{o} 03' 35.57" E
Name of Region:	Eastern	Catchment Area (km^{2})	
Main Purpose	Hydropower	Secondary Purposes	Fisheries, Navigation
Operator of Dam	VRA	No of People Resettled	80,000
Dam/Reservoir Details			
Dam Type:	Rock fill	Dam (Length (m):	
Dam/Crest Height (m):	114	Water Height (m):	79
Reservoir Area (km^{2}):	8480	Volume (km^{3}):	165
Other Information			
Power Generation:	1020 MW	Irrigated Area (ha):	
Fish production:	> 40,000 Metric t/year	Misc.	

General Information			
Name of Dam:	Kpong Head Works	Year of Construction	1981
Major Town:	Akuse	Name of River:	Volta
Latitude:	6^{o} 07' 17.77" N	Longitude:	0^{o} 07' 34.39" E
Name of Region:	Eastern	Catchment Area (km^{2})	(run of river)
Main Purpose	Hydropower	Secondary Purposes	Irrigation
Operator of Dam	VRA	No of People Resettled	2,000
Dam/Reservoir Details			
Dam Type:	Concrete	Dam (Length (m):	
Dam/Crest Height (m):	19	Water Height (m):	14.7
Reservoir Area (km^{2}):	12	Volume (10 ^{6} m^{3}):	190
Other Information			
Power Generation:	160MW	Irrigated Area (ha):	

2.3. Irrigation dams

General Information			
Name of Dam:	Ashiaman	Year of Construction	1965 - 1968
Major Town:	Ashiaman	Name of River:	Dzorwulu
Latitude:	5^{o} 42' 04.15" N	Longitude:	0^{o} 03' 19.12" E
Name of Region:	Greater Accra	Catchment Area (km^{2})	82
Main Purpose	Irrigation	Secondary Purposes	Livestock
Operator of Dam	GIDA - MOFA	No of People Resettled	N/A
Dam/Reservoir Details			
Dam Type:	Earth fill	Dam (Length (m):	700
Dam/Crest Height (m):	11.9	Water Height (m):	10
Reservoir Area (km^{2}):	1.75	Volume (10 ^{6} m^{3}):	5.6
Other Information			
Irrigated Area (ha):	56		
Comments:	The main drain is bushy and needs weeding and desilting. The earthen right bank canal needs rehabilitation. The siphon on the right bank is partially silted, leaking and needs maintenance.		

General Information			
Name of Dam:	Dawhenya	Year of Construction	1975 - 1978
Major Town:	Dawhenya	Name of River:	Dechidaw
Latitude:	5^o 46' 30.24" N	Longitude:	0^o 03' 40.98" E
Name of Region:	Greater Accra	Catchment Area (km^2)	500
Main Purpose	Irrigation	Secondary Purposes	Livestock
Operator of Dam	GIDA - MOFA	No of People Resettled	N/A
Dam/Reservoir Details			
Dam Type:	Earth fill	Dam (Length (m):	915
Dam/Crest Height (m):	14.8	Water Height (m):	11.7
Reservoir Area (km^2):	2.5	Volume (10^6 m^3):	5.8
Other Information			
Irrigated Area (ha):	200		
Comments:	The project is not functioning due lack of power supply and the breakdown of all the pumps. The gates, canal turnouts laterals are all in goods condition and can facilitate any measurement. Used and excess irrigation water drain easily into the main reservoir (i.e. most of the project water is recycled).		

General Information			
Name of Dam:	Kplikpa	Year of Construction	1965 refurbished 1982
Major Town:	Afife	Name of River:	Ageli & Kplikpa
Latitude:	6^o 08' 33.48" N	Longitude:	0^o 58' 27.66" E
Name of Region:	Volta	Catchment Area (km^2)	334
Main Purpose	Irrigation	Secondary Purposes	Livestock
Operator of Dam	GIDA - MOFA	No of People Resettled	N/A
Dam/Reservoir Details			
Dam Type:	Earth fill	Dam (Length (m):	1586
Dam/Crest Height (m):	18.5	Water Height (m):	15.5
Reservoir Area (km^2):	2.73	Volume (10^6 m^3):	31.4
Other Information			
Irrigated Area (ha):	880		
Comments:	The flow of water in the main drain is a problem due to flow-back causing water logging. The main road, farm roads and top of embankment are in deplorable conditions as a result of the extensive development of potholes. There is undue growth of aquatic plants on the project.		

General Information			
Name of Dam:	Mankessim	Year of Construction	1974 - 1978
Major Town:	Barfikrom	Name of River:	Apprapong
Latitude:	5^o 18' 52.08" N	Longitude:	1^o 01' 45.08" W
Name of Region:	Central	Catchment Area (km^2)	-
Main Purpose	Irrigation	Secondary Purposes	Livestock
Operator of Dam	GIDA - MOFA	No of People Resettled	N/A
Dam/Reservoir Details			
Dam Type:	Earth fill	Dam (Length (m):	195
Dam/Crest Height (m):	10.4	Water Height (m):	-
Reservoir Area (km^2):	1.92	Volume (10^6 m^3):	5.67
Other Information			
Irrigated Area (ha):	17		
Comments:	The project faces the problem of water logging during the wet season. One pumping machine which should have served as a standby is completely broken down. The project lacks sufficient pipe systems, i.e. sprinklers, mainline, laterals, hydrants, risers, nozzles and end caps. The project lacks spare parts. There is lack of storage facility for the produce of farmers and for farm inputs and equipments.		

General Information			
Name of Dam:	Okyereko	Year of Construction	1973 - 1982
Major Town:	Okyereko	Name of River:	Ayensu
Latitude:	5^{o} 24' 58.52" N	Longitude:	0^{o} 35' 48.27" W
Name of Region:	Central	Catchment Area (km^2)	1,685
Main Purpose	Irrigation	Secondary Purposes	Livestock
Operator of Dam	GIDA - MOFA	No of People Resettled	N/A
Dam/Reservoir Details			
Dam Type:	Earth fill	Dam (Length (m):	612
Dam/Crest Height (m):	18.6	Water Height (m):	16.6
Reservoir Area (km^2):	0.9	Volume (10^6 m^3):	2.96
Other Information			
Irrigated Area (ha):	42		
Comments:	There is frequent siltation of the headrace due to materials being deposited into it during the rainy season when the area becomes flooded. Some fields cannot be irrigated because they are higher than the canals.		

General Information			
Name of Dam:	Bontanga	Year of Construction	1978 - 1983
Major Town:	Tamale	Name of River:	Bontanga (White Volta)
Latitude:	9^{o} 34' 15.75" N	Longitude:	1^{o} 01' 21.13" W
Name of Region:	Northern	Catchment Area (km^2)	165
Main Purpose	Irrigation	Secondary Purposes	Livestock
Operator of Dam	GIDA - MOFA	No of People Resettled	N/A
Dam/Reservoir Details			
Dam Type:	Composite/earth	Dam (Length (m):	1900
Dam/Crest Height (m):	12	Water Height (m):	9
Reservoir Area (km^2):	-	Volume (10^6 m^3):	25
Other Information			
Irrigated Area (ha):	370		
Comments:	The drain structures are silted to a considerable extent. The project has neither storage nor processing facilities for the farm produce which was to be tomatoes. The need for rapid processing before spoilage makes this lack a major impediment.		

General Information			
Name of Dam:	Golinga	Year of Construction	1971 - 1974
Major Town:	Golinga	Name of River:	Kornin
Latitude:	9^{o} 34' 15.75" N	Longitude:	1^{o} 01' 21.13" W
Name of Region:	Northern	Catchment Area (km^2)	16,500
Main Purpose	Irrigation	Secondary Purposes	Livestock
Operator of Dam	GIDA - MOFA	No of People Resettled	N/A
Dam/Reservoir Details			
Dam Type:	Earthfill	Dam (Length (m):	560
Dam/Crest Height (m):	25.63	Water Height (m):	
Reservoir Area (km^2):		Volume (10^6 m^3):	12.3
Other Information			
Irrigated Area (ha):	16		
Comments:	None		

General Information			
Name of Dam:	Tono	Year of Construction	1975 - 1985
Major Town:	Navrongo	Name of River:	Tono
Latitude:	10^{o} 52' 11.67" N	Longitude:	1^{o} 08' 00.00" W
Name of Region:	Upper East	Catchment Area (km^2)	650
Main Purpose	Irrigation	Secondary Purposes	Domestic Water
Operator of Dam	ICOUR	No of People Resettled	N/A
Dam/Reservoir Details			
Dam Type:	Composite	Dam (Length (m):	3471
Dam/Crest Height (m):	18.6	Water Height (m):	
Reservoir Area (km^2):	18.6	Volume (10^6 m^3):	92.6
Other Information			
None			
Comments:	State of Facilities: Good because of regular maintenance. Farmers cannot control water effectively. 50ha is flood prone. Farmers crop around drains leading to siltation. Main drain becomes inadequate when dam is spilling.		

General Information			
Name of Dam:	Vea	Year of Construction	1965 -1980
Major Town:	Bolgatanga	Name of River:	Yarigatanga
Latitude:	10^{o} 59' 59.12" N	Longitude:	0^{o} 51' 04.27" W
Name of Region:	Upper East	Catchment Area (km^2)	136
Main Purpose	Irrigation	Secondary Purposes	Domestic Water
Operator of Dam	ICOUR	No of People Resettled	N/A
Dam/Reservoir Details			
Dam Type:	Composite	Dam (Length (m):	1580
Dam/Crest Height (m):	11.9	Water Height (m):	
Reservoir Area (km^2):	40.5	Volume (10^6 m^3):	17
Other Information			
Irrigated Area (ha):	500		
Comments:	Farmers tamper with gates. Animals, mainly cattle, cross canals and wooden culverts breaking them in the process. Main drain silted. Farmers crop inside main drain. Flooding after heavy rainfall. There are several damaged portions along main canal, laterals and turnouts		

2.4. Water supply dams

General Information			
Name of Dam:	Weija	Year of Construction	1978 (new dam)
Major Town:	Weija	Name of River:	Densu
Latitude:	5^{o} 34' 17.04" N	Longitude:	0^{o} 20' 39.65" W
Name of Region:	AMA/ Greater Accra	Catchment Area (km^2)	2460
Main Purpose	Water Supply	Secondary Purposes	Irrigation (Fisheries)
Operator of Dam	Ghana Water Co Ltd.	No of People Resettled	N/A
Dam/Reservoir Details			
Dam Type:	Earthfill with rock	Dam (Length (m):	375
Dam/Crest Height (m):	17.07	Water Height (m):	14.33
Reservoir Area (km^2):		Volume (10^6 m^3):	116.04
Other Information			
Water Produced (m^3):		Irrigated Area (ha):	220
Comments:	Dam generally in good condition. No apparent slope movement. Some seepage d/s. Toe drain and relief well collection system needs to be restored to operation. Undergrowth at d/s toe on LH embankment needs clearing. Toe ditches need to be repaired on both side embankments. Some cracking to spillway concrete, but not major, seals to radial gates need attention.		

General Information			
Name of Dam:	Barikese	Year of Construction	1970 - 1979
Major Town:	Barikese	Name of River:	Offin
Latitude:	x° xx' xx.xx"	Longitude:	x° xx' xx.xx"
Name of Region:	Ashanti	Catchment Area (km^2)	906
Main Purpose	Water Supply	Secondary Purposes	-
Operator of Dam	Ghana Water Co Ltd.	No of People Resettled	N/A
Dam/Reservoir Details			
Dam Type:	Composite	Dam (Length (m):	603
Dam/Crest Height (m):	18.5	Water Height (m):	15.5
Reservoir Area (km^2):	6.4	Volume (10^6 m^3):	35.3
Other Information			
Water Produced (m^3):		Irrigated Area (ha):	
Fish production:		Misc.	
Comments:	Dam is generally in good condition. Embankment overgrown - especially RHS. Mechanical equipment not maintained. Although monitoring facilities have been provided, no records are kept. Original instrumentation for settlement/movement monitoring housed in building on d/s of LHS embankment - no longer working.		

General Information			
Name of Dam:	Owabi	Year of Construction	1928 raised in 1960
Major Town:	Owabi	Name of River:	Owabi
Latitude:	x° xx' xx.xx"	Longitude:	x° xx' xx.xx"
Name of Region:	Ashanti	Catchment Area (km^2)	
Main Purpose	Water Supply	Secondary Purposes	-
Operator of Dam	Ghana Water Co Ltd.	No of People Resettled	N/A
Dam/Reservoir Details			
Dam Type:		Dam (Length (m):	
Dam/Crest Height (m):		Water Height (m):	
Reservoir Area (km^2):		Volume (10^6 m^3):	
Other Information			
Water Produced (m^3):		Irrigated Area (ha):	
Fish production:		Misc.	
Comments:	Dam generally in good condition. Remedial work required to mechanical equipment to bring to operational standard. Right hand embankment extensively overgrown - needs clearance. Left hand embankment well maintained but one large tree growing u/s and several d/s. Spillway crest rising in poor condition - leakage under.		

General Information			
Name of Dam:	Kwanyaku	Year of Construction	1965
Major Town:		Name of River:	Ayensu
Latitude:	x° xx' xx.xx"	Longitude:	x° xx' xx.xx"
Name of Region:	Central	Catchment Area (km^2)	821
Main Purpose	Water Supply	Secondary Purposes	-
Operator of Dam	Ghana Water Co Ltd.	No of People Resettled	N/A
Dam/Reservoir Details			
Dam Type:	Concrete Gravity	Dam (Length (m):	152
Dam/Crest Height (m):	15.5	Water Height (m):	12.7
Reservoir Area (km^2):		Volume (10^6 m^3):	1.36
Other Information			
Water Produced (m^3):		Irrigated Area (ha):	
Comments:	Dam and intake generally in good condition. Refurbishment of penstocks and gate valves at intake tower required. Weed growth to be cleared from u/s of spillway. Scour gates to be operated to attempt to flush silt. Vegetation clearance and minor remedial work required downstream.		

General Information			
Name of Dam:	Brimsu	Year of Construction	1926 raised 1959 4m
Major Town:	Brimsu	Name of River:	Kakum
Latitude:	x^{o} xx' xx.xx"	Longitude:	x^{o} xx' xx.xx"
Name of Region:	Central	Catchment Area (km^{2})	330
Main Purpose	Water Supply	Secondary Purposes	-
Operator of Dam	Ghana Water Co Ltd.	No of People Resettled	N/A
Dam/Reservoir Details			
Dam Type:	Concrete Gravity	Dam (Length (m):	60
Dam/Crest Height (m):	10.4	Water Height (m):	9
Reservoir Area (km^{2}):		Volume (10 ^{6} m^{3}):	2.3
Other Information			
Water Produced (m^{3}):		Irrigated Area (ha):	
Fish production:		Misc.	
Comments:	Dam and spillway structure in reasonable condition for age - minor remedial work needed. Remedial work required to d/s sidewalls and apron concrete. General maintenance of mechanical equipment needed. Original intake mechanical equipment to be reinstated for emergency use. Scour valves to be operated to clear silt. Minor vegetation growth in bridge joints to be cleared.		

General Information			
Name of Dam:	Inchaban	Year of Construction	1918 raised 1955 0.7m
Major Town:	Inchaban	Name of River:	Anakwari
Latitude:	x^{o} xx' xx.xx"	Longitude:	x^{o} xx' xx.xx"
Name of Region:	Western	Catchment Area (km^{2})	65
Main Purpose	Water Supply	Secondary Purposes	-
Operator of Dam	Ghana Water Co Ltd.	No of People Resettled	N/A
Dam/Reservoir Details			
Dam Type:	Concrete Gravity	Dam (Length (m):	140
Dam/Crest Height (m):	12.35	Water Height (m):	10
Reservoir Area (km^{2}):		Volume (10 ^{6} m^{3}):	1.73
Other Information			
Water Produced (m^{3}):		Irrigated Area (ha):	
Fish production:		Misc.	
Comments:	Dam and intake generally in reasonable condition. Refurbishment of scour vertical lift & gate valves required - including lifting mechanism. Vegetation clearance and remedial work needed in d/s apron area. Cracks in access walkway and landing to be repaired. Hand railing in reasonable condition but needs repainting. Metal flooring around scour vertical lift gate operating mechanism needs replacement urgently – rusted badly with holes and dangerous. Tree growing in RH side scour vertical lift gate slot to be removed. Vegetation growing on d/s face of dam to be removed.		

2.5. Planned Future Dams

Despite the construction of the West African Gas Pipeline, Ghana's association with hydro power is set to continue through the modernisation of the Akosombo facility and the construction of new dams. In the middle of last year, the Ghanaian government published its National Strategic Energy Plan, which laid out the nation's energy strategy over the years 2005-2025. Four hydro schemes are scheduled for development during this period: Bui should be in place by 2012, Hemand and Juale by 2015, and Pwalugu by 2020. The project which is most imminent is the Bui Project as financing has been secured.

The Bui hydro project will be developed on the Black Volta River in Brong-Ahafo region. Although the venture was originally proposed during the 1970s and prospects for its development have been

revived on several occasions over the past 30 years, the government seems keen to finally see it constructed. The Ghanaian and Chinese government signed a Memorandum of Understanding on the development of the project by Chinese firm Sino Hydro in November last year. An environmental impact assessment (EIA) is currently being carried out but the two governments have yet to publish full details of project funding or the timetable for development.

The government has listed the scheme for development for many years but the resulting flooding of part of Bui national park has been opposed by environmental groups. Previous government statements have indicated that the hydro venture would be developed on a build operate transfer (BOT) basis, with 400MW of new capacity added at a cost of US$700M. Apart from improving the provision of power within Ghana, the government hopes that the facility will have surplus electricity to export to Cote d'Ivoire, Mali and Burkina Faso.

A further BOT contract has been mooted for another hydro project, on the Pra river, with generating capacity of 125MW. With average annual rainfall of 2500mm, Ghana is certainly well blessed by water resources but the number of suitable sites for dam projects is limited because of the number of people who would be affected by flooding and the extent of the likely environmental damage. However the real reason for lack of progress on the dam projects still remains the issue of funding.

The information given in the table below on the potential new sites for Hydropower was extracted from a 2004 Ministry of Energy publication Hydropower Development in Ghana: Summary Description of Potential Sites. It should be pointed out that sites and figures are very different in several documents, e.g., the Hydropower potential of Pwalugu being cited as 35, 40and 50 MW in documents stretching back to 1965.

Table 2.2. Potential new sites for Hydropower in Ghana
(Sources: Ministry of Energy, 2004)

River Basin	Catchment area (km^2)	Hydropower Potential (MW)	Annual Energy Generation (GWh)
Black Volta	**148,820**		
Koulbi		68	392
Ntereso		64	257
Lanka		95	319
Bui		400	1000
Jambito		55	180
Total		**682**	**2148**
White Volta	**105, 540**		
Pwalugu		50	184
Kulpawn		40	166
Daboya		43	194
Total		**133**	**544**
Oti	**71,949**		
Juaben		90	405
Tano River	**14,700**		
Asuaso		25	129
Sodukrom		17	67
Jomuro		20	85
Tanoso		56	259
Total		**118**	**540**
Pra River	**22,290**		
Awisam		50	205
Heman		90	336
Abaumesu		50	233
Kojokrom		30	136
Total		**220**	**910**
Total Potential		**1,243**	**4,547**

Up to 36 dams are scheduled for construction in the Northern, Upper East and Upper West regions, almost entirely for irrigation. It was revealed that some of the dams developed on a local basis had been inadequately constructed and so the government was keen to ensure that proper construction techniques were used. The government has offered to contribute US$60M to the development of the various dam projects but it has not revealed the total construction costs for the 36 schemes or their precise location.

Training courses are being offered in small scale dam construction to local communities by the Ghana Irrigation Development Authority, but it is likely that contracts will be offered to interested private sector parties on the larger projects. Very little information exists on there proposed training courses Apart from countering the effects of future droughts, it is hoped that the new reservoirs will extend the growing season, which is restricted because eight months of the year are largely dry, even during an average year.

Background information to the Bui Project

The Bui site is located on the Black Volta, approximately 150 kilometers upstream from Volta Lake, at the border between the Northern and the Brong-Ahafo Regions. The main dam will be located in the deep gorge created by the Black Volta in the Banda Hills. It will have a maximum height above the foundation of about 110 meters, and a crest length of 470 meters. The dam body will be made of roller compacted concrete. Two saddle dams of a maximum height of 37 meters will also be constructed at a distance of about 1 km from the main dam. Three turbine units are planned to be installed. The estimated generation capacity is 285 MW with an annual energy generation of 1150 GWh. As physical infrastructure in the region is poor, the project must also provide for the construction of appropriate facilities. The length of the reservoir along the Black Volta and its tributaries will reach 40 km with a surface of 440 square km. Its capacity is estimated at 12,600 million cubic meters, with an active storage of approximately 6,000 million cubic meters. The reservoir lies in part within the boundaries of a natural reserve, the Bui National Park, established in 1971. In order to mitigate its environmental impact, the project proposes detailed resettlement programmes and a plan for the protection of an area equivalent to the part of the Park flooded The construction period of the Bui project is estimated to be five years.

PROJECT FACILITY	DESCRIPTION
MAIN DAM	
Dam Type	Gravity dam made of roller compacted concrete
Location	Bui Gorge, 150 km upstream of Lake Volta
Crest Height	185 m National Level Datum (NLD); 186.1 m NLD with flashboards and parapet wall
Crest Length	470 m
Dam Height Above Ground Level (AGL)	90 m AGL
SADDLE DAM 1	
Dam Type	Rockfill
Location	Right bank of River, 500 m from main dam
Crest Height	187 NLD
Crest Length	300 m
Dam Height AGL	37 m AGL
SADDLE DAM 2	
Dam Type	Zoned earthfill
Location	North of Bui Camp along right bank of River, approximately 1 km from main dam
Crest Height	187 NLD
Crest Length	580 m
Dam Height AGL	7 m AGL
RESERVOIR	
Full Supply Level (FSL, also referred to as Maximum Operating Level or MaxOL)	183 m NLD
Reservoir Area and Dimensions at FSL	Area: 440 km² (21% of Bui National Park) Length: 40 km Average depth: 29 m
Storage Volume at FSL	Total: 12,350 million m³ Active: 6,000 million m³
Minimum Operating Level (MOL)	167.2 m
Reservoir Area at Minimum Operating Level (MinOL)	288 km²
Storage Volume at MinOL	Total: 6,600 million m³
POWERHOUSE	
Turbine Number and Type	4 Francis turbines (133 MW each)
Location	Left bank of River, 20m downstream of dam
Size of Powerhouse	90m X 19m
Maximum Generation Capability	Maximum generation capability of 400 MW
Average Net Generation	960 GW h/yr

The project has six components:

1) *Preparatory Works and Construction Facilities*: include the cost of infrastructure (road between Bamboi and Bui site and bridge across the Black Volta downstream of the dam) and project site facilities.

2) *Civil Works*: include the cost of river diversion, main dam, saddle dams and powerhouse station.

3) *Hydro-electromechanical Equipment*: include the hydro-electric equipment of the power plant (turbines, generators and transformers), and the equipment of the intakes and the spillway.

4) *Interconnection with the Transmission Grid*: include the necessary lines and entries in the existing substation as well as the cost of the "New Kumasi" 161 kV substation for transmission of the power generated to Kumasi.

5) *Engineering and Administration Costs*: include the detailed design studies, construction drawings, and construction supervision.

6) *Environmental Impact Mitigation Costs*: include reforestation, resettlement, and extension of the Bui National Park and improvement of the Bui National Park management.

3. Stakeholders in dams and development

Fink 2005 carried out an extensive stakeholder analysis for the Bui dam project and as this is the most recent study available as well as incorporating the WCD approach, his write-up on the Bui Stakeholders is used below to illustrate the stakeholder issues.

On the broader scale, the main stakeholders at the level of government are the national permit authorization agency which in this case is the Environmental Protection Agency (EPA). The ability of the EPA to engage fully in the process that lead up to the inception of a dam project is limited. This not because the Agency does not know what needs to be done, but rather due to the lack of funding to the agency and the lack of internal capacity to implement the needed activities.

The importance of stakeholder groups identified above for the dam planning process varies considerably. Some stakeholders are of central importance as they have a lot of influence or are affected severely by the effects of the project. Others in comparison play a quite marginal role. To make these differences transparent and take them into consideration in the further steps of this study, the stakeholder groups were rated into three categories, using the following definitions DFID 2002:

- "**Key stakeholders**: Those who can significantly influence or are important to the success of an activity.
- **Primary stakeholders**: Those individuals and groups who are ultimately affected by an activity, either as beneficiaries (positively impacted) or dis-beneficiaries (adversely impacted).
- **Secondary stakeholders**: All other individuals or institutions with a stake, interest or intermediary role in the activity".

Key stakeholders

Financial investor: The funding arrangements for the Bui project have not yet been finalised. As an involvement of international development banks seems unlikely, loans or grants from other sources have to be provided to the Government of Ghana and / or to the dam developer undertaking the project on a Build-Operate-Transfer scheme. At the time of Fink's writing, the China Export-Import Bank had expressed interest to fund the project. This is a government-owned bank active in export credits, guarantees and concessional loans for Chinese companies. According to a study undertaken by IRN, the China Export-Import Bank "does not appear to have any guidelines on the environment" and is involved in several dam projects worldwide. The financial investor is a key stakeholder of the Bui project as access to capital currently is the main bottleneck for implementation.

Dam developer and operator: The Ghanaian government proposes to develop Bui as a Build-Operate- Transfer scheme. The Chinese construction and hydropower company Sino Hydro has expressed interest to develop the Bui project, but is unlikely to also operate it. Dam developer and operator play a central role in the planning process and are considered key stakeholders of the Bui project.

Energy sector stakeholders: The Ministry of Energy is tasked with the overall coordination of the Bui planning process, and other energy sector organisations play a significant role in providing assessments on the project, its necessity and its alternatives. Energy sector stakeholders are therefore considered key stakeholders of the Bui project.

Regulatory authorities: Regulatory authorities play a significant role in the planning process and are therefore considered key stakeholders of the Bui project.

Primary stakeholders

Affected communities and community-level groups: The communities displaced by the dam group is particularly heterogeneous, with different interests expressed by elders and youth, farmers and fishers, people living from tourism and those currently unemployed. These internal conflicts have to be carefully considered in further planning to ensure that all interests are included in the further planning process. As the communities are the most directly affected stakeholders of the Bui project, they clearly are primary stakeholders of the Bui project.

Political representatives: The people living in the Bui area are represented politically on different levels. On the district level, they elect members of the District Assembly. Two Members of Parliament represent Tain and Bole on the national level. As elected representatives and those ultimately tasked with decision-making in a democracy, political representatives are considered primary stakeholders of the Bui project.

Traditional Authorities: The independent chieftaincy system, with representatives on the local, regional and national levels as well as paramount chiefs speaking for ethnic communities.

Regional and district institutions: Regions and districts are affected in many ways by effects of the Bui dam project, but have very limited competences and resources to respond to this. Regions and districts will be strongly affected by positive and negative effects of the Bui project and are considered primary stakeholders.

Non-Governmental Organisations: Several NGOs are already involved in the Bui planning process, mostly representing environmental and / or social interests. Protests organised by NGOs played an important role in preventing implementation of the Bui project in 2000-2002. On the other hand, they can significantly contribute to the planning process. They are therefore considered primary stakeholders of the Bui project.

Irrigation sector stakeholders: According to the Ghanaian policy of multiple comprehensive uses of resources, projects are supposed to target several objectives wherever possible. Given the irrigation potential of the Bui project and the relatively low efforts necessary to tap them, it would have to be considered a waste if only energy generation would result from project implementation. Additionally, ambitious targets were set for the irrigation sector for the coming years and Bui may be the only chance to reach them. This means that GIDA has a high stake in the Bui project. For people living in the area, irrigation is a potential to boost agricultural productivity in the future. As they have relatively little influence, irrigation stakeholders are rated as primary stakeholders.

Authorities involved in mitigation of effects: The competences of several ministries and their administrations will be involved by the environmental and social effects of the Bui project. The operation of social infrastructure such as schools or health posts provided to resettled communities will for example be their responsibility. These authorities have an important role to play in the implementation and operational stages of the project. It is important to consult mitigation institutions in planning to ensure that infrastructure provided is properly maintained throughout the operational phase of the project. Because of this important role, mitigation authorities are considered primary stakeholders of the Bui planning process. Unfortunately, mitigation authorities were not covered in the data collection undertaken for this study; no interviews were conducted with education or health facilities and no documents were obtained from them. Planning is an iterative process, and the finding that some stakeholders have been overlooked in the earlier phases of this study underlines how important it was to undertake the stakeholder analysis. For practical reasons, it was impossible for the author to schedule a second phase of data collection; therefore a gap remains in this study. The authorities involved in mitigation measures therefore are excluded from further analysis and recommendations even though they are rated as primary stakeholders. This does not imply that they are less important than any of the other key or primary stakeholders.

Secondary stakeholders

Economic interest groups: Several economic groups stand to gain from the Bui project, from formal business associations down to petty traders. They however do not have much influence on the implementation of the project, and their gain is not an important reason for undertaking the project.

Development Assistance Organisations: Donor organisations can potentially play a central role in planning and implementation of mitigation measures that might otherwise be neglected in a complex project like Bui. However, as Ghana has decided to undertake Bui as a Build-Operate-Transfer scheme under the lead of the private sector and no development assistance is involved in the dam project, the dam developer following the “polluter pays” principle should be responsible for the management of negative effects inseparable from the Bui project. To pass social and environmental mitigation costs to the public while profits are privatised would constitute a subsidization of the project.

Religious institutions: Religious institutions have some role to play in preserving cultural heritage and social cohesion.

Researchers and Experts: Researchers and Experts from Ghanaian and international research institutions can make valuable inputs towards the planning of Bui, especially by preparing and

undertaking monitoring studies and helping to draw and monitor the implementation of mitigation measures.

Media: The media play an important role in the provision of information and can significantly influence the public debate on the project.

Fink came out with an extensive list of stakeholders for the Bui project, this list is presented below as an illustration of the scope of consultation that is required in a modern dam project.

Non-Governmental Organisations
Conservation International
Volta Basin Development Foundation
Integrated Social Development Centre
Traditional Authorities Political representatives
Members of Parliament

Bui village (displaced community) level groups
Communities located around the Bui reservoir
Women
Farmers
Traders

RCC Northern Region
Tain DA
District Departments (works, agriculture, education, health, social welfare, disaster prevention, water and sanitation)
Ministry of Food and Agriculture
Ministry of Education, Ghana Education Service
of effects
Ministry of Roads and Highways
Ghanaian Business Associations
Labour unions
Traders
Possible tourism investors
Religious institutions
Media

Energy Foundation
League of Environmental Journalists
International Rivers Network
Local NGOs (CDC, PAPADEV)
Assembly Members
Batoor (displaced community) Affected communities and community-
Campo Tornu (displaced community)
Downstream communities
Youth
Fishers
RCC Brong Ahafo Regional and district institutions
Bole DA
Wenchi DA
Volta River Authority

Authorities involved in mitigation
Ministry of Health, Ghana Health Service

National Commission on Culture
Economic interest groups
Transport operators
Ghana Tourism Board
Development Assistance Organisations
Researchers

Fink makes the assertion that based on his analysis the Bui dam project is likely to fail most WCD recommendations if no changes are undertaken on the foreseen planning process. One important issue in this context is the question of financing mitigation measures and the planning process itself. This issue so far has not been sufficiently addressed. His analysis further reveals that the issue of organising an inclusive and transparent planning process is at the heart of the looming shortcomings. Reaching targets such as getting appropriate mitigation measures in place depends on the ability of and opportunity for all legitimate stakeholders to participate in decision making. Looking at the shortcomings of the way the Bui project is being pursued, it becomes evident that integrating the WCD recommendations could greatly benefit the planning process.

Since Fink presented his thesis in 2005, the Environmental and Social Impact Assessment Study of the Bui Hydroelectric Power Project carried out on behalf of the Ministry of Energy and the Bui Dam Secretariat have addressed many if not all of his concerns, including the issues of transparency participation and the relevance of the mitigation measures.

4. Positive and Negative Impacts of Dams

Dam construction is a very expensive and contentious and as such dams are not built just for "fun". In Ghana the dams have made important and significant contribution to national development, and the benefits derived from them have been considerable. The role of hydropower which has till recent times insulated Ghana from the fluctuations in the price of oil, and for many years served as a significant foreign exchange earner can not be underestimated. The role of dams in water supply is also very clear as is their role in agricultural production especially in the Northern Part of the country.

The Volta dam development scheme to produce electricity for an aluminium industry was broadened into a Volta project focused on an over all basin development objective. Production of cheap electricity was seen as creating a necessary precondition for industrialization in the country. For Ghana, without fossil fuel, construction of a large dam for purposes of developing the vast hydropower potential of the Volta was seen as the most economic means of providing adequate supply of electricity.

A comprehensive assessment of the cumulative full value of the Volta dam in terms of power generation, use and export, transport, fisheries, tourism, ecological services such as ground water recharge could not be found. However it can be said that without the Volta Dams, Ghana would be in a completely different economic position compared to the current situation.

The impacts of dams can be looked at in several ways that is:

Project time line	**Time**	**Location**	**Thematic**
Pre-construction	Immediate	Upstream	Socio-economic
Construction	Mid-term	Reservoir	Environmental
Operation	Long-term	Downstream	Physical
De-commissioning		Coastal/Estuarine	Cultural

The point to make here is that all these ways of approaching the issue of impacts of dams must be used. In this section, a generalised picture of the various impacts that have been experienced in dam projects will be presented, and then some specific examples of impacts would be used to illustrate the points. Boxes 4.1. and 4.2. presents the impacts that are experienced by the presence and operation of a dam and the impact of the Akosombo and Kpong dams on the Volta system.

Box 4.1.

Impacts due to existence of dam and reservoir	**Impacts due to pattern of dam operation:**
Imposition of a reservoir in place of a river valley (loss of habitat)	Changes in downstream hydrology; a) change in total flows; b) change in seasonal flows c) short-term fluctuations in flows d) change in extreme high and low flows.
Changes in downstream morphology of riverbed, delta, coastline due to altered sediment load (increased erosion)	Changes in downstream morphology caused by altered flow pattern.
Changes in downstream water quality: effects on river temperature, nutrient load, turbidity, dissolved gases, concentration of heavy metals and minerals.	Changes in downstream water quality caused by altered flow pattern.
Reduction of biodiversity due to blocking of movement of organisms (e.g. salmon) & because of above changes.	Reduction in riverine/riparian/floodplain habitat diversity, especially because of elimination of floods.

Source: McCully (1996) From the HORIZON Solutions Site, www.solutions-site.org

The lack of comprehensive baseline information makes it very difficult to assess what the impact of a dam has been on an area, it is relatively easy to count people and houses than it is to assess fish communities and identify rare species of plants. For a project the size of Akosombo, several years of pre-impoundment studies should have been carried out. At circumstances were, researchers were literally running ahead of the rising waters to collect data. This was especially true of the archaeological studies carried out by the Volta Basin Research Project during the filling of the lake.

Ecology

Pre-impoundment studies were carried out in the Volta Basin before closure of the Akosombo dam in 1964. Similar studies on the Volta Lake in the post-impoundment era indicated that as at 1969, only

about 1% of the lake area had been covered by aquatic weeds and the situation has not changed much since then. The virtually weed-free situation observed on the Volta Lake has been entirely different on the Kpong Headpond and in the Lower Volta River.

In spite of the application of mechanical and manual control, about 35% of the headpond is still infested with aquatic weeds. Areas cleared are re-infested at a fast rate (6-8 weeks after clearing).

The proliferation of weeds on the headpond has been facilitated by a number of factors including:

- The presence of seeding material in the ponds and creeks originally in the area earmarked for inundation in the form of seeds, shoots, offsets, turions, rhizomes etc.
- The shallowness of the headpond (max. depth 18m) allowing for sunlight penetration and good aeration which promote plant growth.
- import of nutrients from the sewage system at nearby Akosombo, cattle dung on the East Bank, fertilizer import from nearby rice farms and also nutrients from the inundated area itself (1/6th of this area was under intensive commercial agriculture) and
- The presence of a relatively large number of sheltered coves and physical barriers which provided undisturbed conditions required for weed growth and development.

Box 4.2. Impacts of the Akosombo and Kpong Dams on Ecosystems and Aquatic Biodiversity

Upstream

- Change from lotic to lentic conditions – Temperature, Sedimentation, Water Quality
- Loss of Habitat (e.g., Gallery Forests)
- Loss of many of the riverine fish species
- Loss of lentic benthic fauna
- Invasion of aquatic weeds
- Replacement of *Oncocerca* with *Schistosoma*
- Increase in fish production

Downstream

- Loss of flood plain – displacement of people
- Change in Soil Characteristics
- Changes in water quality leading to habitat changes and hence to species range e.g., clams, river prawns
- Growth of aquatic weeds
- *Schistosoma*
- Loss of flood plain fisheries - more stress on lake and sea
- Social Impacts linked to Biodiversity Changes
  - Loss of role models
  - Loss of Cultural Identity
  - Emigration (more stress on new areas – taboos/tradition)

Estuarine and Marine

- Loss of Habitat
- Change in Hydrology
- Change in channel morphology
- Loss of species
- Impact on marine fisheries (anadromous fish)
- Loss of mangroves

Source: Gordon and Amatekpor 1999

This weed development at the Head pond has interrupted/impeded some economic activities in the area. For example, there have been instances where some power generating units have had to be shut down in order to remove weeds that have drifted into them. The infestations are extensive and dense with a square metre of harvested weeds weighing as much as 160kg. It has been observed that among others, the following factors have contributed to this development.

- The regulated water flow from the 2 dams to the estuary has caused a reduction in the volume of water flowing downstream making the river shallow and sluggish and hence suitable for weed growth.
- The retention of water in the 2 reservoirs results in desliting which makes the water discharged downstream very transparent which has encouraged weed growth.

The construction of the two dams on the Volta River, at Akosombo has created ecological changes in the Volta Basin. In the riverine portion of the Volta between Amedeka and Azizanya at the estuary,

these ecological changes are manifested in such noticeable features as the proliferation of aquatic weeds and snail vectors of Schistosomiasis, and the creation of a sand-bar at Azizanya. The ecological changes have affected the riparian communities adversely as follows:

- Reduction in fishery and fishing grounds
- Reduction in crop farming on the flood plains due to cessation of natural irrigation and supply of alluvial soil that used to be brought in during the annual floods of the pre-impoundment era
- Proferation of aquatic weeds and shall vectors of Schistosomiasis in the bed of the Volta river and
- Increased prevalence of Schistosomiasis especially the intestinal type which was originally not in the area.
- The reduction in tidal sea-water influx, which used to flush the freshwater system up to about 30km upstream, has increased the habitat for freshwater biota including weeds and snail vectors in the area.

With the on-going dredging of the sand-bar, tidal sea-water influx is now recorded as far as 20km upstream of the estuary and this has resulted in the elimination of both aquatic weeds and snail vectors of Schistosomiasis previously inhabiting the area between the estuary and Ada Foah.

Health

Onchocerciasis or River blindness is transmitted by *Simulium damnosum s.l*; black flies that breed in very fast flowing sections of rivers and streams. In the Volta River proper, these flies used to be found at about 20 miles up-stream of Akosombo at the Dodi Island areas. The breeding sites were covered when the dam was completed in 1966 and the flies migrated into the rapids created downstream in the Atimpoku to Kpong areas. These breeding sites again were eliminated after the second dam at Akuse. Currently therefore, there is no proper breeding of black flies in the main Volta from the North to Ada in the south. Breeding however continues in almost all rivers and streams within the Volta Basin.

Like all other vector-borne diseases, Onchocerciasis is controlled by both treating the host (human) and attacking the vector. The human is subjected to skin-snips, which are examined under the compound microscope. When found positive, then he-she is treated with microfilariacide - Barnocide or Suramin, which is both microfilariacide and macrofilariacide. With respect to the vector, the larval stage is attacked by putting Emulsiflable concentrates in the water, just above the breeding site. The chemical used currently is an Organophosphate called “ABATE” and treatment is at weekly intervals owing to the larval life-span. Biting population is reduced drastically after 5 weeks of treatment, if the breeding river is isolated but chemical control should be continued for 12 weeks. River blindness can thus be controlled by using the above 2 methods, particularly when detected early in the hosts.

The main intermediate hosts of Schistosomiasis in the Volta basin are *Bulinus truncatus rohfsi* (for S. haematobium) and *Biomphalaria pfeifferi* (for S. mansoni). The construction of the two dams on the Volta River at Akosombo created ecological changes favouring the proliferation of these snails in the lake area, on the headpond and in the Lower Volta. Prevalence rates of urinary bilharzias have ranged between 70 and 75% in some lakeside communities and in some cases rates of almost 100% have been recorded among school children. The situation has not been very different in the Lower Volta where disease prevalence has been on the increase especially the intestinal type. In some riparian communities for example, within a short period of 4 years (1989-1993) prevalence rate of intestinal Schistosomiasis has risen from 6% to 53.3%. In its simplest form, the control of Schistosomiasis is avoidance or reduction of water contact, avoiding defecating and urinating into the water body, but this involves change of human behaviour which makes the control more complex.

Malaria responded to the change in hydrology in various ways, the lack of pools during flood recession reduced the number of mosquito breeding areas, but the increased density of people in the new settlements increased the rate of transmission.

Social Impacts

The Tongu Union give the following as the major socio-economic and cultural impacts: Farming and fishing activities along the River have been seriously disrupted; The very profitable oyster (clam) fishing has almost ceased; Most of the many lagoons and creeks have dried up since there are no floods to replenish the water and fish stock; Migration of about 20,000 people in 1962-63 alone

followed the damming of the river. The once cheap and reliable river transportation between Tongu towns and villages has been crippled; There is loss of dignity of the Tongu people caused by their exodus to fishing grounds along Volta Lake, characterised by hostile reception and continued resistance from, and degradation by the indigenous people; With the drying up of the water-source, many stock-farmers have been forced to abandon animal rearing in the area. The migration of elders and those who uphold tradition and maintain discipline resulted in juvenile delinquency, poor school attendance and decline in moral standards.

5. Application of Mitigative Measures to Reduce Negative Impacts of Dams

5.1. Introduction

The last major dam in Ghana was constructed about 20 years ago, since that time there have been several global initiatives to appreciate and reduce the impact of dams on affected human populations and on the environment. These initiatives include the World Commission on Dams, the adoption of the Equator Principles by financial institutions as well as EIA and Strategic Environmental Assessments being carried out on a sector by sector basis.

Forty years ago for Akosombo and Twenty years ago for Kpong, not much attention was placed on the downstream communities. Most of the irrigation and water supply dams are relatively small and in the main local communities welcomed them, seeing the benefits rather than the costs. This was not the case for the large dams and there was and continue to be much resistance by local people caused by the perceived negative impact on their lives.

During the construction of the Akosombo dam, a UNDP project looking at the environmental impacts of the venture was established. The studies carried out then can not be compared to the sort or work now expected for an Environmental Impact Study. However much of the work by the research teams became very valuable as baseline data.

It can be argued that under the present global thinking neither of the two dams on the Volta that is, Akosombo and Kpong would have found the financing or enjoyed political support if they had been mooted today. The review of the corrective and mitigative measures for Akosombo and Kpong are drawn from the writings of Mr Kalitsi and Mr Yeboah both of VRA who were actually part of the exercise for both dams and Togbi Anapati, a vocal traditional authority of the downstream communities as reported in (Gordon and Amatekpor 1999). The Mitigative measures proposed for the Bui Project are from the EIS document under review.

5.2. The Akosombo Dam

The Akosombo dam and the formation of the Lake displaced about 80,000 people. These had to be resettled in 52 new resettlement townships. On the whole 1,300 houses were constructed with 82 school blocks, 46 markets, 146 public latrines. In addition, 52 boreholes 6 wells and 34 mechanical and 23 hand pumps were installed, about 500 miles of roads were constructed and over 100,000 hectares of farmlands established.

Compensation was paid for all properties destroyed by the formation of the lake but it was initially limited to farmlands, crops and economic trees. Because of time constraints, the resettlement under Akosombo project adopted the core house concept. This provided a single room together with foundation for three additional rooms provided for each settler family. Material for developing these rooms and experts to assist in completing the houses were provided. This method was adopted in order to beat the fast rising waters.

The basic philosophy was for the re-settlers to use self help in finishing these houses. It is a sad commentary that even up to today, some of the resettlement houses in the resettlement townships still remain in its core form. In addition to the provision of houses, other social amenities were provided. Schools, health facilities, water in the form of bore holes or wells, latrines and market centres were provided depending on the size of the resettlement town.

One of the criticisms of the Akosombo resettlement was that the core house was provided indiscriminately. In other words, despite the size of one's original house, which had been flooded out, the same core house was allocated. Those with large houses in the original villages therefore rightly felt cheated.

The social and cultural impacts were in the main ignored this is true not only for the people who were relocated but also for the communities, which had to deal with the assimilation of resettled people due to dam projects. Studies are now being published on this aspect of dam impact, e.g., Tsikata, (2006) "Living in the shadow of large dams". For this document and others, it is clear that the significant and

intergenerational effects of trans-location were severely under estimated.

With hindsight it is apparent that not only were certain social impacts/mitigation measures overlooked, but also that those measures that were implemented (e.g., health care) were not properly implemented. The main factor for this, apart from the lack of planning, was the lack of funding for the communities who bore the brunt of the formation of the lake. Happily since the time of the Akosombo and Kpong dams, several guidelines for social impact analysis have been developed and the use of such instruments and the application of the results are required by certain donors.

Kalitsi, in his submission to the World Commission on Dams states the following *"Resettlement of displaced people was carried out on the basis of three core policy approaches: compensation in cash or in kind, settlement in large communities; and housing on basis of core houses and self help housing completion.*

First, people affected were given the choice between receiving cash compensation and relocating themselves, or be resettled, i.e. receiving compensation in kind by joining a centrally planned resettlement program. Over 90% chose to be resettled. In either case compensation was based on valuation of housing, farms and other properties. The valuation was done independently by a government agency, the Lands Department. This valuation arrangement delayed delivery of critical information on compensation entitlement of affected people and became a source of complaint about inadequacy of coverage and pricing of properties. The biggest complaint was about land not having been compensated for.

The second policy approach was to group the over seven hundred and forty (740) scattered affected communities into a smaller number of larger and more compact communities which could be provided with basic physical and social infrastructures as well as plots of land for development into farms. A typical settlement was sized for about 1300 people. The largest would contain some five thousand and the smallest about 130 people. Sites were selected on the basis of wishes expressed during consultations with both communities to be affected and potential hosts. Potential sites selected by officials or suggested by local communities would first have been checked for capability of available land to take on more farmers and feasibility of providing necessities like water and access roads.

The third policy plank was to construct core houses for completion with self-help labour. Non-availability of property valuation details identifying settlers' compensation entitlements before detailed planning of housing requirements compelled adoption of standardised uniform housing types. It was not possible to match housing types to compensation entitlements. Uniform housing designs were developed for all the communities to be resettled and direct labour used to complete a "core" portion of the houses comprising two rooms and one veranda. The rest of the house was left to be developed by the resettled communities on self-help basis".

VRA Resettlement Trust Fund

The Volta River Authority has recognized the enormous difficulties encountered by the resettlement towns especially those established under the Akosombo project. In order to assist these resettlement towns and other communities adversely affected by the operations of the Authority around the Volta Lake, a trust Fund known as VRA Resettlement Trust Fund has been set up at the initiative of Government. The living conditions of the inhabitants of the 52 resettlement townships constructed had been a source of worry to successive governments. To alleviate their suffering the Government and the Volta River Authority in 1996 agreed to create a fund with contribution mainly from Volta River Authority to undertake projects for the benefit of these resettlement townships. The types of projects include: Environmental amelioration projects; Social Welfare Projects; Public Health projects; Education projects; Electricity projects; Water supply and Sanitation projects; and any other projects and needs approved by the Managing Trustees. The purpose is mainly to assist these communities in their socio economic development. The authority's contribution to the Fund is half a million dollars per year. Monies are already been paid into the fund and its disbursement will follow as soon as the Trust Fund Deed is executed.

The original intent was for the fund to cover the impacts felt by the 52 displaced villages above the dam. After discussion and debate, the fund is to be extended not only to those communities affected by the Akosombo dam but also the Kpong impoundment as well as the communities which have absorbed significant displaced people. It has took about 30 years for the fund to be created and in real

terms the amount of money is rather small, even restricting the funds would give each community about US$ 10,000 per year.

It should be noted that the VRA trust fund and its operation is very different from the normal compensation given to traditional land owners for government acquired lands. There are disputes on this aspect of compensation, VRA saying that it has been paid, and local indigenes saying it has not. The issue for the land compensation is vastness of the Volta Lake and the time frame from project initiation to the time of filling. The funding available for compensation was also inadequate as were the structure that would ensure fair and equitable sharing of the compensation that was available.

5.3. The Kpong Head-works

The problems in the Lower Volta were practically ignored by the VRA till the mid 1990s, thirty years after the Akosombo dam. The main problems were linked with, health issues, poverty and lack of employment as well as poor farming yield due to the loss of the seasonal flooding. The Volta Basin Research Project was commissioned by the VRA to investigate and come up with practical solutions that could be applied by affected communities to improve their lives.

Biological and Ecological Control of Weeds and snails

The biological and ecological control methods for weeds as well as snail reduction involve manual and mechanical clearing of aquatic weeds. The fishermen in the communities around and within the lake and head pond areas and the Lower Volta Basin were organised into cooperative groups by Chiefs and youth leaders in the fishing communities to participate in this project of weed control. This method was moderately successful and contributed to some improvement in the river flow rate.

The VRA also opened the river outlet into the sea at the estuary, which was hitherto closed by a sandbar. This allowed intrusion of saline water several kilometres upstream causing the death of the snails which could not survive in the saline conditions. This method was found to have killed snail hosts some 30km upstream, thereby, reducing the prevalence rates of schistosomiasis (bilharzia) by about some 70%.

Health Education

Health education was a major component of the mitigation process. The riparian and lakeside communities were constantly educated on the transmission and pathology of the disease. They were also educated on control measures. Health education was to help the communities change the social and cultural habits which encouraged transmission of the infection. Because schoolchildren constituted one of the most vulnerable groups, songs on control measures, mode of transmission and on habits that render school children vulnerable to the attack of the schistosome parasite were composed and taught in the schools in the lakeside and riparian communities. These songs were translated into local languages (Dangme & Ewe) and taught to fishermen and school children. This method yielded very successful results: a considerable reduction in the prevalence of bilharzia among school children.

Implementation of Income-Generating Projects

The socio-economic problems that arose downstream resulted in strong protest from chiefs and opinion leaders of the affected communities, the Volta River Authority (VRA) came under intense pressure to institute remedial measures to mitigate the economic hardships brought to bear on them. As a remedial measure, the VBRP with support from (VRA) implemented some of income-generating projects that sought to provide employment opportunities for the inhabitants of the affected areas. Artificial shrimp farms were established in the Lower Volta communities using very simple and inexpensive methods. The farming method was such that the local people could easily learn and practise to generate incomes. The shrimp farming empowered the local people economically by providing them with employment opportunities and sources of income.

Treatment of soils with locally produced lime

Farmers were introduced to very simple farming practise which involved the liming of the heavy clay soils with powdered clam shell which is readily available in the area. Maize yields even without fertilizer almost doubled.

Problems and Constraints to implementation of Mitigation efforts in the Lower Volta
The most serious constraint of the mitigation efforts has been the general apathy of the local people towards a progressive attitudinal and behavioural change. The major constraint was the reluctance of members of the community to get involved if no payments were forthcoming. This attitude eventually led to the collapse of the cooperative groupings. This lack of involvement stems from the general lack of ownership caused by inadequate consultation of stakeholders, particularly affected persons.

The low levels of education of the local people has also been a serious limitation to the success and sustained momentum of the project. The lack of will on the part of the local people to change their behaviour and attitudes provided an impetus for high rates of re-infection of schistosomasis (bilharzias) in some communities, particularly among school children. In Ada-Foh, the follow-up studies after 14 months indicated that re-infection rate was 6%. This was attributed to the reluctance of the school children in this town to change their habits. Also, about 35% of the head pond area is still infested with aquatic weeds. This is largely due to the high re-infestation rate (6-8 weeks after clearing) of the aquatic weeds. The high rate of re-infestation is promoted by several factors, the most significant ones being:

- The presence of seeding material in the ponds and creeks originally in the area earmarked for inundation in the form of seeds, shoots, offsets, rhizomes etc;
- The shallowness of the head pond (max-depth 18m) allowing for sunlight penetration and good aeration, which promote plant growth;
- Import of nutrients from the sewage system from the nearby Akosombo cattle dung on the East Bank, fertilizer import from nearby rice farms, and nutrients from the inundated area itself (1/6th of this area was under intensive commercial agriculture); and;
- The presence of relatively large number of sheltered coves and physical barriers, which provided undisturbed conditions required for weed growth and development.

Hindsight from the Akosombo and Kpong Experience (EKA Kalitsi)
The former CEO of the Volta River Authority reflects some 40 years on regarding the resettlement experience of the VRA the points below are a summary of the key issues.

a) The need for Detailed and Extensive Studies
There is a need for detailed and extensive studies during the planning phase long before implementation time. These studies will have to be intensified during implementation and the results used to modify the plans. With environmental data gathered during the construction and filling stage, it was possible to plan mitigation and eradication measures to monitor and assess changes in the ecosystem. Similarly social data gathered during the construction period helped in refining arrangements for resettlement of affected people. So planning should not be static but be adjusted as new conditions arise. This was the approach taken on the Volta development. And yet when it came to actual implementation the information available was found to be inadequate. This is how we found ourselves having to provide to settlers uniform core houses not related to the value of their properties affected or having to leave in the reservoir area trees whose stumps have now created serious hazards to navigation causing loss of many lives annually.

b) The timeliness and quality of information on socio-economic conditions of affected communities is critical for effective interventions.
The timeliness and quality of information on the socio-economic conditions and resources of communities and families which includes land, buildings, farms, crops and perennial trees is critical.

c) Property Assessments by independent consultants is vital
In relation to properties to be flooded, it is important to contract independent professional consultants to prepare and price the inventories of all properties. Property owners should be made aware of the value of their properties before evacuation and type of resettlement property granted to each person as compensation in kind should be related to the value of their properties and they should have a right to challenge the valuation.

d) The need to appreciate the long-term nature of engagement with problems of affected communities
One observation today is that at about forty years after relocation, the settler population, adjacent communities in which the settlers were relocated and downstream communities in the lower Volta, is,

by and large dissatisfied. They feel that urban communities and industries have taken more of the project benefits in the form of cheap electricity while they the locals are left with the bane of public health problems, and inadequate compensation. Some have suffered reduced farm incomes and others reduced fishing incomes. For a long time electricity was not extended to the settlers.

e) The need to provide credit to support fishing and farming activities of resettlers.
Income generating activities in the settlements turned out to be poor. The farms failed. Some of the population migrated back to the lake-side for fishing. We should have given them credit to buy boats and nets for fishing and simple farm tools and implements.

f) The need to provide Resettlers with Legal ownership of housing and farming plots
A programme to give legal ownership or occupancy to those allocated housing and farming plots started but was not pursued. An effort was made to integrate settlers in the local and community administration. Partial success was achieved in some areas but difficulties arose in other areas. Government agencies providing technical support in the rural areas were courted to extend services and facilities to the settlements. These local management units were themselves so weak that they have not supported the settlements adequately. Settlers should be given the legal documents, validating their occupancy and granting them the right to pass property on to their successors.

g) While self-help as an approach to housing is desirable, it is not a practical option in the face of severe time constraints on resettlement.
In relation to housing people displaced by dam construction, an approach which enables people to apply self-help in building their houses and farms is considered desirable. However, when dealing with large numbers of people who have to be relocated within a short time period, a self-help approach is not very practical. Relocated people are too dispirited to generate the necessary energy immediately for such critical work.

5.4. The Bui Dam proposals to Mitigate Impacts

The mitigative actions proposed for the Bui Dam project would seem to be on paper "Best Practice" as the EIA and EMP followed World Bank, the DDP and the WCD guidelines. The summary mitigative actions presented here are in four sections water, ecology and biodiversity, socio-economic and cultural. Actions are proposed in the design stage, the construction stage, the filling stage and the operations stage.

Impacts on Water
Project Design: Design of spillways to manage the temperature and preventing anoxic discharges; • Design of reservoir shoreline to minimise adverse impacts from drawdown on neighbouring land use.
Construction Management: Develop and implement a site construction waste and wastewater management plan to minimise environmental damage from construction activities, Install wastewater treatment facilities to treat wastewater from worker compounds and other construction facilities and to remove oil and grease from drainage water before discharge to adjacent water courses; implement soil erosion control measures including sediment traps; dry season sand excavation from the riverbed to limit sediment transport; maintain a vegetative buffer zone alongside river and drainage channels during construction; minimise soil disturbance and excavation during wet season; construct culverts where upgraded roads cross streams; site water abstraction locations to minimise impact on existing water supply sources.
Reservoir Inundation: Clearance of vegetation prior to inundation including commercial salvage of trees; design and implement agreed seasonal compensation flow regime during inundation; Monitoring of borehole yields in community wells.
Reservoir Operation: design and implement agreed seasonal compensation flow regime during operation; manage operations to avoid rapid fluctuations in downstream flow; undertake regular (preferably continuous) flow monitoring downstream; undertake regular water quality monitoring in reservoir, to include dissolved oxygen, nutrients (N & P), pesticides and nuisance plants; monitor groundwater levels and water quality in representative selection

Ecology and Biodiversity

Detailed design

• Locate all associated structures and temporary and permanent construction-related sites (e.g. construction camp, borrow pits) as far as possible within the zone of inundation, or outside the Park boundary and in disturbed habitat locations to minimise habitat loss and human/wildlife interactions;
• Minimise the width of construction right of way for construction of new transmission lines and upgrading of access roads and ensure that the transmission line to Kumasi will be within the ROW of the existing lines so that no additional permanent land take is required;
• Design the operational regime for the hydro-electric plant to mimic seasonal variations in the hydrological cycle as far as possible, to meet environmental flow requirements, and to ensure a minimum flow is maintained at all times;
• Develop operational plan for the Bui hydroelectric plant that includes managing the reservoir drawdown to optimise native vegetative growth in littoral zone.

Resettlement Planning Framework/Resettlement Action Plan

• Incorporate environmental criteria (*e.g.* carrying capacity, proximity to species of conservation concern etc.) into site selection criteria for resettlement host sites;
• Incorporate wildlife awareness training programme into the RAP, to address possible pressures on wildlife in host areas for resettlement;
• Consider impacts on habitats and wildlife in identifying suitable resettlement sites and manage resettlement movements to minimize impact during relocation.

Protected Area Management Plan for Bui National Park

Develop and implement a Protected Areas Management Plan (PAMP) for Bui National Park, including:

- Controls over land use, new settlement, poaching, agricultural encroachment and burning;
- Long-term wildlife and vegetation monitoring to document changes in flora and fauna in the reservoir and surrounding lands and address any problems that may occur;
- Building capacity of park management staff;
- Identification of additional, sustainable sources of funds to support park protection;
- A wildlife awareness training programme (including training in native and rare species, effects of bush meat hunting etc) targeted at workers, their families and people residing in villages near the park where hunting is known to be a main livelihood activity, such as Gyama, Banda Nkwanta and Kwame Kwesi;

• Identification of an area (or areas) of suitable habitat that can be gazetted and added to the existing Bui National Park to offset quality habitat that has been inundated, and in addition extend the national park south to the Banda Hills, to incorporate the southern perimeter of the reservoir.

Construction Mitigation

• Minimise riverbed and shoreline disturbance (*e.g.* restricting access of construction activities and workers to susceptible areas that could contribute to sediment loading);
• Implement education programmes for construction workers on, *inter alia*: respect for wildlife and vegetation avoidance of fires and accidental damage and generally minimising the footprint of the construction camp and work areas;
• Prohibit development of unnecessary spur roads off main access roads, to limit land degradation and habitat disturbance;
• Develop and implement a site access plan to prohibit/control public access to the Park via the site access road from Banda Nkwanta to the Dam site;
• Develop “good construction environmental management” protocols to reduce effects on vegetation and wildlife, covering site working practices, noise management (1) , avoidance of spills, maintenance of pollution control measures such as oil separators, and a dust management plan;
• Minimise riverbed and shoreline disturbance (*e.g.* restricting access of construction activities and workers to susceptible areas that could contribute to sediment loading);
• Replant or take measure to encourage recolonisation by native vegetation in disturbed or denuded areas immediately following construction.

Inundation Mitigation

• Provide for rescue of rare or distressed animals and strategic fire management;
• Selectively harvest tall trees (above 30m in height) within the inundation area prior to impoundment to force tree-dwelling wildlife to migrate from the area prior to flooding;

• Begin reservoir inundation after the dry season once hibernating animals have emerged;
• Plant fodder species (*e.g. Setaria barabata*) favoured by hippopotamus and other species along the littoral zone of the reservoir;
• Reduce the biomass that will be flooded by selective forest clearing and the commercial salvage of forest products;
• Implement 'nuisance' plant monitoring programme for the reservoir.

Social Health and Economic Impacts

Mitigation Measures at the Detailed Design/Preparatory stage

The Resettlement Planning Framework (RPF) will provide the basis for a full Resettlement Action Plan (RAP), which should be completed during the design stage. The RPF will include: the results of a detailed social survey of the households that will be displaced by the Bui Project; a detailed social baseline description of these communities; proposed eligibility of the displaced people for compensation; valuation of compensation for losses; proposed resettlement measures; details of site selection, preparation, and the provision of social and environmental management services at these sites; and proposed monitoring and evaluation. Other aspects of the design of the project that should be reconsidered or confirmed in order to mitigate social, health and economic impacts are:
• Design of the flow regime during construction in order to allow adequate flow of water downstream when the reservoir is filling;
• Design of the operating regime of the dam in order to ensure adequate supplies of water downstream during operation;
• Confirm location of the construction camp and lay down areas, and locate traffic routes in order to minimise impacts on neighbouring communities;
• Confirm location of quarries and borrow pits in order to minimise impacts on local communities.

Mitigation Measures: Construction Phase

Measures to mitigate social, health and economic impact that are proposed for implementation during the construction and inundation phase concern:
• Construction Management Plan;
• Employment and Workforce Policies;
• Community Support Measures;
• Bui National Park Management Plan;

Construction Management Plan

The contractor should be required to adhere to a detailed Construction Management Plan. Measures to be incorporated into this plan in order to reduce or avoid social, health and economic impacts are:
• Inform local communities of major activities in advance;
• Ensure all dangerous construction sites, quarries and borrow pits are fenced off;
• Strictly enforce and monitor road safety standards;
• Identify water sources for construction that will not deplete local water supplies and ensure that construction minimises its use of water;
• Implement measures to prevent the entry of sediment from construction areas into the river;
• Minimise the removal or disturbance of vegetation along rights of way around construction site;
• Follow best practice to prevent the creation of stagnant water or other breeding areas for mosquitoes;
• Spray construction areas and roads regularly with water to suppress dust emissions;
• Ensure that possibly disturbing construction noise is not produced outside of working hours, and ensure sound proof walls are built around blast sites;
• Monitor dust emissions and noise levels in settlements adjacent to construction activities; and
• Improve quality of roads being used by the project.

Employment and Workforce Policies

The contractor should be required to adhere to a policies and codes of conduct concerning employment and workforce behaviour. Measures to be incorporated into these policies in order to reduce or avoid social, health and economic impacts are:
• Screen the health of possible employees (*e.g.* for TB, malaria, flu) as part of the recruitment process;

• Ensure that the workers camp and construction areas are open only to formal employees;
• Develop and enforce a strict code of conduct for workers to regulate behavior in the local communities, including road safety, prevention of hunting, and prevention of buying bush meat;
• Provide awareness training to the workforce, in particular regarding the transmission of STDs, and traffic safety awareness;
• Build adequate facilities for workers and their families (housing, schools, water facilities, electricity, recreation facilities, *etc*);
• Provide the workforce with access to primary healthcare on site, providing insecticide-treated mosquito nets, prescriptions, prophylactics, and condoms, basic testing for TB *etc*. The healthcare facilities should provide their own medicines and equipment, in order to prevent the depletion of local healthcare facilities; and
• Conduct regular fitness and medical tests on the workforce.

Community Support Measures
A series of support measures should be provided to local communities, in order to mitigate social, health and economic impacts. These are:

• A local employment and sourcing policy to discourage in-migration, entailing a ban on the employment of casual migrants to the site, and the recruitment of labour through offices located away from the site, *e.g.* in Sunyani;
• Inform local communities of employment and procurement opportunities;
• Engage an NGO to prepare community institutions for any influx of migrants (*e.g.* by developing by-laws and community policing systems for larger numbers of migrants);
• Support local healthcare facilities *i.e.* training of local healthcare professionals, supply of regular medical supplies and updated equipment;
• A community health programme including support to existing or new local programmes such as mother and child, nutrition, community health awareness, HIV/AIDS awareness, hygiene and immunization, malaria control measures (indoor spraying of insecticides, personal protection measures, and control of mosquito larvae), campaigns to raise traffic awareness, and local Voluntary Counselling and Testing (VCT) programmes;
• Provide electricity, build additional schools, water facilities, upgrade roads, and transport services *etc* for communities absorbing itinerant migrants;
• Engage NGO to build capacity of community groups to save and leverage increased income (e.g. through micro-credit and small businesses);
• Provide downstream communities with water boreholes;
• Establish a programme to support intensification of small scale agriculture, including the identification of alternative farming and grazing areas, for farmers affected by loss of farming land, loss of grazing area, or reduced land productivity owing to the altered hydrological regime;
• Engage an NGO to work with local authorities to plan the development of new fishing settlements that might develop on the shores of the reservoir; and • Engage NGO to prepare communities for out-migration of workers (*e.g.* by savings schemes, and helping businesses adapt).

Bui National Park Management Plan
The Bui National Park Management Plan should incorporate the following measures in order to address social and economic impacts:

• Collaborative buffer zone management with communities in order to identify areas for the collection of forest products, as compensation for any that may have been lost to the inundation area;
• Ensure that all fishing activity is controlled and sustainable;
• Measures for working with communities to maximize opportunities from tourism.
The Bui National Park Management Plan should be updated regularly, to continue beyond the construction phase, and into the period of operation.

Mitigation Measures: Operation
In addition to the Bui National Park Management Planning, a number of measures should continue through the operation of the Bui Project to mitigate health impacts, and the changing agricultural ecology downstream of the dam. Measures will address the risks of bilharzias, trypanosomiasis, intestinal and guinea worm, and malaria. They are:

• Community health education;
• Safe supply of drinking water, and water purification education to address intestinal and guinea worms;
• Improved sanitation facilities and accompanying hygiene education;
• Adequate healthcare facilities amongst local communities, providing regular active surveillance, case detection, prompt diagnosis and treatment, and specific programmes such as de-worming;
• Control of disease vectors and hosts, and vector breeding areas. Measures to address a changing agricultural ecology downstream of the dam:
• Replenishment of nutrients in floodplain agricultural areas through the distribution of fertilizers to farmers;
• Support to the development of alternative livelihoods for floodplain farmers;
• A programme to support the intensification of small-scale agriculture; and • If necessary, relocation of farmers affected by salinisation, or the promotion of good soil and water conservation techniques and practices in affected areas.

Archaeological and Cultural Heritage

Loss of Archaeological Value
The destruction of ancestral sites, indigenous iron production centres, features and material remains, due to land take is irreplaceable loss. Mitigation measures should centre on 'Salvage Archaeology' to obtain an adequate documentation of and samples from a selected number of areas. Specific mitigation measures would include:
• Further survey and test excavations at the archaeological sites in the Bui
village area and on the left bank of the river around Lucene;
• A reconnaissance survey in the stretch of land to be used for erecting transmission lines from the eastern side of the power station through Gyama to link up with the main lines on the Bole-Bamboi road.

Loss of Cultural Value
The Resettlement Planning Framework that is currently under development should include sufficient attention to the effects of resettlement on the loss of culturally valued sites, and the displaced people's reactions. Mitigation measures should be centered on the following principles:
• Consultation and partnership with chiefs, priests and priestesses, elders and ordinary people;
• Each community should be evaluated individually and according to their historical experiences, and indigenous culture, owing to the great variation in beliefs, both within and between communities;
• Consideration to ensuring that the relocation or loss of culturally-valued sites can make use of traditional practices such as drinks for libation, animal sacrifice, purification and pacification.

6. Legal and Institutional Framework

6.1. Key Institutions

The Key institution that takes decisions on whether or not a dam is built is the Ghana Environmental Protection Agency. The process for this follows the National Environmental Laws and is given in Section 6.2. onwards. Usually a dam project would be mooted at Ministerial level, by one of its departments or agencies for consideration by Parliament due to issues related to funding.

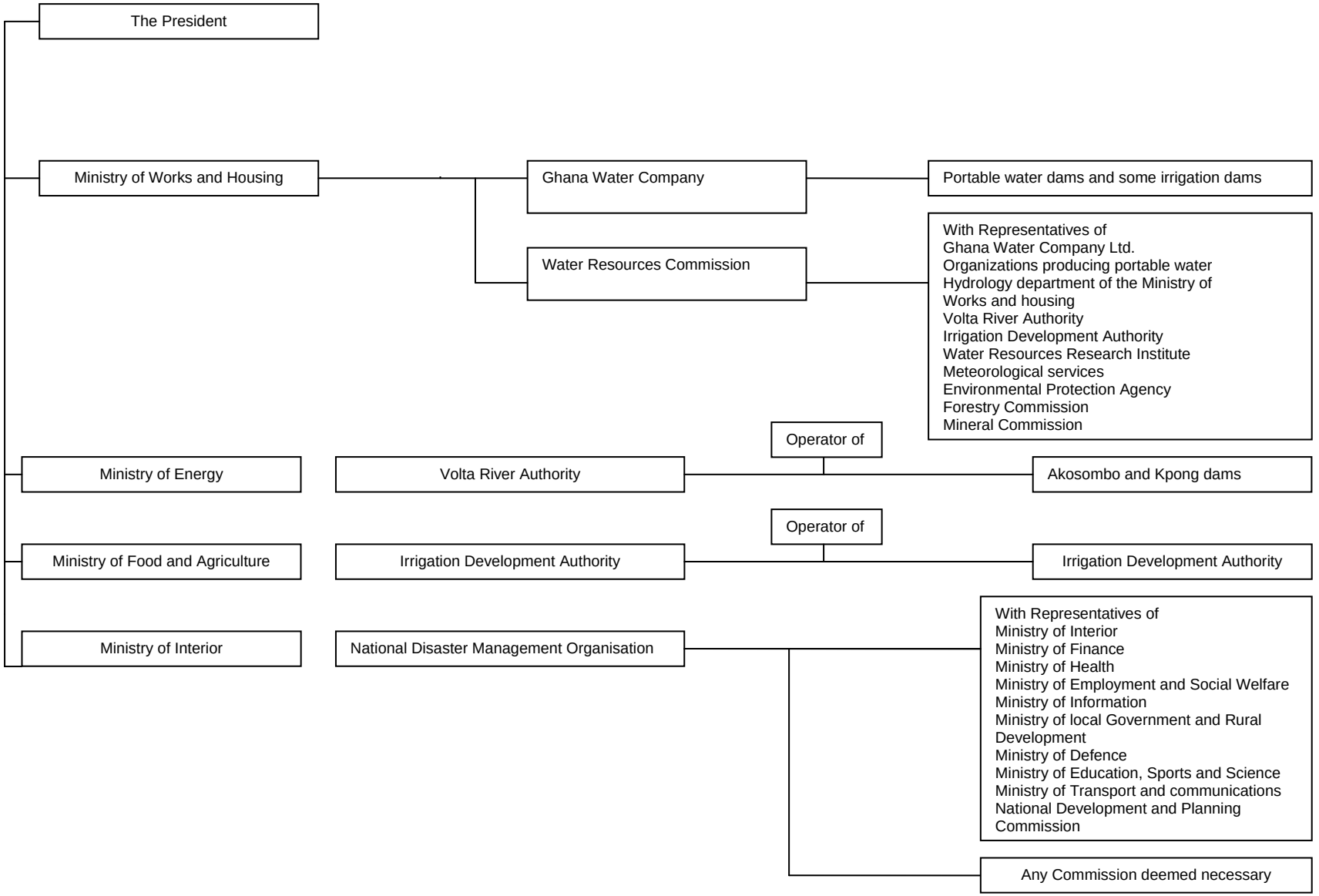
Table 6.1. Ministries, Departments and Agencies Responsible for Water Resources Development and Utilization in Ghana

Ministry	Department/Institutions	Responsibilities
Ministry of Water Works and Housing (MWH)	Water Resources * Commission	Planning and regulation of the development and use of freshwater resources in Ghana
	Ghana Water Company Ltd. **	Provision of potable water for urban settlement
	Community Water and Sanitation **	Provision of potable water for rural communities
Ministry of Local Government, Rural Development and Environment	Environmental Protection Agency (EPA) *	Management of the country's environment, collaborating with relevant state institutions and international bodies in ensuring sustainable development of the country's natural resources
Ministry of Lands, Forestry and Mines	Forestry Commission *	Control and planning of forestry resources
	Mineral Commission*	Granting of mining rights
Public Utilities Regulatory Commission		Regulate the supply, Transmission, and distribution of treated water
Ministry of Energy (ME)	Volta River Authority (VRA) **	Plan, execute and manage the development of the Volta River for hydropower generation
	Bui Dam Secretariat	Plan, execute and manage the development of the Bui Dam Project for hydropower generation
Ministry of Food and Agriculture	Irrigation Development Authority **	Development of irrigation in the country
	Fisheries Commission	Development of Fisheries in the country
Ministry of Roads and Transport	Meteorological Services Division ***	Assessment of meteorological data for climate and weather prediction.
Ministry of Education Sports and Science	Water Research Institute of CSIR ***	Assessment of surface and groundwater resources in quantity and quality.

* Organization involved primarily in the regulation of the environment and natural resources.
** Organization involved mainly in the development and use of water resources.
*** Organization involved mainly in the data collection and processing of data/information for water resources management.

Other institutions involved include the Ministry of Health, who through their Community Health Unit manage some elements of water related diseases. The Volta Dams are of strategic importance so the Ministry of Interior and the Ministry of Defence also have a role protecting the dams. The National Disaster Management Organization which is nominally under the Ministry of Interior, comes in if there were a case of flooding or other natural disasters

Figure 6.1.Key institutional players in connection with decision making on dams in Ghana



6.2. National and International Legal Requirements

National Environmental Law

The current National Environmental Policy of Ghana aims at ensuring a sound management of our resources and the environment so as to avoid any undue exploitation of these resources and follows a sustainable development path. The Environmental Protection Agency (EPA) through 1994EPA Act 490 and lately Environmental Assessment Regulations LI 1652 initiated appropriate procedures to ensure that all developmental projects are assessed environmentally before they are undertaken.

The enactment of Act 490 marked an important milestone in Ghana's attempt at codifying EIA requirements in the developmental process. Act 490 [Section 2 (i)] created a body corporate called the Environmental Protection Agency (EPA). Among its functions, the Agency was given the power "*to ensure compliance with any laid down environmental implementation assessment procedures in the planning and execution of development projects, including compliance in respect of existing projects*."

Under Section 12 (1) of the Act, the Agency "*may by notice in writing require any person responsible for any undertaking which, in the opinion of the Agency has or is likely to have adverse effects on the environment, to submit to the Agency, in respect of the undertaking, an environmental impact assessment containing such information within such period as shall be specified in the notice*".

Where a notice is issued within the terms of Section 12 (1), the Agency shall inform any organ or department of government that has responsibility for the issue of any license, permit, approval or consent in connection with any matter affecting the environment that the notice has been issued, and the organ or department shall not grant the license, permit, approval or consent unless it has been notified by the Agency that the notice has been complied with.

Section 28 of the Act deals with Regulations. It provides under sub-section 2(b) that regulations may be made to provide for the category of undertaking, enterprises, constructions, or development in respect of which environmental impact assessment or environmental management plan is required by the Agency.

The Environmental Impact Assessment Regulations, 1999 (L.1. 1652) came into force on 24th June, 1999. The Regulations are divided into three parts, and have a total of 30 sections in addition to Schedules. The provisions in the Regulations deal with the various procedures to be followed prior to the granting of a permit. It also includes how to file complaints, offences and penalty.

Environmental Impact Assessment procedure in Ghana

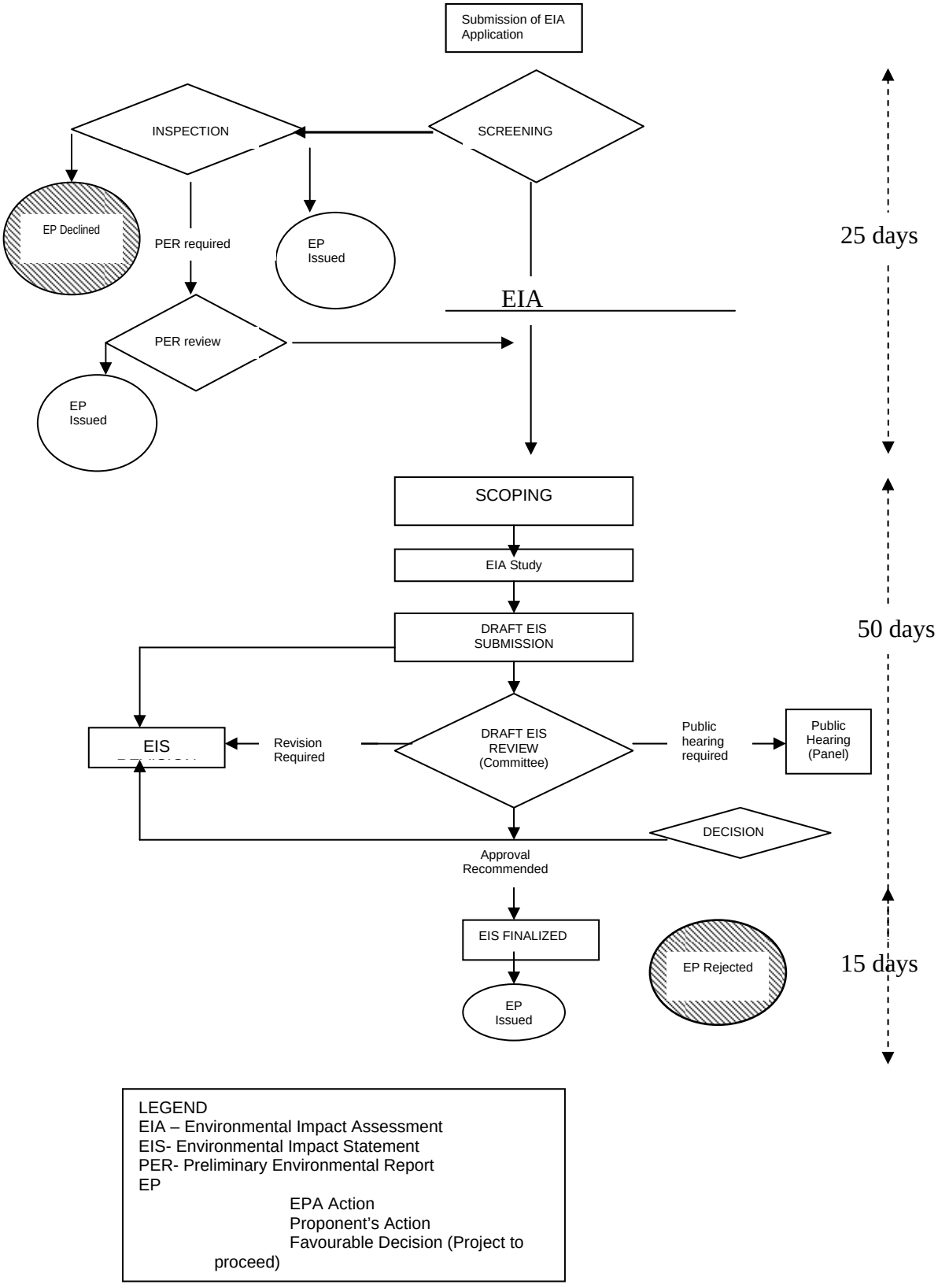
The Environmental Impact Assessment procedure in Ghana has been developed primarily as an aid to an environment planning of new development projects, the expansion of existing development projects or the management of existing facilities. The aim of environmental impact assessment in Ghana is to assess the overall impact on the environment of development projects proposed by the public and private sectors. The objectives include the following:

- to identify and incorporate into the project plan appropriate abatement and mitigating measures,
- to predict significant residual environmental impacts,
- to determine the significant residual environmental impacts predicted, and
- to identify the environmental costs and benefits of the project to the community

The following when properly executed are envisaged benefits of the EIA:

- EIA provides guidelines and information, which help reduce conflicts,
- It identifies and reduces risks associated with long term projects,
- Incorporating EIA at the initial stages for a project tends to be cheaper because the process will identify and address unforeseen issues during the planning and implementation stages which reduce capital and recurrent cost, and avoid environmental damages as well as social disruption,
- It provides opportunity for co-ordination and negotiation between stakeholders,
- EIA broadens the boundaries of project appraisal so that consideration can be made for alternative approaches and designs,
- And it avoids conflicts, between proponents and the public, stakeholders,

Fig. 6.2. The Environmental Impact Assessment Process in Ghana



To complete an environmental impact assessment in an efficient manner and to realise the objectives discussed earlier, the assessor should take the following steps in sequence.

- Describe the proposed project as well as the options
- Describe the existing environment
- Select the impact indicators to be used
- Predict the nature and the extent of the environmental effects
- Identify the relevant human concerns
- Assess the significance of the impacts
- Incorporate appropriate mitigating and abatement measures into the project plan
- Identify the environmental costs and benefits of the project to the community and
- report on the assessment

The Procedure

The EIA starts with the proponent registering the undertaking which might have an impact on the environment. This registration is done with the Environmental Protection Agency (EPA). The responsibility for determining what constitutes an impact on the environment for registration purposes however lies with the EPA.

Within 25 days from the time a registration form is received, the EPA with the assistance of a cross-sectoral technical committee, including the Ministry, will make a decision by placing the undertaking at the appropriate level of assessment. In making the decision at this stage, an inspection by EPA officers may be necessary and consideration will be given to the following:

- The location, size and output of the proposed undertaking
- The technology to be used
- Concerns of the general public
- Land use considerations
- Any other factors relevant to the particular undertaking

The screening decision may be one of the following:

- Environmental approval granted
- Environmental approval declined
- Preliminary Environmental Assessment (PER) required
- Full EIA required

The requirement for a PER is to provide sufficient information on the undertaking as a sound basis for the decision-making on whether an EIA is required for the undertaking or not. If the decision indicates that an EIA is required, then an Environmental Permit cannot be issued on the basis of the PER, and the proponent will accordingly be advised to initiate EIA.

Whenever the screening result of the initial project registration or a subsequent Preliminary Environment Report (PER) indicates that significant adverse environmental impact may result from the undertaking, the proponent will be required to submit an Environmental Impact Statement (EIS) resulting from a thorough Environmental Impact Assessment.

First step for the proponent is to commission or undertake a Scoping Exercise of the proposed (alternative) site(s). This will involve consultations with interested/affected parties such as government officials, (and relevant ministries, departments, local authorities etc.), traditional authorities and members of the public. The objective is to determine how their concerns and others will be addressed in the Terms of Reference (ToR) for the EIA. The proponent then prepares a scoping report, which would include draft “Terms of Reference” (TOR) for the EIA study, and submit ten (10) copies to the EPA. If the EPA agrees with the ToR, then the proponent is mandated to proceed with EIA.

The proponent shall be required to commission a detailed Environmental Impact Assessment. This study will involve baseline survey and inventory, development of proposal option, potential impact identification and prediction, mitigation, considerations and other requirements of the ToR. In the course of gathering data for the EIA, the proponent is required to initiate a public information programme for the area likely to be affected by the undertaking.

Through such a programme, local residents will be fully informed (and be able to make their concerns known), of the nature of the undertaking and its effects on the environment. Copies of all reports on original studies undertaken in relation to the EIA are made available to the EPA. The concerns of the public which were recorded during the original studies undertaken in relation to the EIA will be made available to the EPA. The concerns of the public shall be recorded and must be addressed in the EIS. Public notice of the assessment process for the undertaking will be issued by the EPA through newspaper advertisements and/or announcements posted in appropriate public places.

Once the final draft of the Environmental Impact Statement is completed, the proponent shall submit 12 copies of the EIA to the EPA. A cross-sectoral technical committee including the Ministry and other agencies shall assist the EPA in the review of the EIS.

Copies shall be made available at appropriate public places. A 21-day public notice of the EIS publication shall be served by the EPA for public information and reaction, through newspaper advertisement or posting at appropriate places as part of the review process. The EPA will collate public views and shall undertake a field/site verification exercise if considered necessary.

If a strong public concern over the undertaking is indicated and impacts are extensive and far reaching, the EPA shall hold a public hearing relating to the assessment. The EPA shall appoint a panel which will organise the public hearing on the proposed undertaking.

The information received at these hearings, together with the final report and any recommendations of the panel may be made public. In the event where a public hearing is held on an undertaking, the processing of the application may extend beyond the normal 90-day period for processing an application.

The is also a need for an Environmental Management Plan (EMP) in order to effect the provisions of the Act on environmental management the Environmental Assessment Regulations 1999 (LI 1652) was enacted, consistent with section 28 of EPA Act 490 of 1994. The Environmental Management Plan (EMP) procedure is not only a regulatory tool to be enforced pursuant to section 24 of LI 1652, but also a compliance promotion tool to ensure effective prevention and minimization of potential impact of industries that existed as at February 1999 on the coming into force of LI 1652.

The EMP was proactively initiated as a compliance promotion tool to create awareness and encourage environmental management systems development in industry. The programme is an evolving process beginning from a situation of no environmental regulations and an ill – informed industry on environmental issues to one where industry would be well informed of their environmental obligations and make choices in self – regulation and compliance with regulations and standards that were then being anticipated. The specific objectives of developing and implementing EMP include the following:

- to ensure the clear recognition of the distinction and the inter – relationship between the external and the working environments, factors/activities that impact on them; and the appropriate legislation regulating them
- to effectively identify potential releases into air, water and land media from the various process activities

- To encourage the development of capabilities and capacities of industry to obtain accurate information on sources of emissions, effluents and solid waste generation in order to put in place minimization and to address them
- to determine qualitatively, the characteristics (i.e. pollution, indicator/parameter levels) of emissions, effluent and solid wastes as a basis of potential impact and reduction plan
- to develop material balances as appropriate including water balance, and raw material balance as basis of obvious waste reduction plan
- to appreciate the effect of potential impact of the various activities if 'business as usual' or 'no action attitude is adopted where the pollution indicators exceed regulatory levels
- to encourage self – regulations and compliance through institution of prevention, reduction of waste generation at source and the selection of a combination of primary process and pollution abatement techniques which constitute the Best Practicable Environmental Option (BPEO)
- ensure that the Best Available Techniques Not Entailing Excessive Cost (BATNEEC) will be used in preventing or minimising and rendering harmless any release of described substances into the environment
- ensure the institution of relevant monitoring regime to ensure compliance with any international or national regularity limits as appropriate
- obtain detailed information about specific individual processes for the development of Process Guidance Notes or Company Profiles for the purposes of authorization or permitting

Benefits and Hindrances to Effective Public Hearing

While it is a statutory requirement within the EIA review process, public hearings have been beneficial in terms of:

- providing an avenue for public information and interaction between the proponent and all interested groups;
- allowing people to articulate their views about a given project and make inputs which eventually enhance the quality of the project environmental assessment;
- leading to social acceptability of projects and promotion of harmonious relationship between the proponent and affected communities;
- unearthing issues that may be hidden from the reviewing authority; and resolving conflicts during public meetings since every party is given the opportunity to express concerns before an independent panel

In spite of these benefits the effectiveness of public hearings has been hampered by:

- The inability of the affected communities to easily understand project proposals due to the low levels of literacy. It would have been more beneficial if the locals could have a thorough understanding of the EIS to facilitate effective discussions. Lack of understanding has usually led to hostilities during public hearings.
- The absence of EIA capacity at the District Assembly Level to undertake their own EIS review and to guide their communities to make inputs into EIA Studies.
- The absence of organised NGOs to assist communities in understanding the issues and in making meaningful comments about a given project.

Box 6.1. Ghana: International Conventions related to Sustainable Development

- African Convention on the Conservation of Nature and Natural Resources
- Convention Concerning the Protection of the World Cultural and Natural Heritage
- Convention on Biodiversity (CBD)
- Convention on International Trade in Endangered Species of Wild Fauna and Flora
- Convention on the Conservation of Migratory Species of Wild Animals
- Convention on Wetlands of International Importance, Especially as Waterfowl Habitat
- Convention to Combat Desertification (CCD)
- International Convention for the Conservation of Atlantic Tunas (ICCAT)
- International Convention for the Prevention of Pollution of the Sea by Oil
- International Convention on Civil Liability for Oil Pollution Damage
- International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage
- International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties.
- Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water
- Treaty on the Prohibition of the Emplacement of Nuclear Weapons of Mass Destruction on the Seabed and the Ocean Floor and in the Subsoil thereof
- United Nations Convention on the Law of the Sea
- United Nations Framework Convention on Climate Change (UNFCCC)
- World Heritage Convention

Box 6.2. Ghana: Laws and Policies pertaining to Sustainable Development

Wildlife Conservation Policy and Legislation

- Wild Animals Preservation Act, 1961 (Act 43)
- Wildlife Conservation Regulations, 1971 revised 1999 LI 685)
- Wildlife Reserves Regulations, 1971 (LI 710)
- Wildlife Conservation Policy, 1974

Forestry Protection

- Trees and Timber Decree, 1974 (NRCD 273)
- Forestry Commission Act, Act 571 of 1999
- Forest Policy of 1948, 1994
- Forestry Ordinance of 1927 (Cap 157) and subsequent amendments of:
- Forest Protection Decree, 1994 (NRCD 243)
- Forest Protection (Amendment) Law 1986 (PNDC L 142)

Fisheries Resources Protection

- Fisheries Law 1991 (PNDC L 256)
- Fisheries Commission Act 1993 (Act 457)
- Fisheries Development and Management Bill, 1996
- Fisheries Decree, 1972 (amended 1977, 1984)

Oil and Gas Development

- Petroleum (Exploration and Production) Law, 1984 (PNDC L 84)
- Minerals (Offshore) Regulations 1963 (L.I.257)
- Minerals (Oil and Gas) Regulations 1963 (L.I. 258)
- Oil Mining Regulations, 1957 (L.I. 221)
- Oil in Navigable Waters Act, 1964 (Act 233)
- The Minerals Commission Act, 1993 (Act 450)

Environmental Management

- Beaches Obstruction Ordinance 1897 (Cap 240)
- Council for Scientific and Industrial Research Act, 1996 (Act 521)
- Draft Coastal Zone Management Law
- Environmental Protection Agency Act, 1994 (Act 490)
- Ghana Water and Sewerage Act 310
- IDA regulations 1987
- Land Planning and Soil Conservation Ordinance, 1953 (No. 32)
- Lands Commission Act, 1994 (Act 483)
- Local Government Act. 1993 (Act 462)
- National Development Planning Commission (NDPC) Act, 1994 (Acts 479, 480)
- Local Government (Establishment of Urban, Zonal and Town Councils and Unit Committees) Instrument, 1994 (LI 1589)
- PNDC Law 42, 1982
- Rivers Ordinance 1903 (Cap 226)
- VRA. Act 46 1961 (Volta River Development Act)
- Water Resources Act 1997
- Water Resources Commission Act, 1996 *(*Act 522)
- National Land Policy, Ministry of Lands and Forestry, 1999

6.3. Decision Making Process

The laws, regulations and the decision-process for planning and implementing dam projects in Ghana exist on paper – the reality is that all such large projects are political decisions and as such it is the Government (sometimes The President) in power which would determine the process. In this respect, dams are no different from any other infrastructure project. Advice from

the Technocrats in the Ministry – opposition from Conservation groups, is really not heeded. The bottom line is whether or not the funding for the project has been secured. The other aspect is even when good decisions have been made based on a comprehensive EIA and stakeholder consultation; there is no guarantee that the decisions will be implemented by Government.

7. Conclusions and Recommendations

After viewing several hundred documents on the impact of dams in developing counties, the main conclusion that can be drawn is that it is sheer luck (or divine providence) that the impacts of the various hydro-development options that have been initiated in Ghana have not brought major environmental disaster or social unrest upon the nation. At the United Nations Symposium on Hydropower and Sustainable Development held in Beijing in 2004, Kalitsi states "From VRA's experience in assessing and managing the social and environmental impacts of the Akosombo dam certain lessons emerged. Some of these are the need for detailed and timely information on the local communities and on the natural environment. Secondly, it is important to ensure that public awareness programs are mounted on dam projects and local communities participate actively in the planning of such projects." There is a need for greater involvement of civil organization groups, during planning and after construction of the dams is essential (as in the Bui plan). There is also a need for training at the district assembly level on the basic principles of EIA and IWRM would empower them to take a more active part in the dam debate.

It is recommended that the following be decide as soon as possible:

- Establishment of the Dams and Development multi-stakeholder group (Forum) in Ghana
- Formation of a Coordination Committee
- Agreement on the Roles and Responsibilities
- Agreement on the Mode of Operation
  - Promoting Dialogue
  - Networking
  - Dissemination
  - Best Practice
- Possibilities for hosting of Secretariat and host institution commitment.

The specific role of the Ghana Dams and Development Forum is to;

- Act as a platform for National multi-stakeholder dialogue on dams-related issues,
- Exchange experiences and lessons,
- Act as a consultative body.

The Coordinating Committee has the role of:

- Provide advice to stakeholders, including Government
- Ensure that the multi-stakeholder consultative character is maintained
- Convene meetings of the Ghana Dams and Development Forum
- Provide reports/information to the Ghana Dams and Development Forum members

The suggested composition of the Ghana Dams and Development Forum should be as follows:

Grouping	Representatives
National MDAs -	MoF, MoE, MMLF, MLGRD&E, WRC, EPA, NDPC, FC, MWRW&H, MC, Energy Comm., MW&CA
National Operators & Private Sector	VRA, GWCL, MF&A-GIDA, GCmines, AGI, GNCC, ECG
Local Level Institutions	District Assemblies, MPs, Reg Cood. Council, CWSA, GNCanoe FA
Community and Traditional Structures	Dam affected communities, NAVRAT52, Regional House of Chiefs, Queen mothers
Local NGOs & Media	VBDF, CI, GWS, FoE, ISODEC, KITE etc. Env. Journalists, Media houses
Research Organisations	Universities (VBRP, ISSER) CAW CSIR-WRI, CSIR-STEPRI
International Finance/Donor Agencies/Banks	WB, AfDB, IFC, DFID, GTZ, Danida

International non-financial institutions IWMI, WWF, UNEP, UNDP, Wet. Int, DDP
* Observers

The Coordinating body would be drawn from this membership.

The National Dialogue would provide a platform to discuss these topics such as internal conflicts between stakeholders, their apathy towards a progressive attitudinal and behavioural change as well as the problem of a low level of understanding due to a lack of literacy. The Forum would seek avenues to develop together with the affected local population methods to solve those problems.

The main recommendation however is that Ghana should not reinvent the wheel. There are a multitude of documentation, techniques and guidelines available today based on several decades of work, including the work of the World Commission of Dams, and the on going Dams and Development Project. The approach does not even need to be modified for the Ghanaian situation as they are within our technical and institutional capabilities. The key remaining element, as always, is funding. Issues such as benefit sharing, improving the decision making process, participation and involvement of stakeholders are all part of the modern approach.

For example, below is presented the key elements of the World Bank resettlement policy and Key criteria that should be used in comparing various energy options as well as hydropower alternatives. These documents can be used as is and would assist the decision making process.

The Ghana environmental impact assessment procedure follows the World Bank and OECD models very closely. In principle, following the procedure is a good way to ensure that dam projects have reduced impact. The problem is there is a lack of capacity to effectively monitor and evaluate compliance to the EIA and to the EMP by the EPA. There have been numerous calls and documents from both within and external to the EPA on this need for capacity building, this problem is being addressed gradually but is being hampered by the comparatively low salaries that EPA staff receives as compared to the private sector.

When making the initial decision on whether a dam should be built or not, the alternative options for their key services (energy and water supply) should be considered very early in the process as part of a comprehensive options assessment.

- A comprehensive options assessment is part of a decision making process that works toward identifying the most appropriate option to satisfy defined needs. The processes are conducted at policy, strategic planning and project levels
- The main outputs are:
  - Improvement of development outcomes
  - Legitimacy for selected outcomes
  - Reduction of controversy
  - Create ownership by stakeholders
  - Facilitate buy-in by stakeholders of results

Below are given the criteria used for energy and dam options by the International Hydropower Association.

Key criteria that should be used in comparing various energy options (IHA)

Key criteria	Commentary
1. *Assess the options in terms of need against supply-side and demand-side efficiency measures.*	Ideally, this process should be carried out by governments. Assessments need to consider existing supply-side and demand-side efficiency standards in the affected region, the economic feasibility and practicability of alternative efficiency options and the delivery of equivalent benefits.
2. *Assess the options in terms of resource depletion*	This is a question of inter-generational equity. Projects that consume finite resources can be transferring costs to future generations. Projects using abundant resources are preferable to those depleting scarce resources.

Key criteria	Commentary
	Renewable energy options do not directly consume finite resources.
3. *Assess the options in terms of energy payback ratio*	Energy payback is the ratio of energy produced during the normal life span of a project divided by the energy required to build, maintain and fuel the generation equipment. Renewable sources have most of their energy inputs during the construction phase, whereas fossil fuel systems continue to consume energy through extraction, transportation and processing.
4. *Assess the option in terms of economic viability over the life of the facility.*	The economic feasibility and viability of each option needs to be considered over the projected life of the facility. Electricity generation is a long-term business, with most hydro facilities being considered viable for at least 40 years. With refurbishment they have a longer life than many alternatives such as coal, nuclear or gas generation.
5. *Assess the option in terms of the availability and cost of resources over the projected life of the facility.*	The availability and cost of fossil fuels may change over the operating life of a power station with availability decreasing and cost increasing. With hydropower, drought can impact on the ability to generate power although water use is basically non-consumptive.
6. *Assess the options in terms of appropriateness of the technology, levels of efficiency and service required.*	Projects should use appropriate and proven technology to cost effectively maximize the benefits to be derived from use of a resource. Comparisons should be made on the efficiency of conversion and the flexibility and reliability of the product provided. The comparison should take account of the level of service required (e.g., some electric systems may require peak load capacity while others may seek stable base load). Hydro-electric systems generally rate highly level of service provided. They are very efficient, have relatively low maintenance costs and can provide a flexible and reliable product that supports other less flexible systems in the overall energy mix.
7. *Assess the options in terms of additional or multiple use benefits.*	The creation of reservoirs for hydropower projects provides opportunities for multiple-use benefits rarely associated with other forms of electricity production. Examples include drinking water supply and sanitation, water for business and industry, water for sustainable food production (both in-reservoir and via irrigation), flood mitigation, water-based transport, and recreation and tourist opportunities.
8. *Assess the options in terms of poverty reduction through flow on benefits to local communities via employment, skills development and technology transfer.*	Many energy development projects provide jobs for the local population. Direct and indirect employment opportunities, both during construction and for the life of the project, as well as expansion of the local skills base, capacity building and the benefits of technology transfer should all be assessed when evaluating options.
9. *Assess the options in terms of carbon intensity and greenhouse gas emissions.*	In general terms hydro-electric schemes and other renewable energy projects have low carbon intensity and low levels of greenhouse gas emissions. This compares, for example, with coal-fired systems that emit approximately 1000 tonnes of CO2 per GWh produced.
10. *Assess the options in terms of land area affected (environmental footprint) and associated aquatic and terrestrial ecological impact.*	The relatively dilute nature of renewable resources often means that these types of projects have a large environmental footprint per unit of energy produced. Run-of-river and mini-hydro projects usually have relatively small environmental footprints. Projects that are spread over large areas of land often have limited or easily mitigated environmental effects. Wind farms, for example, have limited impact on other land use activities. Some fossil fuel-based projects can have a very large footprint, for example, the area affected by air emissions. The impact of the environmental footprint needs to be assessed in relation to the associated aquatic and terrestrial ecological impacts and the degree to which they can be mitigated and/or compensated.
11. *Assess the options in terms of waste products (emissions or discharges to air, water and land).*	Waste products are a major sustainability issue for fossil fuel and nuclear projects. Negative health effects can result from particulate and other emissions to air. Disposal of waste to tailings dams and radio-active waste repositories represents an inter-generational transfer of cost and environmental liability.

Key criteria that should be used in comparing hydro-electric project alternatives (IHA)

Key criteria	Commentary
1. *Prioritize upgrading of existing facilities*	Although hydro-electricity is an essentially efficient form of electricity generation, refurbishment and modification of operational regimes, particularly of older power stations, can often result in significant additional energy generation.
2. *Prioritise alternatives that have multiple-use benefits.*	Hydro-electric projects normally have a variety of other uses and benefits. These can include irrigation, water supply, fishing, flood mitigation, water-based transport, tourism and recreation. The value of these additional benefits should be considered when comparing project alternatives. The value should be discounted against any loss of benefits (including environmental costs) associated with the project.

Key criteria	Commentary
3. *Prioritise alternatives on already developed river basins.*	The potential of sites on already developed rivers is not always fully realised. While consideration of cumulative and other environmental impacts is necessary it is often preferable to develop new hydro-electric projects on already regulated river systems.
4. *Prioritise alternatives that minimise the area flooded per unit of energy (GWh) produced.*	Increasing the area flooded generally increases environmental impacts. Impact avoidance is more effective than mitigation so the selected site and project design should tend towards minimising the flooded area per unit of energy produced (square kilometres per gigawatt hour)
5. *Prioritise alternatives that maximize opportunities for, and do not pose significant unsolvable threats to, vulnerable social groups.*	Where vulnerable social groups will be affected, projects should include comprehensive social and cultural enhancement programs. Projects that present significant threats to vulnerable social groups should be avoided if the threats cannot be mitigated.
6. *Prioritise alternatives that enhance public health and / or minimise public health risks.*	Hydropower developments can often provide significant new public health benefits to previously poorly developed areas. Projects can also pose risks, such as increases in waterborne diseases and a temporary rise of mercury levels in fish. Where these risks exist they need to be managed and monitored with an appropriate public health plan.
7. *Prioritise alternatives that minimize population displacement.*	Where population displacement is necessary, comprehensive resettlement and rehabilitation plans need to be developed and implemented in consultation with the affected population. Opportunities to modify scheme design to reduce population displacement need to be carefully examined. An example could be lowering the full supply level of a proposed reservoir.
8. *Prioritise alternatives that avoid exceptional natural and human heritage sites.*	Developers should make every effort to avoid, or reduce to a minimum, alteration to sites of exceptional national and international value.
9. *Prioritise alternatives that have lower impacts on rare, vulnerable or threatened species, maximize habitat restoration and protect high quality habitats.*	Potential impacts on rare, vulnerable or threatened species should be carefully assessed as part of the decision-making process. Consideration of the creation of alternative habitats or the protection of adjacent areas should be considered as part of any mitigation program. Habitats are of varying quality and priority should be given to protecting or restoring higher quality habitats. Significant damage to areas of high conservation value (including critical habitat for endangered species) should be avoided when adequate mitigation or compensation is not feasible.
10. *Prioritise alternatives that can achieve or complement community-supported objectives in downstream areas.*	Regulation of a river, or its diversion, creates environmental change in the downstream reaches. Environmental flow regimes should be developed on the basis of community-supported objectives.
11. *Prioritise alternatives that have associated catchment management benefits and lower sedimentation and erosion risks.*	Sites and options should be assessed for sedimentation and erosion risks, both within the reservoir and downstream. Catchment management strategies can reduce sediment load entering reservoirs. Developers need to assess the need for the creation of catchment reserves or other management strategies to reduce erosion and sediment transport. Where appropriate, support should be given for conservation areas in catchments. Construction programs should be geared to ensuring minimum disturbance and appropriate rehabilitation of disturbed sites.

Key Elements of the World Bank's Resettlement Policy

- Avoid or minimize. Involuntary displacement should be avoided or minimized whenever feasible, because of its disruptive and impoverishing effects.
- Improve or restore livelihoods. Where displacement is unavoidable, the objective of Bank policy is to assist displaced persons in their efforts to improve, or at least restore, former living standards and earning capacity. The means to achieve this objective consist of the preparation and execution by the Borrower of resettlement plans as development programs. These resettlement plans are integral parts of project designs.
- Allocate resources and share benefits. Displaced persons should be: (i) compensated for their losses at replacement cost, (ii) given opportunities to share in project benefits, and (iii) assisted in the transfer and in the transition period at the relocation site.
- Move people in groups. Minimizing the distance between departure and relocation sites and moving people in groups can facilitate the resettlers' adaptation to the new socio-cultural and natural environments. The trade-offs between distance and economic opportunities must be balanced carefully.

- Promote participation. Resettlers' and hosts' participation in planning resettlement should be promoted. The existing social and cultural institutions of resettlers and their hosts should be relied upon in conducting the transfer and reestablishment process.
- Rebuild communities. New communities of resettlers should be designed as viable settlement systems equipped with infrastructure and services, able to integrate in the regional socio-economic context.
- Consider hosts' needs. Host communities that receive resettlers should be assisted to overcome possible adverse social and environmental effects from increased population density.
- Protect indigenous people. Tribal and ethnic minorities, pastoralists, and other groups that may have informal customary rights to the land or other resources taken for the project, must be provided with adequate land, infrastructure, and other compensation. The absence of legal title to land should not be grounds for denying such groups compensation and rehabilitation.

(Based on World Bank Operational Directive 4.30: Involuntary Resettlement.)

Literature consulted

Adelle, C., J. Hertin, and A. Jordan. (2005). Sustainable Development 'outside' the European Union: What Role for Impact Assessment? CSERGE Working Paper EDM 05-08. 23 pp.

African Development Bank (ADB). (2005). Accra Sewerage Improvement Project. Summary Report of the Environmental and Social Impact Assessment, Accra. 19 pp.

Andersson, E.; Nilsson, C.; Johansson, M. E. (2000). Effects of river fragmentation on plant dispersal and riparian flora, *Regulated Rivers: Research and Management* 16: 83 - 89

Appiah-Opoku, S. (2001). "Environmental impact assessment in developing countries: the case of Ghana " Environmental Impact Assessment Review 21: 59 - 71.

Asante, K.A. (1999) Nutrient Status of Two Ghanaian Water Reservoirs, 25th WEDC Conference – Integrated Development for Water Supply and Sanitation, Addis Ababa, Ethiopia, 1999

Association of State Dam Safety Officials, (2000), Ohio Dam and Safety Laws. Ohio.

Bao, M. (2006). "The Evolution of Environmental Policy and its Impact in the People's Republic of China." Conservation and Society 4(1): 36 – 54.

Barbagallo, S., S. Consoli, Pappalardo, N., Greco, S. and Zimbone, S. M. (2006). "Discovering Reservoir Operating Rules by a Rough Set Approach." Water Resources Management 20: 19 - 36.

Bateman, I., S. Georgiou, I. Lake. (2005). The Aggregation of Environmental Benefit Values: A Spatially Sensitive Valuation Function Approach CSERGE Working Paper EDM 05-04. 65 pp.

Bohman, A (2006) Framing the Water Challenge, Multilateral Donor Policies for Water Supply and Sanitation 1960 – 2005. Occasional Papers in Economic History No. 10, 98 pp

Brew-Hammond, A. () Renewable Energy in Ghana, PowerPoint presentation for Theme Challenges for the 21st Century. University of Science and Technology (UST), Kumasi / University of Science and Technology (UST), Kumasi / Kumasi Institute of Technology and Environment (KITE)

Brismar, A. (2004) Attention to impact pathways in EISs of large dam projects. *Environmental Impact Assessment Review* 24 (1):59-87

Brody, S., (2003), Measuring the Effects of Stakeholder Participation on the Quality of Local Plans Based on the Principles of Collaborative Ecosystem Management, *Journal of Planning Education and Research* 22:407-419

CGIAR Challenge Program on Water and Food (2006). Synthesizing knowledge on livelihoods, water, food and the environment. Background to the International Forum on Water and Food. Vientiane, Lao PDR, 12 - 17 November 2006.

Delaware Source Water Assessment Plan (SWAP) (1999). Delaware Department of Natural Resources and Environmental Control. 82 pp.

Dudgeon, D., A. H. Arthington, et al. (2006). "Freshwater biodiversity: importance, threats, status and conservation challenges." Biological Reviews 81: 163 - 182.

Dungumaro, E. W. (2006). "Improving water resources management in Tanzania." African Journal of Environmental Assessment and Management 11: 33 - 41.

Edjekumhene, I., M.B. Amadu and A. Brew-Hammond. (2001). Power Sector Reform in Ghana: The Untold Story. Kumasi Institute of Technology and Environment (KITE). 47 pp.

Endter-Wada, J., D. Blahna, et al. (1998). "A Framework for Understanding Social Science Contributions to Ecosystem Management." Ecological Applications 8(3): 891 - 904.

Energy Commission. Ghana Power Sector Reform in Perspectives. http://www.energycom.gov.gh/news/downloadnews/pdf/ES_Presentation.pdf

Environmental, Resettlement and Dam Safety Studies for Ghana WSRP. 2004a. Ghana Water Sector Restructuring Project Dam Safety Assessment. Draft final Report. Royal Haskoning. Netherlands.

Environmental, Resettlement and Dam Safety Studies for Ghana WSRP. 2004b. Ghana Water Sector Restructuring Project: Part 2: Environmental Assessment Management Plan. Draft final Report. Royal Haskoning. Netherlands.

FAO (2005). Irrigation in Africa in figures: AQUASTAT Survey – 2005. Ghana. Available at http://fao.org/agl/aglw/docs/wr29_eng.pdf

FAO 2005. Ghana. Profile in Water Report No. 29.

FAO Corporate Document Repository. Supporting aquaculture development in Africa: Research Network on Integration. Chapter 2: Ghana.

Ferguson, A. E. and W. O. Mulwafu (2005). Irrigation reform in Malawi: exploring critical land-water intersections. African Water Laws: Plural Legislative Frameworks for Rural Water Management in Africa

Freshwater (2004) Freshwater Country Profile: Ghana http://www.un.org/esa/agenda21/natlinfo/countr/ghana/waterghana04f.pdf

Grey, D. (2002). Water Resources and Poverty in Africa: Breaking the Vicious Circle. Paper presented at Inaugural meeting of AMCOW, Abuja, Nigeria – 30 April 2002. Based on paper written by Grey, D., and Sadoff, C.

Guide to Electric Power in Ghana First Edition. Resource Center for Energy Economics and Regulation. Institute of Statistical, Social and Economic Research, University of Ghana. 63 pp. Available at http://www.beg.utexas.edu/energyecon/IDA/USAID/RC/Guide_to_Electric%20Power_in_Ghana.pdf

International Hydropower Association, (2004), Sustainability Guidelines,

International Rivers Network. 2006. IRN and the World Commission on Dams. Background. http.

International Water Power and Dam Construction. 2006. Private and public – time to work together? Feature by Ogunbiyi, C. 14 December 2004. Published by Wilmington Media Ltd. http site.

Joyce, S., (1997). Is it worth a Dam? Environmental Health Perspectives 105 (10).

Kusi, G. E. (2005). Ghana's Experience with Power Sector Reform: Legislative and Policy Issues Parliamentarian Forum on Energy Legislation and Sustainable Development. Cape Town, South Africa.

Larbia, W. O., A. Antwia, et al. (2003). "Compulsory land acquisition in Ghana—policy and praxis." Land Use Policy 21: 115 -127.

Levit, S.M. and D. Chambers, (2005). Environmental and Social Impact Assessment: Ahafo South Project. Technical Review. Center for Science in Public Participation. 24 pp.

Liebe, J., van de Giesen, N. Andreini, M. (2005) Estimation of small reservoir storage capacities in a semi-arid environment: A case study in the Upper East Region of Ghana, *Physics and Chemistry of the Earth* 30: 448–454

McAllister, D. E., J. F. Craig, et al. (2001). Biodiversity Impacts of Large Dams. Background Paper Nr. 1, International Union for Conservation of Nature and Natural Resources, United Nations Environmental Programme

Morris, R. K. A., I. Alonso, et al. (2006). "The creation of compensatory habitat—Can it secure sustainable development?" Journal for Nature Conservation 14: 106 - 116.

Mulvihill, P. (Regulation, R. C. f. E. E. a. (2005). Guide to Electric Power in Ghana. First Edition. Legon, Accra, Ghana, Institute of Statistical, Social and Economic Research: 63.

Nam Theun 2 Project – Social Development Plan. (2005). Volume 3 – Chapter 8: Mitigation, Resettlement and Livelihood Restoration. 61 pp.

Neumann-Silkow, F., () The Environmental Manual for Power Development (EM): A Tool for Comprehensive Options Assessment in the Energy Sector, Relevant WCD Strategic Priority.

Niels Jungbluth, N., (1995). Environmental Manual for Power Development. Data Sources and Data Compilation for the Indian Dataset. Documentation for the Indian Database for the Environmental Manual. Berlin. 62 pp.

NZSOLD (New Zealand Society on Large Dams), (2006). Regulations for the Dam Safety Scheme, New Zealand.

Opoku-Agyemang, M., (2005). The role of the district assemblies in the management of transdistrict water basins in Ghana. Presented at International workshop on '*African Water Laws: Plural Legislative Frameworks for Rural Water Management in Africa*', 26-28 January 2005, Johannesburg, South Africa

Paavola, J., (2005). Environmental Conflicts and Institutions as Conceptual Cornerstones of Environmental Governance Research. CSERGE Working Paper EDM 05-01. 25 pp.

Pochat, V. (). Identification, Collection of Information and Compilation of Examples of Relevant Practices concerning the Integration into Policy/Normative Frameworks and Implementation of Key Priority issue: DDP - International Policy in Shared River Basins Submitted to Dams and Development Project. 159 pp.

Pottinger, P., (2000). International Rivers Network: Working to Protect Rivers from Large Dams. International Journal of Water 1 (1).

Practical Action Consulting (2006) Issue of Identification of Options in Context of Dam Planning and Management. Final Report to UNEP/DDP, 152 pp.

PricewaterhouseCoopers (2004). Sub-Saharan Africa's Energy conundrum. Available at http://www.pwc.com/gx/eng/about/ind/gov/ifi/pdf/electricity_sector_overview_in_africa.pdf

Randolph, J., and M. Bauer, (1999), Improving Environmental Decision Making, *Policy Studies Review* 16:3/4, 25 pp

Remediation of the environmental impacts of the Akosombo and Kpong dams. 2003 Submitted by Fobil, J. to the Horizon Solutions Site. http.

Resettlement Policy Framework Volume 1, Draft final Report, Royal Haskoning.

Sarpong, G.A. Customary Water Laws and Practices: Ghana. Unpublished paper.

SEI (Stockholm Environment Institute) (2005). Sustainable Pathways to Attain the MDGs: Addressing the Key Role of Water, Energy and Sanitation. www.ecosanres.org

Stanley, T. R., Jr., (1995). "Ecosystem Management and the Arrogance of Humanism." Conservation Biology 9(2): 255 - 262.

Suen, J.-P. and J. W. Eheart (2006). "Reservoir management to balance ecosystem and human needs: Incorporating the paradigm of the ecological flow regime." Water Resources Research 42: W03417, doi: 10.1029/2005WR004314.

Tetteh, I. K., E. Fremponga, et al. (2004). "An analysis of the environmental health impact of the Barekese Dam in Kumasi, Ghana." Journal of Environmental Management 72: 189 - 194.

Tomkins, R., 2003. Ghana Power Sector. Review of Reform Programme. Prepared for Economic Consulting Associates Ltd. 56 pp.

UN Millennium Project. 2004. Background Paper: Millennium Development Goals Needs Assessments for Ghana, Tanzania, and Uganda, UN Millennium Project: New York.

UNEP Dams and Development Project. (2006a). Stakeholder Participation Compendium of Relevant Practices. Sherwood Natural Resource Management and

UNEP Dams and Development Project. (2006b). Compendium on Relevant Practices: Social Impact Assessment of Affected People, Final Report, ACER (Africa) Environmental Management Consultants, South Africa, 255 pp

UNEP Dams and Development Project. (2006c). Compendium on Relevant Practices: Addressing Outstanding Social Issues, Revised Final Report prepared by Schmidt-Soltau, K., 83 pp

UNEP Dams and Development Project. (2006d). Compendium on Relevant Practices on Improved Decision-Making, Planning and Management of Dams and their Alternatives. Draft Final Report prepared by Ramsey, J. 130 pp

UNEP Dams and Development Project. (2006e). Compendium on Relevant Practices – 2nd Stage: Compensation Policy Issue. Prepared by Roquet, V. 138 pp.

UNEP Dams and Development Project. (2006f). Compendium on Relevant Practices on. Compliance Theme prepared by Bruch, C., 220 pp

UNEP Dams and Development Project. (2006g). Compendium on Relevant Practices – 2nd Stage: Benefit Sharing Issue. Revised Final Report prepared by Égré, D., 110 pp

UNEP Dams and Development Project. (2006h). Compendium on Relevant Practices for Improved Decision-Making, Planning and Management of Dams and their Alternatives. Draft Rev 0.5. 152

USAID/GHANA COUNTRY STRATEGIC PLAN (2004-2010) 2003 Empowering Ghanaians through Partnerships to Build a Prosperous Nation 177 pp. http://www.dec.org/pdf_docs/pdaby444.pdf

van Edig, A., Engel, S., Laube, W. (2003): Ghana's water institutions in the process of reforms: from the international to the local level, in: Neubert, S. et al. (eds.), Reforming Institutions for Sustainable Water Management. German Development Institute, Bonn: 31-50 http://www.glowa-volta.de/publications/printed/van_edig_etal_2003.pdf

Vanclay, F. (2000). Social Impact Assessment, Contributing Paper to World Commission on Dams http://www.dams.org/docs/kbase/contrib/ins220.pdf

Water and Sanitation Program (2002) Rural Water Sector Reform in Ghana: A Major Change in Policy and Structure. Field Note 2 written by Kleemeier E., for Water and Sanitation Program – Africa Region (WSP-AF)

Water for Energy Country Report. Central African Republic. Report submitted by Energie Centrafricaine (ENERCA). 23 – 25. http.

Water for Energy: Country Reports Turkey. Report submitted by: Ministry of Energy and Natural Resources, State Hydraulic Works – DSI 125 - 135

Water Resource Commission (WRC) (2001) LI 1692 Water Use Regulations

Water Resources Commission Act (1996) Act 522. Parliament of the Republic of Ghana

WAWI (2006). West Africa Water Initiative (WAWI) 2006 – 2010 Strategic Plan. The Power of Partnership. Prepared by Doyle, B., and J.M. Corliss Jr.

White Paper (2006) Eliminating World Poverty: Making governance work for the poor. A White Paper on International Development. DFID Department for International Development UK. http://www.dfid.gov.uk/wp2006/whitepaper-printer-friendly.pdf

World Bank (2001). The World Bank Operational Manual: Operational Policies. Available at http://wbln0018.worldbank.org/Institutional/Manuals/OpManual.nsf/023c7107f95b76b88525705c002281b1/c12766b6c9d109548525672c007d07b9?OpenDocument

World Commission on Dams (1999). The World Bank Position on the Report of the World Commission on Dams Available at http://www.dams.org/news_events/media211.htm

World Commission on Dams (2000) Chapter 9: Criteria and Guidelines – Applying the Strategic Priorities Dams and Development: A New Framework for Decision-Making 259 - 307

World Commission on Dams (2000) Environmental and Social Assessment for Large Scale Dams, WCD Thematic Reviews Draft Working Paper. 48 pp

World Commission on Dams (2000) The Social Impact of Large Dams: Equity and Distributional Issues, WCD Thematic Review 1.1 Social Issues. Draft Working Paper. 64 pp

World Commission on Dams 2002. Dams and Ecosystems: Assessing and Managing Environmental Impacts (Ghana's Experience). Written by Kalitsi, E.A.K. Serial No: Env 101. http.

World Resources Institute (2003) Country Profile: Water Resources and Freshwater Ecosystems - Ghana http://earthtrends.wri.org/pdf_library/country_profiles/wat_cou_288.pdf

Worldwatch Institute. 1996. Development Affecting Rivers and Wetlands Boomerangs to Cause Economic and Biological Loss. Hold for Release Saturday, March 23, 1996. http link.

WWF International (2000). The Impact of Dams on Life in Rivers. A WWF Research Report. Prepared by Biksham, G. and Hunziker, D.O., Switzerland. 69 pp.