



Addressing Transboundary Concerns in the Volta River Basin and its Downstream Coastal Area

# **Study relating to the establishment of a regional data and information exchange mechanism in the Volta River Basin**

**(Ghana)**

Project Number: 53885

## **Final report**

**December, 2008**





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## Executive summary

This report is the contribution from the study carried out for Ghana towards establishing a regional information and data exchange mechanism in the Volta River Basin. The Volta River Basin is shared by the six riparian countries, Benin, Burkina Faso, Ghana, La Cote D'Ivoire, Mali and Ghana.

It has been a source of water for the population of the basin for their social and economic development. Because the resources have not been so well managed, problems like water shortages, water quality degradation, water borne diseases, loss of biodiversity, growth of aquatic weeds and coastal erosion among others have arisen.

The six countries have asked for GEF assistance to help them manage the basin in an integrated and participatory manner to meet the needs of present and future generations and to protect the ecosystem.

The implementation of the GEF project requires various kinds of data. Unfortunately at present the mechanism for exchanges of environmental data and information essential for the sustainable management of the basin is non-existent. Access to and use of the increasingly diverse, comprehensive data and information on transboundary river basin environment is required by the riparian countries in order to deal with the vast array of policy management, scientific and other practical issues.

To accomplish this, the GEF plans to compile and link sets of data and information to create the required database and facilitate access to decision-makers and other users of data and information.

This study was therefore undertaken with the objective to establish a regional information and data exchange mechanism and to make recommendations concerning a working mechanism for effective management of the information system. The outputs expected are:-

- An inventory and analysis of Ghanaian data and information on the Volta River Basin.
- Development of a Training Plan for Ghanaian institutions on data and information management.

The Study was carried out by collecting data on the institutions, the data that they gather and manage their human resources they have at national and local levels. The data collected were analysed and the following findings, conclusions and recommendations were made

From the findings of the study, the following Conclusions and Recommendations are made.

- About twenty (20) national institutions were identified which contribute to the data and information required for the integrated management of water resources to meet socio-economic and ecosystem protection objectives in Ghana.
- Most of the institutions have fax, e-mail and website addresses which they use for data and information exchange. It appears these communication facilities can be exploited more fully.
- Information about the data collected are available as meta data and can be obtained generally on request. The institutions have database management softwares acquired for particular needs. Some are out of date and need upgrading. Data and information are available in hard copies and in digitised formats.
- Various categories of users including Policy Makers, Planners, Designers and Contractors, Operators of Water Systems, Water Users, Education and Research Institutions, Regulators of the Environment and Awareness Creators were identified. Their special data needs were noted to be catered for.
- All the institutions have trained human resource for their work. The need for training is justified on the basis that :-
  - Staff training had not kept up with the policy of periodic training to keep abreast with new knowledge and technologies.
  - New staff who are being recruited to replace older staff have to be trained.

- Equipment and facilities acquired through donor projects to strengthen the data collection institutions some ten (10) years ago, need replacement with more modern ones. This must be accompanied by training to use the new equipment and facilities efficiently.
- In view of the large number of institutions, a priority list of institutions should be selected for establishing the mechanism for the exchange. These are the GMA, HSD, WRI and GSS. This is in view of their critical role in generating water cycle, physiographic, socio-economic and cultural data for IWRM.
- Within these institutions, emphasis should be placed on the operational staff viz those involved in data collection, transmission, processing, archiving and retrieval.
- Based on the limited training needs assessment and the gaps found, a training plan was developed as presented in Table 23.
- Ownership of the report by the national institutions as was originally expected in the TOR cannot be said to have been achieved.

From the above findings and conclusions, it is recommended that the mechanism to exchange information and data should carry out the following:-

- The HSD must be assisted to acquire fax, e-mail and website facilities.
- The WRC website should be fully developed and links established to the websites of the HSD, GMA, WRI, CERSGIS and GSS. This is to better position Ghana in the regional mechanism for data and information exchange.
- Implement the Training Plan as defined in Table 23.
- The national institutions should be given a chance to validate the report.

## List of abbreviations and acronyms

Abbreviation	Definition
AITI	- Advance Information Technology Institute (Kofi Annan Centre)
AMSL	- Above Mean Sea Level
AVHRR	- Advance Very High Radiometric Radiometer
CERSGIS	- Centre for Remote Sensing and Information Services
CLICOM	- Climatological Data
CSD	- Crop Services Directorate
CLIDA	- Climate Data
CSIR	- Council for Scientific and Industrial Research
CWSA	- Community Water and Sanitation Agency
DFID	- Department for International Development
EMMSDAG-	Mapping and Monitoring Development Projects in Ghana
EPA	- Environmental Protection Agency
FAO	- Food and Agriculture Organisation
FC	- Forestry Commission
GERMP	- Ghana Environmental Resources Management Project
GIDA	- Irrigation Development of Ghana
GIS	- Geological Information System
GLOWA	- Global Hydrological Cycle
GMA	- Ghana Meteorological Agency
GPS	- Global Positioning System
GSS	- Ghana Statistical Service
GWCL	- Ghana Water Company Limited
GWV	- Groundwater for Windows
HSD	- Hydrological Services Department
HYDATA	- Hydrological Data
IT	- Information Technology
IUCN	- International Union for Conservation
IWRM	- Integrated Water Resources Management
MDA	- Ministries, Departments and Agencies
MOFA	- Ministry of Food and Agriculture
MOFI	- Ministry of Fisheries
NADMO	- National Disaster Management Organisation
NDPC	- National Development Planning Commission
NGOs	- Non-Governmental Organisations
PAGEV	- Programme for Water Governance in the Volta Basin
SAP	- Strategic Action Plan
SRI	- Soil Research Institute
SRID	- Statistics, Research and Information Directorate
TDA	- Transboundary Analysis
UG	- University of Ghana
UK	- United Kingdom
VBA	- Volta Basin Authority
VBRP	- Volta Basin Research Project
VBTC	- Volta Basin Technical Committee
VSD	- Veterinary Services Directorate
VLTC	- Volta Lake Transport Company
VRA	- Volta River Authority
WRC	- Water Resources Commission
WRI	- Water Research Institute
WRIS	- Water Resources Information Services

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# 1 Introduction

## 1.1 Background

1. The Volta River has been a source of water for the populations in the basin for many years. Since the 1960s and with growth in population and economic development, there has been a corresponding growth in water use. The river is presently developed as a source of hydropower in Ghana, Togo, Benin and Burkina Faso. It is also a source of drinking and industrial water supply for rural communities and urban centres like Ouagadougou, Bobo Diolasso, Tamale and Accra. The development of agriculture particularly in the drier parts of northern Ghana depends very much on a number of dams (small, medium and large) which have been constructed to provide irrigation water for dry season farming and for livestock watering.
2. These have resulted in land and water management problems. These problems include water shortages, water quality degradation, water borne diseases, flooding, loss of biodiversity, growth of aquatic weeds, coastal erosion, etc. These problems have been worsened by the fact that the developments have been driven by individual national needs with less consideration for other riparians. In the past decade or so, there have been a number of initiatives to get the riparian countries to co-operate either at the bilateral or multilateral level to consult and co-operate in addressing the problems in an integrated manner.
3. The development of water resources to meet various sectoral needs in a sustainable manner should be seen within the national contexts of the National Water Visions and the Goals of National Poverty Reduction Strategy Papers, the West African Water Vision, The African Water Vision and the goals of the New Partnership for African Development, and the Millennium Development Goals.
4. As the pressure of human development on the basin grew, the six riparian countries sought assistance from the Global Environmental Facility to help them manage the basin. Towards this end, a Transboundary Diagnostic Analysis (TDA) has been carried out and a Strategic Action Programme (SAP) has been developed towards joint management of the basin for the equitable benefit of the countries. This was developed between 2001 and 2002 and resulted in GEF – UNEP Volta Basin Project. Following this, an Intergovernmental Consultative Committee called the Volta Basin Technical Committee (VBTC) made up of representatives of the six riparian countries was established in 2004 to facilitate the creation of the Volta Basin Authority. The Convention and Statutes to set up the authority was signed in Lome in July 2006. The secretariat of the VBA was established in October 2006 while the statutes were ratified by the Heads of State of the six riparian countries in January 2007.
5. Following the preliminary SAP GEF approved a project to assist the six countries to the transboundary problems. This is the UNEP/GEF Volta River Basin Project for “*Addressing Transboundary Concerns in the Volta River and its Downstream Coastal Area*”. It is a regional initiative of six riparian countries. The project which has been designed to facilitate the integrated management, sustainable development and protection of natural resources of the Volta River Basin plan to achieve its objectives by addressing priority regional transboundary issues and problems as identified through a preliminary transboundary diagnostic analysis (TDA) earlier conducted on the basin. The project is expected to promote a more sectorally-coordinated management approach, based on integrated Water Resource Management (IWRM) principles, both at the national and the regional levels, with a strong emphasis on an expanded role for all stakeholders.
6. The long-term goal of the project is to enhance the ability of the countries to plan and manage the Volta catchment areas within the territories and its aquatic resources and ecosystems on a sustainable basis.
7. The project aims at contributing to regional integration, promoting coordination and dialogue

among the riparian member countries and tottering the participation of the local populations and the stakeholders as far as the Volta River Basin resources are concerned.

8. Since 2005, the World Conservation Union (IUCN) also initiated a programme of assistance to improve Water Governance in the Volta Basin (PAGEV). The programme is aimed at Policy and Institutional Change; Promoting the use of Principles of IWRM and developing a Decision Support System to assist in the allocation and conservation of water among the riparian countries. Other projects which have a bearing on land and water management in the basin are the GLOWA project which is focussed on land use and climate on water resources and the challenge programme on Water for Food which is aimed at finding ways of producing more food with less water.
9. Unfortunately at present, the mechanism of exchange of environmental data and information essential for the sustainable management of the basin is non-existent. Access to and use of the increasingly diverse, comprehensive data and information on transboundary river basin environment is required by the riparian countries in order to deal with the vast array of policy, management, scientific and other practical issues.
10. To accomplish this, the GEF Volta Project plans to compile and link sets of data and information to create the required database and facilitate access to decision-makers and other users of data and information.

## 1.2 Objective of the Study and Expected Outputs

11. The overall objective of the consultancy is to establish a national mechanism as part of regional information and data exchange mechanism and also make recommendation concerning working mechanism for effective management of the information system.
12. The expected output is to deliver a report containing:
  - An inventory and analysis of existing national data and information on the Volta river basin
  - A Developed Training plan for national institutions on data management
  - Data and information sharing mechanism

## 1.3 Methodology

13. The general methodology consisted of data collection, data analysis and the preparation of this report. From the TOR, a data collection Questionnaire was prepared to collect the required data on the institutions, the data they collect and hold their human resources etc. A copy of the questionnaire is presented at Annex C.
  - Methods of data collection: Data were collected by :-
    - Reviewing and extracting relevant data and information from available reports, publications, documents, etc. ;
    - Administering the questionnaires to gather data.
    - Interviewing key persons at management and supervisory levels to assess performance of institutions and the challenges they face, carry out Training of Needs Assessments to identify who need training and in what areas.
    - Visits to relevant websites on the internet,
  - Analysis of Data Collected: data and information were extracted and analysed from the completed Questionnaires. From this information required within the framework of the two output areas were presented. The two areas are :-
    - Inventory and Analysis of Existing Data and Information in the Volta River Basin in Ghana ;
    - Development of training plan for national institutions on data management.

## 1.4 Structure of the Report

14. The report consists of an Executive Summary and a Main Report:

- The Executive Summary provides the background, main findings and recommendations.
- The Main Report consists of 6 parts.
  - The first part which is covered by Section 1 gives the context, the problems, objectives and expected outputs of the study. It also presents the methodology, which consists of data collection, data analysis.
  - The second part is presented by Section 2, which gives a brief description of the geography, socio-economic and the biophysical environment of the Volt River Basin in Ghana.
  - The third part is covered by Section 3, which presents the results of the analysis on existing data and information in the Volta basin which addresses:-
  - The Development of Training Plan for National Institutions is covered in Section 4, while Section 5 presents the existing mechanism for data and information sharing.
  - The conclusions and recommendations are presented in Section 6.

## 2 The Volta River Basin in Ghana

15. The Volta River Basin in Ghana consists of the sub-basins - Black, White, Daka, Oti and Lower Volta River basins. It has an area of 165,712 km<sup>2</sup>. The area lies within the Upper East, Upper West, Northern Volta, Brong Ahafo, Eastern and Greater Accra administrative regions.
16. The population of the basin in Ghana was estimated at 4,393,252 in 1984 and projected to grow to 12,982,696 by 2020. The mean density of population was 24.1/km<sup>2</sup> and the mean annual growth rate was 3.3%.
17. The main economic activities consist of food and industrial crop production inland and marine fishing, livestock rearing and small scale manufacturing. The crops are mainly millet, maize, yams, vegetables and groundnuts. The livestock are mainly sheep, cattle and goats. Industrial crops like cotton, mangoes, dawa dawa and shear nuts are grown. The manufacturing activities consist of pito brewing, shear butter making, weaving of local dresses, etc. The export of yam is a thriving economic activity.
18. The relief is generally about 200 AMSL in the White Volta Basin to an average of 0-150 meters AMSL in the Lower Volta.
19. The basin in Ghana is underlain by rocks of the Voltain system, Basic Intrusives, Birrian granites, Togo and Buem series among others. The water bearing capacity of rocks in the basin is generally low varying from yields of about 5.7 m<sup>3</sup>/hr in the Lower Volta to 2.10 m<sup>3</sup>/hr in the White Volta. Most of the rocks do not have primary porosity.
20. Most of the soils in the basin are subject to moderate to very severe sheet and gully erosion.
21. Climatically mean annual temperatures vary from 23.5° to 28.1°C in the Lower Volta to from 28.0° to 28.6°C in the White Volta. Mean annual rainfall from 876.3 to 1565.0 mm in Lower Volta to 929.7 to 1054.2 mm in the White Volta basin. Mean annual potential evapotranspiration in the Lower Volta ranges between 1450.00 mm to 1800.00 mm while in the White Volta the range is from 1650.00 mm to 1968.00 mm.
22. With regard to mean annual runoff, this varies from 8300x10<sup>6</sup> m<sup>3</sup> in the Black Volta to 8180 x 10<sup>6</sup>m<sup>3</sup> in the White Volta to 8717x10<sup>6</sup> m<sup>3</sup> in the Oti basin.
23. The vegetation cover in the basin is predominantly guinea savannah woodland and Sudan savannah in the White, Black and Oti basins, while it is predominantly guinea savannah woodland in the Lower Volta basin.
24. Some key statistics about population, economic indicators, and also physiographic, climatic and environmental data on the Volta river basin in Ghana are given in Annex C1 to C7 of the report.

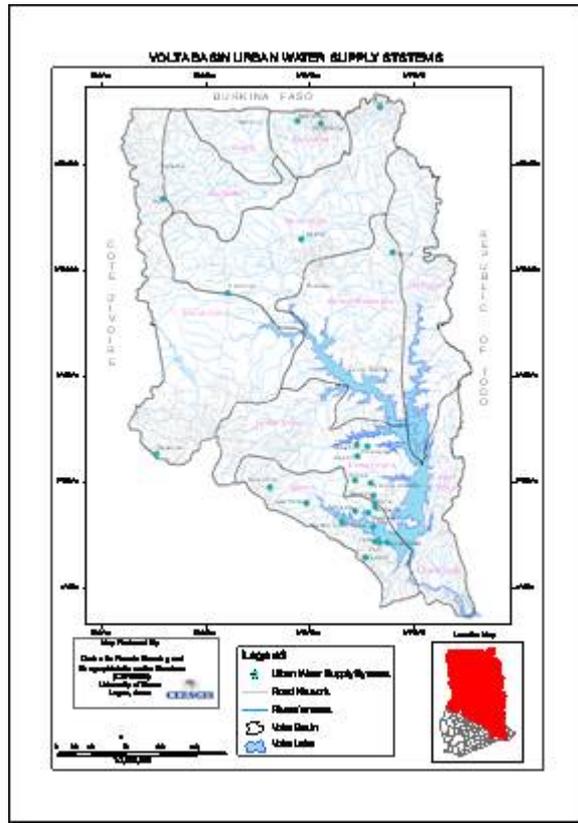


Fig. 1: Map of Volta Basin in Ghana

### **3 Inventory of institutions, data and information**

25. This section presents the findings of the institutions and the existing databases and other forms of information, an inventory and assessment of human resources, user groups, and the definite format to make data and information available to them. These are described in the following sub-sections.

#### **3.1 Inventory of Existing Institutions**

26. Table 1 presents the inventory and gives the addresses and mandates of the institutions. The focus is on the institutions which have national mandate for data collection. The fax, e-mail and web addresses show the potential that the institutions have in using modern technology to exchange data and information.

**Table 1 : Inventory of Data Collection on Institutions**

NO	Name of Institution	Address				Data Mandate	Contact Person	
		Postal	Tel.	Fax	Email			Website
1	METEROLOGICAL SERVICES AUTHORITY	P.O. Box 187 Legon Accra, Ghana.	233-21-7012 520/1; 778390		<a href="mailto:meteo@africaonline.com.gh">meteo@africaonline.com.gh</a>	<a href="http://www.meteo.gov.gh/">http://www.meteo.gov.gh/</a>	Meteorological data	
2	HYDROLOGICAL SERVICES DEPARTMENT	P.O. Box MB 501 Accra, Ghana	233-21-662984/6773 83		NIL	NIL	Hydrological data	Director
3	WATER RESEARCH INSTITUTE	P.O.Box M 32, Achimota, Accra	233-21-775351/2761 031; 776044		<a href="mailto:wri@ghana.com">wri@ghana.com</a>	<a href="http://www.csir.org.gh/wri.html">http://www.csir.org.gh/wri.html</a>	Groundwater Water Quality	Director
4	ENVIRONMENTAL PROTECTION AGENCY	P.O. Box M 326, Accra – Ghana.	233-21-664679/8 667524	233-21-662690	<a href="mailto:epaed@africaonline.com.gh">epaed@africaonline.com.gh</a>	<a href="http://www.epa.gov.gh/">http://www.epa.gov.gh/</a>	Environmental	Executive Director
5	VOLTA RIVER AUTHORITY	P.O. Box MB 77 Accra, Ghana	322-21-660068,6600 72			<a href="http://www.vra.com">www.vra.com</a>	Hydropower generation	Director of Corp-orate Serv.
6	VOLTA LAKE TRANSPORT COMPANY						Transport of people & goods	
7	COMMUNITY WATER & SANITATION AGENCY	Off Legon, Tetteh Quarshie road, Accra, Ghana	233-21-518401/ 518405		<a href="mailto:info@cwsagh.org">info@cwsagh.org</a>	<a href="http://www.cwsagh.org">http://www.cwsagh.org</a>		
8	SURVEY DEPARTMENT	P.O. Box CT. 903, Accra - Ghana	233-21-777331 ; 777847		<a href="mailto:survey@ghana.co">survey@ghana.co,</a>		Survey & mapping	Director
9	SOIL RESEARCH INSTITUTE	Academy Post Office, Kwadaso, Kumasi, Ghana	233-51-50353/50/4		<a href="mailto:soil@aol.com.gh">soil@aol.com.gh</a>	<a href="http://www.scir.org.gh/sri">http://www.scir.org.gh/sri</a>		
10	FORESTRY COMMISSION	4 Third Avenue Ridge, Accra,. P.O. Box MB 434 Accra-Ghana	233-21-401210 ; 401227		<a href="mailto:info@hq.fcghana.com">info@hq.fcghana.com</a>	<a href="http://www.fcghana.com">http://www.fcghana.com</a>	Forestry and Wild Life	Chief Executive Officer
11	GEOLOGICAL SURVEY DEPARTMENT	P.O. Box CT 5630 Accra - Ghana	233-21-679238		<a href="mailto:info@gsd.ghana_mining.org">info@gsd.ghana_mining.org</a>	<a href="http://www.ghana-mining.org">www.ghana-mining.org</a>	Geological	Director
12	WATER RESOURCES COMMISSION	P.O. Box CT 5630, Accra – Ghana	233-21-763651/7658 60	233-21-763649	<a href="mailto:watrecom@wre.gh.org">watrecom@wre.gh.org</a>	<a href="http://www.wrc-gh.org">www.wrc-gh.org</a>	Overall water resources management	Executive Secretary

NO	Name of Institution	Address					Data Mandate	Contact Person
		Postal	Tel.	Fax	Email	Website		
13	GHANA STATISTICAL SERVICES OF MFEP	P.O. Box 1098 Accra, Ghana		233-21-664304				
14	GHANA WATER COMPANY LIMITED	P.O. Box M194, Accra-Ghana	233-21-666781		gwclafiraonline.com.gh	<a href="http://www.waterforghana.org">http://www.waterforghana.org</a>		
15	COMMUNITY WATER & SANITATION AGENCY	NIL	233-21-518401 ; 518405	233-21-518402 ; 518404	info@cwsagh.org	<a href="http://www.cwsagh.org">www.cwsagh.org</a>	Rural & Small towns piped systems	
16	DEPT OF URBAN & FEEDER ROADS						Roads	
17	GHANA IRRIGATION DEVELOPMENT AUTHORITY	P.O. Box M. 154, Ministries, Accra	233-21-662050/668661				Irrigation	
18	LANDS COMMISSION	P.O. Box CT 5008, Cantonments, Accra Ghana			<a href="mailto:landscom@ncs.com.gh">landscom@ncs.com.gh</a>		Land Owner-ship	
19	FISHERIES DEPARTMENT						Marine & Inland Fisheries	
20	MINISTRY OF FOOD AND AGRICULTURE	P.O. Box M37, Ministries, Accra	233-21-663036			<a href="http://www.mofa.gov.gh">http://www.mofa.gov.gh</a>	Agricultural Production	
21	MINISTRY OF WATER RESOURCES WORKS AND HOUSING	P.O. Box M 43, Accra Ghana	233-21-665940	233-21-668246		<a href="http://www.water-mwrwh.com">www.water-mwrwh.com</a>	Water Use	Director - Water
22	PUBLIC UTILITIES COMMISSION	P.O. Box C3059 Accra, Ghana	233-21-244181-4		purc@ghana.com	-	Water tariffs	Chairman
23	CENTRE FOR REMOTE SENSING & GEOGRAPHICAL INFORMATION SERVICES	P.O. Box L 17 (UG) Legon, Accra, Ghana	233-21-501796	233-21-500310	cersgis@ug.edu.gh	<a href="http://www.cersgis.org">www.cersgis.org</a>	Remote Sensing	Executive Director

**Table 2: List of Data Bases used by Institutions for Managing their Data**

NAME OF DATABASE OR .....	NAME OF ORGANISATION	MINISTRY
<b><u>WATER CYCLE</u></b>		
C LICOM - Hydrometeorological data	Ghana Meterological Agency	Ministry of Communication
HYDATA - Hydrological data	Hydrological Services Division	Ministry of Water Resources Works and Housing
Excel Database – Surface Water Quality	Water Research Institute of CSIR	Ministry of Environment Science and Technology
GWV for WINDOWS Groundwater Data	Water Research Institute of CSIR	Ministry of Environment Science and Technology
GWV for WINDOWS Groundwater Quality	Water Research Institute of CSIR	Ministry of Environment Science and Technology
Excel – Sediment Data	Water Research Institute of CSIR	Ministry of Environment Science and Technology
<b><u>PHYSIOGRAPHIC</u></b>		
Arch Info. Arc GIS for land Survey and Aerial Photo Data	Survey Department	Ministry of Lands, Forestry and Mines
GIS – Geological Data	Geological Survey Department	Ministry of Lands, Forestry and Mines
Excel – Soil Data	Soil Research Institute of CSIR	Ministry of Environment Science and Technology
ArcInfo – Soil Maps in 1:250,000	GERMP Project – SRI/CSIR	Ministry of Environment Science and Technology
ArchInfo – Land Suitability Maps 1:250,000	GERMP Project – SRI/CSIR	Ministry of Environment Science and Technology
FAO – APT4 Length of Growing Period Map 1:250,000	GERMP Project – SRI/CSIR	Ministry of Environment Science and Technology
FAO – APT4 Length of Growing Period Map 1:250,000	GERMP Project – SRI/CSIR	Ministry of Environment Science and Technology
FAO – APT4 Relative Humidity Map – 1:250,000	GERMP Project – SRI/CSIR	Ministry of Environment Science and Technology
GIS – Harmonised Regional Environmental datasets packaged for all the 10 regions of Ghana – 1:250,000	GERMP Project - CERSGIS	Environmental Protection Agency and University of Ghana, Legon.
ArchInfo. Arch GIS – ERDAS Vegetation Data	Centre for Remote Sensing and Geographical Information Services of EPA & UG	Ministry of Environment Science and Technology & Ministry of Education and Sports
ArchInfo. Arch GIS Land Use Data	Centre for Remote Sensing and Geographical Information Services of EPA & UG	Ministry of Environment Science and Technology & Ministry of Education and Sports
GIS - Road Infrastructure database	DfID - CERSGIS	Environmental Protection Agency and University of Ghana, Legon.
GIS – Land Cover Atlas for Ghana	GERMP Project - CERSGIS	Environmental Protection Agency and University of Ghana, Legon.
GIS – Database for capture environmental sensitivity of areas along the coast of Ghana in Arcview shape files	EPA	Ministry of Environment Science and Technology.
GIS – Coastal Sensitivity Atlas of Ghana – Vol. 1 & 2	EPA	Ministry of Environment Science and Technology
<b><u>SOCIO-ECONOMIC</u></b>		
CSPro (census and Survey Processing)	Ghana Statistical Services	Ministry of Finance & Economic Planning
Excel database – Sampled data on effluent discharges from Industries and Commercial Concerns	EPA	Ministry of Environment Science and Technology

Excel database – Water Quality	EPA	Ministry of Environment Science and Technology
Excel database – Urban Water Supply Systems	GWCL	Ministry of Water Resources, Works and Housing
Excel database – Small Towns Piped Systems	CWSA	Ministry of Water Resources, Works and Housing
Excel database – Irrigation Projects	GIDA	Ministry of Food and Agriculture
Oracle – Hydropower Information	VRA	Ministry of Energy
Excel – Agricultural Production Data	Statistics Research and Information Directorate	Ministry of Food and Agriculture
<b>CULTURAL</b> GIS Traditional Boundaries Data.	District, Municipal and Metropolitan Assemblies	Ministry of Local Government and Rural Development
GIS - Land Ownership Data	Lands Commission Stool Lands Commission	Ministry of Chieftaincy Affairs Ministry of Lands Forestry and Mines
Word National Park Data	Forestry Commission	Ministry of Lands, Forestry and Mines

### 3.2 Water cycle data

27. Information is provided on each type of data. The information is extracted from the questionnaire returns. The information presented relate to:

- Metadata including the spatial location at which data is gathered;
- A map of the spatial locations where available;
- The database management system;
- Extracts from the database where immediately available as example of what is held.
- Forms in which other data and information are held
- Data and information exchange.

#### 3.2.1 Hydro-meteorological Data

28. Hydro-meteorological data is collected by Ghana Meteorological Agency. There are about:-

- 22 Synoptic stations;
- 55 Climatological stations;
- 50 Agrometeorological stations;
- 300 Rainfall stations.

29. The data collected are temperature, humidity, evaporation, rainfall, sunshine hours and wind speed. A full list of stations in the Volta Basin is presented in Annex D.

- Meta Data: This covers station identification, location, data collected and period of record as presented in Table 3. This covers six selected stations in the basin.
- Mapping of Stations: The stations are geo-referenced. A digitised map of the stations is available.
- Database: There is a database and this is managed by the CLICOM software which has been replaced by CLIDATA since 2001.

30. For the six selected stations, an assessment has been made on the extent of gaps in meteorological data and the results are presented in Table 4. A similar assessment of gaps in the rainfall records of the selected stations was made and the resources are presented in Table 5. The stations are synoptic stations and as such have rainfall recorders.

31. Forms in which other data and information held: Various publications exist. They are in hard copies or in digitised formats.

32. Data and information exchange: The agency has an e-mail and web site. Information is on the sites. Requests for data have to be made to the Director-General.

**Table 3: Metadata of Selected Meteorological Stations**

No.	Station	Latitude	Longitude	Monthly Rainfall mm	Daily Evapratn. mm	Relative Humidity co	Mean Daily Temp. °C	Wind Speed Knots	Period of Record
1.	Bole	09° 02'N	02° 29'W	x	x	x	x	x	1961 - 2005
2.	Kete Krachi	07° 49'N	00° 01'W	x	x	x	x	x	1961 - 2005
3.	Tamale	09° 33'N	00° 51'W	x	x	x	x	x	1961 - 2005
4.	Navrongo	10° 53'N	01° 05'W	x	x	x	x	x	1961 - 2005
5.	Wa	10° 04'N	02° 30'W	x	x	x	x	x	1961 - 2005
6.	Yendi	09° 26'N	00° 01'W	x	x	x	x	x	1961 - 2005

Source: GMA

**Table 4: Summary of Extent Gaps in Meteorological Data at Selected Stations**

STATION	INSTITUTION RESPONSIBLE	TYPE OF DATA	DATE STARTED	DATE CLOSED	EXTENT OF GAPS	FORMAT	DATA BASE
BOLE	GMA	Temperature	1961	Operational	0%	Excel Table	CLICOM to CLIDATA
		Windspeed	1961	Operational	0%	“	“
		Humidity	1961	Operational	0%	“	“
		Evaporation					
		Evapotranspiration					
		Sunshine Duration	1961	Operational	0%	“	“
KETE KRACHI	GMA	Temperature	1961	Operational	0%	Excel Table	CLICOM to CLIDATA
		Windspeed	1961	Operational	15%	“	“
		Humidity	1961	Operational	0%	“	“
		Evaporation					
		Evapotranspiration					
		Sunshine Duration	1961	Operational	56%	“	“
TAMALE	GMA	Temperature	1961	Operational	0%	Excel Table	CLICOM to CLIDATA
		Windspeed	1961	Operational	13%	“	“
		Humidity	1961	Operational	13%	“	“
		Evaporation					
		Evapotranspiration					
		Sunshine Duration	1961	Operational	6%	“	“
NAVRONGO	GMA	Temperature	1961	Operational	0%	Excel Table	CLICOM to CLIDATA
		Windspeed	1961	Operational	3%	“	“
		Humidity	1961	Operational	0%	“	“
		Evaporation					
		Evapotranspiration					

		Sunshine Duration	1961	Operational	2%	“	“
WA	GMA	Temperature	1961	Operational	0%	Excel Table	CLICOM to CLIDATA
		Windspeed	1961	Operational	2%	“	“
		Humidity	1961	Operational	0%	“	“
		Evaporation					
		Evapotranspiration					
		Sunshine Duration	1961	Operational	3%	“	“
YENDI	GMA	Temperature	1961	Operational	0%	Excel Table	CLICOM to CLIDATA
		Windspeed	1961	Operational	1%	“	“
		Humidity	1961	Operational	0%	“	“
		Evaporation					
		Evapotranspiration					
		Sunshine Duration	1961	Operational	1%	“	“

**Table 5 : Summary of Assessment of Gaps in Rainfall Data at Selected Stations**

STATION	INSTITUTION RESPONSIBLE	TYPE OF DATA	DATE STARTED	DATE CLOSED	EXTENT OF GAPS	FORMAT	DATABASE	COMMENTS
BOLE	GMA	Instantaneous	1961	operational	1%	Tables		
		Daily	“	“	“	“		
		Monthly	“	“	“	“		
		Annual	“	“	“	“		
KETE KRACHI	GMA	Instantaneous	1946	operational	1%	Tables		
		Daily	“	“	“	“		
		Monthly	“	“	“	“		
		Annual	“	“	“	“		
TAMALE	GMA	Instantaneous	1944	operational	0%	Tables		
		Daily	“	“	“	“		
		Monthly	“	“	“	“		
		Annual	“	“	“	“		
NAVRONGO	GMA	Instantaneous	1946	operational	50%	Tables		
		Daily	“	“	“	“		
		Monthly	“	“	“	“		
		Annual	“	“	“	“		
WA	GMA	Instantaneous	1952	operational	1%	Tables		
		Daily	“	“	“	“		
		Monthly	“	“	“	“		
		Annual	“	“	“	“		
YENDI	GMA	Instantaneous	1951	operational	1%	Tables		
		Daily	“	“	“	“		
		Monthly	“	“	“	“		
		Annual	“	“	“	“		

### 3.2.2 Hydrometric Data

33. The Hydrological Services Division of the Ministry of Water Resources Works and Housing has mandate to collect surface water data in the areas of river water level, river flow, sediment transport and sample for river water for quality analysis. This is in addition to its mandate for coastal protection, design of drainage works, minor sewerage design and desilting of urban drains. The division has a total of 67 stations in the basin of which 29 are operational.

- Meta Data: A Meta data is available and covers station identification, location, drainage area, type of gauge date established, etc. An example of ten selected stations is presented in Table 6. A full list of the stations in the Volta Basin is presented in Annex E.
- Mapping of Stations: With the stations geo-referenced the list of stations can be mapped.
- Database: The database management is by the HYDATA software developed by the Institute of Hydrology in the UK.
- An assessment was made to determine the extent of gaps in the records of the stations mentioned in Table 6. The results are presented in Table 7. The assessment was made on monthly data except the Buipe station where daily records are kept of the Akosombo Reservoir water level.
- Forms in which other data and information held: The Division used to publish annual hydrological year books but has ceased doing so.
- Requests for data must be made to the Director of the Division. Data is supplied at a cost recovery fee. Data and information are held in hard copies or in digital formats.
- Data and Information Exchange: The division does not have its own e-mail address and web-site yet.

**Table 6: Extract of Metadata of Hydrological Stations in the Volta basin - Ghana**

Sub Basins	River	Type	Stn Name	StationID	Area	Gauge	Zero	Region	Project	Established	Co-ordinates	
											Lat N	Long W
Black Volta	Black Volta	Tributary	Buipe	1006004	52283.0	235.2	ft	Northern	GoG	26-May-58	08/46/00 <sup>N</sup>	01/28/00 <sup>W</sup>
Black Volta	Black Volta	Tributary	Bui D/S	1006009	461.00	101.9	m	Northern	WRIS	17-Feb-65	08/17/00	02/14/00
Black Volta	Black Volta	Tributary	Bamboi	1006001		34.75	m	Northern	WRIS	8-Mar-50	08/09/00	02/02/00
Kulpawn	Kulpawn	Tributary	Yagaba	1003001	35003.0	126.3	m	Upper	WRIS	20-Feb-58	10/14/50	01/16/48
Kulpawn	Sissili	Tributary	Nakong	1003004	2359.00	696.2	ft	Upper	WRIS	25-Jun-65	10/47/14	01/29/44
Oti	Oti	Tributary	Sabari	1010003		82.55	m	Northern	WRIS	6-Jun-59	09/26/00	01/49/00
Oti	Oti	Tributary	Saboba	1010002		310.6	ft	Northern	GoG	20-Mar-53	09/06/00	01/27/00
Pru	Pru	Tributary	Prang	1007002	2543.00	41.43	m	Ashanti	WRIS	01-May-57	07/59/00	00/53/00
White Volta	White Volta	Tributary	Nawuni	1001003		311.6	ft	Northern	GoG	08-May-53	09/39/36	01/03/18
White Volta	White Volta	Tributary	Pwalugu	1001001	3134.00	123.7	m	Upper	WRIS	01-May-51	10/35/08	00/50/30

Source: HSD

**Table 7 : Summary of Gaps in the Hydrometric Data at Selected Stations**

STATION	INSTITUTION RESPONSIBLE	PARAMETER MEASURED	TYPE OF DATA	DATE STARTED	DATE CLOSED	EXTENT OF GAPS	FORMAT	DATABASE	COMMENTS
BUIPE on Black Volta	HSD	H/Q	Q <sub>instantaneous</sub>				Tables	HYDATA	
			Q <sub>daily</sub>				«	«	
			Q <sub>annual</sub>				«	«	
			H <sub>instantaneous</sub>				«	«	
			H <sub>daily</sub>	1958	operational	38%	«	«	
			H <sub>annual</sub>				«	«	
BUI (DIS) on Black Volta	HSD	H/Q	Q <sub>instantaneous</sub>				Tables	HYDATA	
			Q <sub>daily</sub>				«	«	
			Q <sub>monthly</sub>	1954	operational	18%	«	«	
			H <sub>instantaneous</sub>				«	«	
			H <sub>daily</sub>				«	«	
			H <sub>annual</sub>				«	«	
BAMBOI on Black Volta	HSD	H/Q	Q <sub>instantaneous</sub>				Tables	HYDATA	
			Q <sub>daily</sub>				«	«	
			Q <sub>monthly</sub>	1950	operational	41%	«	«	
			H <sub>instantaneous</sub>				«	«	
			H <sub>daily</sub>				«	«	
			H <sub>annual</sub>				«	«	
YAGABA on Kulpawn	HSD	H/Q	Q <sub>instantaneous</sub>				Tables	HYDATA	
			Q <sub>daily</sub>				«	«	
			Q <sub>monthly</sub>	1958	opretional	55%	«	«	
			H <sub>instantaneous</sub>				«	«	
			H <sub>daily</sub>				«	«	
			H <sub>annual</sub>				«	«	
NAKONG on Kulpawn	HSD	H/Q	Q <sub>instantaneous</sub>				Tables	HYDATA	
			Q <sub>daily</sub>				«	«	
			Q <sub>monthly</sub>	1965	operational	67%	«	«	
			H <sub>instantaneous</sub>				«	«	
			H <sub>daily</sub>				«	«	
			H <sub>annual</sub>				«	«	
			Q <sub>instantaneous</sub>				Tables	«	

STATION	INSTITUTION RESPONSIBLE	PARAMETER MEASURED	TYPE OF DATA	DATE STARTED	DATE CLOSED	EXTENT OF GAPS	FORMAT	DATABASE	COMMENTS
SABARI on Oti	HSD	H/Q	Q <sub>daily</sub>				«	«	
			Q <sub>monthly</sub>	1959	operational	21%	«	«	
			H <sub>instantaneous</sub>				«	«	
			H <sub>daily</sub>				«	«	
			H <sub>annual</sub>				«	«	
SABOBA on Oti	HSD	H/Q	Q <sub>instantaneous</sub>				Tables	HYDATA	
			Q <sub>daily</sub>				«	«	
			Q <sub>monthly</sub>	1955	operational	19%	«	«	
			H <sub>instantaneous</sub>				«	«	
			H <sub>daily</sub>				«	«	
PRANG on the Pru	HSD	H	Q <sub>instantaneous</sub>				Tables	HYDATA	
			Q <sub>daily</sub>				«	«	
			Q <sub>monthly</sub>	1957		56%	«	«	
			H <sub>instantaneous</sub>				«	«	
			H <sub>daily</sub>				«	«	
NAWUNI on White Volta	HSD	H/Q	Q <sub>instantaneous</sub>				Tables	HYDATA	
			Q <sub>daily</sub>				«	«	
			Q <sub>monthly</sub>	1953	operational	13%	«	«	
			H <sub>instantaneous</sub>				«	«	
			H <sub>daily</sub>				«	«	
PWALUGU on White Volta	HSD	H/Q	Q <sub>instantaneous</sub>				Tables	HYDATA	
			Q <sub>daily</sub>				«	«	
			Q <sub>monthly</sub>	1951	operational	43%	«	«	
			H <sub>instantaneous</sub>				«	«	
			H <sub>daily</sub>				«	«	
YARUGU on White	HSD	H/Q	Q <sub>instantaneous</sub>				Tables	HYDATA	
			Q <sub>daily</sub>				«	«	
			Q <sub>monthly</sub>	1962	operational	47%	«	«	

STATION	INSTITUTION RESPONSIBLE	PARAMETER MEASURED	TYPE OF DATA	DATE STARTED	DATE CLOSED	EXTENT OF GAPS	FORMAT	DATABASE	COMMENTS
Volta			H <sub>instantaneous</sub>				«	«	
			H <sub>daily</sub>				«	«	
			H <sub>annual</sub>				«	«	

H - Level

Q - Discharge

**Table 8: Extracts from the Metadata and Database of Boreholes in the Black Volta Basin – Ghana**

No.	PWellID	Community	District	River Basin	Geology	Aquifer Mat	Well Status	Drill Date	BH Depth (m)	SWL (m)	Depth to Aquifer (m)	Aquifer Thickness (m)	Est. Yield (l/min)	DWL
1	437-H21(RBH)	Babile Agric. Station	Jirapa-Lambussie	Black Volta	Granites	Weath. Gneiss	Wet	05/01/1999	40.6	11.40	24.00	2.10		
2	441-G03(RBH)	Balanta	Jirapa-Lambussie	Black Volta	Granites		Dry		35.0			4.80		
3	441-G-2(RBH)	Balanta	Jirapa-Lambussie	Black Volta	Granites		Dry		36.0			1.80		
4	400 A-01	Bazuu	Jirapa-Lambussie	Black Volta	Granites	Granodiorite	Wet		34.8		21.00	6.00		
5	DW 325	Bo-Mission	Jirapa-Lambussie	Black Volta	Granites	Fract. Granite	Wet		49.0	8.19	39.00	12.00	30.00	3.74
6	DW 217	Bo-Naayiri Gangne	Jirapa-Lambussie	Black Volta	Granites	Fract. Granite	Wet		31.0	14.63	17.00		200.00	
7	438-D17(RBH)	Boo-Mission	Jirapa-Lambussie	Black Volta	Granites	Fract. Granite	Wet	06/12/1999	49.0	18.20	38.00		10.00	
8	438-D17(RBH)	Boo-Mission	Jirapa-Lambussie	Black Volta	Granites		Dry		36.0			4.80		
9	438-D16(RBH)	Boo-Naayiri	Jirapa-Lambussie	Black Volta	Granites	Fract. Granite	Wet		36.0	7.60	23.00	4.00	34.00	
10	440-B06(RBH)	Fielmon	Jirapa-Lambussie	Black Volta	Granites	Weath. Granite	Wet		44.0	3.80	26.00	15.00	21.00	
11	DW 329	Gbari-Bombari	Jirapa-Lambussie	Black Volta	Granites	Fract. Granite	Wet		31.0	11.25	17.00	4.80	600.00	14.45
12	438-G12(RBH)	Jeffiri	Jirapa-Lambussie	Black Volta	Granites	Weath. Granite	Wet	03/04/1999	26.0	4.00	19.00	8.00	31.00	
13	DW 202	Jurapa-Hospital	Jirapa-Lambussie	Black Volta	Granites	Weath. Granite	Wet		28.0	9.84	16.00	8.10	15.00	
14	438-06(RBH)	Kogre	Jirapa-Lambussie	Black Volta	Granites	Fract. Granite	Wet	06/04/1999	46.0	20.60	25.00		16.00	
15	DW 321	Koro (Lawra)	Jirapa-Lambussie	Black Volta	Granites	Fract. Granite	Wet		52.0	14.61	38.00		15.00	27.02
16	DW 317	Koro-Dinder	Jirapa-Lambussie	Black Volta	Granites	Fract. Granite	Wet		49.0	11.49	39.00		15.00	15.88

### 3.2.3 Groundwater Data

34. Groundwater data (quantitative and qualitative) are generally generated by the CWSD (formerly Rural Water Division of GWCL) through public and private projects. The WRI also generates groundwater data and information from research and consultancy activities. WRI is the agency which has responsibility to collect all the data generated in the country and processes them so as to disseminate information on the availability of groundwater both in quantity and quality and how it can be utilised on a sustainable basis.
- *Meta Data:* Metadata is available and they cover borehole identification geo-referenced location, geology, aquifer material, well status, date drilled, depth, aquifer thickness, yield, etc. An example is presented in Table 8.
  - *Mapping of Stations:* Mapping is presently on-going with more data coming from the CWSA and others.
  - *Database Management System:* The database is managed by non-commercial (free) software called Ground Water for Windows (GWW). The software has four structures related to the Master Data, Chemistry Data, Pump Test Data and Well Log Data. The numbers of boreholes from which WRI has collected data by regions for groundwater assessment is shown in Table 9.
  - *Forms in which other data and information are held:* Staff of the institute produces scientific papers which are published in scientific journals. They also produce conferences papers, consultancy reports, technical reports, annual reports, etc. These are held in hard copies or digitised formats. Consultancy and technical reports are produced at the request of clients.
  - *Data and information exchange:* The Institute is expected to have a link from the website of the CSIR. Data is available in hard copies. When available it can be exchanged by e-mail. The usual manner is to apply to the Director. The Institute has in addition a Website. This is used to exchange data and information.
  - *Piezometric and Water Quality Monitoring:* In addition there are twenty-seven piezometric stations in the basin out of which 4 are in the Upper West region, 5 in the Upper East region, 12 in the Northern region and 5 in the Afram Plains. These are used to monitor water levels and water quality. The levels are continuously logged with water level recorders. The extent of gaps in the data is shown in Table 10.

**Table 9: Status of Hydrogeological Database**

REGIONS	MASTER DATA	CHEMICAL DATA	PUMPING TEST DATA	WELL LOG
Northern	2075			
Upper East	2274	217	224	506
Upper West	1650	391	2	28
Ashanti	1192	632	1191	1191
Brong-Ahafo	232	112	113	53
Central	472	256	470	213
Western	634	483	633	38
Eastern	1685	705	1298	30
Greater Accra	266		51	
Volta	2586	1223	502	1503
<b>TOTAL</b>	<b>13026</b>	<b>4019</b>	<b>4484</b>	<b>3300</b>

*Source: WRI Annual Report 2005*

**Table 10: Summary of Gaps in GW Level Monitoring Data at Selected Stations**

No.	Station	Responsible Institute	Type of Data Collection	Date Opened	Date Closed	Extent of Gaps	Format	Databas e	Com ments
1.	Wa-Danko (WVB1)	WRC	G/w level & quality	08/06	ongoing	none	Electronic & Hard copy	GWW	All gaps have been caused by malfunctioning of recording devices
2.	Wa-N/E (WVB2)	WRC	G/w level & quality	08/06	ongoing	none	Electronic & Hard copy	«	
3.	Tumu (WVB3)	WRC	G/w level & quality	10/05	ongoing	none	Electronic & Hard copy	«	
4.	Bonia-Navrongo (WVB4)	WRC	G/w level & quality	10/05	ongoing	none	Electronic & Hard copy	«	
5.	Gowrie-Tingre (WVB5)	WRC	G/w level & quality	10/05	ongoing	none	Electronic & Hard copy	«	
6.	Bongo-Nayire (WVB6)	WRC	G/w level & quality	09/05	ongoing	6 months	Electronic & Hard copy	«	
7.	Datoko (WVB7)	WRC	G/w level & quality	10/05	ongoing	10 months	Electronic & Hard copy	«	
8.	Bawku (WVB8)	WRC	G/w level & quality	07/06	ongoing	none	Electronic & Hard copy	«	
9.	Ducie Camp (WVB9)	WRC	G/w level & quality	10/05	ongoing	3 months	Electronic & Hard copy	«	
10.	Yagbum (WVB10)	WRC	G/w level & quality	10/05	ongoing	none	Electronic & Hard copy	«	
11.	Bugya-Pala (WVB11)	WRC	G/w level & quality	10/05	ongoing	none	Electronic & Hard copy	«	
12.	Tinguri (WVB12)	WRC	G/w level & quality	07/06	ongoing	none	Electronic & Hard copy	«	
13.	Galiwei (WVB13)	WRC	G/w level & quality	09/05	ongoing	15 months	Electronic & Hard copy	«	
14.	Murugu (HAP1)	WRC	G/w level & quality	10/07	ongoing	3 months	Electronic & Hard copy	«	
15.	Buachepe (HAP2)	WRC	G/w level & quality	10/07	ongoing	4 months	Electronic & Hard copy	«	
16.	Kanshegu (HAP4)	WRC	G/w level & quality	10/07	ongoing	none	Electronic & Hard copy	«	
17.	Janga (HAP5)	WRC	G/w level & quality	10/07	ongoing	9 months	Electronic & Hard copy	«	Ditto
18.	Zabaraya (HAP7)	WRC	G/w level & quality	10/07	ongoing	9 months	Electronic & Hard copy	«	
19.	Gnani (HAP8)	WRC	G/w level & quality	10/07	ongoing	5 months	Electronic & Hard copy	«	
20.	Tacheku (HAP10)	WRC	G/w level & quality	10/07	ongoing	9 months	Electronic & Hard copy	«	
21.	Nalerigu (HAP11)	WRC	G/w level & quality	10/07	ongoing	6 months	Electronic & Hard copy	«	
22.	Nakpeuk (HAP12)	WRC	G/w level & quality	12/07	ongoing	3 months	Electronic & Hard copy	«	
23	Tease (APDO Office)	WRC	G/W level & quality	Oct, 2005		Nil	Electronic & Hard copy	«	Ditto
24	Forifori	WRC	G/W level quality	Oct, 2005	On-going	Nil	Electronic & Hard copy	«	

No.	Station	Responsible Institute	Type of Data Collection	Date Opened	Date Closed	Extent of Gaps	Format	Databas e	Com ments
25	Samanhyia	WRC	G/W level quality	Oct, 2005	Ongoing	Nil	Electronic & Hard copy	«	«
26	Adofokrom	WRC	G/W level quality	Oct, 2005	On-going	Nil	Electronic & Hard copy	«	«
27	Gazeri Camp	WRC	G/W level quality	Oct, 2005	Ongoing	Nil	Electronic & Hard copy	«	«

Source: WRI

### 3.2.4 Surface Water Quality Data

35. Surface water sampling and monitoring are normally undertaken by other organisations such as the HSD and public and private organisations. The samples are sent to the WRI laboratory for analysis. The WRI also collects samples to analyse in connection with its own research projects. Samples are normally analysed for physical, chemical, biological and microbiological quality. The institute has data for a number of sites including sites in the Volta Basin.

- *Meta Data:* This covers location, date of sampling, physical, chemical and microbiological parameters. Presentation is in Excel. Particulars about the stations from which they collect data and the type of data collected are presented in Table 11.
- *Mapping of Stations:* This is in progress.
- *Database Management System:* Excel software is used for the management of data.
- *Other forms in which other data and information held:* The information on groundwater applies to surface water, in that is available in hard copies and digitised formats.

### 3.2.5 Sediment Discharge Data

36. Sediment discharge samples are collected by Hydrological Services Department (HSD) on a routine basis at designated stations and by the Water Research Institute (WRI) in connection with its own research project.

- *Meta data:* Meta data is available. This covers location, date of sampling, river stage, wash load, bed load, etc. Table 12 shows the particulars about the sediment stations.
- *Database Management:* This is available in Excel.
- *Other forms in which data and information are held:* There are publications in hard copies and in digitised formats. Request for data must be made to the Director.

**Table 11: Meta Data of Surface Water Quality Monitoring Station**

SAMPLING STATION	RESPONSIBLE INSTITUTION	TYPE OF DATA	DATE OPENED	DATE ENDED	FREQUENCY	EXTENT OF GAPS	FORMAT	DATA BASE
Weija Lake	WRI	Physic-Chemical	2005	2008	Physico Chemical 5 times per year.		Excel Table	Excel
Potroase-R.Densu	WRI		2005	2008			Excel Table	Excel
Mangoase-R.Densu	WRI	Bacteriological	2005	2008	Bacteriological 2 times per year. Pesticides 2 times per year.		«	Excel
Nsawam-R.Densu	WRI	Pesticides	2005	2008			«	Excel
Mankrong J-R.Ayensu	WRI	Trace metals	2005	2008			«	Excel

Akim Oda- R.Birim-Pra	WRI	water	2005	2008	Densu only for 2005 to 2007. Pesticides at all stations in 2008. Trace Metals in water 2 times in a year in 2005 & 2006 only. Trace Metals in sediment – once in 2006 from 12 stations and once in 2007 from 10 stations. Total Phosphate and Total Nitrate not determined in 2005.		“	Excel
A Brenase- R.Pra(mid)	WRI	Trace metals sediment	2005	2008			“	Excel
Daboase-R.Pra	WRI	Total Phosphate	2005	2008			“	Excel
Dunkwa- R. Offin	WRI		2005	2008			“	Excel
E. Ekotsi- R.Ochi-Amisa	WRI	Total Nitrate	2005	2008			“	Excel
Brimso- R.Kakum	WRI		2005	2008			“	Excel
Ewusijo- R.Butre	WRI		2005	2008			“	Excel
Dominase-R- AnkobrPrestea- R.Ankobraa	WRI		2005	2008			“	Excel
Elubo -.Tano	WRI		2005	2008			“	Excel
Sefwi-W- R.Tano	WRI		2005	2008			“	Excel
Dadieso – R.Bia	WRI		2005	2008			“	Excel

Source: WRI

**Table 12: Meta data on Sediment Station Data**

NO.	STATION	RESPONSIBLE INSTTTUTE	TYPE OF DATA COLLECTION	DATE OPENED	DATE CLOSED	EXTENT OF GAPS	FORMAT	DATABASE	COMMENTS
1.	R. Ankobra at Ankwaso	CSIR Water Research Institute	1, 2, 3, 4	21 May 1985	12 Dec 1992	Some data missing in 1989, 1990 and 1992; whole of 1991 missing	-	MS Excel	Data collected monthly
2.	R. Tano at Jomoro		1, 2, 3, 4	21 Jan 1987	9 Dec 1992	-	-	-idem-	
3.	R. Pra at Beposo		1, 2, 3, 4	23 Jan 1987	8 Dec 1992	-	-	-idem-	
4.	R. Ayensu at Okyereko		1, 2, 3, 4	6 Feb 1987	7 Dec 1992	-	-	-idem-	
5.	R. Amisa at Mankesim		1, 2, 3, 4	3 Apr 1987	7 Dec 1992	-	-	-idem-	
6.	R. Tordzie at Tordienu		1, 2, 3, 4	6 Aug 1987	4 Dec 1992	-	-	-idem-	
7.	R. Nakwa at Ekotsi		1, 2, 3, 4	16 Apr 1987	16 Nov 1992	-	-	-idem-	
8.	R. Tordie at Kpetoe		1, 2, 3, 4	18 Feb 1989	4 Dec 1992	-	-	-idem-	
9.	R. Birim at Oda		1, 2, 3, 4	14 Mar 1989	7 Dec 1992	-	-	-idem-	
10.	R. Ofin at Dunkwa		1, 2, 3, 4	15 Mar 1989	10 Dec 1992	-	-	-idem-	
11.	R. Pra at Twifo Praso		1, 2, 3, 4	16 Mar 1989	8 Dec 1992	-	-	-idem-	
12.	R. Ayensu at Oketsew		1, 2, 3, 4	19 Apr 1989	7 Dec 1992	-	-	-idem-	
13.	R. Nakwa at Ochiso		1, 2, 3, 4	19 Apr 1989	7 Dec 1992	Some data missing	-	-idem-	
14.	R. Bonsa at Bonsaso		1, 2, 3, 4	20 Apr 1989	7 Dec 1992	-	-	-idem-	
15.	R. Ankobra at Prestea		1, 2, 3, 4	20 Apr 1989	7 Dec 1992	-	-	-idem-	
16.	R. Pra at Assin Praso		1, 2, 3, 4	29 Aug 1989	7 Dec 1992	-	-	-idem-	
17.	R. Tano at Hwidiem		1, 2, 3, 4	22 Jan 1991	10 Dec 1992	-	-	-idem-	
18.	R. Densu at Densuso		1, 2, 3	26 Jan 1991	20 Nov 1992	-	-	-idem-	
19.	R. Ofin at Mfensi		1, 2, 3, 4	27 Jan 1991	10 Dec 1992	-	-	-idem-	
20.	R. Birim at Bunso		1, 2, 3, 4	27 Jan 1991	11 Dec 1992	-	-	-idem-	
21.	R. Anum at Konongo		1, 2, 3, 4	27 Jan 1991	11 Dec 1992	-	-	-idem-	
22.	R. Pra at Dadieso		1, 2, 3	28 Jan 1991	11 Oct 1992	-	-	-idem-	
23.	R. Oda at Ejisu		1, 2, 3, 4	24 May 1991	7 Jul 1992	-	-	-idem-	
24.	R. Oda at Anwia-Nkwanta		1, 2, 3, 4	23 Dec 1991	10 Dec 1992	-	-	-idem-	
25.	R. Asukawkaw at Dodo Tamale	CSIR Water Research Institute	1, 2, 3	10 Mar 1997	9 Dec 1998	-	-	MS Excel	Data collected 2 – 4 times a week
26.	R. Menu at Menuso		1, 2, 3, 4	12 Mar 1997	9 Dec 1998	-	-	-idem-	
27.	R. Asukawkaw at Asukawkaw		1, 2, 3, 4	28 May 1997	9 Dec 1998	-	-	-idem-	
28.	R. Dayi at Hohoe		1, 2, 3, 4	28 May 1997	9 Dec 1998	-	-	-idem-	
29.	R. Black Volta at Lawra		1, 2, 3, 4	8 Jun 1994	21 Mar 1995	-	-	-idem-	
30.	R. White Volta at Nawuni		1, 2, 3, 4	10 Jun 1994	24 Mar 1995	-	-	-idem-	
31.	R. White Volta at Pwalugu		1, 2, 3, 4	4 Jul 1994	20 Mar 1995	-	-	-idem-	
32.	R. Black Volta at Bamboi		1, 2, 3, 4	4 Jul 1994	18 Mar 1995	-	-	-idem-	
33.	R. Afram at Aframso		1, 2, 3, 4	21 Aug 1995	20 Aug 1996	-	-	-idem-	
34.	R. Pru at Pruso		1, 2, 3, 4	22 Aug 1995	13 Dec 1996	-	-	-idem-	
35.	R. Oti at Saboba		1, 2, 3, 4	23 Aug 1995	21 Aug 1996	-	-	-idem-	

NO.	STATION	RESPONSIBLE INSTITUTE	TYPE OF DATA COLLECTION	DATE OPENED	DATE CLOSED	EXTENT OF GAPS	FORMAT	DATABASE	COMMENTS
36.	R. Yaratanga at Ve	CSIR Water Research Institute	1,3,5	25 Jul 1989	3 Sept 1991	-	-	MS Excel	Data collected daily
37.	R. Chasi at Gabuga		1,3,5	26 Jul 1989	7 Aug 1991	-	-		-idem-
38.	R. Tono at Songobuga		1,3,5	26 Jul 1989	17 Aug 1991	-	-		-idem-

1: Water Level (m)

2: Temperature (°C)

3: Sediment Concentration (mg/l) 4: Sediment Discharge (tonnes/day)

5: River Flow Rate (m<sup>3</sup>/s)

Source: WRI

### 3.3 Physiographic Data

#### 3.3.1 Survey Data

37. Survey data consisting of locations, altitudes, distances and areas are collected and held by the Survey Dept. These include:-

- Geodetic framework
- Aerial photographs
- National/international boundaries
- Regional and district boundaries
- Metro/Municipal boundaries
- Sea level measurements
- *Meta Data:* The map series cover topography, rivers, roads, settlements, boundaries (international, regional and district), protected areas, impoundments, etc. Currently, a Consultant has been engaged to develop a metadata for all data sets held by the Department.
- *Mapping:* Maps have been produced at various scales as follows:-
  - 1: 500,000 map series
  - 1: 250,000 map series
  - 1: 25,000 map sheets
  - 1: 2,500 town sheets
- A summary of the maps is presented in Table 13.
- *Database Management System:* GIS and ArchInfo softwares are used.
- *Other forms in which other data and information held:* Other information is held in hard copy and digitised (ArchInfo) format.
- *Exchange of Data and Information:* There is no website. Exchange is through sales and by application to the Director.

**Table 13: Summary of Maps**

PROGRAMME	INSTITUTION	FREQUENCY	SPATIAL SCALE	COMMENT
<b>BASE MAPS</b>				
Locations	Survey Dept	N/A	1:250,000	
Altitudes				
Contours			1:50,000	
Drainage				
<b>THEMATIC MAPS</b>				
Roads	Survey Dept	N/A	1:1,000,000	
Settlements			1:500,000	
Boundaries			1:250,000	
Protected Areas (Forest & Wild Life Reserves)			1:50,000	
Land Use Map	FAO	1964	1:25,000	
Aerial Photograph (black & white)	Survey Dept	1960	1:10,000 1:40,000	Northern Ghana
		1974	1:10,000 1:40,000	Southern Ghana
Closed canopy forests of Ghana	Hall & Swaine	1976	1:3,000,000	
Clima Vegetation of Ghana	Taylor	1952	1:200,000 1:500,000	
Onchocerciasis areas in Upper region	USAID/TAMS	1979	1:250,000	

### 3.3.2 Plant and Animal Species Data

38. The plant and animal species are collected and held by the Forest Services Division and Wild Life Division of the Forestry Commission.

- *Meta Data:* This is available on request and cover:-
  - Protected area boundaries
  - Plant list of the various protected area
  - Botanical sampling plot locations
  - List of useful plants in Ghana
  - List of species of conservation value
- *Mapping of Species:* Available for the reserves/protected areas.
- The vegetation and wildlife in some selected protected areas (reserves) are presented in Table 14A, whilst a classification of Tree species is shown in Table 14B.
- *Other forms in which other data and information held:* Various publications are available. These are in hard copy and digital formats. Requests for information must be made to Directors.
- *Exchange of data and information:* The Forestry Commission has an e-mail address and website. It is not clear whether there are links from the website to the divisions under the Commission.

### 3.3.3 Soil Data

39. Data on soil composition, structure, type, etc. are held by the Soil Research Institute of the CSIR. It holds data on soils in various agroecological zones of the country.

- *Meta Data:* Metadata are available and they are geo-referenced. They provide information on location, soil pH, and percentage organic matter, percentage Total Nitrogen, Available Phosphorus, and Available Calcium.

- *Mapping of Stations:* The data collected has been used to prepare:-
  - Soil maps at 1:250,000
  - Land Suitability maps at 1:250,000 scale
  - Length of growing period map @ 1:250,000 scale
  - Thermal Zone Map at 1:250,000.
- *Database Management System:* Management of the database is by Excel.
- *Other forms in which other data and information held:* These are held in hard copies and digital/GIS readable formats)
- *Exchange of data and information:* The Institute has e-mail address and a website. These are used to exchange data and information.

**Table 14A: Vegetation and Wild Life in Selected Protected Areas**

PROTECTED NAME OF AREA	VEGETATION	FAUNA WILD LIFE	COMMENT
Owabi Wild Life Sanctuary (130 km <sup>2</sup> )	Plantation of an exotic species Cassia siamea (10%) coverage Rest consist of secondary vegetation riverine forests and aquatic vegetation	Sanctuary for indigenous birds	
Mole National Park (4840 km <sup>2</sup> )	Pristine Guinea Savannah vegetation with gallery forests along the rivers and streams	Over 90 mammal species including elephants, buffalo, roan, KOB, hartebeest, 4 primate species and over 300 bird specimen	
NiNi Sukien National Park of Ankasa Resource Reserve	Locate in the wet evergreen forest area of the Western Region. 300 plant species per hectare	43 manual species including the bongo, forest elephant, 10 primate species, rich bird fauna	
KaKum National Park and Assin Attandanso Reserve (350 km <sup>2</sup> )	Moist evergreen forest zone. Exceptionally high emergent trees up to 65 metres.	Varied wild life elephants, bongo red river-hog, tour squirrels, 200 bird species and 400 butterfly species	
Digya National Park (3478 km <sup>2</sup> )	Guinea Savannah woodland predominates with gallery forest along the major lines.	Six primate species, including black and white colobus elephants and a variety of antelopes, manatee and clawless otters.	

**Table 14B: Classification of Tree Species in Ecological Zones**

SPECIES	LOCAL NAME	PLANT FAMILY	VEGETATION TYPE
<i>Azelia Gfricana</i>	-	Mimosaceae	Savanna
<i>Anogeissus leiocarpus</i>	-	Combretaceae	Savanna
<i>Borassus aethiopum</i>	-	Palmae	Savanna (Revarine forest)
<i>Celtis integrifolia</i>	Fan patin tree	Vlmaceae	Savanna
<i>Daniellia Oliver</i>	-	Caesalpiodeae	
<i>Diospyros mespiliformis</i>	-	Ebenaceae	Savanna
<i>Combretum adenogonium</i>	-	Combretaceae	Savanna
<i>Combretum collinum</i>	Ebony tree	Combretaceae	Savanna
<i>Combretum molle</i>	-	Combretaceae	Savanna
<i>Combretum nigricans</i>	-	Combretaceae	Savanna
<i>Ficus sycomorus</i>	-	-	-
<i>Ficus glumosa</i>	-	Moraceae	Savanna
<i>Ficus ingens</i>	-	Moraceae	Savanna
<i>Ficus platyphylla</i>	-	Moraceae	Savanna
<i>Isobertinia tomentosa</i>	-	Caesalpinioideae	Savanna
<i>Isobertinia doka</i>	-	Caesalpinioideae	Savanna
<i>Kaya senegalensis</i>	Mahogany	Meliaceae	Savanna/Forest
<i>Lannea kerstingii</i>	-	Anacardaceae	Savanna
<i>Lannea acida</i>	-	Anacardaceae	Savanna
<i>Sclerocarya bierrea</i>	-	-	
<i>Tamarindus indica</i>	-	Caesalpinioideae	Savanna
<i>Terminalia laxiflora</i>	-	Combretaceae	Savanna
<i>Terminalia avicennioides</i>	-	Combretaceae	
<i>Terminalia mollis</i>	-	Combretaceae	Savanna
<i>Vitellaria paradoxa</i>	Shea-nut tree	Sapotaceae	Savanna

### 3.3.4 Geological Data

40. Geological data are collected by the Geological Survey Department.

- *Meta Data:* This is available on request. They cover:-
  - General geology
  - Geochemistry
  - Clay mineral
  - Geophysics
  - Hydrogeology
  - Environmental and engineering geology
  - Geohazards.
- *Mapping of Areas:* The data has been used to map the geology of the country.
- *Database Management System:* Management is by GIS software.
- *Other forms in which other data and information held:* These are in hard copies and digitised (including the GIS format)
- *Exchange of data and information:* The Department has both an e-mail and web-site address. Exchange is by e-mail. Requests for data and information must be made to the Director.

### 3.4 Socio-Economic Data

41. Socio-economic data are collected and held by the Ghana Statistical Services. Demographic data is collected and held by the Ghana Statistical Services. The data include:-

- Population and Housing Census of Ghana;
  - Alphabetical list of localities with Statistics on population, houses and household.
42. These cover employment production in agriculture services, manufacturing, education, health, etc.
- *Meta Data:* This is available on demand. They give information on location, size of population, number of houses and households, sex, infrastructural facilities, urban, rural, etc. Demographic and socio-economic metadata are presented in Table 15.
  - *Mapping of Stations:* The data are mapped. The data are geo-referenced at locality, settlement, and district, regional and national levels).
  - *Database Management System:* The database is managed by CSPro (Census and Survey Processing). Also it uses a number of other softwares for analysis. These are incorporated in the table on Socio-economic data Table 13.
  - *Other forms in which other data and information held* There are various publications. These are in hard copies and digitised formats.
  - *Exchange of data and information:* The services have both e-mail and web-sites. They are used to exchange data and information. Requests for data and information should be made to the Government Statistician.
43. Agricultural data are produced by SRID of MOFA. The relevant data consists of:-
- *Meta Data:* Data available on request are the relevant once which cover:-
    - Crop statistics
    - Crop yield and average production
    - Livestock statistics
    - Fish production



- *Mapping of Stations:* The data are geo-referenced within national, regional and district context.
- *Database Management System:* Management of the database is by Excel software. Table 16 shows data collected on crops, livestock statistics and the institutions responsible in the agricultural sector.
- *Other forms in which other data and information held:* Various publications are available including annual reports. They are in hard copies or digitised.
- *Exchange of data and information:* The Ministry has both an e-mail and web-site address. Requests for data and information must be made to the Chief Director. The use of e-mail and the web in their regard is to be investigated.

**Table 15: Socio-Economic Data**

TYPE OF DATA	INSTITUTION RESPONSIBLE	SPATIAL COVERAGE	FREQUENCY	EXTENT OF GAPS	FORMAT	DATA BASE
Population and Housing Census : distribution, age & sex structure nationality, birthplace (Ghanaian), ethnicity, household composition and structure. marital affiliation, religious affiliation, literacy, educational attainment, economic activity occupation, industry, employment status, employment sector, stock of houses, dwelling units, construction materials, household facilities and amenities and waste disposal facilities.	GSS/MFEP	National, Regional District Locality, Urban Rural	Inter-census	0%	Reports with Tables and Charts	
Key Social Economic Demographic Indicators: % distribution of urban/rural pop. by sex, age, Structure, sex structure	GSS/MFEP	National Urban Rural	1960, 1970, 1984, 2000	N/A	Reports with Tables and Charts	
Ghana Living Standards Survey; demographic Characteristics, education, health, employment, migration, housing, household agriculture, non-farm enterprises, total household income & expenditure, credit, assets and savings.	GSS/MFEP	National, Urban Rural Ecological	1987-99 – 1998/99	0%	Reports With table	
Patterns and Trends of Poverty in Ghana: consumption poverty, patterns and changes in consumption poverty, household assets, access to service, human development	GSS/MFEP	National, Regional Urban Rural Ecological	1991/92 – 1998/99 1991-2006	0%	Reports With tavkes	
Core Welfare Indicators: socio-economic characteristics of household heads, employment, education, health status and satisfaction with health service, household amenities, assets and access to services.	GSS/MFEP	National, Regional Urban Rural	1997	N/A	Reports	
The State of the Ghanaian Economy: fiscal development, monetary and financial, developments, international trade and payments, agric sector, industrial sector, international trade and growth.	ISSER University of Ghana, Legon	National	Annual	0%	reports	

**Table 16: Data Collected by the division of Ministry of Agriculture**

SECTOR	DATA & INFORMATION PRODUCED	SYSTEM FOR COLLECTING DATA	INSTITUTION
AGRICULTURE	Crop Statistics	Survey	CSD
	Livestock Statistics	Administrative	VSD
	Fisheries Statistics	Survey	MOFI

Source: MOFA

### 3.5 Environmental Data

44. Environmental data is collected and held by the Environmental Protection Agency.

- *Meta Data:* The meta data covers:-
  - Environmental sensitive areas along the coast of Ghana in Arc view shape files;
  - Data on the coastline of Ghana;
  - Aerial photographs of the coast of Ghana;
  - Effluent discharge data from industries and commercial establishment;
  - Data on ambient Air quality;
  - Data on water quality;
  - Satellite Imagery of Ghana (1990 & 2000);
  - Land Cover/Land Use Map Ghana (1990 and 2000);
  - AVHRR data re-sampled and geo-referenced.
- *Mapping of Locations:* The data on the coastline have been geo-referenced and have been mapped on scale of 1:20,000.
- *Database Management System:* GIS-Arc view has been used to manage the coastal database on the coastline.
- *Other forms in which other data and information held:* Various publications and maps have been produced. These are held in hard copy and digitised formats.
- *Exchange of data and information:* The agency has both an e-mail and web addresses. These are used for the exchange of data and information. Also, requests for information can be made to the Executive Director.

### 3.6 Remote Sensing and Geographical Information Data

45. Remote sensing and geographical information data are collected compiled and held by CERSGIS.

- *Meta Data:* This is available on demand. Information about remotely sensed images used in Ghana is presented in Table 17A. This covers:-
  - Satellite Imagery of Ghana (1990, 2000)
  - Land Cover/Land Use data of Ghana (1990, 2000)
  - Road infrastructure databases
  - Infrastructure facilities database
  - Current district boundaries
  - Harmonised regional environmental datasets packaged for all 10 regions of Ghana at a scale of 1:250,000;
  - Ghana-Country-at-a-Ghana data-base at a scale 1:1,000,000.
- *Database Management System:* The database management is by means of Arc GIS and ERDAS

Images.

- *Other forms in which other data and information held:* Various reports have been produced. They are in hard copy and digital formats. Requests for data and information have to be made to the Executive Director. The analysis of the images to determine land cover/land use in two different periods viz 1990 and 2000 is presented in Table 17B as an example.
- *Exchange of data and information:* The Centre has both e-mail and web addresses. Exchanges of information are made through them. It is in the process of upgrading its website for data in formats exchange.

**Table 17A: List of Remote Sensing Data (images) Used in Ghana**

NO.	COVERAGE	NAME	TYPE	SPATIAL RESOLUTION	SPECTRAL RESOLUTION
1.	Countrywide	Landsat ETM 1990,2000	Multispectral Panchro-matic	20 m 10 m	8 channels
2.	Selected Areas	SPOT	Panchro-matic	20 m	4 channels
3.	Accra, Kenya (BH) Nkwanta (UR)	Quick Bird	Fused Multispectral and Panchro-matic	60 cm	3 channels
4.	95% of Country	Aster	Panchromatic	15 m	4 channels

**Table 17B: Changes in Land Cover/Land use – 1990 and 2000**

VEGETATION	COVERAGE IN 1990	COVERAGE IN 2000	CHANGE (1990-2000)
	AREA KM <sup>2</sup>	AREA KM <sup>2</sup>	AREA KM <sup>2</sup>
<b>SURVEY OF GHANA MAP SHEET 0901</b>			
Reserved closed Savannah Woodland	0	223.79	+223.79
Reserved open Savannah Woodland	0	152.90	+152.90
Open access grassland with/without farms, grazing	251.67	2074.80	+1823.13
Riverine vegetation with/without farms	434,200	0	- 434.20
<b>VOLTA REGION</b>			
Reserved closed forest	0	3.294	+3.29
Open access closed forest	66.32	0	- 66.32
Open access grassland with/without scattered farms/grazing	788.04	338.12	- 449.92
Riverine vegetation with/without farms/grazing	430.40	112.49	- 317.91

Source: CERSGIS 2003 Land cover/Land use update presentation conference

### 3.7 Water Damming, Diversion and Abstraction Data

46. Data on licenses granted to dam, divert or abstract water from surface and groundwater sources for various purposes (drinking, industrial, mining, hydropower, navigation, irrigation, etc) are held by the Water Resources Commission. The data consists of register of Water Users

- *Meta Data:* There is a Meta data available. It covers location, Permit holder, Type of source, purpose, etc. as presented in Table 18.
- *Mapping of Stations:* Sites for which the licenses have been granted are being geo-referenced. When



this is completed the sites can be mapped.

- *Database Management System:* Presently, Excel software package is being used to manage the database.
- *Extracts from Database:* Table 16 shows an example of the list of water users granted license to operate in 2007.
- *Other forms in which other data and information held:* Various publications including annual reports are produced by the Commission. These are available in hard copies and digitised formats.
- *Exchange of data and information:* The Commission has both an e-mail and web-site address. Requests for data are made to the Executive Secretary. Data and information are provided free or at a cost.

**Table 18: Extracts from the Metadata and Register of Water Users – 2006**

Permit Holder	Point of Use	District	Type of Source	Primary Purpose	Expiry Date	
Ghana Water Company Ltd	Kwanyako Dam	Agona	Ayensu River	Domestic/Municipal	39083	Ashanti
Ghana Water Company Ltd	Avenorpeme	Akatsi	Groundwater	Domestic/Municipal	39083	VOLTA
Ghana Water Company Ltd	Ofoase-Akim	Akim Oda	River Pra	Domestic/Municipal	39083	EASTERN
Ghana Water Company Ltd	Obuasi	Amansie West	River Oda	Domestic/Municipal	39083	Ashanti
Ghana Water Company Ltd	Nubuom(Konongo-Odumasi)	Ashanti-Akim North	River Anum	Domestic/Municipal	39083	Ashanti
Ghana Water Company Ltd	Breman-Asikuma (Weir)	Asikuma-Odoben-Brakwa	Ochi-Nakwa	Domestic/Municipal	39083	Central
Ghana Water Company Ltd	Goaso	Asunafo	River Go	Domestic/Municipal	39083	
Ghana Water Company Ltd	Anum Boso	Asuogyaman	Volta Lake	Domestic/Municipal	39083	EASTERN
Ghana Water Company Ltd	Acherensua	Asutifi	RiverTano	Domestic/Municipal	39083	Brong Ahafo
Ghana Water Company Ltd	Nsein	Axim	River Denkyezule	Domestic/Municipal	39083	WESTERN
Ghana Water Company Ltd	Bawku Township	Bawku-East	Groundwater	Domestic/Municipal	39083	UPPER EAST
Ghana Water Company Ltd	Berekum	Berekum	Groundwater	Domestic/Municipal	39083	
Ghana Water Company Ltd	Zuarungu/Bongo	Bolgatanga	River Yaregatanga	Domestic/Municipal	39083	UPPER EAST
Ghana Water Company Ltd	Brimsu Treatment Works	Cape Coast	River Kakum	Domestic/Municipal	39083	Central
Ghana Water Company Ltd	Biaso	Dormaa	River Bia	Domestic/Municipal	39083	Brong Ahafo
Ghana Water Company Ltd	Winneba - Weir	Efutu-Awutu-Senya	Ayensu River	Domestic/Municipal	39083	Central
Ghana Water Company Ltd	Weija	Ga	River Densu	Domestic/Municipal	39083	
Ghana Water Company Ltd	Kpedze	Ho	River Tale	Domestic/Municipal	39083	VOLTA
Ghana Water Company Ltd	Tsito	Ho	River Wuve	Domestic/Municipal	39083	VOLTA

Source: WRC

### 3.8 Irrigation Infrastructure Data

47. The irrigation infrastructure has been developed mainly the Ghana Irrigation Development Authority. Subsequently, a number of private systems have been developed.

- *Meta Data:* This is available in Excel. It covers location, project name, water source, irrigation system, irrigable area, crops, etc. as presented in Table 19.
- *Mapping of Stations:* Presently, a consultant has been appointed by the World Bank to map the systems.
- *Database Management System:* A database using Excel has been developed.
- *Extracts from Database:* Table 19 presents an extract of Metadata.
- *Other forms in which other data and information held:* These are in hard copies and digitised formats.
- *Exchange of data and information:* The authority has no-email and web site address. Exchanges of information are by request to the Director.

**Table 19: Metadata and Database of Irrigation**

1	Project Name	Ashaiman	Anum Valley	Sata	Weija	Affe	Aveyime	Kpando
								Torkor
2	Project Description	Dam & lined canal	Weir, pump+	Weir+canal	pump+	dam+cana	pump+	pump+
			Canal		pipe+sprin	network	canal	pipe
3	Project Number	GAR/001	AR/001	AR/002	GAR/002	VR/001	VR/002	VR/003
4	Town	Ashaiman	Nobewan	Satso	Kokrobite/ Tuba	Avalavi	Aveyime	Kpando- Torkor
5	District	Tema Municipality	Asante Akim N. Ejisu-Juaben		Ga West	Ketu	Nrth.Tongu	Kpando
6	Region	Greater Accra	Ashanti	Ashanti	Greater Accra	Volta	Volta	Volta
7	Established Year	1968	1991		1984	1982	1975	1976
8	Consultant and Contr.	IDA	Chinese Co	RDC/IDA Yiadom/A Lang	Tahal/ Asakum/kinsman	Shandong Geo.Kufkak Enter	Nippon	IDA/ Aram-AI- Enter
9	Water Source	Gyorwulu River	Anum & Oweri Rivers	Sata	Densu Res	Kplikpo Agali	Volta	Volta lake
10	Irrigat. System Type	Gravity	Gravity+pump	Weir+ canal network	pump+ Sprinkler	gravity	pump+ gravity	pump+ sprinkler
11	Present Status	Active	Active	rehabilitation	rehabilitati	rehabilitat	rehabilitation	rehabilita.
12	Total Irrig.Area(ha)	130	88	56	1500	950	150	350
13	Present Cultiv. Area(ha)	56	70	34	200	880	59	70
14	Crops	Rice & Vegrtables	Rice+vegeta.	vegetables	vegetables	rice+veg	rice	vegetables
15	Beneficiary communi.	Ashaiman, Adjei Kojo	Nobewan	Satso. Adidwain	Tuba/ Kokrobite	Avalavi, Afefe	Aveyime B attor	Torkor, Dzigbe
16	Dis.proj. to H/Off.(km)	40	230	380	30	165	60	240
17	latitude	5° 43' 10" N/5°40'15'	6°34'34"	7° 14' 19"		6°04'/6°08'		6°59'-
18	Longitude	0°01'05'/0°01'07'	10°15'49"	1° 22' 22"		0°45/0°55		0°15'-0°20'

Source: GIDA

### 3.9 Water Supply Infrastructures Data

48. This is provided by the GWCL for urban areas and by the CWSA for rural and small town communities.

- *Meta Data:* This is presented in Table 20A for urban system and in Table 18b for small town piped systems. They cover system, location, population server, installed capacity, etc.
- *Database Management System:* This is based on Excel.
- *Forms in which other data and information held:* Various publications are available in hard copies and digitised format. The GWCL and CWSA have e-mails and Web sites. Request for data are made to the Managing Director and the Chief Executive of the GWCL and CWSA respectively.

**Table 20A: Extracts from the Database - Urban Water Supply Coverage**

No.	System name	Supply Area Pop. - 2006	Per Capita demand - lpcd	Total demand m3/day (2006)	Installed Capacity m3/day	Current Prod. m3/day (2006)	Current coverage %	Needed Inv. through 2020 \$ million
<b>Northern Region</b>								
1	TAMALE	477,504	80	38,200	19,400	18,785	49%	90
1	DAMONGO	23,628	75	1,772	1,320	190	11%	7
1	YENDI	59,688	75	4,477	2,600	1,400	31%	13
3	<i>TOTAL/AVG</i>	560,820	77	44,449	23,320	20,375	30%	110
<b>Upper East Region</b>								
1	BOLGATANGA	65,176	80	5,214	6,000	3,200	61%	14
1	NAVRONGO	38,649	75	2,899	1,400	890	31%	8
1	BAWKU	68,343	75	5,126	2,250	1,575	31%	18
3	<i>TOTAL/AVG</i>	172,168	77	13,239	9,650	5,665	41%	40
<b>Upper West Region</b>								
1	WA	106,735	80	8,539	2,800	1,180	14%	35
1	<i>TOTAL/AVG</i>	106,735	80	8,539	2,800	1,180	14%	35

Source: GWCL

**Table 20B: Water and Sanitation Projects facilitated by CWSA - 1990-2000**

External Support Agencies	Support Amount to Date	Project Operational Area	Project Duration	Status	Targets/Achievements
Agence Francais de Developpment (AfD)	120 million FF	Phase 1a Central Region – all districts	1990 - 1999	Completed	420 water points
	2. 58 million FF	Phase 1b “ “	2002 – 2005	Completed	300 water points
		Phase 1c “ “		Completed	18 Small Towns & 140 water points
		Phase 2 – Northern Region – Proposals & discussions completed. (western corridor)		New	Awaiting signing – 235 point sources, 13 pipe systems, 2000 house hold & 72 Institutional latrines.
Canadian International Development Agency (CIDA)	Cdn \$ 11 million	COWAP – Upper East & West Regions	1993 - 1999	Completed	Rehabilitated 2600 water points
	Cdn \$ 34 million	GAP 1 – Small Towns Rehabilitation – Northern Upper East & West Regions	1990 – 1994	Completed	Rehabilitated 14 Small towns Water Supply Systems
		GAP 2 – Small Towns Rehabilitation – CIDA Funding went into capacity building	1996 – 2000	Completed	18 Small Towns Water Supply Systems
		NORWASP – Northern Region – Point Sources – 7 districts in the North Eastern Corridor.	1999 – 2006	Ongoing	70 HDW and 630 BH; 14,000 latrines are expected to be provi
Danish International Development Agency (Danida)	DKK 158 mill	Phase 1 – Volta Region – 8 districts	1993 – 1996	Completed	Will provide water for 400,000 people; 10,000 household & 170 institutional latrines
	DKK 11.5 mill	Phase 2 – Volta	1997 – 2003	Ongoing	4 – 5 small towns
	DKK 109 mill	Phase 1 – Eastern & Greater Accra Region	1999 – 2003	Ongoing	Capacity building for key sector actors
	DKK 5.0 mill	Small towns Project for Greater Accra	2001 – 2003	Formulation	
	5. DKK 32.6 mill	Sector Capacity Building Component	1999 - 2003		

External Support Agencies	Support Amount to Date	Project Operational Area	Project Duration	Status	Targets/Achievements
Department for International Development (DFID)		South East Water & Sanitation Project (SEDWASP) - completed		Completed	
European Union (EU)	€15 million	Small Towns Water & Sanitation Project (Ashanti, Western & Brong Ahafo regions) – 25 small towns.	2001 - 2002	Ongoing	Construction work begins 22 <sup>nd</sup> January 2001 for 25 small towns.
	€14 million	Rural Water & Sanitation Project – Northern Region. East & West Gonja & West Mamprusi Guinea Worm Endemic Region.	2002 - 2005	Ongoing	Short listing of Consultants in progress, 475 point sources fitted with pumps, 25 boreholes with solar pumping to be provided.
	3. €32 million (approximately)	Programming Study for Small Towns Water Supply & Sanitation – Central & Western Regions – 50 Small towns	3. 2002 – 2005	Ongoing	2000 latrines  Selection of consulting firm in progress.
European Union	1/3 of funding for micro financing devoted to water supply in project areas.				
Agence Francais de Development (Afd)	120 million FF	Phase 1a Central Region – all districts	1990 - 1999	Completed	420 water points
	2. 58 million FF	Phase 1b “ “ Phase 1c “ “  Phase 2 – Northern Region – Proposals & discussions completed. (western corridor)	2002 – 2005	Completed Completed  New	300 water points  18 Small Towns & 140 water points Awaiting signing – 235 point sources, 13 pipe systems, 2000 house hold & 72 Institutional latrines.
Canadian International Development Agency (CIDA)	Cdn \$ 11 million	COWAP – Upper East & West Regions	1993 - 1999	Completed	Rehabilitated 2600 water points
	Cdn \$ 34 million	GAP 1 –Small Towns Rehabilitation –	1990 – 1994	Completed	Rehabilitated 14 Small towns Water Supply Systems

External Support Agencies	Support Amount to Date	Project Operational Area	Project Duration	Status	Targets/Achievements
	3. Cdn \$ 16.768 million	Northern Upper East & West Regions GAP 2 – Small Towns Rehabilitation – CIDA Funding went into capacity building NORWASP – Northern Region – Point Sources – 7 districts in the North Eastern Corridor.	1996 – 2000  1999 – 2006	Completed  Ongoing	18 Small Towns Water Supply Systems 70 HDW and 630 BH; 14,000 latrines are expected to be provided
Danish International Development Agency (Danida)	DKK 158 mill  DKK 11.5 mill DKK 109 mill  DKK 5.0 mill 5. DKK 32.6 mill	Phase 1 – Volta Region – 8 districts  Phase 2 – Volta Phase 1 – Eastern & Greater Accra Region Small towns Project for Greater Accra Sector Capacity Building Component	1993 – 1996  1997 – 2003 1999 – 2003  2001 – 2003 1999 - 2003	Completed  Ongoing Ongoing  Formulation	Will provide water for 400,000 people; 10,000 household & 170 institutional latrines  4 – 5 small towns Capacity building for key sector actors
Department for International Development (DFID)		South East Water & Sanitation Project (SEDWASP) - completed		Completed	
European Union (EU)	€15 million  €14 million 3. €32 million (approximately)	Small Towns Water & Sanitation Project (Ashanti, Western & Brong Ahafo regions) – 25 small towns.  Rural Water & Sanitation Project – Northern Region. East & West Gonja & West Mamprusi Guinea Worm Endemic Region. Programming Study for Small Towns Water Supply & Sanitation – Central & Western Regions – 50 Small towns	2001 - 2002   2002 - 2005	Ongoing   Ongoing	Construction work begins 22 <sup>nd</sup> January 2001 for 25 small towns  Short listing of Consultants in progress, 475 point sources fitted with pumps, 25 boreholes with solar pumping to be provided.  2000 latrines  Selection of consulting firm in



External Support Agencies	Support Amount to Date	Project Operational Area	Project Duration	Status	Targets/Achievements
			3. 2002 – 2005	Ongoing	progress.
European Union	1/3 of funding for micro financing devoted to water supply in project areas.				

Source : CWSA

**Table 20C: Water and Sanitation Projects Facilitated by CWSA from 2001 to Date**

Project	Donor(s)	Commitment	Target Region(s)	Duration	STATUS
1. CWSP-II Phase II - Small Towns Water Supply and Sanitation Project (STWSSP)	IDA	US\$26.4m.	(i) Ashanti (ii) Brong Ahafo, (iii) Upper East (iv) Upper West (v) Central (vi) Western	2005 – 2008	Implementation ongoing
2. NORWASP	CIDA	CD\$16.768m	Northern (7 dist.)	2000 – 2006 2006 - 2007	Completed in December 2006 – extended for one year to end of 2007
3. Rural Water Supply and Sanitation Project	AFD	US\$10.8m	Northern (6 dist.)	2002 – 2005	completed in Dec. 2006 but in a one year post-project phase
4. Rural Water Supply and Sanitation Project	EU	EUROS 14m.	Northern (4 dist.)	2002 – 2005	Expected to end October 2006
5. Phase II of the Danida Sector Program Support: District Based Water Supply and Sanitation Component	DANIDA	US\$45.2m	Greater Accra, Eastern, Volta and Central regions.	2004 - 2010	Implementation Ongoing
6. Integrated Approach to Guinea Worm Eradication through Water Supply Sanitation and Hygiene	EU	EUROS 20m	Northern Region (9 districts)	2007- 2011	Inception stage, implementation to start in 2008
7. Rural Water Supply and Sanitation Project	AfDB	US\$17m	Ashanti region	2004 - 2008	Implementation Started
8. Fourth Rural Water Supply Programme (RWSP4)	KfW	US\$13.4	Ashanti	2004 - 2007	Implementation Ongoing
9. Small Towns Water Supply and Sanitation Project (40 Towns)	EU	EUROS 32.0m	Central and Western Regions	2003-2010	TA Consultancies Selection completed
10. EVORAP - Small Towns Water and Sanitation Project(8 towns)	DFID (through KfW)	EUROS 3,227,080	Eastern and Volta	2006 – 2008	Civil works to be completed 2007.
11. Northern Region Small Towns Water Supply and Sanitation Project.	CIDA	Cdn 30 million	Northern Region	2007 – 2012	New project. Awaiting selection of Canadian Executing Agency.
12. Access to Water in Guinea Worm Infested Areas					
1. Nkwanta District, Volta Region	DFID/ DANIDA	£1.42m	Nkwanta District, Volta Region	2006-2008	Civil works almost completed
2. Ducie, Upper West Region	DFID/ DANIDA	£0.20m	Ducie, Upper West Region	2006-2008	Civil works almost completed
13. Three District Water Supply Project, Gt. Accra&Volta Regions	DFID/GOG DANIDA	£5.71m	Greater Accra & Volta Regions	2006-2008	On-going, Civil Works almost completed
14. Peri-Urban and Rural Water Supply Project	AFD	US\$20m	Brong Ahafo Region	2008 -2012	Feasibility Completed, contractual agreements ongoing

Source: CWSA

### 3.10 Hydropower Generation Data

49. The Volta River Authority (VRA) is responsible for the hydropower infrastructure presently. A new dam – the Bui dam is presently under construction. There are plans to start construction of smaller dams for hydropower generation on Pra and Ankobra rivers.
- *Meta Data:* This covers Water Balance, Inflows, Lake levels, Electricity Produced and Transmitted; Monthly Peak Demand, Monthly Energy Consumed, Annual Energy Consumed per Class of Consumer, Monthly Maximum Demand per Class of Customer, Power Promotion Statistics, Monthly Energy Balance, etc.
  - *Database Management:* Database Management is by Oracle.
  - *Other forms in which data and information are held:* There are a number of publications including Annual Reports and Audited Accounts which are in hard copies or in digitised format. Exchange of data and information is through e-mail and the website. Requests for information must be made to the Corporate Affairs Officer.

### 3.11 Land Ownership data

50. Land ownership data is held by the Lands Commission. A Consultant has been engaged to develop a Meta data for all data sets held by the Commission
- *Meta Data:* This covers:-
    - State vested lands
    - Stool/skin lands
    - Family lands
    - Various land leases for various purposes such as forestry and mining.
  - *Mapping of Land:* These lands are geo-referenced and therefore mapped.
  - *Other forms in which other data and information held:* Various reports have been produced by the Commission. They are in hard copy and digital formats.
  - *Exchange of data and information:* The Commission has an e-mail but not a web site. Exchanges of information are by the request to the Executive Director.

### 3.12 Existing Structure of the Data and Information Management Systems

51. As shown in paragraphs 3.2 to 3.6, the existing data can be broadly grouped as Water cycle, Physcographic, Socio-economic and Cultural data. Their components have been shown in paragraphs. The data have been used to produce all kinds of information to meet various needs.
52. It is clear that the data are spatial. As such, it is important that they are geo-referenced. Once they are geo-referenced they can be mapped. Secondly, the attributes or fields of the data need to be managed by softwares that have spreadsheet capabilities.
53. In a nutshell the data management softwares must have both mapping and spreadsheet capabilities. It is necessary to persuade all institutions to acquire data management systems with the above capabilities. Some of the agencies like the HSD and WRI have softwares which are free. Hence, they are not updated or upgraded like the commercial ones. Some of the softwares like HYDATA used by HSD are out of production. As such the HSD does not have support from the producers in Wallingford, UK. The initial cost and annual subscription fee of the commercial ones pose a financial burden on the institutions. Unless they can charge cost recovery fees for the services they provide they will have to contend with the limited capabilities of the free softwares. Most of the institutions have recognised the need for GIS and are trying to organise their databases with such systems.

### 3.13 Inventory and Assessment of Human Resources

54. In compiling the inventory, data was extracted from the Questionnaire returns, publications available and from the Internet. Information about the organisational structure both at national and regional GWCL were also obtained. Attempts were made to classify into professional and technical staff. Data was also obtained as to which of the above are in management and supervisory positions at the two levels. The qualifications of the professional and technical staff were inquired into.

#### 3.13.1 Ghana Meteorological Agency (GMA)

55. The agency is headed by a Director-General with two deputies who are responsible for Operations and Finance and Administration respectively at the Head Office. Under the Operations division, there is a Director for Synoptic Meteorology, a second Director for Research and Applied Meteorology, and a third Director for Engineering and Technical Services.

56. In addition to the Head Office, there are 10 regional offices corresponding to the administrative regions of the country. Each region is headed by a Regional Director who is responsible for:-

- Agrometeorological/Climatological/Rainfall stations.
- Synoptic observing stations.

57. At the Head Office, there are:-

- Eleven (11) professional staff, five (5) of when are in management positions. Their academic qualifications are either BSc or MSc degrees.
- Fifty (50) Technical staff. Five (5) of when are in supervisory positions. Their qualification are equivalent to Higher National Diploma to Technician Certificates.
- Twenty (20) supporting staff who are technicians.

58. At each Regional Level there are:-

- One professional staff
- Thirty Technical staff
- Two Supervisory staff
- Three Supporting staff.

59. There is no IT personnel in the agency. IT related jobs are performed by other professionals or are out-sourced. The staff distribution is shown in Table 21.

#### 3.13.2 Hydrological Services Department (HSD)

60. The HSD is headed by a Director at the Head Office in Accra. He is assisted by two Deputy Directors. One Deputy Director is responsible for the Works Division and the other for the Hydro Survey Division. The Hydro Survey Division has seven hydrological regions together with a Data Section under it. The regional Hydro Survey Division is head by a Regional Engineer/Hydrologist.

61. The regional branches are responsible for data collection within the hydrological region. The data collected on rivers are recorded on paper and sent to the regional office. The data is initially checked and entered into computers with the HYDATA software. At the head office they are subjected to final quality checks, after which they are processed and archived with the HYDATA software.

62. The staff can be classified as those with University degrees (MSc & BSc) viz consultants, engineers, quantity surveyors, scientific officers. The others are technical staff made up of Engineering Technicians and Technical Officers with Higher National Diplomas.

63. It must be noted that all those who have the requisite academic qualifications, have had training in their jobs either through projects (WRIS Project) in-service training, etc.

64. As a policy to keep staff abreast with current knowledge and techniques staff are periodically offered the chance to avail themselves of refresher courses available at national, regional or global levels.
65. Among the staff there is no one trained specifically for IT work. The work of database management is done by staff with hydrological or engineering qualification.
66. At the head office there are 25 made up of twelve professionals, ten technical and three supporting staff as shown in Table 21.

### **3.13.3 Water Research Institute (WRI)**

67. The Institute is organised at the national level but operates countrywide. The staff is made up of senior members, senior staff and Junior staff. The Senior members are the Scientific officers. They range from Assistant Scientific officer to Chief Scientific officer.
68. Among the senior and junior staff are the Technical Officers who support the work of the Scientific Officers. The divisions of relevance are the Surface Water, Groundwater Environmental Chemistry, Environmental Biology and Health, Fishery and the Commercialisation and Information Divisions. The Senior members have qualification ranging from BSc to PhD and post-doctoral qualification. The Senior and junior have qualifications ranging from Higher National Diploma to Technician Certificate.
69. The Institute has a Commercialisation and Information section. It is the four (4) senior members and senior staff in the scientific secretariat who handle the work of information technology in the Institute. The distribution of staff is shown in Table 19.

### **3.13.4 Centre for Remote Sensing and Geological Information Services (CERSGIS)**

70. The Centre is organised at the national level but its work covers all the regions and districts of the country. It is headed by an Executive Director with two main divisions under it. The divisions are the Applications Division and the Finance and Administration Division. The Applications Division consists of:-
  - Remote Sensing and Image Processing Unit
  - Training and Capacity Building Unit
  - GIS and GPS Unit
  - Systems Administration and Logistics Unit.
71. The Centre has eleven (11) professional staff with Masters and Bachelors degrees in GIS, Remote Sensing, Geography and Resource Development, Geodetic Engineering and Computer Science. Their experiences range from two to fourteen years. Their qualification and training are adequate to fit them for their work. There is a policy to give staff continuous training to keep them abreast with the latest knowledge and technologies in their field of work. There is one staff specifically trained in IT. The distribution of staff is shown in Table 21.

### **3.13.5 Ghana Statistical Service (GSS)**

72. The GSS is organised both at national level and the regional level. The service is under a Government Statistician with the following divisions and staff at the head office:-
  - Demographic/Statistics (28)
  - Analytical Studies and Development (25)
  - Economic Statistics (22)
  - Social Statistics (19)
  - Industrial and Trade Statistics (27)
  - Field Operations and GIS (1)

- Data Processing and Field Services (ICT) – (34)
- Co-ordination and Capacity Building (6)
- Publicity and Dissemination (12)
- General Administration (130)
- Finance (27)
- Internal Audit (4)
- Management (2)

73. At the regional level the staffing position is as follows:-

- Western - (17)
- Central - (24)
- Greater Accra- (42)
- Volta - (20)
- Eastern - (32)
- Ashanti - (36)
- Brong-Ahafo- (19)
- Northern - (15)
- Upper East- (17)
- Upper West - (16)

74. The staff consists of professionals with qualifications PhD, MSc and BSc in the fields of Statistics, Demography, Sociology Computer Science, Accounting, Economics, Public Relations, Geographic Information Systems, etc. They are supported by technical officers with qualification at Higher National Diploma and Certificate levels. There is a total of 318 staff at the head office and 238 at the regions. There is a Geographic Information Unit headed by a trained staff.

75. The Service benefited from a World Bank project between 1998 and 2002. It was aimed at strengthening the capacity of the service through training of all levels of staff in local and overseas institutions and on the job training through technical assistance. The policy of continuous training to update the knowledge and skills of staff is practised in the service.

**Table 21: Staffing Levels at Selected Data Institutions**

NAME OF ORGANISATION	HEAD OFFICE				LOCAL LEVEL			
	PROFESSION STAFF	TECHNICAL STAFF	SUPPORTING	Total	PROFESSIONS	TECHNICAL	SUPPORTING	TOTAL NUMBER
GMA	11	50	20	18	10	30	50	<b>360</b>
HSD	12	10	3	25	5	27	6	<b>38</b>
WRI	55	28	12	95				<b>0</b>
CERSGIS	6	5	-	11				<b>0</b>
GSS				318				<b>238</b>

### 3.14 Identification, Classification and Needs of Different User Groups

76. Users of the data and information generated and produced by the institutions are many. Examples include the consultants, contractors, agriculturists (farmers, fishermen), ministries, departments and agents of government, cabinet, parliament aviation industry, schools, universities, producers of hydropower, producers of water for domestic and industrial use, aviation and shipping lines, etc. In this study, they have been classified into eight user groups as follows:-

- Policy makers

- Planners
- Consultants and Contractors
- Providers of Water Services
- Users of water
- Regulators of the Environment
- Education and Research organisation
- Awareness Creators

77. Examples of each user group have been given. Further examples of the data and information need of each group have been identified. The information provided relate to the GMA, HSD, WRI , CERSGIS and GSS, These are presented at Tables 22A to 22E. The users of the data and information generated and produced by the remaining institutions can be found in Annex 2. The table below refers to Users of Data and Information in GMA, IDA, HSD, WRI, CERSGIS and GSS.

78. Examples were given of the data and information needs in the third column of the tables 22A to 22E. The format of the presentation will depend on the data needs of the user group. Having regard to the facilities and the present exchange mechanism, they will be provided in either hard copies or digitised formats. In any particular case, the user will have to determine and request the format in which it will need the data or information.

**Table 22A: Users of GMA Data and Information**

USER GROUP	EXAMPLES	DATA & INFORMATION NEEDS
POLICY	Cabinet, Parliament, Ministries, Departments, Agencies	Long term climate variability and change and impact on life socio-economic development and ecosystems sustainability
PLANNING	National Development, Planning Commission, MDAs	Long term mean, monthly, annual variability and extremes
DESIGN & CONSTRUCTION OF WATER INFRASTRUCTURES	Consultants, Contractors	Mean and extreme climate variables
OPERATORS OF WATER SYSTEMS	GWCL, CWSA, GIDA, VRA, VLTC	Forecasts of rainfall weekly, monthly, half yearly, annual
WATER USERS	Households, industries including mining, farmers, fishermen, boat operators, shipping lines, aviation (civilian & military)	Forecasts of rainfall seasonally
REGULATORS OF ENVIRONMENT	EPA, MDAs, WRC	Forecasts of seasonal climate
EDUCATION AND RESEARCH	1 <sup>st</sup> and 2 <sup>nd</sup> cycle, University faculties, Departments, Schools, Research Institutions	Climate variables Daily, monthly, annual means, and extremes.
AWARENESS CREATION	MDAs, NADMO, NGOs	Forecasts of weather

**Table 22B: Users of HSD Data and Information**

USER GROUP	EXAMPLES	DATA AND INFORMATION NEEDS
POLICY	Cabinet, Parliament, Ministries, Departments, Agencies	Water Availability and demand for life and socio-economic of environment and ecosystem sustainability
PLANNING	National Development, Planning Commission, MDAs	Long term Water resources availability under mean and extreme climate
DESIGN AND CONSTRUCTION	Consultants, Contractors	Long term Availability under mean and extreme conditions. Forecasts of rainfall runoff and water levels
OPERATORS OF WATER SYSTEMS	GWCL, CWSA, GIDA, VRA, VLTC	Forecasts of reservoir water levels and inflows
WATER USERS	Households, industries including mining, farmers, fishermen, boat operators	Forecasts of seasonal water availability and quality
EDUCATION AND RESEARCH	1 <sup>st</sup> and 2 <sup>nd</sup> Tertiary cycle Institutions, Research, Departments and Institutions	Hourly, daily, monthly, Annual water availability under mean extreme weather and climate change.
REGULATORS OF ENVIRONMENT	EPA, MDAs, WRC	Forecasts of water availability
AWARENESS CREATION	NADMO, NGOs, MDAs	Forecasts of water availability

**Table 22C: Users of WRI Data and Information**

USER GROUP	EXAMPLES	DATA & INFORMATION NEEDS
POLICY MAKING	Cabinet, Parliament, Ministries, Departments, Agencies	Water Availability and demand for life and socio-economic of environment and ecosystem sustainability
PLANNING	National Development, Planning Commission, MDAs	Long term Water resources availability under mean and extreme climate
DESIGN AND CONSTRUCTION	Consultants, Contractors	Long term Availability under mean and extreme conditions. Forecasts of rainfall runoff and water levels
OPERATORS OF WATER SYSTEMS	GWCL, CWSA, GIDA, VRA, VLTC	Forecasts of runoff and reservoir water levels and quality
WATER USERS	Households, industries including mining, farmers, fishermen, boat operators	Forecasts of seasonal water availability and quality
EDUCATION AND RESEARCH	1 <sup>st</sup> and 2 <sup>nd</sup> Tertiary cycle Institutions, Research, Departments and Institutions	Hourly, daily, monthly, Annual water availability under mean extreme weather and climate change.
REGULATORS OF ENVIRONMENT	EPA, MDAs, WRI	Forecasts of water availability
AWARENESS CREATION	NADMO, NGOs, MDAs	Forecasts of extreme water availability, quantitatively and qualitatively

**Table 22D: Users of CERSGIS Data and Information**

USER GROUP	EXAMPLES	DATA AND INFORMATION NEEDS
POLICY MAKING	Cabinet, Parliament, Ministries, Departments, Agencies	Land cover and land use and its impact on water resources for use in socio-economic development and ecosystem sustainability.
PLANNING	National Development, Planning Commission, MDAs	Suitability of land for various development purposes
DESIGN AND CONSTRUCTION	Consultants, Contractors	Land cover and land use in design of various development projects
OPERATORS OF WATER SYSTEMS	GWCL, CWSA, GIDA, VRA, VLTC	Impact of land cover land use changes on water resources
WATER USERS	Households, industries including mining, farmers, fishermen, boat operators, shipping, aviation	Impact on water availability
EDUCATION AND RESEARCH	1 <sup>st</sup> and 2 <sup>nd</sup> Tertiary cycle Institutions	Knowledge of Land cover and land use and impact on various aspects of development
REGULATORS OF ENVIRONMENT	EPA, MDAs, WRC	Conservation of natural resources
AWARENESS CREATION	NADMO, NGOs, MDAs	Degradation of land and its impact on livelihood

**Table 2E: Users of GSS Data and Information**

USER GROUP	EXAMPLES	DATA AND INFORMATION NEEDS
POLICY MAKING	Cabinet, Parliament, Ministries, Departments, Agencies	Demographic trends and its impacts on Water Resources for Socio-economic Development and Ecosystems Sustainability
PLANNING	National Development, Planning Commission, MDAs	Population size and distribution and development planning
DESIGN AND CONSTRUCTION	Consultants, Contractors	Population and design of water infrastructure
OPERATORS OF WATER SYSTEMS	GWCL, CWSA, GIDA, VRA, VLTC	Current and future population and provision of services
WATER USERS	Households, industries including mining, farmers, fishermen, boat operators	Population and availability of water to meet various demands
EDUCATION AND RESEARCH	1 <sup>st</sup> and 2 <sup>nd</sup> Tertiary cycle Institutions, Research, Departments and Institutions	Demographic data collected at answers.
REGULATORS OF ENVIRONMENT	EPA, MDAs, WRI	Demographic data and impact on environment.
AWARENESS CREATION	NADMO, NGOs, MDAs	Demographic data

## 4 Development of Training Plan for National Institutions

79. This will involve the assessment of the institutions, the identification of training gaps, the prioritisation of training needs, the development of a plan of operation and the outlining of various manuals and tools. These are described in the following sub paragraphs for the GMA, HSD, WRI, CERSGIS and GSS.

### 4.1 Assessment of National Institutions

80. The assessment is done against:-

- The human resources available,
- the equipment and facilities for data collection, transmission, processing, archiving, retrieval and exchange.

#### 4.1.1 Assessment of the GMA

81. *Human Resources:* The agency has eleven professionals and fifty technical staff at the national level. For each of the ten regions, there is one professional and 30 technical staff. Most of them together with technicians are MSLC holders, who are nearing retirement age and need to be replaced. A comparison with what the establishment should be is not meaningful because of the embargo placed on recruitment as a result of the national institutional reform. The agency has no dedicated IT specialist. However, it is to be noted that they do perform their functions albeit the restrictions on recruitment. The staff also benefitted from training which became possible through the Danida Project on Strengthening the Water Resources Information Institution (WRIS) between 1997 and 2003.

82. *Equipment and facilities:* During the WRIS project the agency acquired new meteorological data collection and transmission equipment, data processing and database management equipment like computers. The software used for database management is CLICOM WMO approved software.

83. *Data Exchange Equipment:* The agency also acquired new photocopiers, fax machines and printers. Presently the agency has an e-mail address and also a website. The website is not updated regularly.

84. *Recommendation:* The staff are qualified for their work. They have had formal and periodic training as a means of helping them be abreast with new knowledge and technology. However:-

- New staff needed to replace the aging ones should be trained in the use of the meteorological and communication equipment, and also in the use of computers and the data management softwares in use in the agency. This is after their training needs have been assessed.
- The equipment – meteorological instruments computers and software which were procured during the WRIS project may need to be replaced since they are getting more than five years old.
- The email and website need to be exploited more fully in the exchange of data.
- A data information system that combines the spatial nature of the data collected and the database management should be the focus.
- An IT expert should be groomed from among the present professionals so as to comply with the embargo - new staff recruitment.

#### 4.1.2 Assessment of the HSD

85. *Human Resources:* HSD has Professionals, technical officers and technical assistants at national level and in the seven hydrological regions. They have the necessary qualification and training for the job. There is no IT expert. In view of the policy on embargo on recruitment in the civil service an assessment of staff strength is not meaningful. It is learnt that some new staff who were recruited left because of low salaries.

86. *Equipment and facilities:* The HSD like the GMA benefited from training and acquisition of field of equipment. These include hydrological measuring equipment, computers, HYDATA software for data processing and database management. These equipment are some five years old.
87. *Data Exchange Facility:* The division has no e-mail and no website. This limits its ability to exchange data and information.
88. *Recommendation*
- The GIS component of the HYDATA software should be exploited more fully. The staff who left because of poor salaries have to be replaced and trained in the use of hydrological measuring equipment, computers and softwares for managing the database.
  - An IT expert should be selected from among the present staff doubling as hydrologists and IT experts, and properly trained in data management and exchange technologies.
  - Computer equipment and software acquired five years ago need to be replaced with up to date ones. The HYDATA software which is out of production need replacement with one that can be supported by the suppliers.

#### **4.1.3 Assessment of the WRI**

89. *Human Resources:* Its human resources are made up of Professionals and Technical staff. It operates at the national level and has no regional offices like the GMA and the HSD.
90. *Equipment:* The WRI also benefited from the WRIS project through training of staff at all levels. Staff were trained in groundwater exploration and assessment techniques. It acquired equipment and softwares to set up a GIS office. It also acquired field and laboratory equipment for water sampling and testing for both surface and groundwater quality. Staff have also been trained in database management.
91. *Data Exchange Facilities:* The Institute has an e-mail address and a website but appear not to be exploited as they should.
92. *Recommendation;* The staff are qualified for their job, however:-
- Their equipment and softwares should be upgraded or replaced as appropriate. Staff should be trained in the use of the upgraded and new equipment.
  - The e-mail and web-site need to be exploited more fully for data and information exchange.

#### **4.1.4 Assessment of the CERSGIS**

93. *Human Resources:* The human resources are adequate in terms of qualification and numbers for the work the Centre does. A recent project EMMSDAG undertaken to map and monitor development projects in Ghana has given the opportunity to train staff and to upgrade its equipment and facilities. The project was supported by the EU. The staff include an IT Technician.
94. *Equipment and Facilities:* The point made about human resource development under the EMMSDAG is applicable here to the acquisition of equipment and facilities.
95. *Data and Information Exchange:* The Centre has both an e-mail address and web-site. The web site need to be updated more regularly and mobilised as a means of information exchange. Fortunately, under the EMMSDAG the centre will acquire equipment to enable it procure server(s) (for Database and Maps) on which all the results of EMMSDAG will be held and exchanged with other users of development information at district and regional levels also includes a V-Satellite Dish with modem and Master Router to serve as the internal gateway. In addition to the Servers, to hold the Maps and the Database, there will be an Application Server and a Domain Server.
96. *Recommendation:* It is recommended that the Centre makes effort to acquire the above equipment

and facilities for the exchange of data and information.

#### 4.1.5 Assessment of the GSS

97. *Human Resources:* The human resources at the head office and regional offices are adequate for the work of the service, within the limitations imposed by the government's embargo on the recruitment of staff. As already stated, a recent World Bank Project strengthened the service through manpower development and the provision of equipment.
98. *Equipment and Facilities:* Among the most important is the procurement of computers and softwares to set up a GIS office. Also, sizeable quantities of GPS equipment were procured to enable field enumerators locate the geographical co-ordinates of localities in the field. Also data management software was procured and staff trained in their use. The above training facilitated the conduct of the 2000 Census - Population and Housing Survey. It also made it possible for the raw data to be compiled in digital format. The analysis of the data and studies undertaken were made easier with these facilities.
99. *Data and Information Exchange:* The Service has an e-mail and a website. The website is regularly updated. It may need to be exploited more fully in the exchange of data and information. The availability of an IT expert can facilitate this process if he should team up with the GIS expert at post.
100. *Recommendation:* The Service has trained human resources. They have been given opportunities since their qualification to benefit from further training in fulfilment of the continuous training policy of the service. However:-
- The equipment – computers, softwares GIS and GPS equipment acquired during the World Bank project over ten years ago need to be replaced with more up to date ones. The same applies to softwares.
  - Training in the use of new equipment and software when procured will benefit the staff.

#### 4.2 Identification of Training Gaps at National and Local Level for Data Management

101. As shown in 4.1 the five agencies were strengthened by training of staff at local and overseas institutions, provision of equipment and facilities through the WRIS, EMMSDAG and World Bank projects. Apart from EMMSDAG, the projects ended about five to ten years ago, majority of the staff are still at post in the institutions viz GMA, HSD, WRI, CERSGIS and GSS. The following will be the basis for identifying the training gaps:-
- The need to make GIS the tool for the management of data and databases. This requires that the computer equipment and softwares should be upgraded and the necessary training given in their use.
  - The second is the selection and training of ICT experts who will set up efficient web-sites which will be updated regularly.
  - Where field equipment are obsolete and are to be replaced training must be given on how to use the equipment to collect reliable, accurate and regular data.

#### 4.3 Need for Prioritisation

102. There is need for prioritisation because:
- A number of the staff who are in the data and information management positions have had training formally or through the many training courses brought about through projects.
  - It is seen from the inventory of institutions that the institutions are many and there may not be adequate resources to cater for all of them.
  - However, it is obvious that the key institutions are the GMA, HSD, WRI, CERSGIS and GSS. In these institutions, there are the clear distinctions between the Operational Divisions and the Finance and Administrative divisions. Emphasis should be placed on the staff in the Operational

Divisions.

- Moreover, among the Operation Staff, not all are in the data collection and database management units. For instance in HSD, the operation division consists of staff who are in coastal protection, drainage and flood control works. As such, it is the staff in the hydro data collection in the regional offices and the data processing, archiving, retrieval and exchange at the head office that must be the focus of training.

103. What has also emerged through the limited contact with the institutions is that:-

- New technologies have come up on the market since they were last trained.
- Computers and softwares acquired some years ago need to be replaced with up to date ones.
- The policy which exists for the continuous training of staff to be abreast with new knowledge and technologies need to be implemented. Consequently:-
  - Those who have not should be targeted.
  - An effort be made to select people for IT training in the institutions.
  - Top level management supervisory staff will need to be trained to appreciate the use of data information management systems, so that they will feel comfortable to drive the training programs in their institutions.

#### 4.4 Plan of Operation

104. The Plan of operation addresses the prioritised institutions and staff, training areas, training providers, duration and timing and training manuals. These are described briefly below.

105. *Institutions Target and Training Areas:* At paragraph 4.2 the training needs areas were identified from information collected from documents at the websites and preliminary contact with some staff of the institutions. These happen to the target staff who use:-

- Field measurement equipment, transmission, processing and archiving data;
- Laboratory equipment for water quality and sediment analysis;
- GIS equipment and softwares for mapping and database creation;
- Spatial data analysis and modelling
- Website and communication equipment for exchange of data and information.

106. The target groups who should be given training at the various levels have also been identified.

107. *Training Providers:* In addition, the providers of training for the training courses have been indicated. Each Training provider will be asked to provide information regarding:-

- Objectives of Training;
- Competences to be addressed;
- Target trainees;
- Course content;
- Duration (days/weeks);
- Method of training (lectures, exercises, field and laboratory work, etc.);
- Types of Training experts (hydrologists, meteorologists, IT & Communication experts, GIS and Database experts, Spatial Analysts, Software specialists, Demographers, Economists, Modellers, Equipment specialists, etc.);
- Estimated cost.

108. *Duration and Timing:* The duration of training have been estimated and so is the timing.

109. *Training Manuals:* Training manuals will be provided by the Training providers as indicated above.
110. *Implementation:* A committee headed by the WRC with representatives from key institutions like GMA, HSD, GSS, CERSGIS, should be set up to implement the plan. The committee will ensure that the plan is elaborated by providing sufficient time and resources to visit and interact adequately with the staff to assess their specific training needs. Thereafter, each Training Provider will be invited to develop a Training manual to cover the training areas identified above. The committee will discuss and approve the Training manual. Thereafter, the selected candidates will be submitted for training. The Training plan is presented in Table 23.

**Table 23: Training Plan**

INSTITUTIONS	TARGET STAFF	TRAINING AREAS	TRAINING PROVIDER	DURA-TION	PERIOD OF IMPLE- MENTATION	ESTIMATED COST \$
GMA	District level	Meteo equipment recording & monitoring	AGREHYMET, Niamey	2 to 6 weeks	2009 - 2010	?
	Regional level	Communication equipment				
	Head office Accra	Computers				
		GIS Softwares and Equipment				
		Spatial data analysis and modelling				
Database Management Softwares						
HSD	Station observers	Hydrological measuring equipment (manual recording)	SAL Consult, Accra.	2 to 6 weeks	2009 – 2010	600/Person for 10 days
	Regional offices	Computing & data management software				
		Spatial data analysis and modelling				
	Head office	Web site development for data & information exchange.				
WRI	Groundwater	Hydrogeological exploration equipment	NII CONSULT & UNIHYDRO, Accra	2 to 4 weeks	2009 – 2010	500/Person for 10 days
	Water Quality	Water quality sampling and field testing equipment				
	Surface Water	Laboratory equipment				
		Computers for data management				
		Spatial data analysis and modelling				
GIS software & equipment						



INSTITUTIONS	TARGET STAFF	TRAINING AREAS	TRAINING PROVIDER	DURATION	PERIOD OF IMPLEMENTATION	ESTIMATED COST \$
CERSGIS	IT specialist	Web site exploitation	AITI, Accra.	2 weeks	2009	460/Person for 10 days
		Communication equipment				
GSS	Head Office	Web site exploitation	ISSER, UG, Legon	2 to 4 weeks	2009 - 2110	500/Person for 10 days
	Regional level	GIS equipment and softwares				
	District level	Computers and data management softwares				

## 5 National Exchange of Data and Information

111. From the data gathered on the institutions it was found that:-

- Almost all have e-mail addresses except one important institution – HSD;
- Almost all have web-addresses except the HSD.
- The data and information are not held in web-format and are not regularly updated or maintained for the timely exchange of data and information;
- The institutions do not have the necessary servers, softwares and communication equipment web data exchange;
- The websites have no linkages with the WRC;
- There is no central repository for data and information. Each institution is independent of the others;

112. For Ghana to prepare and be ready for the regional mechanism, it must set up its own national mechanism. This rests on two options:-

- The first option is to have a central depository for data like the WRC. All data and information will be sent to the central depository to which anybody needing data and information will have to refer. This option has been discussed at length some time ago and the consensus was that it will not be workable. This is because each institution has its own mandate and serve other sectors of the economy and not the water sector alone. For instance, the GMA whose climate and weather data and information serves agriculture, industry, services, aviation, shipping, world weather watch, etc. would find it difficult to operate under such a centralised system. Even the GSS which has the national mandate to collect data does not think this is a feasible solution. In view of this efforts to bring all environmental data and information under the Ghana Environment Resources Management Project in the 1990s, did not succeed.
- The preference is for a second option which maintains the autonomy of the institutions and recognises the role of the WRC as the national institution with mandate to represent Ghana in managing transboundary waters which Ghana shares with its neighbours.

113. Towards this end:-

- The national institutions should hold their data and information independently.
- The WRC must obtain technical assistance and finance to:-
  - Assist the national institutions particularly GMA, HSD, WRI, CERSGIS and GSS upgrade their websites with the necessary servers, softwares, communication equipment and train staff to be able to hold and exchange data and information.
  - Upgrade its own website with the necessary facilities and establish links to the meta data and the databases of the GMA, HSD, WRI, CERSGIS and GSS. This will include conditions to be satisfied to enable access to the data bases to be granted.

114. The regional mechanism will have a link to Ghana at the WRC which will act as gateway to the databases of the institutions in Ghana.

## 6 Conclusion and Recommendations

115. From the findings of the above study, the following Conclusions are made:-

- About twenty (20) national institutions were identified which contribute to the data and information required for the integrated management of water resources to meet socio-economic and ecosystem protection objectives in Ghana.
- Most of the institutions have fax, e-mail and website addresses which they use for data and information exchange. It appears these communication facilities can be exploited more fully.
- Information about the data collected are available as meta data and can be obtained generally on request. The institutions have database management softwares acquired for particular needs. Some are out of date and need upgrading. Data and information are available in hard copies and in digitised formats.
- Various categories of users including Policy Makers, Planners, Designers and Contractors, Operators of Water Systems, Water Users, Education and Research Institutions, Regulators of the Environment and Awareness Creators were identified. Their special data needs were noted to be catered for.
- All the institutions have trained human resource for their work. The need for training is justified on the basis that :-
  - Staff training had not kept up with the policy of periodic training to keep abreast with new knowledge and technologies.
  - New staff who are being recruited to replace older staff have to be trained.
  - Equipment and facilities acquired through donor projects to strengthen the data collection institutions some ten (10) years ago, need replacement with more modern ones. This must be accompanied by training to use the new equipment and facilities efficiently.
- In view of the large number of institutions, a priority list of institutions should be selected for establishing the mechanism for the exchange. These are the GMA, HSD, WRI and GSS. This is in view of their critical role in generating water cycle, physiographic, socio-economic and cultural data for IWRM.
- Within these institutions, emphasis should be placed on the operational staff viz those involved in data collection, transmission, processing, archiving and retrieval.
- Based on the limited training needs assessment and the gaps found, a training plan was developed at as presented in Table 23.
- Ownership of the report by the national institutions as was originally expected in the TOR cannot be said to have been achieved.

116. From the above findings and conclusions, it is recommended that the mechanism to exchange information and data should carry out the following:-

- The HSD must be assisted to acquire fax, e-mail and website facilities.
- The WRC website should be fully developed and links established to the websites of the HSD, GMA, WRI, CERSGIS and GSS. This is to better position Ghana in the regional mechanism for data and information exchange.
- Implement the Training Plan as defined in Table 23.
- The national institutions should be given a chance to validate the report.



## **7 Annexes**

## 7.1 Annex A: Bibliography

1. 2000 Population and Housing Census of Ghana  
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14. MWRWH (1998) – Water Resources Management Study, Information  
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15. PAGEV (2007) – Water Audit Report of the Volta Basin shared between  
Ghana and Burkina Faso.
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Conference – Accra.

## 7.2 Annex B: List of persons contacted

- Salome Danso – Director of PPMED, Ministry of Agriculture
- J.S. Odoi – Deputy Director, (PPMED), Ministry of Agriculture
- Emmanuel Gati – Asst. Agriculture Economist (PPMED)
- Florence Fiadzawu – Chief Executive Officer and Head of Registry (PPMED)
- Rosalin Quartey – Head of GIS, Statistical Service
- Emmanuel Lamptey – Principal Administrative Officer, Statistical Service
- GSS Information Officer, Statistical Service
- Adwoa Painstil – Deputy Director (WRC)
- Samuel Oppong-Antwi – Head – Digital Mapping and Cartography Section, Survey Department
- Mr. Kwame O. Boamah – Head – Information Management Division, Geological Survey Department
- Mr. Augustine Aurthur – Database Administrator, Forestry Commission
- Mr. Sulemana Mahama – Head, GIS and Research Unit, Lands Commission
- Mr. Emmanuel Tachie-Obeng, Programme Officer, Environmental Protection Agency
- Mr. Enoch Boateng, Principal Research Scientist, Soil Research Institute – CSIR
- Mr. K. Agyekum-Sabraw, Director – Human Resource, Ministry of Agriculture.
- Resources from the Web, FRNR – KNUST
- Mr. J. Wellens-Mensah - Director HSD, Accra.
- Mr. E.A. Allotey - Hydrologist, HSD, Accra.
- Mr. M. Tanu – Director-General, GMA, Accra
- Dr. S. Dapaah-Siakwan – Head Groundwater Division, WRI, Accra.
- Dr. Hudgson – Head Water Quality Division, WRI, Accra.
- Mr. Patrick Amankwa Mensa – GW Division WRI, Accra.
- Mr. Thomas Adom – Commercialisation & Information Division, WRI, Accra.
- Mr. Ben Ampomah – Ag. Executive Secretary, WRC, Accra.
- Dr. Gyawu Boakye – Chief Executive, CWSA, Accra.
- Mr. Jacob Oti Awele – Forestry Commission (Wild Life Division, Accra).
- Mr. Andrew Yaw Nkansah, Director Scientific Division, GMA, Accra.



#### 7.4 Annex D : Example of existing data

Catchment Areas and River Lengths of the Sub-Basins

<b>Volta Basin System</b>	<b>Area Km<sup>2</sup></b>	<b>Length of River (km)</b>
Black	35107	1361
White	45804	1098
Daka	9174	412
Oti	16213	904
Lower	59414	489
<b>Sub-Total</b>	<b>165712</b>	

Summary Data for Total Population by Basins

<b>Volta Basin System</b>	<b>1984</b>	<b>1990</b>	<b>1995</b>	<b>2000</b>	<b>2005</b>	<b>2010</b>	<b>2015</b>	<b>2020</b>
Black	607372	738449	872332	1034067	1230088	1468405	1758791	2115192
White	1296468	140634	1768669	2041690	2360310	2732615	3168179	3678365
Daka	144910	171842	198702	230416	267942	312438	365305	428240
Oti	350480	425515	501149	591223	698615	826793	979942	1163109
Lower	1994022	2358764	2598712	3002972	3485521	4063649	4758836	5597790
<b>Sub-Total</b>	<b>4393252</b>	<b>5155204</b>	<b>5939564</b>	<b>6900368</b>	<b>8042476</b>	<b>9403900</b>	<b>11031053</b>	<b>12982696</b>

Summary Data for Population Projection Parameters

<b>Volta Basin System</b>	<b>Area</b>	<b>Density/per/Km<sup>2</sup> 1984</b>		<b>Growth Rate % per Annum</b>	
	<b>Km<sup>2</sup></b>	<b>Range</b>	<b>Mean</b>	<b>Range</b>	<b>Mean</b>
Black	30,582	8.5-60.5	19.9	1.16-5.47	3.7
White	43,830	4.5-171.9	29.6	1.16-4.38	3.0
Daka	8,124	8.9-33.6	17.8	1.42-4.38	3.2
Oti	17,942	8.9-30.2	19.5	1.42-4.38	3.4
Lower	59,537	3.2-696.2	33.5	-0.005-5.47	3.2
Sub-Total					

## Summary Data for Mortality Rates 1993 to 2023 (No. per 1000, Basin)

Volta Basin System	Infant Mortality		Child Mortality		Under – Five Mortality	
	1993	2023	1993	2023	1993	2023
Black	82.3	43.7	100.0	53.1	173.1	92.0
White	101.1	53.7	111.9	59.5	201.6	107.2
Daka	113.7	60.4	139.1	74.0	237.0	125.9
Oti	113.7	60.4	139.1	74.0	237.0	125.9
Lower	68.3	36.4	61.2	32.5	124.5	66.1
<b>Sub-Total</b>						

## Summary Data for Water Borne and Water Associated Diseases and their Vectors

Volta Basin System	Schisto	Oncho	Guinea Worm	Malaria	Filariasis	Cholera	Diarh.	Yaws
Black	+	+	+	+	?	?	+	+
White	+	+	+	+	+	+	+	+
Daka	+	+	+	+	?	?	+	+
Oti	?	+	+	+	?	?	+	+
Lower	+	-	+	+	+	?	+	+

+ Disease and vector recorded in area (1980-96)

- Disease or vector not recorded

? No specific study undertaken

Diarh - Diarrhoea

Oncho - Onchocerciasis

Schisto - Shistosomiasis

## Summary Data for Economic Indicators – Structure of the Economy

Volta Basin System	1 9 9 5				2 0 2 5			
	Agric	Manuf	Serv.	Others	Agric	Manuf	Serv.	Others
Black	70.44	16.63	8.26	4.67	59.28	19.87	15.12	5.72
White	54.94	10.17	18.38	16.51	41.12	11.00	29.89	17.99
Daka	65.30	11.65	13.29	9.76	52.15	13.44	23.05	11.35
Oti	65.30	11.65	13.29	9.76	52.15	13.44	23.05	11.35
Lower	70.52	8.14	13.22	8.12	57.74	8.73	23.75	9.78

Source: MWH: WARM Study Information Building Block - 1998

Summary Data for Economic Development Indicators

	1 9 9 5			2 0 2 5		
	*1 Annual Income/ Capita	Rate of Growth Income/ Capita	Annual Inflation Rate	Annual Income/ Capita	Rate of Growth Income/ Capita	Annual Inflation Rate
Volta Basin System	97092	5.0				
Black	106801	5.5	30	789625	8.8	
White	77674	4.0	30	366283	6.4	
Daka	87383	4.5	30	496932	7.2	
Oti	97092	5.0	30	664932	8.0	
Lower	116510	6.0	31	1152463	9.6	

## 7.5 Annex 5 : Example of Existing Metadata

### MetaData on Meteorological Data – Oti Basin

ID NO	STATION	REGION	CO-ORDINATES			DATE OPENED	DATE CLOSED	TYPE OF STATION
			LAT	LONG	HT (m)			
09000 SAB	Saboba	Northern	09°42 <sup>N</sup>	00°18 <sup>W</sup>	122.0	JAN. 1954	-	RS
09001 BUN	Bunkpurugu	Northern	10°31 <sup>N</sup>	00°06 <sup>W</sup>	241.3	FEB. 1956	Shifted, 2003	CS
09001 BUN	Bunkpurugu	Northern	10°31 <sup>N</sup>	00° 06 <sup>E</sup>	241.3	*AUG. 2003	-	RS
09003 CHE	Chereponi	Northern	10°06 <sup>N</sup>	00° 17 <sup>E</sup>	146.4	AUG. 1963	-	RS
09003 KRA	Nkwanta Krachi	Volta	08°16 <sup>N</sup>	00°32 <sup>W</sup>	235.2	JAN. 1956	-	RS
09003 KRA	Nkwanta Krachi	Volta	08°16 <sup>N</sup>	00°32 <sup>W</sup>	235.2	*JUL. 1975	-	CS

Source: GMA

\* Up-Graded

SS - Synoptic

AS - Agrometeorological

CS - Climatological

RS - Rainfall

### MetaData on Meteorological Data – Daka Basin

ID NO	STATION	REGION	CO-ORDINATES			DATE OPENED	DATE CLOSED	TYPE OF STATION
			LAT	LONG	HT (m)			
08002 KPA	Kpandae	Northern				MAY. 1953	-	C
08016 YEN	Yendi	Northern	09°27 <sup>N</sup>	00°01 <sup>W</sup>	195.2	JAN. 1922	-	RS
08016 YEN	Yendi	Northern	09°27 <sup>N</sup>	00°01 <sup>W</sup>	195.2	*JUN. 1951	-	SS

Source: GMA

\* Up-Graded

SS - Synoptic

AS - Agrometeorological

C - Climatological

RS - Rainfall



## MetaData on Meteorological Data – White Volta Basin

ID NO	STATION	REGION	CO-ORDINATES			DATE OPENED	DATE CLOSED OR SHIFTED	TYPE OF STATION
			LAT	LONG	HT (m)			
02001 FUM	Fumbisi	Upper-East	10°27 <sup>N</sup>	00°19 <sup>W</sup>	212.3	MAR. 1956	-	RS
06009 GAM	Gambaga	Northern	10°32 <sup>N</sup>	00°26 <sup>W</sup>	259.6	FEB. 1915	-	RS
06009 GAM	Gambaga	Northern	10°32 <sup>N</sup>	00°26 <sup>W</sup>	259.6	-	JAN. 1965 (Shifted)	RS
04003 NAV	Navrongo	Upper East	10°53 <sup>N</sup>	01°05 <sup>W</sup>	201.3	JUN. 1932	-	RS
04003 NAV	Navrongo	Upper East	10°53 <sup>N</sup>	01°05 <sup>W</sup>	201.3	APRIL 1946	-	SS
04003 BOL	Bolgatanga	Upper East	10°48 <sup>N</sup>	00°52 <sup>W</sup>	213.0	JUN 1954	-	RS
040003 BOL	Bolgatanga	Upper East	10°48 <sup>N</sup>	00°52 <sup>W</sup>	213.0	-	*JULY 1975	AS
04003 BOL	Bolgatanga	Upper East	10°48 <sup>N</sup>	00°52 <sup>W</sup>	213.0	-	OCT. 2005	AS
09025 NAS	Nasia	Northern	10°09 <sup>N</sup>	00°48 <sup>W</sup>	123.5	NOV. 1967	DD	CS
02010 TUM	Tumu	Upper West	10°52 <sup>N</sup>	01°59 <sup>W</sup>	313.2	JAN. 1950	To Date	RS
02010 TUM	Tumu	Upper West	10°52 <sup>N</sup>	01°59 <sup>W</sup>	313.2	-	Oct. 1943	CS
04002 BUN	Binduri	Upper East	10°58 <sup>N</sup>	00°18 <sup>W</sup>	210.4	SEPT. 1954	Dec. 1949 (Shifted)	RS
04002 BUN	Binduri	Upper East	10°58 <sup>N</sup>	00°19 <sup>W</sup>	210.4	*FEB. 2004	DD	AS
04007 GAR	Garu	Upper East	10°50 <sup>N</sup>	00°10 <sup>W</sup>	237.9	JULY 1954	To Date	RS
04007 GAR	Garu	Upper East	10°50 <sup>N</sup>	00°10 <sup>W</sup>	237.9	-	Oct. 1943	AS
04005 PON	Pong-Tamale Pusiga	Northern	09°42 <sup>N</sup>	00°50 <sup>W</sup>	183.0	NOV 1931 AUG.1954	-	CS

Source: GMA

\* Up-Graded

 SS - Synoptic  
 CS - Climatological

 AG - Agrometeorological  
 RS - Rainfall

## MetaData on Meteorological Data – Lower Volta Basin

ID NO	STATION	REGION	CO-ORDINATES			DATE OPENED	DATE CLOSED OR SHIFTED	TYPE OF STATION
			LAT	LONG	HT (m)			
07003 AKU	Akuse	Eastern	06°06 <sup>N</sup>	00°07 <sup>E</sup>	17.4	JAN. 1915	-	RS
07003 AKU	Akuse	Eastern	06°06 <sup>N</sup>	00°07 <sup>E</sup>	17.4	*MAR. 1944	-	SS
07006 TLE	Tamale	Northern	09°25 <sup>N</sup>	00°51 <sup>W</sup>	183.3	JAN. 1907	-	RS
07007 TLE	Tamale	Northern	09°33 <sup>N</sup>	00°51 <sup>W</sup>	183.3	*JAN. 1945	-	SS
07008 KRA	Kete-Krachi	Volta	07°50 <sup>N</sup>	00°02 <sup>W</sup>	130.7	JAN. 1919	-	SS
07017 HO	Ho	Volta	06°36 <sup>N</sup>	00°28 <sup>E</sup>	157.7	JAN. 1942	SHIFTED 1946	RS
07017 HO	Ho	Volta	06°36 <sup>N</sup>	00°29 <sup>W</sup>	179.7	*JAN. 1946	-	SS
07017 KPA	Kpando	Volta	07°00 <sup>N</sup>	00°17 <sup>E</sup>	213.5	MAY 1904	MAR. 1958	RS
07017 KPA	Kpando	Volta	07°00 <sup>N</sup>	00°17 <sup>E</sup>	213.5	APRIL 1958	-	CS
07017 KPA	Kpando	Volta	07°00 <sup>N</sup>	00°17 <sup>E</sup>	213.3	SEPT. 2003	-	AG
07026 KPE	Kpeve	Volta	06°17 <sup>N</sup>	00°20 <sup>E</sup>	130.7	JAN. 1927	-	AG
07059 AKO	Akosobo	Eastern	06°40 <sup>N</sup>	00°03 <sup>W</sup>	152.5	MAY 1963	-	AG
14000 ABE	Abetifi	Eastern	06°41 <sup>N</sup>	00°45 <sup>W</sup>	594.7	JAN. 1933	-	RS
14067 ABE	Abetifi	Eastern	05°47 <sup>N</sup>	00°45 <sup>W</sup>	594.7	*APRIL 1964	-	SS
23002 ADA	Ada	G/Accra	05°47 <sup>N</sup>	00°37 <sup>W</sup>	5.0	JAN. 1915	SHIFTED	RS
23002 ADA	Ada	G/Accra	06°24 <sup>N</sup>	00°38 <sup>W</sup>	5.2	*AUG. 1950	SHIFTED	SS
14045 ASE	Asesewa	Eastern	06°24 <sup>N</sup>	00°09 <sup>W</sup>	457.2	AUG. 1963	-	AG
14045 ASE	Asesewa	Eastern	06°24 <sup>N</sup>	00°09 <sup>W</sup>	457.2	APRIL 2001	SHIFTED	AS
14039 HUH	Huhunya	Eastern	06°10 <sup>N</sup>	00°09 <sup>W</sup>	122.0	JUN 1960	CLOSED-JUN. 1964	RS
14039 HUH	Huhunya	Eastern	06°10 <sup>N</sup>	00°10 <sup>W</sup>	122.0	JUL. 1964	-	AG
07075 ASE	Asantekrom-Dodi	Eastern	06°32 <sup>N</sup>	00°10 <sup>E</sup>	91.5	JUN. 1973	-	AG

Source: GMA

\* Up-Graded

SS	-	Synoptic	AG	-	Agrometeorological
CS	-	Climatological	RS	-	Rainfall

## 7.6 Annex F: List of stations in the national part of the Volta basin

Stations in: Volta		Basin										
Sub Basins	River	Type	Station Name	Station ID	Area	Length	Gauge Zero	Region	Project	Established	Closed	
Volta	Volta	River	Yeji	01000006	125.00		30.32 m	AS	Ashanti	WRIS	13-May-51	
Volta	Volta	River	Adidome	01000019	0.00				Volta	GoG	01-Jan-63	30-Apr-66
Volta	Volta	River	Ada	01000020			-1.63 ft	NL	Volta	GoG	12-Sep-63	
Volta	Volta	River	Accra Tefle Rd. Gd.	01000024	0.00				Volta	GoG	18-Oct-68	15-Oct-70
Volta	Volta	River	Amedica	01000018	177.00		0.79 ft	NL	Volta	GoG	01-Jan-63	30-Apr-82
Volta	Volta	River	Kpandu	01000022					Volta	GoG	26-May-64	31-Dec-80
Volta	Volta	River	Kete-Krachi	01000014	0.00				Volta	GoG	22-May-62	31-Dec-76
Volta	Volta	River	Kpong	01000005	152175.		-0.04 ft	NL	Eastern	GoG	01-Apr-51	31-Dec-72
Volta	Volta	River	Dodi	01000021	304.00		753.72 ft	NL	Volta	GoG	06-May-64	01-May-79
Volta	Volta	River	Obentenya	01000008	125.00		0.01 ft	NL	Volta	GoG	03-Jul-52	31-Dec-80
White Volta	Tamne	Tributary	Garu	01001011			586.36 ft	NL	Upper	GoG	01-Sep-66	
White Volta	Morgo	Tributary	Nayoko	01001019	594.00		93.86 ft	NL	Upper	GoG	01-Sep-70	31-Oct-80
White Volta	White Volta	Tributary	Yapei	01001002	257.00		76.98 m	NL	Northern	GoG	01-May-51	
White Volta	White Volta	Tributary	Nawuni	01001003			311.64 ft	NL	Northern	GoG	08-May-53	
White Volta	Bopare	Tributary	Tugu	01001014	640.00		352.20 ft	NL	Northern	GoG	02-Sep-66	01-Nov-90
White Volta	Bongtanga	Dam	Voggo	01001015	158.00		379.62 ft	NL	Northern	GoG	09-Sep-69	31-Dec-75
White Volta	Jolo	Tributary	Aduyeli	01001018	341.00		409.39 ft	NL	Northern	GoG	01-Aug-70	31-Dec-97
White Volta	Tono	Tributary	Navrongo	01001010			78.95 ft	NL	Upper	GoG	24-Aug-66	31-Dec-76
White Volta	Diegouro	Tributary	Navio	01001024	0.00		94.27 m	AS	Upper	GLO	26-Apr-04	
White Volta	Morago	Tributary	Nankpanduri	01001004	47.00		536.60 ft	NL	Upper	GoG	01-Jul-58	
White Volta	Yaragatanga	Tributary	Sumbrungu	01001013	272.00		85.70 ft	NL	Upper	GoG	01-Sep-66	
White Volta	Atamore	Tributary	Bolgatanga	01001012	11.00		537.08 ft	NL	Upper	GoG	01-Sep-66	31-Dec-79
White Volta	White Volta	Tributary	Sougu	01001020	222.00		78.40 ft	AS	Northern	GoG	06-Jul-77	
White Volta	Goshie	Dam	Diare	01001017	32.00				Northern	GoG	15-Jul-70	31-Dec-75
White Volta	Pasam	Tributary	Pagaza	01001009	73.00		354.20 ft	NL	Northern	GoG	19-Jul-66	01-Mar-91
White Volta	White Volta	Tributary	Yarugu (Kabori)	01001021	317.00		24.69 m	AS	Upper	WRIS	24-Jun-95	
White Volta	White Volta	Tributary	Daboya	01001007	1647.00		86.81 m	NL	Northern	WRIS	18-Apr-62	
White Volta	White Volta	Tributary	Kpasenkpe	01001006	263.00		89.69 m	AS	Upper	GoG	04-Apr-62	01-Feb-81
White Volta	White Volta	Tributary	Pwalugu	01001001	3134.00		123.77 m	NL	Upper	WRIS	01-May-51	
White Volta	White Volta	Tributary	Yarugu (Bazua)	01001022	0.00	0			Upper	GoG	19-Apr-89	31-Dec-99
White Volta	White Volta	Tributary	Kandiga	01001023	0.00		93.98 m	AS	Upper	GLO	27-Apr-04	
White Volta	Sillum	Tributary	Kumbungu	01001016	233.00		394.46 ft	NL	Northern	GoG	10-Jul-70	01-Feb-77
White Volta	Nabogo	Tributary	Nabogo	01001005	845.00		335.56 ft	NL	Northern	GoG	01-Apr-62	
White Volta	White Volta	Tributary	Yarugu	01001008	383.00		981.11 ft	NL	Upper	GoG	12-Jul-62	19-Apr-89