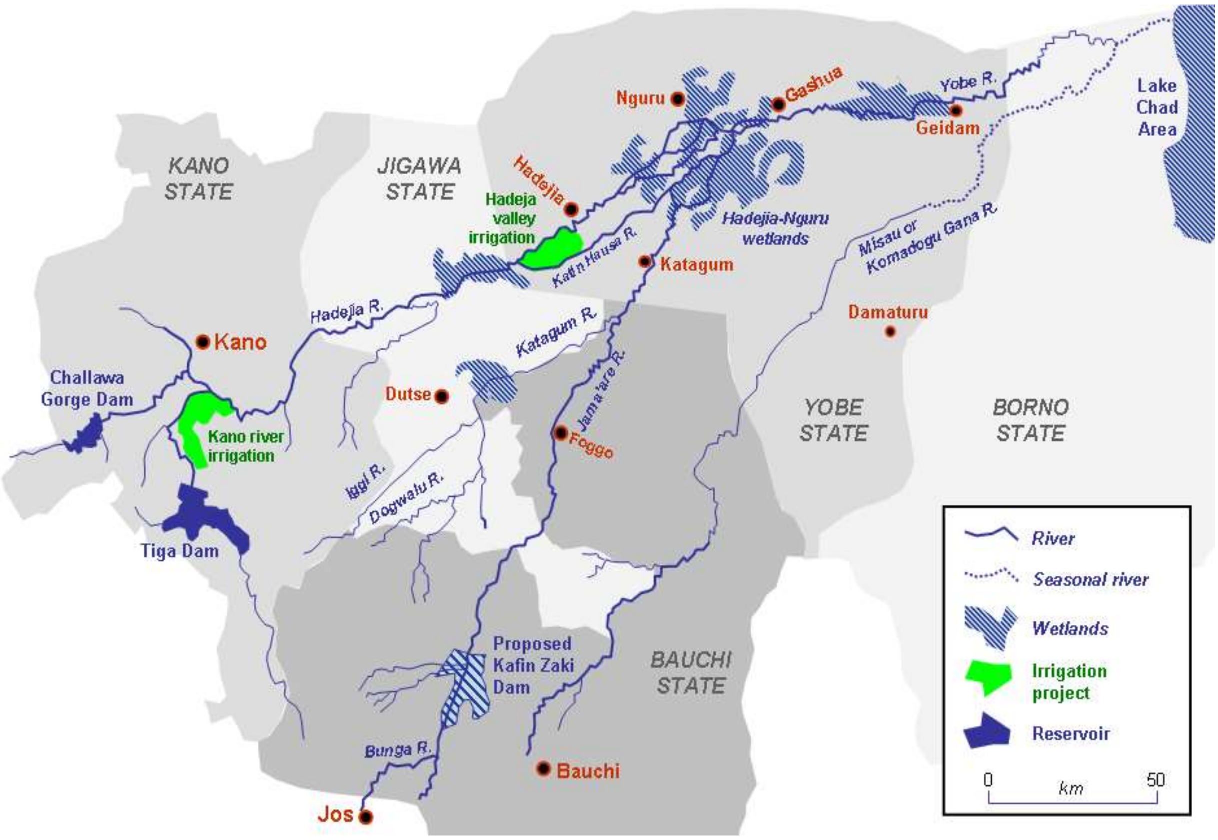
ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF THE PROPOSED CHALLAWA GORGE DAM WATERSHED MANAGEMENT PROJECT



Submitted to

HADEJIA JAMA'ARE KOMADUGU YOBE BASIN-TRUST FUND

JULY 2021

DRAFT FINAL REPORT

Report No.: HJKYB-TF. ProfAB 003

GRANT No.:5600155001401

Client: Hadejia Jama’are Kumadugu Yobe Basin-Trust Fund

Date of Report: AUGUST 2021.

Client: Hadejia Jama’are Komadugu Yobe Basin-Trust Fund

Date of Report: **September 2021.**

Project ESIA Consultant: PROFESSOR ABBAS BASHIR

	Name	**Function**	**Signature**	**Date**
Compiled by	Prof. Abbas Bashir	Lead Consultant		
1		Inception report		June 2021
2		Scoping report		July 2021
3		Draft interim report		August 2021
4		Draft ESIA/ESMPRAP		September 2021

TABLE OF CONTENT

CHAPTER ONE:

1.0 INTRODUCTION

CHAPTER TWO:

2.0 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

CHAPTER THREE:

3.0 PROJECT JUSTIFICATION AND ALTERNATIVES

CHAPTER FIVE

5.0 DESCRIPTION OF PROJECT ENVIRONMENT AND BASELINE CONDITIONS

CHAPTER SIX

6.0 MITIGATION /ENHANCEMENT MEASURES

CHAPTER SEVEN

7.0 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

CHAPTER EIGHT

8.0 CONCLUTION AND RECOMMENDATION

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

ABBREVIATIONS AND ACRONYMS

AF	Additional Funding
ARAP	Abbreviated Resettlement Action Plan
AfDB	African Development Bank
AIDS	Acquired Immune Deficiency Syndrome
BID	Background Information Document
BP	Bank Policy
CBDA	Chad Basin Development Authority
CBO	Community Based Organization
CLO	Community Liaison Officer
CSO	Community Support Organizations
DaLA	Damage and Loss Assessment
BOD	Biochemical Oxygen Demand
BOT	Board of Trustee
BMP	Best Management Practice
Ca	Calcium
CBD	Convention on Biological Diversity
Cd	Cadmium
cd	Check Damj
CDC	Community Development Committee
CEO	Chief Executive Officer
CGDWM	Challawa Gorge Dam Watershed Management
cm	Centimetre
CO	Carbon Monoxide
COD	Carbon Oxygen Demand
CO_2	Carbon Dioxide
CMO	Catchment Management Offices
Cr	Chromium
Cu	Copper
DPs	Displaced Persons
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
EPC	Engineering, Procurement and Construction
ERGP	Economic Recovery and Growth Plan
ESA	Environmental and Social Assessments

ESMF	Earth System Modeling Framework
ESIA	Environmental and Social Impact Assessment
ESAP	Environmental and Social Assessment Procedures
ESCP	Erosion and Sediment Control Plan
ESMP	Environmental and Social Management Plan
ESPMP	Environmental and Social Preliminary Management Plan
ESS	Environmental and Social Safeguards
Fe	Iron
FEPA	Federal Environmental Protection Agency
FGD	Focus Group Discussion
FG	Federal Government
FGN	Federal Government of Nigeria
FMEnv	Federal Ministry of Environment
FMWR	Federal Ministry of Water Resources
g	Gram
h	Hour
ha	Hectare
GHG	Green House Gases
Hg	Mercury
HIV	Human Immune Virus
HJRBDA	Hadejia Jama'are River Basin Development Authority
HJKYB-TF	Hadejia Jama'are Komadugu Yobe Basin-Trust Fund
HVIP	Hadejia Valley Irrigation Project
HNO_3	Nitric Acid
HSE	Health Safety and Environment
HSEQ	Health, Security and Environmental Quality
H_2SO_4	Sulphuric Acid
IA	Impact Assessment
IUCN	International Union for Conservation of Nature
IEE	Initial Environmental Evaluation
IESIA	Integrated Environmental and Social Impact Assessment
IPPC	International Plant Protection Convention
ISS	Integrated Safeguards System
KII	Key Informant Interview
KM	Kilometer
KM^2	Kilometer Square
KSEPA	Kano State Environmental Protection Agency
K	Potassium

KYB	Komadugu Yobe Basin
KRIP	Kano River Irrigation Scheme
Lat.	Latitude
Lon.	Longitude
LCD	Liquid Cristal Display
LCBC	Lake Chad Basin Commission
LFN	Law of the Federation of Nigeria
LGA	Local Government Area
LSA	Local Study Area
LULC	Land Use Land Cover
LRC	Local Resettlement Committee
LVO	Land Valuation Office
M&E	Monitoring and Evaluation
MDAs	Ministries, Departments & Agencies
MDG	Millennium Development Goals
MOE	State Ministry of Environment
m	Metre
m^2	Meter square
mg	Magnesium
mg/Kg	Milligram per Kilogram
mg/l	Milligram per litre
ml	Millilitre
mm	Millimetre
MOUs	Memorandum of Understandings
MCM	Million Cubic Metre
MT	Million Tonnes
m/s	Metre per second
Na	Sodium
NAIIS	Nigeria HIV/AIDS Indicator Survey
NCC	National Control Centre
NCF	Nigeria Conservation Foundation
NESREA	National Environmental Standards and Regulations Enforcement Agency
NGOs	Non- Governmental Organizations
NRCAP	National Resource Conservation Action Plan
NH_3	Ammonia
Ni	Nickel

NIMET	Nigeria Meteorological Agency
NIWRMC	Nigeria Integrated Water Resources Management Commission
NIWA	National Inland Waterways Authority
NO^3-	Nitrate ion
NOx	Oxides of Nitrogen
NPC	National Population Commission
NSCDC	Nigeria Security and Civil Defense Corp
OS	Operational Safeguards
OSH	Occupational Safety and Health
Pb	Lead
PAPs	Project Affected Persons
PID	Project Information Document
PMU	Project Management Unit
PIU	Project Implement Unit
ppm	Parts per million
PSW	Pilot Sub-Watershed
PWM	Participatory Watershed Management
PTW	Permit to Work
RIT	Implementation Team
RAP	Resettlement Action Plan
RPF	Resettlement Policy Framework
RP	Resettlement Plans
ROI	Return on Investment
RUWASA	Rural Water Supply and Sanitation Agency
RSA	Regional Study Area
SEPA	State Environmental Protection Agency
SAP	Strategic Action Plan
SHE&S	Safety, Health, Environment, Security
SLM	Sustainable Land Management
SON	Standards Organization of Nigeria
SO_4^{2-}	Sulphate ion
St	Sediment Trap
T	Tonnes
ToR	Terms of Reference
TMP	Traffic Management Plan
TRIMING	Transforming Irrigation Management in Nigeria
T/d	Tonnes per day
UNAIDS	United Nations Program on HIV/AIDs

UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank
WHO	World Health Organization
WRECA	Water Resource Engineering and Construction Agency
WWF	World Wildlife Fund

EXECUTIVE SUMMARY:

ES 1.0 Background

This ESIA Report is a consultancy service commissioned by the Hadejia Jama'are Komadugu Yobe Basin Trust Fund (HJKYB-TF) (the Proponent) as part of requirements to implement its 25 year Strategic Action Plan (2019) with specific reference to Challawa Gorge Dam Watershed Management sub-program out of four priority projects identified by the Agency. The Challawa Gorge Dam Watershed Management project is a priority project the development of which may significantly impact both the bio-physical and human environments of the watershed area.

The African Development Bank (AfDB) in its review of an earlier ESIA report for the project classified it as a class A or II project that may have moderate to adverse impacts and therefore requires full ESIA/ESMP studies. This is supported both by the Environmental Impact Assessment Decree No. 86 of 1992 Laws of Federal Republic of Nigeria, and the Revised 2015 AfDB Environmental and Social Management Assessment Guidelines, which stipulates that:

> *"Project that is likely to have detrimental site-specific environmental and/or social impacts that are less adverse than those of Category 1 projects and can be minimized by applying appropriate management and mitigation measures or incorporating internationally recognized design criteria and standards …. require an appropriate level of Environmental and Social Assessment (SESA for program operations or ESIA for investment projects) tailored to the expected environmental and social risk so that an adequate ESMP can be prepared in the case of an investment project or an Environmental and Social Management Framework (ESMF) can be designed and implemented by the borrower in the case of program operations to manage the environmental and social risks of sub-projects in compliance with the Bank's safeguards."*

Challawa Gorge Dam was built in the early-90s to supply drinking water to Kano State and supply irrigation water for Kano irrigation project. However, recently, watershed degradation has been a serious problem resulting in erosion and sedimentation problems in Challawa Reservoir, threatening the life of the reservoir and making water treatment very costly because of high turbidity. In addition, erosion in the upland watershed is affecting farmers' lands and encroaching towards private property. As a result of this, project scope has been defined to address the problem of erosion and gully formation in the watershed, reservoir sedimentation and problems in the Challawa water works treatment plant through watershed management.

ES 1.1 Project Proponent

The proponent of the project is the Hadeja, Jama'are komadudugu, Yobe Basin Trust Fund (HJKYB-TF). The ESIA/ESMP report presents findings and assessment of the assignment in line with the terms of reference with a work breakdown, and schedule for mobilization, strategy, methodology, quality assurance plan and timetable for the services execution of the consultancy. In addition, the report addresses the Safeguard instruments being prepared, the tasks to be met, the African Development Bank's (AfDB's) requirements, the timeline of the activities and the deliverables.

ES1.2 Purpose of ESIA Report

The purpose of the ESIA is to assess the potential biophysical and social impacts of the proposed project, which includes a detailed Environmental and Social Management Plan (ESMP). The ESIA will establish modalities of implementing the ESMP under Nigeria Environmental policies and laws and the AfDB ISS.

ES1.3 Objective of the Environmental and Social Impact Assessment

The objective of the assignment is to prepare the Environmental and Social Impact Assessment (ESIA) and Environmental and Social Management Plan (ESMP) in line with the AfDB's Integrated Safeguards Systems policies and adhering to country environmental standards and approved mechanisms for permit issuance. The Consultant is required to undertake an Environmental and Social Impact Assessment (ESIA) and propose an Environmental and Social Management Plan (ESMP) from the generated baseline data. The land acquisition, resettlement, compensation and valuation of land required or affected by the development shall be fully determined by the Consultant including stakeholder consultations and disclosure requirements consistent with the applicable environmental laws and regulations.

For solution to the Challawa Gorge Dam watershed management problem, two main and twelve finger gullies were identified for remediation in two pilot sub watersheds during the preparation of the project plan (SMEC 2019). For the two sub-watersheds namely PSW_1 and PSW_2, structural measures are to be provided inside the gullies and bio-remediation and agricultural measures to be provided on eroded gully banks and on adjacent farm lands respectively. Gabion check dams and sediment traps are the main structural measures to be constructed; the unstable section of the gullies was designed to be provided with check dams to stabilize flow and promote sediment deposition upstream of the check dams. The Check dams are designed for 10-year return period design floods and their stability is checked for a 25-year return period. Generally, about 50 Gabion check dams differing in size are to be provided in both Pilot sub watersheds (i.e. PSW_1 and PSW_2). Gullies with relatively stable slopes are to be provided with embankment filled sediment traps at their outlet locations. Theses sediment traps will serve to trap sediments which come from agricultural land until the agricultural and bio remediation erosion control measures fully develop and reduce sediment. Provision is made for four sediment traps at the outlets of finger gullies in the two pilot sub watersheds. Each sediment trap is equipped with a rock riprap overflow spillway and concrete pipe dewatering orifice. The spillway is designed to pass the 25-year return period design flood while the orifice is designed to empty the 10-year design flood volume in 24 hours.

Furthermore, on eroded banks of gullies and on the adjacent agricultural lands, bio-remediation and agricultural erosion control measures shall be provided. Gully banks and steep agricultural lands are proposed to be protected with provision of bio engineering (bio-remediation) and agricultural erosion control measures respectively. The main bio engineering measures proposed is planting of vetiver grass. Vetiver grass was proposed on eroded gully banks by trimming and grading steep gully banks prior to planting, while the agricultural measures focus on controlling soil loss from agricultural lands by implementing agricultural practices such as contouring, strip cropping and conservation tillage involving the community and in close consultation with farmers. The other source of sediment for Challawa Gorge Dam Reservoir is from the surrounding adjacent agricultural area and from stream bank erosion in the upland watershed as non-point sources. These non-point sources are treated by providing vegetated buffer zones.

The ESIA study for this project is carried out in a way that meets the ESAP of the AfDB, the Nigerian ESIA standards and International best practices. The ESIA analyzes the environmental and social aspects including land acquisition and resettlement sensitivities in the project area and, through the consideration of alternate project designs, to develop project proposals that avoid or minimize potential adverse environmental and socioeconomic impacts arising from the implementation of the project. The study therefore will present:

- An ESIA study report including drafting a livelihoods restoration plan for the affected subjects. Issues to be addressed include but not be limited to: Soil erosion and sedimentation in the catchment areas where the project sites are located; Flooding and Water-logging issues; Health diseases issues; Fertilizer and pesticide applications; Effects on quality of water in downstream receptors; Involuntary displacement and re-settlement of affected population; Soil quality, ground water, biodiversity, waste inventory and management, hydrobiology and aquatic resources as well as COVID-19, HIV/AIDS, Malaria, Typhoid and etc. awareness; and other socioeconomic conditions especially gender issues.

- An Environmental and Social Management Plan (ESMP) to mitigate the negative impacts including resettlement of affected farmers based on the following points;
    a) Critical review and analysis all available data and information relating to environmental conditions and sensitivities in and around the proposed Watershed Management intervention areas.
    b) Carry out complementary environmental investigations through visits and discussions at environmental protection agencies and organizations and at projected development sites.
    c) Prepare environmental questionnaires aimed at complementing and confirming the available and obtained data and information at the level of farmers and rural community residents, to be applied during the farmer and stakeholder surveys.
    d) Execute the environmental components of the farmer and stakeholder surveys, and assembly, processing and documentation of results for use in detail assessments and in the separate subsequent environmental impact assessments.
    e) Prepare watershed specific characterization of existing or potential environmental issues, to serve as a basis and guideline for addressing these as warranted in the preliminary project designs and feasibility assessments.
    f) Investigate relevant environmental studies in the proposed project area and review critically to incorporate major issues appreciable
    g) Assess all base line conditions prevailing in and around the project areas and description of pertinent regulations and standards governing environmental quality, health & safety, protection of sensitive areas, protection of endangered species, land uses control, etc.
    h) Assess the characteristics of the pilot watersheds such as land use/land cover, topography, soils, crop and conservation factors, climatic factors, etc. to study the extent of soil erosion or land degradation.
    i) Assessment of possible pollution of drainage water from agro-chemicals and the possible effect of reduced base flows on increasing concentrations, and determine the dilution capacity of the receiving water body.
    j) Assess the impacts on flora and fauna of the project area; and assessment of the risks of proliferation of aquatic weeds, crop pests and diseases; and evaluation of any other adverse effects of those not mentioned above, on biophysical and socioeconomic environment of the project area.
    k) Investigate and describe alternative environmental considerations to major activities of the proposed project including design, technology, construction techniques, operation and maintenance procedures, etc.

ES 1.4 Scope of the ESIA/ESMP Study

The aim of the Environmental and Social Impact Assessment (ESIA) is to assess the potential environmental impacts (positive and negative) of the proposed Challawa Gorge Dam Watershed (CGDWM) project and related activities, and to propose an Environmental and Social Management Plan (ESMP) to mitigate the short and long term environmental, Social and Economic challenges arising from the project implementation. The core objective of undertaking the ESIA/ESMP study is to assist HJKYB-TF in its effort to obtain environmental clearance from the Federal Ministry of Environment (FMEnv.) and thus to secure the AfDB's commitment to finance the execution of the Watershed Management Project.

ES 1.5 Justification for the Project

There are three main problems associated with Challawa Gorge Dam Watershed that started from watershed erosion and gully formation in the upland watershed, sediment deposition and siltation of the reservoir and sedimentation problems associated with Challawa Water Works treatment plant. These three problems are mainly due to watershed degradation in the upper reaches of the Challawa Gorge Dam Watershed. To fix these problems and extend the longevity of the reservoir to realize its purpose is the main justification for the project**.**

The main objective of the Challawa Watershed Management project is to extend the longevity of the reservoir by reducing the sediment flux into the reservoir through integrated watershed management. This will help to significantly reduce the siltation problem in the Challawa reservoir and also contribute for the soil conservation within the watershed. It will also address the problem of sedimentation at the Challawa Water Works treatment plant.

ES 1.6 ESIA Report Structure

The structure of this ESIA report is presented below.

- Executive Summary briefly highlights the main issues considered and reported in the main ESIA/ESMP Report.
- Chapter 1. Introduction Provides a background to the proposed Project and the ESIA and provides information about the Proponent.
- Chapter 2. Policy, Legal and Administrative Framework. The Legal and Regulatory Frameworks within which the ESIA was undertaken were also stated while other environmental legislation, standards and guidelines applicable to the Project were listed.
- Chapter 3. Description of project and justification. It presents the project justification,

the need/value and its envisaged sustainability as well as the project development and site/route options considered

- Chapter 4. Baseline conditions of the project environment. The chapter defines the areas of direct and indirect influence of the Project. It describes the biophysical and socioeconomic baseline of the Project's areas of influence and presents the public participation process in the ESIA.
- Chapter 5. Associated and social impact assessment. The chapter the approach and methodology for the impacts assessment process. It identifies and assesses potential Project impacts (biophysical and socioeconomic impacts).
- Chapter 6: Mitigation Measures. This chapter defines relevant mitigation measures to avoid, reduce, compensate or enhance Project impacts (as applicable).
- Chapter 7. Environmental and Social Management Plan (ESMP). It presents the Project ESMP, organizing all mitigation, management and monitoring requirements and management programs.
- Appendices. This section provides support information referenced throughout the ESIA.

ES 2.0 Policy, Legal And Administrative Framework

ES 2.1 National (Country) Laws and Legislations:

- ***The Nigerian constitution***: As the national legal order, recognizes the importance of improving and protecting the environment and makes provision for it. Section 20 of the constitution makes it an objective of the Nigerian State "*to improve and protect the air, land, water, forest and wildlife"* of Nigeria. Nigeria has policy and programme instruments founded on its international, sub-regional and national commitments in the area of environmental protection, Land and water resources administration and management.
- ***The National Environment Standards and Regulation Enforcement Agency Act, 2007:*** Administered by the Ministry of Environment, the National Environment Standards and Regulation Enforcement Agency (NESREA) Act of 2007 replaced the Federal Environmental Protection Agency (FEPA) Act of 1999. It is the embodiment of laws and regulations focused on the protection and sustainable development of the environment and its natural resources. Various Legal and Legislative Instruments that are reflected in the laws that require the conduct of an ESIA to ensure that a project complies with existing environmental standards include the Environmental Impact Assessment Act, LFN, 2004; River Basin Development Authorities Act, LFN, 2004; Water Resources Act, LFN, 2004; the National Water

Resources Management Policy, 2007; the Nigerian Land Use Act CAP 202 LFN 2004 and the National Resource Conservation Action Plan, 1992 among several other National, State and Local Governments Regulations.

- ***Federal Environmental Protection Agency (FEPA) Act, 1988 (Decree Nº 58) and amendment Decree Nº 59 of 1992:*** By this Decree, FEPA was strengthened and transferred to the Presidency and expanded its mandate to include the conservation of biodiversity and sustainable use of Niger preparation of a comprehensive national policy for the protection of the environment and conservation of natural resources, including procedure for environmental impact assessment.

- ***The Environmental Impact Assessment Decree No. 86 of 1992, Laws of the Federation of Nigeria:*** The law defines the fundamental principles of environmental protection. The Environmental Impact Assessment (EIA) Act Cap E12, LFN2004 which lays down the operating rules for environmental protection procedure, is one of the implementing instruments of that law which governs the whole Environmental and Social Impact Assessment (ESIA) process. Decree 86 empowers FEPA and its custodian, to ensure that all major developments including the utilization of water resources are undertaken in a manner that does not result in unacceptable environmental impacts. In essence, the decree requires every major development projects undergoes a FEPA approved EIA process prior to its implementation. It also empowers FEPA to shut down all offending projects and prosecute the operators.

- ***The National Water Resources Law:*** *The National Water Resources Act, CAP W2, LFN 2004* on the other hand is targeted at developing and improving the quantity and quality of water resources. It vests the right to use and control all surface waters and groundwater and of all water in any watercourse affecting more than one state in the Federal Government. This act is the highest existing legislation governing water resources management in Nigeria. It confers on the Federal Ministry of Water Resources (FMWR) the responsibility for controlling the use of trans-state surface and groundwater resources throughout Nigeria. The Act represents the contemporary approach on water resources development, conservation, allocation and use that aims to optimize and sustain social, economic and environmental needs based on the IWRM approach.
- ***The National Resource Conservation Action Plan,(NRCAP) 1992:*** The NRCAP, 1992 was concerned to set out objectives for living resources conservation through, maintaining genetic diversity in order to ensure permanence in the supply of

materials to satisfy basic human needs and thus improve the well-being of society; promoting the scientific value of natural ecosystems, the study of which is required to enhance conservation itself, to improve the management of man-made systems, and to provide clues to technical innovations in agriculture, medicine and industry; regulating environmental balance in such factors as carbon dioxide and radiation levels and the bio geo-chemical cycles; maintaining ecological services through the protection of catchment's areas in order to enhance water resources and check soil erosion and flooding, protection of grazing lands against desert encroachment and the stabilization of coastal zones and; Enhancing the amenities values of natural resources, including aesthetic, heritage, religious, sentimental, ethical and recreational values on which tourism may be built.

- ***The River Basin Development Authorities (RBDAs)Decree 1976:*** The RDBAs came into existence following the promulgation of Decree 25 of 1976. They were conceived as vehicles for attaining a pan Nigerian Programme of water resources development. The current law on RBDAs is the RBDA Act cap 396 Laws of the Federation of Nigeria, 1990. This statute spells out diverse functions and objectives for these Authorities from which it may be inferred that their existence nationwide propels their acceptance as an appropriate unit for water management. Section 4(1)(a)-(d) of the RBDA Act vest the Authorities with the legal powers to undertake comprehensive development of both surface and underground water, to construct and maintain dams irrigation and drainage system, to supply water to all users, and to construct and maintain infrastructural services including roads and bridges across project sites.

- **National Water Resources Institute (NWRI) Act, 1990:** The NWRI enabling law is the NWRI Act, Cap 284 LFN 1990. Section 2, thereof, spells out the Functions of the institute in both general and specific terms. It is empowered to perform Engineering research function related to such major water resources projects as may be required for flood control, river regulation, reclamation, drainage, irrigation, domestic and industrial water supply, sewage and sewage treatment. The institute is further charged with the performance of other functions related to planning of water resources management and river basin development.
- ***The Nigerian Land Use Policy:*** The Land Use Act CAP 202 LFN 1990 sets the legal basis for land acquisition and resettlement in Nigeria. It vests land in the Governor of each State, and provides that it shall be held in trust for the use and common benefit of all people. The administration of land is divided into urban and rural land. The urban land is directly under the control and management of the Governor of each State who would hold such Land in trust for the people and would

henceforth be responsible for allocation of land in all urban areas to individuals resident in the State and to organizations for residential, agriculture, commercial and other purposes; and non-urban land, which will be under the control and management of the Local Governments.

- ***National Environmental Standards & Regulations Enforcement Agency (NESREA) Act, 2007****:* This is an agency under the Federal Ministry of Environment. It was established by Act 25 of 2007. The agency is charged with enforcing regulatory standards relating to the environment.

ES 2.2 The African Development Bank (AfDB) Requirements and Guiding Principle

The guiding principles for the conduct of the ESIA, ESMP and RAP shall include the use of African Development Bank Guidelines and Federal Ministry of Environment legislations. Safeguard instrument for this project shall be prepared pursuant to the requirements of the African Development Bank (AfDB) Integrated Safeguards System (ISS) 2013, and the AfDB Revised Environmental and Social Assessment Procedure (ESAP) 2015, which are the cornerstone of its strategy to promote growth that is socially inclusive and environmentally sustainable. The Banks's Integrated Safeguards System (ISS) has a set of operational safeguards (OS) applicable to the proposed project. These include policies on conduct of Environmental and Social Impact Assessment (OS1), Involuntary Resettlement, Land acquisition, Population displacement, and compensation (OS2), Biodiversity and Ecosystems Services (OS3), Pollution Prevention and Control, Green House Gases, Hazardous Materials and Resources Efficiency (OS4), and Labour Conditions, Health and Safety (OS5) (table 2.1). The AfDB Revised Environmental and Social Assessment Procedure (ESAP) spells out guidelines for Projects Environmental and Social Impact Studies and reporting.

The Integrated Safeguards System (ISS)

The Environmental and Social Safeguards (ESS) of the AfDB form the fulcrum of the Bank's support for inclusive economic growth and environmental sustainability in Africa. The AfDB applies the Integrated Safeguards System (ISS) for all projects. The ISS is designed to promote project outcomes by protecting the environment and people from potentially adverse impacts of projects. The ISS provides that all the projects funded or supported by the AfDB must comply with the ISS requirements during projects preparation and implementation. The aim of the safeguards includes:

- Avoidance of adverse impacts of projects on the environment and affected people while maximising potential development benefits to the extent possible;
- Minimise, mitigate, and compensate for adverse impacts on the environment and affected people when avoidance is not possible; and

- Help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage E&S risks.

The Integrated Safeguards Policy Statement

The Policy Statement describes the common objectives of the Bank's safeguards and lays out policy principles. It is designed to be applied to current and future lending modalities. It considers the various capacities and needs of regional member countries in both the public and private sectors. The Integrated Safeguards comprises of Policy Statement that sets out the basic tenets that guide and underpin the Bank's approach to environmental safeguards. The Bank's Integrated Safeguards Policy Statement sets out the Bank's commitments to and responsibilities for delivering the ISS in order to:

i. ensure systematic assessment of Environmental and Social impacts and risks;
ii. apply the Operational Safeguards (OS) to the entire portfolio of Bank operations;
iii. support clients and countries with technical guidance and practical support in meeting the requirements;
iv. implement an adaptive and proportionate approach to Environmental and Social management measures to be agreed with clients as a condition of project financing;
v. ensure that clients engage in meaningful consultations with affected groups; and to
vi. Respect and promote the protection of vulnerable groups in a manner appropriate to the African context.

AfDB Operational Safeguards OS1-5

Operational Safeguard	Description
OS 1: *Environmental and social assessment*	This overarching safeguard governs the process of determining a project's environmental and social category and the resulting social and ecological assessment requirements.
OS 2: *Involuntary Resettlement: Land Acquisition, Population Displacement and Compensation*	This safeguard consolidates the policy commitments, and requirements set out in the Bank's policy on involuntary resettlement and incorporate a few refinements designed to improve the operational effectiveness of those requirements.
OS 3: *Biodiversity and Ecosystem Services*	This safeguard aims to conserve biological diversity and promote the sustainable use of natural resources. It also translates the commitments in the Bank’s policy on integrated water resources management into operational requirements.
OS 4: *Pollution Prevention and Control, Greenhouse Gases, Hazardous Materials and Resource Efficiency*	This safeguard covers the range of critical impacts of pollution, waste, and hazardous materials for which they are aligned to international conventions, as well as comprehensive industry-specific and regional standards, including greenhouse gas accounting, that other multilateral development banks follow.
OS 5: *Labour Conditions, Health and Safety*	This safeguard establishes the Bank's requirements for its borrowers or clients concerning workers' conditions, rights and protection from abuse or exploitation. It also ensures greater harmonisation with most other

Operational Safeguard	Description
	multilateral development banks.

State Laws and Legislations:

The Nigerian Constitution allows States to make legislations, laws and edicts on the environment. The FEPA Amendment Act No. 58 of 1988 also recommends the setting up of State Environmental Protection Agencies (SMENV) to participate in regulating the consequences of project development on the environment in their areas of jurisdiction. The SMENVs thus have the responsibility for environmental protection within their states. In accordance with the provisions of Section 24 of FEPA Act 58 of 1988 (Cap 131 LFN 1990) the Kano State Environmental Protection Agency Edict was enacted. The edict empowers the State Environmental Protection Agency (SEPA) "to establish such environmental criteria, guidelines/specifications or standards for the protection of the state's air, lands and waters as may be necessary to protect the health and welfare of the people." The SEPAs are empowered to undertake functions that include, routine liaison and ensuring effective harmonization with the FMEnv in order to achieve the objectives of the National Policy on the Environment; co-operate with the FMEnv and other relevant regulatory agencies in the promotion of environmental education; be responsible for monitoring compliance with waste management standards; and to monitor the implementation of the EIA and Environmental Audit Reports (EAR) guidelines and procedures on all developmental policies and projects within the State:

- ***Kano State Legislations***: The relevant Kano State Institutions charged with issues on environment include the State Environmental Protection Agency (KSEPA); the Kano State Rural Water Supply & Sanitation Agency (RUWASA) backed by the Kano State Environmental Sanitation Laws of 1985 and 2000; Kano State Public Health Law of 1999; and the Kano State Environment Pollution Control Law of 1985. The Kano State Environmental Protection Agency and the State Ministry of Environment are important stakeholders in the proposed Challawa Gorge Dam Watershed project. Other State Water Edicts and byelaws also form the legal basis and authority for water use and management as far as they relate to intrastate watercourses and water bodies. The present set up in Nigeria is such that virtually every state of the federation has a State Water Agency with its enabling laws. These agencies deal with individual aspects of water use to serve individual sectors of the economy.

- **Local Level**: At the local government level, customary laws on water use can be as important and binding as any written enactment in regulating water resources related activities especially at the level of rural community. A universally accepted principle is that all persons belonging to the community have a right to use water passing through the community. The water right so possessed by all is, however subject to reasonable use. Reasonable right entails ensuring that the quality of water is preserved.

ES2.3 AfDB Project Categorization Process

The ESAP also includes procedural requirements such as categorising projects, disclosing and monitoring projects during implementation and operation. All AfDB financed projects will be categorised and structured to meet AfDB ISS requirements. Under AfDB ISS, each project undergoes E&S appraisal to determine a project funding feasibility as well as ensuring that the E&S considerations are incorporated effectively in the planning, implementation, and operation of the projects. Each subproject will undergo **initial E&S screening** and be categorised accordingly at the initial stage of the project cycle to determine the nature and level of E&S investigations, information disclosure and stakeholder engagement required. The categorisation is done according to the guidelines stipulated in the AfDB ESAPs.

- Based on the categorisation, the projects will then be subjected to an appropriate E&S assessment and mitigation measures will be formulated to ensure E&S considerations are incorporated in the course of the project's implementation.

ES 2.4 International Protocols and Agreements on Water and Sustainable Environment

It is reckoned that in many parts of the world, cooperative arrangements for trans-boundary rivers, lakes and aquifers are lacking or too weak to deal with growing water-related challenges. Therefore, establishment and/or strengthening governance arrangements for these waters is considered necessary in providing the enabling environment for integrated water resources management (IWRM) and investment, and to allow riparian countries reap the numerous shared benefits that trans-boundary cooperation can offer. In support of this, countries including Nigeria became a Party to the United Nations global water conventions, i.e. the Convention on the Protection and Use of Trans-boundary Watercourses and International Lakes (Water Convention), and the Convention on the Law of the Non-Navigational Uses of International Watercourses (Watercourses Convention). The Water Convention aims to protect and ensure the quantity, quality and sustainable use of trans-boundary water resources by facilitating cooperation. It provides an intergovernmental platform for the day-to-day development and advancement of trans-boundary cooperation. Initially negotiated as a regional instrument, it turned into a universally available legal framework for trans-boundary water cooperation, following the entry into force of amendments in February 2013, opening it to all UN Member States, Nigeria inclusive.

ES 2.5 Institutional Framework

This section describes the leading institutions that are relevant to the formulation, monitoring implementation and monitoring of the resources Management at all levels. Institutional gaps and capacity constraints identified are also discussed in section 2.7.2 of this chapter. Relevant Institutions for Water Resources and Environmental Conservation

The Federal Government of Nigeria has established institutional frameworks at the national and river basin levels and at the state level with responsibilities for policy making, implementation, operation and monitoring at the federal and River Basin levels. The relevant institutions with a mandates in the various aspects of water resource development and environmental conservation are briefly discussed as follow:

The National Council on Water Resources: this is the top-most water resources policy formulating body in Nigeria.

The Federal Ministry of Water Resources (FMWR): it is responsible for implementation of federal water policies in Nigeria. The Federal Ministry of Water Resources is the major government agency that has the statutory responsibility for policy formulation and coordination for water resources development and management throughout the country. However, due to the dependence of other sectors of the economy on this critical resource, as well as the three-tier system of government which Nigeria operates several other statutory and none statutory institutions are active players in the management of water resources. These include Federal Ministry of Environment; the Nigerian Inland Water Ways Authority (NIWA), the Hadeja-Jama'are River Basin Development Authority (HJRBDA), Chad Basin Development Authority, the governments of Kano, Katsina, and Kaduna States (as riparian states to the Challawa Gorge Dam project) through their State level ministries in charge of water resources and environment, etc. Two governmental institutions, namely Federal Ministry of Water Resources and Federal Ministry of Environment are actively involved in water resources management. The HJKYB-TF is also actively involved in the overall management of the Challawa Basin water resources. Furthermore, there are overlaps in the roles and mandates of the various governmental institutions in the basin.

Federal Ministry of Water Resources (FMWR)

The Ministry of Water Resources was created to provide sustainable access to safe and sufficient water to meet the cultural and socio-economic needs of all Nigerians in a way that will enhance public health, food security and poverty reduction, while maintaining the integrity of fresh water ecosystem of the nation. Mandates of the Ministry include:

- Formulation and implementation of Water Resources Policy Programme;

- Development and support for irrigated agriculture for food security;
- Collection, storage, analysis and dissemination of hydro-meteorological and hydrological data;
- Monitoring and evaluation of projects and programmes for effective performance;
- Supply of adequate and potable water for domestic and industrial uses;
- Provision of adequate sanitation and maintenance of water quality
- Exploration and development of undergrounded water resources;
- Formulation and review, from time to time, of National water legislation;
- Liaison with all relevant national and international agencies on all matters relating to water resources development; and support of studies and research on the nation's underground and surface water resources potentials.

Federal Ministry of Environment (FMEnv)

The Federal Ministry of Environment was established in 1999 to ensure effective coordination of all environmental matters, which were fragmented and scattered among different line ministries before. The creation of the FMEnv was intended to ensure that environmental matters are adequately addressed in all developmental activities in the country. In line with the above and in accordance with the administration's policy the Ministry exercises the following mandates, to:

- Prepare a comprehensive National Policy for the protection of the environment and conservation of natural resources, including procedure for environmental impact assessment of all developing projects.
- Advise the Federal Government on National Environmental Policies and priorities, the conservation of natural resources and sustainable development and scientific and technological activities affecting the environment and natural resources.
- Prescribe standards for and make regulations on water quality, effluent limitations, air quality, atmospheric protection, ozone protection, noise control as well as the removal and control of hazardous substances.
- Monitor and enforce environmental protection measures.

ES 2.6 Environmental Impact Assessment (Eia) Act. Cap E12, LFN 2004. An Environmental Impact Assessment (EIA) is an assessment of the potential impacts whether positive or negative, of a proposed project on the natural environment: The E.I.A Act, as it is informally called, deals with the considerations of environmental impact in respect of public and private projects.

- Sections relevant to environmental emergency prevention under the EIA include:-
- Section 2 (1) requires an assessment of public or private projects likely to have a significant (negative) impact on the environment.
- Section 2 (4) requires an application in writing to the Agency before embarking on projects for their environmental assessment to determine approval.
- Section 13 establishes cases where an EIA is required and
- Section 60 creates a legal liability for contravention of any provision.

ES 2.7 Harmful Waste (Special Criminal Provisions) Act Cap H1, LFN 2004: The Harmful Waste Act prohibits, without lawful authority, the carrying, dumping or depositing of harmful waste in the air, land or waters of Nigeria. The following sections are notable:

- Section 6 provides for a punishment of life imprisonment for offenders as well as the forfeiture of land or anything used to commit the offence.
- Section 7 makes provision for the punishment accordingly, of any conniving, consenting or negligent officer where the offence is committed by a company.
- Section 12 defines the civil liability of any offender. He would be liable to persons who have suffered injury as a result of his offending act.

Hydrocarbon Oil Refineries Act, Cap H5, LFN 2004:The Hydrocarbon Oil Refineries Act is concerned with the licensing and control of refining activities. Relevant sections include the following:-

- Section 1 prohibits any unlicensed refining of hydrocarbon oils in places other than a refinery.
- Section 9 requires refineries to maintain pollution prevention facilities.

Associated Gas Re-Injection Act, Cap 20, LFN 2004. The Associated Gas Re-Injection Act deals with the gas flaring activities of oil and gas companies in Nigeria. The following sections are relevant to pollution prevention:-

- Section 3 (1) prohibits, without lawful permission, any oil and gas company from flaring gas in Nigeria.
- Section 4 stipulates the penalty for breach of permit conditions.

The Endangered Species Act , Cap E9, LFN 2004: This Act focuses on the protection and management of Nigeria's wildlife and some of their species in danger of extinction as a result of overexploitation. These sections are noteworthy:

- Section 1 prohibits, except under a valid license, the hunting, capture or trade in animal species, either presently or likely to be in danger of extinction.
- Section 5 defines the liability of any offender under this Act.

- Section 7 provides for regulations to be made necessary for environmental prevention and control as regards the purposes of this Act.

Water Resources Act, Cap W2, LFN 2004: The Water Resources Act is targeted at developing and improving the quantity and quality of water resources. The following sections are pertinent:

- Section 5 and 6 provides authority to make pollution prevention plans and regulations for the protection of fisheries, flora and fauna.
- Section 18 makes offenders liable, under this Act, to be punished with a fine not exceeding N2000 or an imprisonment term of six months. He would also pay an additional fine of N100 for everyday the offence continues.

Sea Fisheries Act, Cap S4, LFN 2004: The Sea Fisheries Act makes it illegal to take or harm fishes within Nigerian waters by use of explosives, poisonous or noxious substances. Relevant sections include the following:-

- Section 1 prohibits any unlicensed operation of motor fishing boats within Nigerian waters.
- Section 10 makes destruction of fishes punishable with a fine of N50,000 or an imprisonment term of 2 years.
- Section 14 (2) provides authority to make for the protection and conservation of sea fishes.

Inland Fisheries Act, Cap I10, LFN 2004. Focused on the protection of the water habitat and its species, the following sections are instructive:

- Section 1 prohibits unlicensed operations of motor fishing boats within the inland waters of Nigeria.
- Section 6 prohibits the taking or destruction of fish by harmful means. This offence is punishable with a fine of N3, 000 or an imprisonment term of 2 years or both.

ES 2.8 HJKY Basin Trust Fund (HKJYB-TF)

The Federal Government (represented by FMWR), in cooperation with the riparian States, established the Trust Fund at the Damaturu Summit in year 2006. The Trust Fund is an innovative platform for a joint intervention by the riparian states, with the support of the Federal Government of Nigeria for augmenting line agencies in addressing land and water resources issues in the KYB. Riparian state Governors contributed the equivalent of USD 6.5 million to establish the Trust Fund. The Federal Government of Nigeria matched these funds, bringing the total amount available to establish and operate the Trust Fund to some USD 13 million.

The Governors of riparian states, in their May 2017 Summit, renewed their commitment to financially support the Trust Fund, but only FMWR and the Yobe State Government have actually disbursed their part of the pledged funds. Other state governments have approved the pledges but are yet to release funds. However, a new Board of Trustees (BOT) of the Trust Fund has been inaugurated in November 2017. During their recent meeting in April 2018, the Board undertook to persuade the remaining State Governors to provide the funds they pledged as soon as possible.

ES 2.9 The Hadejia–Jama'are River Basin Development Authority

The Hadejia Jama'are River Basin Development Authority (HJRBDA) was created in 1976 along with ten other River Basin Development Authorities by the Federal Government of Nigeria under Decree 25 of 1976. Presently, the HJRBDA has the largest functional irrigation schemes among the twelve River Basin Development Authorities in Nigeria. The Authority covers an area of 45,000 km^2 (the entire area of Kano and Jigawa states, and about two-thirds of Bauchi State) with an irrigation development potential of about 240,000 hectares within the Hadejia and Jama'are River Basin. The Headquarters of the HJRBDA are located in Kano City. The HJRBDA is responsible for the development of surface and groundwater resources for irrigated agriculture, water supply and other uses within its catchment area in Kano, Jigawa and Bauchi States. The HJRBDA has continued to develop and manage dams and irrigation projects since its establishment. These projects have a significant impact on the lives of people in its catchment area and beyond. Currently the HJRBDA has developed only 22,324 ha of irrigated land out of a potential area of 240,000 ha, which is very low progress (10.3%)[3]. The financial performance of the HJRBDA has been declining in recent years, and it is expected that the mandate, roles and organization of the HJRBDA will change once the forthcoming Water Bill becomes law.

ES 2.10 State Level

The institutional arrangements at state level in the KY Basin in general are as presented below.

Borno State:

The institutional framework includes the Ministry of Water Resources and State water agencies; Borno Irrigation Department in the Ministry of Agriculture and Natural Resources, and Ministry of Environment. In addition to state executive governor's directives, the Borno State Water Corporation Edict No. 2 (1999) regulates domestic water supply. The State Water Resources Edicts do not clearly define roles and responsibilities for the various State water agencies, with the result that available water quantity is not sustainably managed in the State.

Yobe State

The Ministry of Water Resources and State Water Board, Ministry of Agriculture and Natural Resources, and the Ministry of Environment are major managers of water resources in the Yobe State. The state activities on water issues are based on ''Water supply and Sanitation policy (January 2010) and executive governor's directives. Roles and responsibilities of the various MDAs involved in managing the waters of the Lake Chad basin are not clearly defined in terms of control, monitoring and enforcement measures on water use in the State. No water resources law in the State to complement the sustainable water charter of HJKYB-TF. Hence, available water quantity was not sustainably managed in the State.

Bauchi State

The institutional framework in Bauchi state includes Ministry of Water Resources and State Water Agencies; Ministry of Agriculture and Natural Resources, and Ministry of Environment. In addition to state executive governor's directives, the Bauchi State government had reviewed in March 2013 the state water supply and sanitation policy.

Kano State: Kano State has a Ministry of Water Resources and State Water Board; Ministry of Agriculture and Natural Resources, and Ministry of Environment. Water related activities are based on annual budgets, Water Resources and Engineering Construction Agency (WRECA) Kano State Edict 1991, and the Water Supply Edict 2013. In addition to state executive governor's directives, there is lack of State Water Resources Edicts with clearly defined control roles and responsibilities for the various State Water Agencies involved in managing the water of the Lake Chad basin. The effect was that available water quantity was not sustainably managed in the State. The State had Ministry of Water Resources and State water agencies; Ministry of Agriculture and Natural Resources, and Ministry of Environment. These MDAs activities were based on annual budgets;

Jigawa State: Water Board and Sanitation Agency law 1999 (Law no. 9, 1999), and water supply and sanitation policy, in addition to state executive governor's directives. There was lack of State Edicts Water with Resource to clearly defined control roles and responsibilities for the various State Water Agencies involved in managing the waters of the Lake Chad basin. Hence, available water quantity in the State was not sustainably managed.

Katsina State

Katsina State Waste Management Act provides for the effective development and maintenance of sanitation in all areas of the State. The law further provides for proper disposition of excavated silt or earth and other construction materials after any construction project or repair works. Open burning of wastes is prohibited with stipulated penalties.

Chad Basin Development Authority

The Chad Basin Development Authority (CBDA) was established to promote the development of rural communities in the Chad Basin; to promote the economic empowerment of women; to encourage the participation of rural women in adult education programmes; to engage in vocational training for he women in rural areas; to provide micro-credit facilities. The CBDA is mandated to address both agriculture and rural development. CBDA should make "Sustainable Agriculture and Rural Development" of Nigerians as its main goal. In line with this goal, the organization should have its own Vision and Mission that provide proper direction to the activities of the organization and the results it can achieve.

ES 3.0 Project Justification And Alternatives

ES 3.1 Introduction:

The Challawa Gorge Dam Watershed Management Project is one of the selected priority projects of the Hadeja Jamaare Kom adugu Yobe Basin Trust fund (HJKYB-TF). The purpose of the project is to extend the longevity of the reservoir by reducing the sediment flux into the reservoir through watershed management. The purpose for which the dam was constructed in the early-90s was built to supply drinking water to Kano city and supply irrigation water for the Kano irrigation project. However, recently, watershed degradation has set in resulting in the problems erosion in the watershed area and serious sedimentation problems in the Challawa Reservoir, thereby threatening the life of the reservoir and making water treatment very costly because of high turbidity. In addition, erosion in the upland watershed is affecting farmers' lands and encroaching towards private property and destroying critical infrastructure such as roads, bridges and the dam reservoir embankment. If unattended, the ecological, biological, social and economic benefits derived from the reservoir may be obliterated sooner than the expected lifespan of the dam. The need to implement the watershed management project therefore becomes imperative and necessary.

ES 3.2 Justification for the Project

There are three main problems associated with Challawa Gorge Dam Watershed that started from watershed erosion and gully formation in the upland watershed, sediment deposition and siltation of the reservoir and sedimentation problems associated with Challawa Water Works treatment plant. These three problems are mainly due to watershed degradation in the upper reaches of the Challawa Gorge Dam Watershed. To fix these problems and extend the longevity of the reservoir to realize its purpose is the main justification for the project. A brief description of each problem is presented below.

Watershed Management Problem

The watershed Management Project is necessitated by the general degradation of the Challawa Sub-basin watershed. This has resulted in related adverse environmental conditions threatening the life of the Reservoir.

The Challawa Gorge Watershed Degradation problem

Challawa Gorge Watershed Degradation is the main cause of erosion in the watershed, Sedimentation in Challawa Reservoir, and the Kano water works and treatment plants downstream. Natural and human factors are the main causes of erosion in the watershed (Fig. 3.1). Human activities resulting in Land use-Land Cover (LULC) due to agricultural and other human activities instigated by the increasing demand for food and other land resources associated with growing population coupled with poor agricultural practices, are some of the main causes of watershed degradation in the area (Fig. 3.2). Natural factors such as topography, soil type and slope of the watershed combined with rainfall have also significantly contributed towards Challawa watershed degradation by promoting runoff formation with anthropogenic interference as a catalyst to the process. In some places, it is also observed that the need for irrigated agriculture has forced farmers to remove vegetation from river banks for easy supply of water from the rivers and streams. These also result in damage of riparian stream buffers and expose them to severe stream bank erosion

ES 3.3 Potential Benefits and Beneficiaries of the Project

Environmental Benefits: The main objective of the Challawa Watershed Management Project is to extend the longevity of the reservoir by reducing the sediment flux into the reservoir through integrated watershed management. Thus, the project was conceived to manage environmental degradation within the Challawa Gorge Dam basin which manifests as gullies and river bank erosion. The following are the anticipated positive environmental and socioeconomic impacts of the project:

a. Reducing erodibility of the soils within the watershed and by extension reduction in siltation and sedimentation of the River Channels and the Reservoir: erosion generally increases sediment load in water and when they are generated from gully and river bank erosion, the amount of sediment load multiplies. However, with proper implementation of this project, the levels of sediment will reduce substantially by by about 75% which will in turn reduce the amount of silt and sediment in both the rivers and the reservoir.

b. *Mitigation of Climate Chang*e: through planting of trees and grasses, this will positively change the land cover from bare to forested land and also provide vegetation to absorb carbon dioxide.

c. *Protection against Strong Winds*: if the trees are properly arranged, they will serve as wind breakers which will serve as protection against violent winds that do occur during the rainy season.

d. *Creation of Underground Water Recharge Zone*: the trees and grasses to be planted will reduce surface flow, allowing for more penetration of water through the soil thereby creating underground water recharge zone. This water can be used by the settlements upstream that mostly depend on underground water during the dry season for both irrigation and domestic use.

e. *Pollution control:* Has the health benefit of improvement in air and water quality with the potential of reducing incidences of air and water-borne diseases;

f. *Water storage:* flood control, checking sedimentation;

g. *Minimization* of over exploitation of resources;

h. *Erosion control* and prevention of soil, degradation and conservation of soil and water;

i. *Restoration and enhancement* of environmental aesthetics value of the environment: the natural beauty and attraction of the environment will be restored and enhanced thereby promoting tourism.

j. A hedgerow of the vertiver grass will stay where it is planted and sediment that is spread out behind the hedgerow gradually accumulates to form a long lasting terrace with vetiver protection. When used for civil systems and designs the vertiver root is likened to a "Living Soil Nail" with an average tensile strength of 1/6 of mild steel. Thus it benefits the soil by protecting it almost on a sustainable basis, and benefits the farmer by improving farm land management, crop production and overall livelihood.

k. Vetiver grass can be used directly as a farm income earning product, or it can be used for applications that will protect river basins and watersheds against environmental damage, particularly point source environmental problems relating to sediment flows and toxic sources.

l. Empirical evidences of numerous trials and mass applications of vetiver grass in the last 20 years in many countries also show that the grass is particularly effective in natural disaster reduction (flood, landslide, road batter failure, river bank, irrigation canal and coastal erosion, water retaining structure instability etc.) environmental protection (reduction of land and water contamination, treatment of solid and liquid waste, soil improvement etc.), and many other uses (Chomchalow, 2005; Nguyen Van Hon et al., 2004; and Le Van Du and Truong 2006).

Potential Beneficiaries

All these applications can directly or indirectly impact on the rural poor through either protection or rehabilitation of farm land, providing better moisture retention and provision of direct farm income, or indirectly by protecting rural infrastructure. Overall, it has the potential of enhancing the livelihood of the ordinary rural dwellers through improved food production, food security and income growth.

ES 3.4 Potential Benefits and Beneficiaries of the Project

Environmental Benefits: The main objective of the Challawa Watershed Management Project is to extend the longevity of the reservoir by reducing the sediment flux into the reservoir through integrated watershed management. Thus, the project was conceived to manage environmental degradation within the Challawa Gorge Dam basin which manifests as gullies and river bank erosion. The following are the anticipated positive environmental and socioeconomic impacts of the project:

m. Reducing erodibility of the soils within the watershed and by extension reduction in siltation and sedimentation of the River Channels and the Reservoir: erosion generally increases sediment load in water and when they are generated from gully and river bank erosion, the amount of sediment load multiplies. However, with proper implementation of this project, the levels of sediment will reduce substantially by by about 75% which will in turn reduce the amount of silt and sediment in both the rivers and the reservoir.

n. *Mitigation of Climate Chang*e: through planting of trees and grasses, this will positively change the land cover from bare to forested land and also provide vegetation to absorb carbon dioxide.

o. *Protection against Strong Winds*: if the trees are properly arranged, they will serve as wind breakers which will serve as protection against violent winds that do occur during the rainy season.

p. *Creation of Underground Water Recharge Zone*: the trees and grasses to be planted will reduce surface flow, allowing for more penetration of water through the soil thereby creating underground water recharge zone. This water can be used by the settlements upstream that mostly depend on underground water during the dry season for both irrigation and domestic use.

q. *Pollution control:* Has the health benefit of improvement in air and water quality with the potential of reducing incidences of air and water-borne diseases;

r. *Water storage:* flood control, checking sedimentation;

s. *Minimization* of over exploitation of resources;
t. *Erosion control* and prevention of soil, degradation and conservation of soil and water;
u. *Restoration and enhancement* of environmental aesthetics value of the environment: the natural beauty and attraction of the environment will be restored and enhanced thereby promoting tourism.
v. A hedgerow of the vertiver grass will stay where it is planted and sediment that is spread out behind the hedgerow gradually accumulates to form a long lasting terrace with vetiver protection. When used for civil systems and designs the vertiver root is likened to a "Living Soil Nail" with an average tensile strength of 1/6 of mild steel. Thus it benefits the soil by protecting it almost on a sustainable basis, and benefits the farmer by improving farm land management, crop production and overall livelihood.
w. Vetiver grass can be used directly as a farm income earning product, or it can be used for applications that will protect river basins and watersheds against environmental damage, particularly point source environmental problems relating to sediment flows and toxic sources.
x. Empirical evidences of numerous trials and mass applications of vetiver grass in the last 20 years in many countries also show that the grass is particularly effective in natural disaster reduction (flood, landslide, road batter failure, river bank, irrigation canal and coastal erosion, water retaining structure instability etc.) environmental protection (reduction of land and water contamination, treatment of solid and liquid waste, soil improvement etc.), and many other uses (Chomchalow, 2005; Nguyen Van Hon et al., 2004; and Le Van Du and Truong 2006).

Potential Beneficiaries

All these applications can directly or indirectly impact on the rural poor through either protection or rehabilitation of farm land, providing better moisture retention and provision of direct farm income, or indirectly by protecting rural infrastructure. Overall, it has the potential of enhancing the livelihood of the ordinary rural dwellers through improved food production, food security and income growth.

Socio-economic Benefits

a. Allows the Dam to Operate at the Designed Capacity: this is particularly important if the purpose for which the dam was constructed is to be achieved, especially in terms of water storage capacity for irrigation and power generation.

b. Reduction in the Maintenance Activities on the Rivers and the Dam: managing the degraded sites in the basin may reduce unwanted materials reaching the rivers and reservoir which hitherto has hindered the optimum performance of the reservoir. This will be economically beneficial to Kano Municipal water supply system not only by reducing management cost, but also improved water quality which also has positive implication for public health in and around the city.
c. Diversification of Income: if the trees are both exotic and non-exotic, they will provide income to land owners and materials for other uses such as poles for electricity and building. The trees can also be used as collateral for loans.
d. Sources of Fuel wood for Domestic Use: the project, if well implemented, it the long term will provide fuel wood for domestic use by the people who solely depend on fire wood for cooking and other domestic use.
e. Reclaiming Lost Farmland: many wasted farmlands will be recovered consequently providing opportunity once again for the owners to begin to earn income from the land and enhance their standard of living.
f. Social Safeguards: it will reduce the number of impoverished people whose situation has been brought about by reduced land for productive activities. Therefore, it will improve the overall prosperity of the areas within the catchment.
g. To reduce the need for perennial labour emigration: long run reclamation of farm lands lost to land degradation, improvement fish and related aquatic resources in the catchments surface water system have the potential to reduce or permanently discourage perennial temporary labour temporary migration commonly known *Chin-rani* and the cases of "migrant tenant farmers" from the catchment area to other parts of Nigeria in search other means of livelihood among the Hausa people of the area.

ES 3.5 Beneficiaries: the Kano state government in particular, the community of farmers, herders, fishermen, including youths, women and other vulnerable groups especially within the riparian communities are potential beneficiaries of the Challawa Gorge Dam watershed management project.

ES 3.6 Project Sustainability

The general sustainability principles (technical, economic, environmental and social) that guided the project's design are set below**.**

Technical Sustainability

The proposed project is technically feasible because it is professionally designed, and the technology employed is readily available and not too complex. The timing of the project when most residents of the Challawa Dam Environment and the Kano State government are expressing concern about the continuous sedimentation of the dam with ripple effect on the water treatment plant at Panshekara supplying water to Kano Municipality and its environs.

The Hadeja Jamaare River basin Authority's pool of technical and administrative experts, and the pool of technical expert in the industrial region of Kano are encouragement for sustainability of the project. Moreover, the predominantly agricultural community of the project area constitutes a pool of employable labour to support the bio-remediation and agricultural measures components of the project because they stand to be immediate benefiaries of the project. With government political will and support the project is highly sustainable.

Economic Sustainability

The project is targeted to cover 985 Ha (around Reservoir, Pilot '1' and Pilot '2') and a further 500 ha of farmlands. There will be no immediate direct benefits for the 500 of farm lands, it is expected that the 985 ha will be placed under grass, trees, fruit trees and intercrops.

Social Sustainability

Social sustainability is contingent on social acceptability which, for the Challawa Gorge Dam, is not in doubt, judging from the ecstasy with which the communities welcomed the idea of watershed treatment for future survival of the infrastructure. Residents of Karaye and other communities in the neighborhood of the Challawa Gorge Dam in Kiru, Rogo and Turawa welcome the project which in their opinion has reduced the phenomena of temporary youth migration out of the communities for dry season job-seeking otherwise known in Hausa as *chinrani* because of the irrigation and fishing opportunities provided by the Dam. Also, the benefit to create job opportunities for unemployed indigenes especially the youths and diffusion of erosion management techniques hitherto unknown to the community of farmers would ensure social sustainability. The HJKYB-TF on the other hand nas demonstrated commitment to effective and sustained stakeholders' engagements and consultations towards the success of the watershed rehabilitation project. The proponent is also committed to complying with applicable national social laws, relevant international conventions, and AfDB safeguards requirements and training and retraining the PIU team members on environmental and social management risks.

Environmental Sustainability

The project is a rehabilitation activity to improve the functionality, sustainability and operational efficiency of the Challawa Gorge Dam which has been in existence since 1992. The watershed management is to enhance the ecosystem, improve biodiversity, protect the soil from further degradation, reduce or mitigate channel and reservoir sedimentation through bio-engineering techniques that are environmentally friendly, socially acceptable and economically viable. Moreover, social and environmental mitigation measures have been suggested for the identified environmental and social impacts of the watershed management project.

The proponent (HJKYB-TF) is aware of, and committed to, complying with all relevant country environmental laws, applicable international conventions and AfDB environmental and social safeguard requirements to implementing the ESMP developed to guarantee environmental sustainability. The proponent also has a department that handles environmental issues related to its activities in the discharge of it mandates. The HSE department is headed by a Director who reports directly to the Bank's senior vice president. A significant number of ESIAs and environmental audits have been conducted in the past by the proponent; hence, they have the technical skills needed to manage the mitigations determined for the identified impacts of this project.

ES 3.7 Analysis of Project Alternatives

Watershed management technique is not a one-cap fit all-heads strategy. Several alternatives are possible. However, the choice of any approach depends much on the watershed scale (size), nature of the watershed problem, objectives of the watershed management intervention and the administrative and legal system of the management process. The cost of Watershed Management system is also a determinant of alternative choices in watershed management strategy to be adopted. Engineering and Bio-remediation options designed for the Challawa gorge dam watershed may be expensive in terms of construction, management and sustainability even though its advantages are also enormous. Alternative watershed management approaches that may be possible to address the degradation of the Challawa Gorge Dam are presented in table 3.2 and discussed in subsequent sections.

ES 4.0 Project Description

ES 4.1 Background to the Watershed Management Project

The Komadugu Yobe Basin (KYB) covers an area of 84,000km^2. It is of strategic national and international importance as it supports the livelihood of over 15 million people in six Nigerian States including Bauchi, Borno, Jigawa, Kano, Plateau and Yobe who are directly or indirectly dependent on the scares water resources. The KYB which is located in the semi-arid north-eastern Nigeria represents approximately 35% of the Lake Chad Basin and is important as a trans-boundary water resource. The Federal Government of Nigeria, in collaboration with SMEC and the African Water Facility, has prepared the Komadugu Yobe Basin Strategic Action Plan (SAP 2019) as a long-term development strategy promoting the management and use of the basin water resources for inclusive and sustainable growth and development. The Strategic action plan (SAP 2019) for the water resources development in the Komadugu Yobe (KY) basin, obtained from the HJKY-TF, identified four priority Sub-Programs/Schemes, among which is the Challawa Gorge Dam Watershed Management Sub-Program.

The Government of Nigeria through funding from the AfDB is financing additional studies for the priority investment projects. The studies include Environmental and Social Impact Assessment for the proposed Challawa Gorge Dam Watershed Management Sub-Program. In this regard the HJKY-TF (which is the Implementing Agency) seeks for consultancy services to prepare the ESIA and ESMP of the Watershed Management to assess the potential (positive and negative) environmental impacts of the proposed infrastructures construction and related activities and propose a management Environmental and Social Management Plan to address the predicted impacts for the Challawa Gorge Dam Watershed Management Sub-Project.

The SAP (2019) report identified three sets of leading problems associated with the Challawa Gorge Dam Watershed component of the HJKYB development. The previous study revealed that the problems started from watershed erosion and gully formation in the uplands watershed, sediment deposition and siltation of the rivers and the reservoir (Plates 4.1 and 4.2), and sedimentation problems downstream associated with Challawa Water Works treatment plant, all arising mainly from watershed degradation in the upper reaches of the Challawa Gorge Dam Watershed Area. Thus, the project was conceived to remediate environmental degradation within the Challawa Gorge Dam area which manifests as gullies and river bank erosion, and eventually river beds and Challawa reservoir sedimentation and destruction to critical infrastructure (Plate 4.3) while also affecting biodiversity through ecosystem destabilization.

ES 4.2 Project Location

The Project is located in Kano State Northern Nigeria, close to Karaye town about 120 km south west of Kano City, within the HJKY Basin (Fig. 4.1 and 4.2). The main Challawa Gorge Dam watershed boundary falls into three States' administrative boundaries namely Kano, Katsina and Kaduna. The project area is located in the HJKY River Basin with geographic coordinates of 11°41'21.29"N and 8° 0'49.16"E, at the Challawa Gorge Dam (figure 4.3). The watershed area covers about 3,842 km^2 with an altitude ranging between 520 to 720masl. It is a major reservoir on the Challawa River, a tributary of Kano River. The Challawa Dam itself lies astride the land areas of three riparian local government areas of Karaye, Rogo and Kiru in Kano State. Although the upper reaches of the Challawa Sub-basin watershed extends to parts of Katsina and Kaduna States, the greatest areas of the project likely to be more affected lie in Kano state, especially areas in Karaye, Kiru and Rogo Local Government Areas. The Challawa River itself forms a tributary to the Kano River which drains into Tiga Dam in Kano State and further downstream of the Hadeja Jamaare river system in Jigawa and Bauchi States.

ES 4.3 Objectives of the Challawa Gorge Dam Watershed Management Project

The Challawa Gorge Dam Watershed Management Project is one of the four priority projects selected for development by the HJKY-TF. The overall objective of the project is to extend the longevity of the Challawa Gorge Dam reservoir by reducing the sediment flux into the reservoir through watershed management, involving design of erosion control structures, provision of bioremediation and other agricultural measures; and construction of gabion check dams and sediment traps, etc. The SAP (2019) of the Challawa Gorge Dam rehabilitation project noted that the project is expected to significantly reduce the siltation problem in the Challawa reservoir and contribute significantly to soil conservation within the watershed, and also address the problem of sedimentation at the Challawa Water Works treatment plant with all the associated positive effects

ES 4.4 The Project Components and Activities

General Site Description of the project

The Challawa Watershed management project is aimed at erosion and gully control and reducing sediment deposition in the reservoir through watershed management intervention. The proposed watershed management work largely includes provision of erosion control structures in the upland active watersheds producing large amounts of sediments. For this purpose, two pilot sub watersheds were selected and appropriate erosion control measures were designed and presented for the two sites.

The selected Pilot sub watersheds have been designated as **PSW_1** and **PSW_2**, each containing its own main and finger gullies and draining into the main rivers that later join the Challawa River (fig. 4.4). The gullies identified in the two sub watersheds (PSW_1 and PWS_2 and the works to be carried out on each are presented in table 4.1. The gullies have very steep slopes from the head to middle reach and tend to have milder slope near the outlet, forming a relatively stable and wide bed. The gullies are expanding upstream by head cutting and laterally with stream bank erosion. Urgent intervention is needed to stop the gully from developing laterally and endangering the surrounding farm land and deposition of sediments in the downstream reservoir. The gully is shallow at its tail and is deeper in the middle and head section, up to 30m depth. The width of the gully varies from 60m at shallower areas to 30m at the deeper sections. The shape of the gully is generally V-shape gully at the head and middle with a side slope ranging from 30^o to 40^o. In Pilot Sub Watershed 1 gully site, the level of gully erosion is so active that it is progressing aggressively towards the adjacent farm lands encroaching into private properties.

PWS_1 and PWS_2 Main and Finger Gully Features and proposed works

Description	Length (m)	Proposed Work	Remark
MG	4,581	Bank protection, Check Dams, sediment trap and buffer	PW_1
LFG-1	1,006	Bank protection and Check Dams	PW_1
LFG-2	2,124	Bank protection and Check Dams	PW_1
LFG-3	787	Bank protection and Check Dams	PW_1
RFG1	2,612	Bank protection	PW_1
MG	8,047	Bank protection, Check Dams, sediment trap and buffer	PW_2
LFG-1	654	Bank protection	PW_2
LFG-2	760	Bank protection and Check Dams	PW_2
LFG-3	705	Bank protection and Check Dams	PW_2
LFG-4	955	Bank protection and Check Dams	PW_2
LFG-5	937	Bank protection and Check Dams	PW_2
RFG1	902	Bank protection and Check Dams	PW_2
RFG2	1,984	Bank protection	PW_2
RFG3	2,152	Bank protection	PW_2

Source: SMEC (2019) SAP Report, p.35

Note: MG = Main gully; LFG = Left finger gulley; RFG = Right finger gully;

PWS_1 and PWS_2 Main and Finger Gully Features and proposed works

Description	Length (m)	Proposed Work	Remark
MG	4,581	Bank protection, Check Dams, sediment trap and buffer	PW_1
LFG-1	1,006	Bank protection and Check Dams	PW_1
LFG-2	2,124	Bank protection and Check Dams	PW_1
LFG-3	787	Bank protection and Check Dams	PW_1
RFG1	2,612	Bank protection	PW_1
MG	8,047	Bank protection, Check Dams, sediment trap and buffer	PW_2
LFG-1	654	Bank protection	PW_2
LFG-2	760	Bank protection and Check Dams	PW_2
LFG-3	705	Bank protection and Check Dams	PW_2
LFG-4	955	Bank protection and Check Dams	PW_2
LFG-5	937	Bank protection and Check Dams	PW_2
RFG1	902	Bank protection and Check Dams	PW_2
RFG2	1,984	Bank protection	PW_2
RFG3	2,152	Bank protection	PW_2

Source: SMEC (2019) SAP Report, p.35

ES 4.5 Stream bank stabilization with Bio-remediation

Grading and trimming

The middle reach of the gully has relatively narrow and very deep exposed gully bank section with slope varying from 45 to 50 degrees. This slope is not stable for such poorly structured geological formation. Therefore, the slope of gully banks is proposed to be graded with the following recommendations:

- Provision of graded slope of 1:1.5 with 4m wide berm at the middle of the bank, the proposed graded bench is horizontal and along the contour and interceptor drainage is provided every 10m elevation interval in order to intercept the storm water and evacuate to the collector drain.
- Provision of bio-degradable geo matt on the treated surface where the gully slopes are steep and exposed the geo-matt will create a support of the banks until the bio-remediation is fully developed.

Even with bank stabilizing measures, the gully banks are still vulnerable to further erosion by uncontrolled surface stormwater runoff from the surrounding areas. Hence, protection measures are provided. After careful analysis of various types of bank protection measures, vetiver grass was selected and explanation provided in the following sub section.

ES 4.6 Bio-remediation (Vetiver grass)

The non-vegetated slopes are subject to frequent and sometimes serious erosion process, due to storm water runoff. The gully banks are exposed in active reaches of the gully and are vulnerable to surface erosion from direct rainfall. These exposed surfaces shall be covered with vetiver or other fast growing deep rooted grass in order to minimise the formation of rill type of waterways. Bio-remediation measures can be used to protect gully bank walls and prevent erosion. They provide important resistance to erosion forces and more aesthetic and environmentally friendly than other structures. Accordingly, the main bio-remedial measure proposed at Challawa Gorge Dam Pilot Sub watershed site is planting of vetiver grass on gully bank slopes of less than 40^0.

ES 4.7 Erosion control structures: The Engineering Construction Component of the Project

Structural (engineering) measures to control gully formation and check channel and reservoir siltation are to be constructed inside the gullies while bio-remediation and agricultural measures are to be provided on eroded gully banks and adjacent farm lands respectively to stabilize soil, and reduce surface flow. Gabion check dams and sediment traps are the main structural measures to be provided at selected sites. Selection was done in an earlier study (SMEC, SAP 2019) after proper identification of erosion processes and hydraulic phenomena, including water surface and velocity profile inside gully channel. Comparison was made in the existing and stable slope. The unstable section of gully is designed to be provided with check dams to stabilize flow and promote sediment deposition upstream of check dams. Check dams are designed for 10-year return period design floods and their stability is checked for a 25-year return period. Generally, over 50 Gabion check dams of differing in size, are to be provided in Pilot sub watersheds of the Challawa Gorge Dam.

ES 4.8 Construction Activities

The construction activities shall be handled by competent professionally skilled contractor to handle the Engineering, Bio-engineering and Agricultural components of the project. The project proponent i.e. the Hadeja Jamaare Komadugu Yobe Basin Trust Fung (HJKY-TF) is not equipped technically and professionally to execute the construction work due to absence of the required manpower. Thus, the contractor may have to import professionally skilled man power from outside the project area while some component of the unskilled labour input may be attracted from the local communities of the project area. The contractor must consider and apply legally binding labour regulations of the country including minimum wage standards and in accordance with global best practices.

Construction material both physical and biological available in the project area is inadequate and must be provided from outside the project area. While rock materials may be carefully mined from the local environment that is charaterised by rock out crops and granitic beds for the construction, the extraction of such materials must be done considering environmental sustainability with minimum encroachment on farmlands or developed areas and without further damaging gully prone sites. Veriver grass seedlings may have to be raised in nurseries and natured for transplanting. Vertiver grass can grow over a short period of 45 - 60 days with good husbandry practice. However, vertiver seeds may not be available within the project area and must be acquired from outside the watershed region.
Subsisting land tenure laws of the country described in section 2.2 of this report is to guide land acquisition for the project and where necessary adequate compensation should be granted all affected land owners/user for any land and or crops affected by the project. The more likely groups to be affected directly and indirectly by watershed remediation activity are the members of the local community (land owners, farmers, animal herders etc.) in the project area especially in Rogo, Karaye and Kiru Local Government Areas of Kano State.

ES 4.9 Activity Phases

Project activities are phased for ease of construction and monitoring progess. The phases are discussed under the following sub-headings:

- Mobilisation or preconstruction phase,
- Construction phase,

- Operation/Maintenance Phase, and
- Decommissioning phase

The proposed project involves Gully bank stabilization, erosion control, sediments control on main and some of the Challawa river tributaries and ecosystem enhancement of the Challawa Gorge Dam watershed.

ES 5.0 Description Of Project Environment And Baseline Conditions

ES 5.1 Introduction:

The purpose of the baseline data acquisition was to establish, the status of the various environmental components that are likely to be affected by the proposed project. In order to achieve this, environmental parameters were determined from literature survey, fieldwork, laboratory and data analyses. The components of the environment evaluated covered biophysical, social and health. The ESIA study of the project incorporated data from already approved Environmental Impact Assessment reports as secondary data which include amongst others, the Challawa Gorge Dam Rehabilitation Project Strategic Action Plan 2019, and the ESIA for the 330/132/33kV Transmission Substation New Kano, Kano State.

The Challawa Gorge Dam Management project is designed to be carried out in three pre-selected areas which are typically representative of the entire sub-watershed in terms of physical (topographic, drainage, soil and vegetation) as well as their human occupancy, land use and agricultural practices. The details of Pilot sub-watershed selection process are clear defined in an earlier Strategic Action Plan Report for this project (SMEC 2019, Volume 1 A). The general environmental, ecological and social conditions of the project site made up of (i) Dam Site, (ii) Pilot Sub watershed_1 (PWS_1) and (iii) Pilot Sub-watershed_2 (PWS_2), are described below. The Project Area of Influence (AOI) i.e. the geographic area likely to be affected by the project is also highlighted.

ES 5.2 General Overview of Conditions of Project Sites

The pilot catchment management sites are located in a remote area which has an undulating and heavily rugged topography (Plate 5.1) with isolated hills. The area is situated within the southern guinea savannah region, with two distinct climatic seasons; wet and dry seasons. The area receives plentiful sunshine all year round, ranging from 11 to 13 hours per day.

The main river that drains the area is River Challawa. The river is seasonal and the quantity and quality of the water reduces drastically during the dry season. The flow of water from the dam is regulated to allow water flow downstream during the dry season for domestic use and irrigation farming. The water for domestic use at Kano is pumped to Panshekara, at the outskirts of Kano where the water treatment plant is located. The irrigation component is yet to be developed. Recently, the Kano state government announced expansion of use of the dam to cover power generation, with some slight modification of the dam required to accommodate the power plant.

The soils surrounding the sites are of different types and can be generally classified as sandy in nature and relatively deep in most places, as evinced at the gully sites, though there are isolated small rocky outcrops scattered around the two sites. A cursory look at farm lands also reveal that the soils are mostly sandy loamy because of the various management practices put in place by the farmers including intensive cultivation without fallow period, ploughing, application of farm yard manure etc., to improve soil for better crop harvest (Figure 5.2). There are a few boreholes and several tube wells located within the nearby settlement and along the roads, for both domestic and agricultural use. The existing land use of at the pilot sites are mainly agriculture for both crop farming and animal husbandry. Other minor land uses are settlements, roads, and for social services like schools, health care centres and open play grounds. The crops produced include maize, guinea corn, groundnuts, beans, soya beans, rice, potatoes, sugar cane, cassava, and other vegetables such as tomatoes, onion and pepper. The animals (usually few in number) raised by individuals include cows, goats, sheep, horse and donkeys. At the settlements, poultry such as fowls, chickens, turkey and ducks were found roaming around freely.

ES 5.3 Area of Project Influence (API)

The area of Potential Project Influence (API) both direct and indirect is identified in terms of coverage or extent of the impact, is determined as the degree, extensiveness or scale of influence. The Project's API is the geographic area where direct or indirect impacts are likely to be experienced. In other words, areas where primary or secondary effects resulting from the project are likely to happen.

Overall, the Challawa Gorge dam watershed covers an area of 3,842 km^2 but the measures proposed cover two pilot sub-watersheds with a total area of 3,150 ha (about 31.50 Km^2 or about 0.82% of the watershed) for pilot_1) and 2,661 ha (26.61km^2 or 0.69% of the watershed) for Pilot _2. The API is estimated base on three considerations in terms areal extent from the end point of buffering/bioremediation, i.e. from a maximum of 60m from Reservoir and gulley banks which make up the footprints of the erosion control measures. viz:

a. On site (within 500m^2)
b. 3 km-5km^2
c. Beyond 5 km^2.

Thus the area of influence is expected to go beyond 5km from the project footprint which includes the 1458 Ha covered by the direct project, out of which 500 Ha will be on farmlands belonging to individual farmers. All project activities will be carried within the footprint area defined below.

- Around reservoir (475 Ha) at 60m from Reservoir embankment;
- In Pilot area _1 (276 Ha) along gully banks, at 30 m-60m from gully banks;
- In Pilot area (218 Ha along gully banks, at 30 m-60m from gully banks;
- In Buffer strips in Pilot area_1 and Pilot area_2 (covering 16 Ha), along main and finger gully banks, at 15m-30m from gully banks; and
- On farmlands (500 Ha).

The Project's Areas of Direct Influence (ADI) within and outside of the footprint area includes the biophysical and socioeconomic impacts. The Project's ADI is therefore demarcated as in figure 5, a schematic representation of the areas of influence. The influences can be categorised into two: Biophysical and Socioeconomic influences. Figure 5.1 provides a graphical illustration of the Areas of Influence.

ES 5.4 Geographic and Environmental Settings of the Project

Baseline information describes the general physical and socioeconomic conditions of the project environment.

Sampling Procedure

The sampling procedure was established during Scoping. These measurements were made in situ to establish the Environmental Baseline:

- Meteorology
- Air Quality and Noise
- Soil, Land use and land cover
- Vegetation and Wildlife
- Geology/Hydrogeology
- Surface water
- Socio-economics
- Health

ES 5.5 Geographic and Environmental Settings of the Project

Baseline information describes the general physical and socioeconomic conditions of the project environment.

Sampling for Physical Characteristics study

The field sampling program took place in July – August 2020 as shown in table 5.6. Parameters such as temperature, pH, turbidity, electrical conductivity and dissolved oxygen were determined *in situ* because of their rapid change on storage. For other parameters samples which could be subject to microbial degradation and transformation were preserved, stored and analysed at minimum time after collection. This combined Work Plan/Field Sampling and Analysis Plan (FSAP) addressed the field sampling, analytical, quality control, and data review procedures for the collection and analysis of sample.
For Climatic data

Samples Collection and Analytical Methods

Baseline data for the study area were generated using a combination of literature survey, field studies; analysis of maps, review of background project documents; site reconnaissance surveys; structured and semi-structured interviews via engagements with the affected riparian communities, focus group discussions (FGD), Key Informants Interviews (KII) as well as a collection of field baseline data for a number of indicators using in-situ measurement methods.

Part of this section relies on existing data as surveyed from relevant literature sources as well as field study and data analysis. Dry and wet season data were obtained from the extensively available literature (SMEC 2019; SMEC, 2015 ESIA for the Proposed 330/132/33kV Transmission Substation New Kano, Kano State Olofin 1987; Waziri, Zakaria and Audu 2015). Since the ESIA study is a one-season (rainy season) study, field sampling survey was used to generate current information (rainy season) for the project area. Dry season data were derived from similar approved ESIA report for the region (Kano Region) (SMEC, 2015)

For the purpose of both physical and socioeconomic sampling, a system of square grids was superimposed on the study area to randomly select sampling locations for air, water and soil studies. A total of 20 sites were sampled in the three project areas namely PSW_1, PSW_2 and Dam Site. However, samples were collected from 10 sampling points around PWS_1 and the Dam site. The PWS_2 sites could not be visited due alleged prevailing insecurity associated with banditry in the remote area. Samples were therefore collected around 10 village areas including Rogo, Turawa, Sakarma, Daura Gari, Yola, Gumshi, Dam Site, Jerre and Challawa.

Air Quality & Noise Studies

Sampling was for a period of eight hours per day with readings of all the parameters determined every hour. The eight-hour monitoring period was carried out from day to day so that reading could be taken from early morning to late at night over the monitoring period. Information on air quality along the route was generated by on site monitoring of air quality at the proposed route locations. This data was supplemented by desk based assessment of historical data from various locations.

Air Quality Parameters

A Portable AeroQual Series 300 Monitor and a Portable Environmental Sensor meters (ASTM D3249-95) were used. Air was pumped continuously from the atmosphere and a portion of the sample automatically sent to the analyzer for the determination of the gaseous pollutants of interest. The analyzer contains modules of each gas that analyzes the quality of the gases in the ambient air. It is a digital meter, which reads parameters at a time weighted average. (NOx, model Z-1400; SOx model Z-1300; NH_3 model Z-800; H_2S model Z-900; CO model ZDL-500 all manufactured by Environmental Sensors Ltd and VOC using AeroQual monitor).

Suspended Particulate Matter

Suspended Particulate matter were determined using Met one instrument, Met One Aerocet 531 Mini volume portable Air sampler manufactured in USA, (ASTM D4096-91).

Noise Level

Noise levels at the different sampling points were measured with the aid of a pre-calibrated digital readout noise meter. The noise sensor of the meter was directed towards the source of noise and the average reading over a period of 5 minutes was measured in decibels (dB). An EXTECH INSTRUMENT (China), model 407730 Sound level meter with measuring range of 40 dB (A) – 130 dB (A), accuracy of ±1.5 dB (A) was used for the monitoring.

Microclimatic Data Collection

Microclimatic Data was gathered using a calibrated hand held and battery powered high precision Kestrel 4500 pocket weather Tracker for wind speed, humidity, temperature and wind direction.

Climatic and meteorological data were obtained through field measurement of some of microclimatic conditions (including relative humidity, wind speed and direction, ambient air temperature), and the climatic and metrological conditions from secondary sources including the Nigerian Meteorological Agency and other online weather trackers. For the ambient microclimatic conditions field survey, an automatic mini weather weather station was set up in an open ground at various sampling station and allowed to run for a minimum of 30mins in order to establish a microclimatic baseline of that particular station. All precautions usually taken when setting up a weather station and during measurements were observed for the onsite measurements.

These include setting up the weather station away from obstacles like buildings and tall vegetation, using an instrument shelter to display all temperature sensitive instruments, orienting the instrument shelter so that the sun's radiation does not fall directly on the instrument during reading and setting up the weather station in an area representative of the study area's totality, as prescribed by the World Meteorological Organization (WMO) standard.

Soil

Soil samples were collected from each of the stations with the aid of a Dutch Hand Auger, Hand gloves, a spool and hammer at depths of 0-15cm and 15-30 cm, representing top and sub-surface samples from eight (10) locations (Plates 5.5 (a) and 5.6 (b). These depths correspond with the depths at which most (>80%) of the plants roots and soil micro-organisms are concentrated.

Vegetation Studies

Vegetation studies were conducted at the same sampling locations as those for soil studies to determine the species composition, diversity and population of plant species. The density and percentage of the major tree species and the herbaceous layers were determined. In addition, the rare and endangered plant species as well as plants of special significance to the ecosystem and the local economy were classified.

Wildlife

Wildlife studies involved a census/count of mammals, birds' reptiles and amphibians sited around the project area. Direct count using a pair of binoculars for sighting was employed for the census of reptiles, birds and other animals that readily appeared during the investigation. The presence of some of the animals was ascertained by probing such habitants like logs, heaps of dead decaying leaves, vegetated areas, ponds and burrows etc. The wildlife sighted, were identified on the spot to ease with help of field guides. Survey of literature relevant to the project environment in (the ESIA Report for the Hadejia Jama'are Sub-Basin with Kano River Irrigation Scheme (KRIS) and Hadejia Valley Irrigation Scheme (HVIS) 2017; and (ESIA) for the Proposed 330/132/33kV Transmission Substation New Kano, Kano State, SMEC March, 2017) also provided opportunity to supplement information on wildlife existing in the area.

Aquatic Studies

Acquatic studies include study of Surface and Groundwater water in the project area. Samples were collected from 4 existing sources including the Challawa Reservoir, Gumshi river, Jerry River, and upstream of Challawa River. Ground water was collected from boreholes in the area.

A water sampler was used to collect water samples at designated locations. Samples for Total Hydrocarbon Content (THC) measurements were placed in 1liter glass containers concentrated hydrochloric acid (HCl) added and sealed with aluminum foil. While the samples for the heavy metal analyses were placed in 150ml plastic container concentrated nitric acid (HNO_3) added to adjust the pH to 2. Biochemical oxygen demand (BOD) samples were collected in 250ml brown reagent bottles, sealed to exclude air bubble while the dissolved oxygen (DO) samples were fixed immediately with Winkler's I and II reagents. Unstable physiochemical parameters of water such as pH, DO, temperature, salinity, turbidity and conductivity were measured in-situ using pre-calibrated portable digital meters. All samples were preserved in a cool box and transported to the laboratory for analyses.

ES 5.6 Design of the Socioeconomic Survey

Several techniques and methods were adopted forb the socioeconomic baseline data collection. These include the use of interview schedules/questionnaire, Key Informant Interviews (KII) and Focus Group Discussion (FGD) as primary sources. In addition, and very importantly, as a primary technique of data gathering, community consultations. Visitations were also carried out on the existing social infrastructural facilities and services, e.g., education and health care infrastructure for necessary information on education and health. As a survey instrument and primary data gathering method, the questionnaire was structured such that binary, optional and open-ended questions were raised to solicit the necessary answers to questions from the community members who were on ground.

ES 5.7 Microbiology

Methods of Sample Collection

Water samples were collected in accordance with the procedures described in standard methods for water and wastewater analysis (APHA, 1998). The same is accepted and adapted by FMEnv as standards for Nigeria. According to the procedure, 200ml of sterilized sample bottle was used for collecting water sample.

The samples were preserved in an ice-cooled container and transported to the laboratory for analysis. All analysis was carried out at the Kano State Ministry of Environment Laboratory, Kano, Kano State.

Quality Control Measures

i) Clean sterile containers were used for sample collection to avoid external contamination of the sample.

ii) Sample was transported in an ice packed cooler to the laboratory and analyzed within 2 hours of collection or stored in refrigerator for analysis at other days.

iii) Procedures for sample collection were done aseptically and in accordance with standard procedures.

Methods of Sample Analysis

(a) Enumeration of Bacteria

Serial dilution procedure as described by Obire and Wemedo (1996); Ofunne (1999) was employed for cultivation and enumeration of bacteria and fungi in the water samples. The ten-fold serial dilution was used to obtain appropriate dilutions of the samples. Aliquots of the required dilutions were plated in duplicates onto the surface of dried sterile nutrient agar (for total heterotrophic bacteria). In case of total/faecal coliform bacteria, the most probable number (MPN) technique described by Collins and Lyne, (1980) was employed for estimation of their numbers in water. Appropriate volumes of undiluted water samples were inoculated into test tubes of MacConkey broth medium. All inoculated media were incubated at 37^{0}C for 24 hours or 3-7 days except for faecal coliform bacterial set up incubated at 44.5^{0}C.

Chain of Samples Custody Procedure

There is a Master Register for all samples brought into the laboratory. Following registration of the sample, a Sample Data Sheet containing pertinent information on the sample was opened for each sample. The information includes:

a) sample reference number;
b) nature or type of sample;
c) site of collection;
d) date and time of collection; and
e) Mode of preservation (depends on nature of material) and analytical data from the field.

Appropriate methods were used in storing the remaining stock materials and sub samples. Samples for storage were kept in labelled compartments on shelves in a storage room. Samples sent to co-operating laboratories were recorded in the Master Register and accompanied by essential data pertaining to the sample material.

ES 5.8 Geological, Hydrology and Geomorphic Characteristics

Geology of the Project Location

The literature survey suggests that the project area in fig. 4.2 is geologically characterized by mainly impermeable basement complex rock formations. Bawden, *et al*. (1973) described the region as being part of the northern plains which is largely characterized by extensive very gently undulating plains sloping gradually from over 600 meters above sea level south and west of Kano and to over 1,000masl north of Jos to less than 300masl towards the Lake

Chad. The river systems in the area provide extensive flood plains that are used for livelihoods.

Pre-Cambrian rock of the basement complex which comprises of gneisses, amphibolite, marbles and the older granites which underlie large parts of Nigeria including the Kano Region (Adamu *et al*, 2014). The Granites are generally Gneissic and commonly developed in a mixture of Pegmatite of schist granite, Gneiss and irregular mass of pegmatite. The Aeolian sand derived from wind deposits cover most part of the area with thickness of about 5 meters in the upland and 10 meters along the lowland plains (Olofin, 1987). The geological structure influences the relief as well as landforms which are relatively flat, with some undulation especially around upstream of the drainage system of the area. The relief of the area has been categorized into four types comprising south and south eastern highlands; the middle and western high plains; the central lowlands and the Chad plain. The highlands occupy more than 50% of the surface area of the region and lies on an elevation ranging between 450 to 650masl. The high plains consist of areas of low relief, usually less than 20masl and areas of grouped hills where the hill may rise higher than 100m above the plains. The plains are developed on rocks of the Basement Complex.

The Hadeja Jamaare Basin is geologically underlain by Basement Complex upstream and the Chad Formation to the middle and downstream. While the upstream part of the basin is characterized by mainly impermeable Basement Complex rocks covered by the permeable quaternary sediments which consist of fine to coarse grained sand, with intercalation of sandy clay, clay and diatomite, the dunes in the middle part of the basin and alluvial deposits along the river systems are superficial deposits lying on the Chad Formation. The river alluvium deposits consist of sands, silts and clays with occasional existence of coarse sands and gravel along younger river channels.

Groundwater Availability and Uses

Groundwater availability varies in the region. Various factors affect its availability. The most recognized and important one is the geological differences. In their study Abubakar et, al (2018) revealed that, the volume of groundwater decreases from the Chad Formation to the Basement Complex region, with Birniwa area in the Chad formation region and Zarewa in the Basement Complex region where this project area lies, having volumes of 9.363.0m^3 and 49.0m^3 of groundwater respectively. Thus, groundwater availability is much higher in the Chad Formation than in the Basement Complex.

The Chad Formation in the Kano region is one of the largest accessible stores of fresh groundwater, and for that groundwater is often considered a logical resource in the region. Conversely, in the Basement Complex region, rapid rising population growth in association with urbanization and climate change have led to intensive exploitation of groundwater through construction of boreholes, principally for domestic water supply. Groundwater in the urban Kano area for instance appears to be a common and low-cost alternative to surface water for many uses because it occurs generally in a more potable quality compared to surface water. However, despite the growing dependency upon groundwater for different uses in the Kano region, concerns remain over the sustainability of this resource principally in terms not only of the rate of abstraction but also in terms of the quality and quantity because the area is underlain by igneous structure.

Results of Soil Analysis

A Summary of the results of soil analyses including physical and chemical properties are presented in table 5.16. The detail result of analysis are attached as **Appendix 5.**

ES 5.9 Groundwater and Surface Water Quality

Groundwater Availability

Ground water is a major source of water in the Challawa sub-basin of the Hadeja Jamare Komadugu Yobe Basin. In some areas, especially in the study area, it is the leading source of water for domestic and other non-domestic uses. It is a basic resource that is for livelihood sustainance. High groundwater use occurs in the eastern part of the Basin by exploitation of the shallow unconfined and deep confined sedimentary aquifers. In the eastern part of the Basin, surface water use is limited due to low rainfall, flat topography and high infiltration rates which limit construction of surface water impoundments. Groundwater recharge in this part of the Basin is enhanced by riverbed and flood infiltration along the river valleys during time of flooding and releases from the Challawa Gorge and Tiga dams). Estimated annual groundwater availability varies from 2,317MCM/yr in 2018 to 1,279MCM/yr in 2019 (SMEC 2017. It is estimated that by 2040, annual sustainable groundwater availability will decrease to 70% of the current estimated volume due to climate change, assuming a decrease in rainfall.

Groundwater occurrences revealed the hydrogeological maps compiled for this study revealed that groundwater is available in three media which are: - Alluvial Aquifer, Soft Overburden Aquifer and Fractured Crystalline Aquifer. The Alluvial Aquifer are found in Rivers e.g. River Kurma, River Takwami, and River Magaga, which are perennial containing water during the dry season. These aquifers are important for small scale irrigation by shadoof system called *Jigo in Hausa* to water crops and vegetable like onions, tomatoes etc. during the dry season.

Soft overburden aquifer consists of saprolite and regolith and is derived from the weathering product of the Basement Complex rocks of elluvial and alluvial origin which makes it heterogeneous. Most of this aquifer are tapped by hand-dug wells and are seasonally bearing water in wet seasons and some at end the of the dry season. . This aquifer covers most parts of the Project area with a minimum depth of 6 m to maximum of 32 m. On the other hand the Fractured Crystalline Aquifer is also perennial and continuous throughout the year and can be tapped by borehole.

Baseline Groundwater Quality

The Physico-chemical analysis results of groundwater collected in the project area during wet and dry seasons are presented in ***Appendix 5.*** The quality of the groundwater samples was compared with WHO drinking water quality index, with most of the parameters recorded to be within WHO drinking water quality index. The water is generally clear and unobjectionable in terms of odour and other physical appearances.

ES 5.10 Land Use

In most parts of Nigeria, land use had been determined by tenurial systems evolved over time and determined by the perceived demand as well as the potential and actual social pressures associated with its supply and use (Powell, 1995; Swallow and Kamara, 2000). Land use in the study area comprises the built environment including residential and nonresidential buildings, industrial buildings, cultural lands such as religious grounds, cemeteries, recreational grounds, roads and paths, market places etc. Other land uses include agricultural lands, forest cover, etc.

The project site and its environ were visited to obtain familiarity with the landscape and surrounding countryside areas. Field studies have included the recording of landscape features, the evaluation of landscape character and quality, and establishment of representative viewpoints. Desk studies have been carried out including a study of the local topography and land use using maps, aerial photographs and photographs taken during field studies and reference to other ESIA reports for projects around the study area (including ESIA (2017) for the Hadejia Jama'are Sub-Basin with Kano River Irrigation Scheme (KRIS) and Hadejia Valley Irrigation Scheme (HVIS), and the ESIA for Transmission Company of Nigeria Project Management Unit (TCN-PMU for the 330/132/33kV Transmission Substation New Kano, Kano State SMEC March, 2017).

The land cover on farms is mainly crops grown by farmers with scattered trees of average to large height and size. The trees are mainly locust bean, tamarind, local mahogany, guava, neem (*darbejia*), and mangoe trees. The uncultivated patches of land around the settlements, there are other species such as Dorawa, Dinya, Kanya (Hausa names for the trees) and many others of economic and medicinal values. The tree density improves and in some cases forms clusters on uncultivated/uncultivable lands especially around the main and figure gully banks.

There are shrubs and grasses that grow freely in several locations within the area. Figure 5.28 and figure 5.29 fairly depict the land use/land cover types in the two pilot sub watersheds of the project area. On both pilot sub-watersheds, the lands are intensively under crop cover especially in the rainy season, while eroded areas are generally uncultivated or uncultivable. There are patches of built up areas of small to medium size settlements on both pilot sub-watersheds.

ES 5.11 Socio-Economic Environment

A socioeconomic assessment of the project area gives an insight into the social, cultural and economic conditions in the project area. A blend of methods including the following, were adopted for data to gathering.

i. Review relevant literature;
ii. Review of existing, reports of Nigeria Demographic and Health Survey ;
iii. Reconnaissance survey to identify the focal communities (Karaye, Rogo, Kiru L.G.As) and the likely adjoining communities that might be directly or indirectly affected by the proposed project;
iv. Focus Group Discussions (FGDs) with stakeholders and project affected peoples (PAPs) in areas closest to the footprint locations of the project.

Settlement Characteristics

The settlements system consists of permanent structures made from grass, wood and sand and, in a few cases, concrete blocks and iron roofs. The main settlements are Karaye, Rogo and Kiru which are LGA headquarters. Several other towns such as Tsara, Turawa and Soho Rogo are fairly big settlements with many other smaller villages such as Unguwan Datti, Dayi and temporary Fulani herdsmen huts scattered around.

The estimated 2016 population of the most affected areas is 888,600 people. The estimated population structure of the people living in the area and in the immediately surrounding hamlets was an average of 30-40 people, mostly constituted of 2 to 3 families per hamlet, with demographic structure of more children and youths compared to adults and with the less males compared to females. The family system is mainly monogamous but it is mostly dictated by economic resources of the man. The average number of births per woman is six and each household has about eight to ten people. The economic activities are mostly farming and commerce. Both men and women participate though with different roles. On the farm, the men mostly do the tedious jobs of cultivation, making of ridges/canals for water reticulation and transportation of harvested crops to markets for sales and to homes for food, while the women participate in planting, weeding and harvesting. In families that have no men, the women do all the tasks.

The 2015 population and average population density for each of the four main sub-basins is given in Table 4.1 of the HKY Basin is about 200 persons/km^2. This indicates that the Basin is the most populated area in the northern region of the country. The Challawa Gorge Dam Sub-basin area which lies within the Kano Close Settled Zone with its high population density is exerting pressure on the water resources of the area. The population of the region is mainly engaged in both rain fed and irrigation farming, in addition to other non-agricultural commercial activities including marketing of agricultural commodity.

ES 5.12 Land Tenure: Land ownership is vested in the state. Farmers hold usufructuary rights, and the rights to a particular piece of land can be passed on by inheritance, sale or rental. The land owned by a particular family is often in fragmented holdings within a varying radius of the village. Islamic inheritance law has resulted in continuous subdivision of existing holdings among family members. The two main customary forms of land tenure are gandu, under which the land right is vested in the family head but the land is worked and its produce shared by all family members, and gayauna, under which the land is worked by the family member who has the right to its use. The gandu is of particular importance as it enables the individual to hold off-farm employment while still enjoying the benefits of agriculture. Land pressures have mounted due to population growth, continual, land accumulation by wealthy individuals, and public requirements (roads, schools, irrigation schemes, etc.)

ES5.13 Crop Production: The bulk of agricultural production comes from manually cultivated rainfed crops. Fadama areas contribute substantially to the farmer's income as they produce most of the cash crops, mainly during the dry season. The most important crops produced in the area where rainfall is higher, maize, cowpeas, guinea corn, groundnuts and sweet potatoes are popular.

Intercropping of two or more crops is very common. About 85% of the farmers reported that mixed cropping or intercropping of two or more crops on the same piece of land is highly beneficial as it permits filling-in of a crop which may not have germinated well, increase the average cropping density on the farm and therefore provides better utilization of available soil and allows adjustment to uncertainty in the event that one crop may fail due to unexpected drought, insect pest attack, and other unforeseen environmental events. Farmers start the season by planting food crops first, usually millet, which may have sorghum or other crops subsequently planted with it. For most (87%) farmers interviewed, there appears to be no evidence of any particular rotational system practiced. Rather, the choice of crops mainly depends on the farmer's particular food needs, market conditions, agro climatic conditions and location of fields in relation to their houses.

Levels of Education

It is evident that the trend of educational development in kano state deliver a sound labour force in the near future. Analysis of educational attainment of the subjects in the region reveals about 46% uneducated persons (Table 5.29 and 5.30). Thus, there is a large size of unskilled labour that possibly relies mainly on agriculture and other unprofessional livelihood activities. This probably partly explains the relatively low cost of labour (less than about #2000/8 work hours) in a day in the area. In fact this scenario is corroborated by Maigari (2012) that the cost of a day man-work (8 hours; 8.00am to 4.00pm) is generally low, ranging from =N=500.00 to =N=2,000.00, while wages and salaries of casual workers ranges from =N=6,000.00 to =N=20,000.00 per month.

Gender

Gender inequality continues to be linked to various traditional practices of many cultural groups in Nigeria. Many cultures promote the belief that, women do not have an identity of their own but those derive from men. The different ethnic groups engage in practices which degrade and discriminate women. In Nigeria, the belief that male issues are more important than female is rampant. Even in issue of education, some families prefer to educate male child at the expense of the female. This is one of the reasons why illiteracy rate is higher among women than men especially rural dwellers in Nigeria. Studies across gender issues in Nigeria disclosed the following factors as major contributors for the prevalence of gender inequality in the basin: Environmental Factors: the environment in Northern region of Nigeria, in general, and HJKYB in particular is not favourable to the development of women due to the problems of desertification and drought and all these are gradually heighted by the impact of climate change. In the North, men and women play different roles in the family.

Economic activities and sources of income

A socioeconomic assessment of the project area gives some insight into the social, cultural and economic conditions in the project area. A blend of formal and informal interviews, FGD and stakeholder engagements methods, which include the following, were used to acquire the socio-economic data.

Kano is the commercial and investment hub of Northern Nigeria and probably the largest non-oil and gas economy in Northern Nigeria. The Economy of Kano state is driven largely by commerce, manufacturing and subsistence agriculture. Predominantly however, the population in Kano State and the project area in particular, is engaged in agriculture either as full time or as a vocation, in addition to other livelihood businesses. The sample survey shows agriculture engages up to 70% of the population directly or indirectly. The informal sector is strong and diverse, with numerous Micro, Small and Medium Scale Industries

(MSMEs) and the informal sector (hawking, show-shining, cobbler, road-side food vending (especially by women), etc. across all economic activities and across all the local government areas, contributing approximately 60 – 70% of output and employment (Public Consultation views).

Economic activities are mostly farming, commerce/trading, informal businesses such as hawking of processed food by young girls and other forms of street food vending by older females including married women within the settlements, shoe shining by young uneducated youths, water vending etc. On the farm, the men mostly do the tedious jobs of cultivation, making of ridges and irrigation canals for water reticulation and transportation of harvested crops to markets for sale and to home for food, while the women participate in planting, weeding and harvesting. In families that have no active men, the women do all the tasks.

Animal husbandry is not very common and stocks are very few averaging 2-10 per family. Bulls are more common because they serve as farming tools and transporting goods and materials. The bulls used for ploughing on farms also serve as means of income where they are used in ploughing for pay/cash. The children, boys only, attend to the animals mostly while the women household domestic duties including fetching firewood, participating in weeding on farm and harvesting and processing crops for food and for sale at the local markets. The commercial activities are mostly smaller trading with some bigger traders selling grains and animals.

ES 5.14 Religion and Believes and Languages Spoken,

Religion: A large number of the Hausa population is Muslim practicing Islam, based off the teachings of the prophet Muhammad and the instructions of the Holy book, Qur'an. It is said that the religion was brought to them by traders from North Africa, Mali, Borneo, and Guinea during their trade exchanges, and they quickly adapted the religion. Muslims pray five times a day, fast during the month of Ramadan and strive to make the pilgrimage to the holy land in Mecca.

Culture and tradition: The Hausa people have unique cultural practices that have stood the test of time regardless of the colonization of the British. This is attributed to the fact that their political and spiritual leaders did not compromise the standards they were well acquainted with; this is why they still maintain their ways of life t in traditions, belief system, values, religion and economy to date.

Household Composition and Size: Typically a household unit in the study area consists of the Household Head (HHH), and members including wife or (wives because the area is

Polygamous), the children and children of relations, sometimes family friends, all dining from the same pot. The house hold type in many cases is the compound type where more than one family or household (HH) share a compound but eating from different pots. On average, a HH is made up of and average of 5 persons. For the Study area an average HH size was (7.5 members) indicating fairly large family sizes, and about 65% (162 respondents) had more than one wife. This includes younger (male) adults aged 30-40 years. Generally only about 4% of the household were headed by aged females, and this mainly arose from widowhood.

ES 5.15 Causes of Morbidity and Deaths

The main causes of death in Nigeria in 2019 were neonatal disorders. More specifically, 12.25 percent of all deaths were reported to have been due to neonatal disorders. Other common causes included malaria, diarrheal diseases, and lower respiratory infects. Figure 5.33 shows the distribution of frequency of morbidity and mortality in Nigeria based on causes. Most causes of deaths and morbidity are preventable.

ES 5.16 Consultations and Stakeholders Engagement and Perception

As a requirement and to be in line with international best practices, consultations were held at different levels and times using a participatory approach in this ESIA process. This is necessary to allow the concerned public/critical stakeholders to be part of the decision-making process towards the project development and operation. The process will also serve to ensure fulfillment of the community's expectations for a sustainable and environmentally friendly project development. Public participation in also deliver some beneficial information to the ESIA process that may enhance project benefits and minimizes any inadvertent but adverse outcomes of the project. Thus to make project development and operation transparent, public consultation is necessary, and continuous throughout the life of the project. Stakeholder consultations on the proposed project activities at the very early stage of decision-making may help to prevent or mitigate unexpected negative outcomes such as conflicts and adverse environmental impacts of the project decisions and to enhance the positive outcomes.

The project proponent, HJKYB-TF, the funding Agency (AfDB), the Federal Ministry of Environment and the Nigerian legal system regard consultation as a requirement for project development especially of the magnitude of a watershed. This is because it is Important to notify the stakeholders about the nature, magnitude, and scheduling of the proposed project, thereby eliminating any fears or apprehension.

Information dissemination and consultations with stakeholders, especially the Project Affected Persons (PAPs) means transfer of information from Project proponents to the affected population. It provides an opportunity for all the communities in the areas to raise issues and concerns pertaining to the project, and allow the identification of alternatives and recommendations.

ES 5.7 Discussion with Stakeholders and Summary of Outcome Conclusion

During the meetings, the general overview of the project was presented to the various stakeholders. In addition, the challenges emanating from the implementation of the project and the support needed from all parties to ensure effective project development and successful implementation were also presented and discussed. A key point mostly pointed out was the fact that the project was designed to benefit the government and the people especially those close to the project site and those downstream of the gorge dam. It was also clarified to the community members the benefits that may accrue to them from the implementation of the project such soil and gully stabilization leading to protection of their farm lands from river bank erosion and other forms of destructions arising from surface run off; introduction of exotic plant species especially the vertiver grass, fruits-bearing economic trees etc. It was also stressed that the proposed watershed management activity may create employment opportunities for the local community during the construction phase and facilitate for them innovative erosion control and management practices to enhance farm productivity and food security. Stakeholders emphasized the need to source for local workforce and labor from qualified personnel within the communities affected should the need arise.

ES 6.0 Mitigation/Enhancement Measures

ES 6.1 Introduction

This chapter identifies and presents the impacts mitigation and enhancement measures arising from the ESIA outlined in the previous chapters. The mitigation measures are guides on what is required to avoid/minimize the likely negative environmental, social and economic undesirable consequences of the project implementation and how to enhance the positive impacts.

The ESIA is an instrument used to identify, predict and assess the likely environmental, climate change and social consequences of a proposed development project in order to ascertain the means through which to avoid, minimize, mitigate, compensate/offset and/or monitor adverse impacts, and increase development benefits. This ESIA therefore assesses the direct, indirect and cumulative impacts of the Challawa Gorge Dam Watershed Management Project in its area of influence; examines project alternatives; and determines the significance of each of the impacts identified. The ESIA identifies ways of improving project selection, design, siting and implementation in order to avoid or mitigate and manage adverse environmental and social impacts that may arise from the project activities.

The broad approach (and methods) adopted for assessing the impacts of the proposed Challawa Gorge Dam Watershed Management project on the physical, biological and social environments is hinged on the Federal Ministry of Environment ESIA Guidelines and the AfDB guidelines contained the AfDB's revised operational safeguards and sustainability series, Volume 1 - Issue 4 (November 2015). Furthermore, the primary information obtained during field data gathering in the project area (including information gathered from members of affected communities and other stakeholders during consultations), secondary information from existing relevant literatures as well as professional experience and judgments of the multidisciplinary ESIA team formed the bedrock upon which the potential impacts were identified and evaluated. In line with the above, impact assessment was carried out in stages as follows:

- Impact Prediction: this entails prediction of changes to the environment that could result from the proposed watershed management project. The prediction of these changes will be based on the identification of potential interactions between the project and the physical, biological and social resources/receptors.
- Impact Characterization: which entails characterizing/forecasting the nature, scale, extent, duration, frequency of the impacts. Characterization will essentially help to determine the magnitude of impacts and degree of change the impact is likely to have on the receptor.
- Impact Evaluation: this entails determination of the significance of impacts based on the magnitude, value, sensitivity/fragility and recoverability of the affected receptors. This requires an in-depth appraisal of the attributes of potential receptors which has been carried out in the baseline studies and presented in Chapter 5 of this report.

The Chapter also presents the approach adopted for the mitigation of identified impacts and outlines the approach for predicting any residual consequences after the application of mitigation measures. The short-term (preconstruction, construction and decommissioning phases) and the long-term (operational phase) were considered. Provision of the assessment methodology used in evaluating impact significance, considering the impact magnitude and sensitivity of receptors and resources affected, is also outlined.

ES 6.2 Impact Assessment Approach and Methods

This section describes the overall approach used for the assessment of impacts. Topic-specific methodologies are described under each section of the impact assessment. The assessment of impacts follows an interactive process involving the following key elements:

- Prediction of potential impacts and their magnitude (i.e., the consequences of the proposed on the natural and social environment);

- Evaluation of the significance of impacts taking into consideration the sensitivity of the environmental resources or human receptors into account;
- Develop mitigation measures to avoid, reduce or manage the impacts or enhancement measures to increase positive impacts; and assess significant residual impacts after applying mitigation and enhancement measures.
- Where significant residual impacts remain, further options for mitigation may be considered and impacts re-assessed until they are as low as reasonably practicable for the Project.

ES 6.3 Overall Impact Significance Ranking

Overall Significance Ranking

The identified environmental and social impacts are evaluated, categorized and scored according to the criteria defined in Tables 6.1; 6.4. Overall consequence of the project is finally determined using the consequence equation and the criteria in table 6.6.

Project Consequence (Overall Impact Significance) = [(A+ B + C + D)] **X** Likelihood (Z) = Significance evaluation score.

Approach to mitigation measures

The approach adopted this report for identifying mitigation measures and their significance are based on the following considerations:

- Environmental laws and regulations in Nigeria, with emphasis on permissible limits for waste streams (FMEnv (formerly FEPA), 1991);
- AfDB's and other relevant international requirements;
- Best available Technology for Sustainable Development;
- Feasibility of application of the proposed mitigation measures in Nigeria;
- View and concerns of stakeholders as expressed during extensive consultations carried out during the study.

The essence of developing mitigation measures is to avoid, reduce, remedy or compensate for any adverse impacts identified, and to create or enhance positive impacts including environmental and social benefits. In this regard therefore, mitigation measures are understood to include operational controls as well as management actions. These measures may include:

- changes to the design of the project during the design process (e.g. changing the development approach);
- engineering controls and other physical measures applied (e.g. substation maintenance facilities);

- Operational plans and procedures (e.g. Occupational Health Safety Plans); and the provision of like-for-like replacement, restoration or compensation.

For any impact that is major significance, a change in design, layout or concept is usually required to avoid or minimize it. Impacts evaluated as moderate in importance, specific mitigation measures such as engineering controls or other alternatives may be needed to reduce the impacts to as low as reasonably possible levels. In this case the approach also takes into consideration the technical and financial feasibility of the mitigation measures. Impacts assessed to be of Minor significance are usually managed through best engineering and technical practices and operational procedures. While negligible impacts may require no mitigation action, nonetheless they are usually included in the project design. Mitigation measures are proposed by focusing on such measures that can prevent or minimize undesirable impacts through the design and management of the project.

ES 6.4 Residual Impact Assessment

Impact prediction considers any mitigation, control and operational management measures that are part of the project design and project plan. A residual impact is predicted to remain once mitigation measures have been designed into the intended activity. The residual effects that may remain after applying the impact mitigation measures have also been discussed for further reduction as possible.

ES 6.5 Cumulative Impacts

Defining Cumulative Impacts

Development of this watershed management project may be happing simultaneously with other developmental activities within and around the Challawa Watershed (project area). When taken together these simultaneous (mutually related or unrelated) projects or programs may generate impacts that will affect the same receptors/resources. Such impacts from all potential outcomes will become cumulative. These impacts are regarded as cumulatively induced from impacts, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted. In general, cumulative Impacts are impacts that act with influences from other projects such that:

- The totality of the impacts is greater than their parts; or
- The sum of the effects attains a threshold level such that the impact becomes significant.

  The cumulative impacts that are considered to be relevant in the case of the CHallawa Gorge Dam Watershed Management include the following:

- **Accumulative**: the overall effect of different types of impacts at the same location. An example would be noise and water pollution effects of the Kano State government's proposed Hydro-electric power generating plant at the Challawa reservoir which has started, impacting the local communities as a nuisance/ disturbance and scaring wildlife from their natural harbitats.
- **Interactive**: where two different types of impacts (which may not singly be important) react with each other to create a new impact (that might be important) (e.g. water abstraction from a watercourse might exacerbate the consequences caused by increased sediment loading).
- **Additive** or **In**-**combination**: where impacts from the primary activity (i.e. the construction and operation of the Project) are added to impacts from third-party activities, e.g. An example would be noise and water pollution effects of the Kano State government's proposed Hydro-electric power generating plant at the Challawa reservoir which has started, impacting the local communities as a nuisance/ disturbance and scaring wildlife from their natural habitats in addition to the already identified effects of the Challawa Gorge Dam Watershed Mangement Project.

ES 6.6 Identification of Relevant Development(s)

The cumulative impact assessment focuses on the combined effects of the Project with potential future development in the immediate area around the Project site. The cumulative assessment impacts the potential project in view, depending on the status of other projects and the level of data available to characterize the magnitude of the impacts.

Given the lack of available information regarding such future developments, this assessment follows a generic pattern. It focuses on critical issues and sensitivities for this project and how these might be influenced by cumulative impacts with a combination of other developments. Consultations with local and state authorities and identification of relevant and significant developments via searches of relevant documents provided invaluable assistant in this assessment. The main developments identified are cumulative impacts from other projects within 2km.

ES 7.0 Environmental and Social Management Plan

An Environmental and Social Management Plan (ESMP) is an important component of an Environmental and Social Impact Assessment (ESIA) as it provides an important tool that can be used to measure and check, in a continuous manner, the efficacy of the mitigation measures and project commitments incorporated in the ESIA to minimize or eliminate identified negative impacts. In addition, the ESMP may also be used to ensure compliance with statutory requirements, and corporate safety & environmental and social management policies.

The key features of an ESMP, drawing from relevant existing guidelines as well as the Nigerian ESMP guidelines, is that it is applicable to a range of types and scales of projects or developments, from projects with a low level of environmental risk to those with high environmental risk; assumes a broad understanding of the term “environment”, that includes the biophysical, social and economic components; includes the enhancement of positive impacts (benefits) as well as the mitigation of negative impacts; and should not be viewed as a prescriptive and inflexible document.

An ESMP is therefore, a tool which ensures continuous assessment of the environmental and social impact of a project operation as well as proactive response to the impacts to reduce their overall effect on the identified environmental parameters. It makes an organization to do the right thing at the right time rather than responding to situations borne out of statutory or legal compulsion. This essential tool is contained in the International Standards Organization (ISO).

In this section, an ESMP is presented to be used throughout the life span of the proposed project in Challawa Gorge Dam, Kano State. This ESMP will facilitate environmental and social management of the proposed project and procedures that are provided to help prevent, avoid or minimize negative environmental impacts that may occur from the project planning phase through construction and operations.

ES 7.1 Objectives of the ESMP

The ESMP is needed to successfully manage the project's environmental and social performance throughout its lifecycle. It integrates social and ecological management with overall project engineering, procurement, construction, and operations. The ESMP is prepared to achieve the following objectives:

ES 7.2 Objectives of Environmental and Social Management Plan (ESMP)

The objectives of ESMP for the proposed project are to:

i. Monitor the project proponent’s compliance with all the mitigation measures and commitments in the ESIA report;
ii. Provide early warning signals on potential environmental changes, so that appropriate actions can be taken to prevent or minimize environmental and social impacts;

iii. Put in place a sound and cost-effective contingency plan that can be activated for prompt response to any unforeseen occurrence;
iv. promote environmental and social control in the project implementation in all phases;
v. Ensure that all relevant stakeholders are well informed about their individual and collective responsibilities;
vi. Incorporate environmental and social management into the project design and implementation processes;
vii. Serve as a proxy action plan for social and ecological management for the project;
viii. Provide a framework for implementing environmental and social commitments (such as mitigation measures identified in the ESIA);
ix. Prepare and maintain project ecological and social performance records for monitoring and evaluating performance monitoring, audits and non-compliance tracking.

The essence of the ESMP is to encourage and achieve the highest environmental and socio-economic performance standards, and routinely monitor project functions and activities.

ES 7.3 The Project Implementation Unit (PIU) will manage the project.

The PIU shall hire and manage contractors; a witness NGO shall be accredited to monitor and evaluate the implementation of the ESMP to a certain extent. The contractors are responsible for the performance of the ESMP. Overall regulatory agencies at the National, State and Local Government levels are accountable for implementing ESMP.

Project Proponent (HJKYB-TF)

The project proponent is the Hadejia Jama'are Komadugu Yobe Basin Trust Fund. Six riparian States established the body in collaboration with Federal Government in Damaturu in 2006. The Trust Fund is an regional platform for a joint intervention with the support of the Federal Government of Nigeria for augmenting line agencies in addressing land and water resources issues in the KYB. An Executive Secretary heads the HJKYB-TF. A PIU has been constituted with a Project Manager who reports to the Executive Secretary.

Project Implementation Unit (PIU))

The PIU set up by the HJKYB-TF-AfDB is saddled with the responsibility of project implementation. A Project Manager heads it. Members of the PIU consist of technical experts and environmental, social, and two liaison officers appointed from the Federal and Kano State Ministries of Water Resources.

PIU is responsible for the overall project planning and execution, including preparing bidding documents, hiring project management consultants, EPC contractors, and supervising the works. This approach includes ensuring proper implementation of the environmental and social management measures contained in the ESMP and monitoring. To provide additional oversight, the project PIU will retain the services of the ESIA Consultant to manage the ESMP implementation. The PIU will also invite relevant NGOs to monitor and ensure the adequate performance of the ESMP.

ES 7.4 The Ministry's HSE Department

The HSE department shall be responsible for ensuring the implementation of management measures during the operation phase (post-commissioning), including audits, compliance monitoring, and preparation of periodic reports required by regulations to the operations.

ES 7.5 Regulatory Agencies and Other Concerned Authorities

The Federal Ministry of Environment (FMEnv) is responsible for implementing the EIA Act 86 of 1992. Furthermore, the proponent and the affected LGA have specific oversight roles, which they perform under the coordination of the FMEnv. Responsibilities for the ESIA and its implementation are shared between multiple stakeholders, including Ministries of Water Resources (Federal and State) competent authorities, the project implementation unit (PIU), the proponent and the contractors.

ES 7.6 The Federal Government of Nigeria

Federal Ministry of Environment

The Federal Ministry of Environment is responsible for the overall environmental policy of the Country. It has the responsibility for ESIA implementation and approval under the EIA Act. It has developed specific guidelines and regulations to protect the environment and promote sustainable development. It will monitor the implementation of mitigation measures when the project commences. And they can issue directives to the project on specific actions related to the environment in the project area. The Ministry involves the States typically and sometimes local governments in this responsibility depending on the particular activity.

ES 7.7 Kano State Ministry of Water Resources and Environment

The Environment department of the ministry manages both human and industrial waste, protects and conserves the environment, and enforces laws on the environment in the State.

ES 7.8 Project Proponent

HJKYB-TF has the overall management for implementing the Challawa Gorge Dam project. However, the body has delegated the daily implementation operations to the PIU.

ES 7.9 Kano State Environmental Protection Agency

The agencies are responsible for preparing and updating periodic master plans for the development of environmental science and technology and advise the government of the financial and material required for the implementation of such programs; to establish a mechanism to predict ecological disasters; identify the problems of drainage and sewage systems and carry out measures to improve, protect and remedy their ecosystems, also protection and development of the environment and also ensuring a healthy environment.

ES 7.8 Kano State Ministry of Transport (KnSMT)

The significant roles of the Ministry are;

*****To formulate and implement effective policies regarding road transportation to ensure that adequate road safety measures are implemented across the State.

*****To coordinate the creation of transportation parks, identification and development of railways and river transportation.

*****To ensure effective and efficient movement of goods and services that will enhance socio-economic growth throughout the States.

ES 7.9 Kano State Ministry of Land Survey Housing and Urban Planning (KNSMLSHUP)

The Ministry is vested with the authority of land administration. They are also charged with the survey of state lands, determination of land use and control, compensations, housing policies and urban development. The Ministry is also responsible for the supervision of the PIU, mapping and surveying, registration of title to lands, development and maintenance of open spaces.

ES 7.10 Local Government Areas (LGAs)

The affected LGAs are involved in the ESIA approval process. According to the national EIA requirement, the LGAs will have representatives in the panel that will review the report and advise the Minister to make decisions on the project.

ES 7.11 The Customary District Councils

The traditional head of Karaye Emirate has an essential role in the project concerning mobilising the community members to support the project, grievance redress, peace and security of personnel, equipment, and facilities to be installed. Close contact and regular consultation shall be maintained with customary chiefs throughout the life of the project.

ES 7.12 Witness NGO

To enhance transparency and trust from PACs, it is suggested that a witness NGO, recognised and credible in the project area, be retained, through a public proposal and selection process, to provide independent advice, and report on ESMP implementation and management, focusing on consultation activities, corporate social responsibilities/related activities and grievances management. This NGO could be a recognised and credible Human Rights advocacy group or an NGO active in rural, environmental, social or development.

This outside look will ensure that proper procedure and stated ESMP processes are followed, that PACs grievances are well taken care of, and that PACs are treated with fairness. This model of supervision is consistent with best practices nationally and internationally. It will ensure that the process is fair and equitable with net positive benefits for the PACs. It also minimises grievances.

ES 7.13 Contractor Environmental Manager

Each contractor shall appoint a qualified environmental manager who, after approval by the PIU, will be responsible for daily management onsite and the respect of management measures from the ESMP. This manager will regularly report to the environment and social expert of the PIU during the entire construction period. Contractors must hold all necessary licenses and permits before the work begins. It will occur to provide to the PIU all of the required legal documents, among which the signed agreements with owners, authorisations for borrow pits and temporary storage sites, etc.

ES 7.14 Communities (Community Liaison Officers)

Leaders and traditional institutions of the affected communities will assist in public sensitisation efforts to advance the implementation of ESMP.

ES 7.15 Operational Control Procedures

Each significant impact identified in the ESIA will have an operational control associated with it that specifies appropriate procedures, work instructions, best management practices, roles, responsibilities, authorities, monitoring, measurement, and record-keeping to avoid or reduce impacts. Operational controls are regularly monitored for compliance and effectiveness through a monitoring and auditing procedure described in the ESMP.

Operational control procedures will be reviewed and, where appropriate, amended to include instructions for planning and minimising impacts or reference relevant documents that address impact avoidance and mitigation.

ES 7.16 Managing Changes to Project Activities

Changes in the Project may occur due to unanticipated situations. Adaptive changes may also occur during the final design, commissioning or even operations. The Challawa gorge dam management will implement a formal procedure to manage changes in the project that will apply to all project activities.

ES 7.17 Grievance Mechanisms

During the implementation of the ESMP, disputes/disagreements between the project developer and the PACs may occur. There are significant challenges associated with grievance redress, especially in projects of this magnitude. A grievance procedure based on community grievance resolution channels and regulatory agencies shall be used.

ES 7.18 Proposed Management Plan

The Environmental and Social mitigation/enhancement measures and the responsibilities for implementation are in Tables 7.2&7.3. The EPC contractor has the responsibility for implementing the mitigation actions during the construction phase. The budget for implementation shall be included in the EPC contract as part of the overall construction cost.

Details of the monitoring plan are presented in the main body of this report and it contains details of responsibilities, parameters to be monitored, monitoring methods and standards/targets, and locations and monitoring frequency. The cost estimates cover costs of analyses of samples (where required), travelling expenses and regulatory costs. The budget for environmental and social monitoring during construction shall be added to the EPC contract budget. The EPC Contractor shall be required to disburse when needed, as may be directed by the Project Manager.

The budget for the monitoring during operations shall be provided by the Ministry's management in its annual budgeting process and administered directly by the appropriate authorities responsible for ensuring mitigation actions are implemented effectively. The Ministry shall adopt these measures and impose contractual conditions during the operation phase of the project. Additional detailed policies and specific plans have been developed to support the implementation. The total estimated cost of implementing the ESMP is one hundred and ninety seven Million, four hundred and Eighty Thousand Naira only (**N197,480,000).**

ES 8.0 Summary and Conclusion

This Environmental and Social Impact Assessment (ESIA) Report was prepared in accordance with the requirements of the Federal Ministry of Environment and the African Development Bank (AfDB). Based on interactions between project activities and the recipient environment, the ESIP/ESMP is well documented in this report.

The proposed Challawa Gorge Dam Watershed Management Project by the HJKYB_TF is justifiable and will have a number of significant positive effects in the short and long term including:

- Reduce Environmental Pollution;
- Minimize global warming and climate change;
- Ensure minimum or no siltation of the Challawa Dam Reservoir which will boost agricultural, commercial, uninterrupted Kano Municipal water supply for domestic and industrial use in the area;
- Stabilize soils and control the menace of gully formation and farm lands destruction around the river banks in the area;
- Contribute to national water resources development and management; and
- Create employment opportunities for the people of the area.

The overall impacts associated with the activities of the proposed project can demonstrably be managed within reasonable and acceptable limits by applying all the recommended mitigation measures.

In addition to the identified mitigation measures, there are a number of other commitments to be followed. These include:

- Undertaking a Best Practicable Environmental Option (BPEO) for the watershed management;
- Define and undertake monitoring for atmospheric emissions, soil loss, sediment influx and social impacts;
- Regular auditing of environmental performance of the project operational elements;
- Carry out further studies to determine the best decommissioning strategy towards the end of the project lifecycle; and

An Environmental and Social Management Plan (ESMP) has also been drawn up to manage residual impacts, ensure compliance with regulatory requirements and the incorporation of environmental controls throughout the project life cycle.

ES 8.1 Recommendation

In view of all that had been documented in this ESIA/ESMP report and the commitment by HJKYB-TF to ensure strict compliance with this ESIA, the Hadeja-Jamaare-Komadugu-Yobe Basin Trust Fund hereby requests the endorsement of the AfDB and the National Regulatory body (FMEnv.) for Approval to enable timely commencement of the proposed project.

CHAPTER ONE:

INTRODUCTION

1.1 Background

This ESIA Report is a consultancy service commissioned by the Hadejia Jama’are Komadugu Yobe Basin Trust Fund (HJKYB-TF) (the Proponent) as part of requirements to implement its 25 year Strategic Action Plan (2019) with specific reference to Challawa Gorge Dam Watershed Management sub-program out of four priority projects identified by the Agency. The Challawa Gorge Dam Watershed Management project is a priority project the development of which may significantly impact both the bio-physical and human environments of the watershed area.

The African Development Bank (AfDB) in its review of an earlier ESIA report for the project classified it as a class A or II project that may have moderate to adverse impacts and therefore requires full ESIA/ESMP studies. This is supported both by the Environmental Impact Assessment Decree No. 86 of 1992 Laws of Federal Republic of Nigeria, and the Revised 2015 AfDB Environmental and Social Management Assessment Guidelines, which stipulates that:

> *“Project that is likely to have detrimental site-specific environmental and/or social impacts that are less adverse than those of Category 1 projects and can be minimized by applying appropriate management and mitigation measures or incorporating internationally recognized design criteria and standards …. require an appropriate level of Environmental and Social Assessment (SESA for program operations or ESIA for investment projects) tailored to the expected environmental and social risk so that an adequate ESMP can be prepared in the case of an investment project or an Environmental and Social Management Framework (ESMF) can be designed and implemented by the borrower in the case of program operations to manage the environmental and social risks of sub-projects in compliance with the Bank’s safeguards.”*

Challawa Gorge Dam was built in the early-90s to supply drinking water to Kano State and supply irrigation water for Kano irrigation project. However, recently, watershed degradation has been a serious problem resulting in erosion and sedimentation problems in Challawa Reservoir, threatening the life of the reservoir and making water treatment very costly because of high turbidity. In addition, erosion in the upland watershed is affecting farmers’ lands and encroaching towards private property. As a result of this, project scope has been defined to address the problem of erosion and gully formation in the watershed, reservoir sedimentation and problems in the Challawa water works treatment plant through watershed management.

1.2 Project Proponent

The proponent of the project is the Hadeja, Jama'are komadudugu, Yobe Basin Trust Fund (HJKYB-TF). The ESIA/ESMP report presents findings and assessment of the assignment in line with the terms of reference with a work breakdown, and schedule for mobilization, strategy, methodology, quality assurance plan and timetable for the services execution of the consultancy. In addition, the report addresses the Safeguard instruments being prepared, the tasks to be met, the African Development Bank's (AfDB's) requirements, the timeline of the activities and the deliverables.

Table 1.1: Contact Details of the Proponent

Project Proponent	Hadejia Jama'are Komadugu Yobe Basin - Trust Fund (HJKYB –TF)
Address	Potiskum Road, P.O. Box 479, Damaturu, Yobe State
Contact Person	Prof. Hassan Bdliya, Executive Secretary
Contact Email	kybtrustfund@yahoo.com

1.3 Purpose of ESIA Report

The purpose of the ESIA is to assess the potential biophysical and social impacts of the proposed project, which includes a detailed Environmental and Social Management Plan (ESMP). The ESIA will establish modalities of implementing the ESMP under Nigeria Environmental policies and laws and the AfDB ISS.

1.4 Objective of the Environmental and Social Impact Assessment

The objective of the assignment is to prepare the Environmental and Social Impact Assessment (ESIA) and Environmental and Social Management Plan (ESMP) in line with the AfDB's Integrated Safeguards Systems policies and adhering to country environmental standards and approved mechanisms for permit issuance. The Consultant is required to undertake an Environmental and Social Impact Assessment (ESIA) and propose an Environmental and Social Management Plan (ESMP) from the generated baseline data. The land acquisition, resettlement, compensation and valuation of land required or affected by the development shall be fully determined by the Consultant including stakeholder consultations and disclosure requirements consistent with the applicable environmental laws and regulations.

For solution to the Challawa Gorge Dam watershed management problem, two main and twelve finger gullies were identified for remediation in two pilot sub watersheds during the preparation of the project plan (SMEC 2019). For the two sub-watersheds namely PSW_1 and PSW_2, structural measures are to be provided inside the gullies and bio-remediation and agricultural measures to be provided on eroded gully banks and on adjacent farm lands respectively. Gabion check dams and sediment traps are the main structural measures to be constructed; the unstable section of the gullies was designed to be provided with check dams to stabilize flow and promote sediment deposition upstream of the check dams. The Check dams are designed for 10-year return period design floods and their stability is checked for a 25-year return period. Generally, about 50 Gabion check dams differing in size are to be provided in both Pilot sub watersheds (i.e. PSW_1 and PSW_2). Gullies with relatively stable slopes are to be provided with embankment filled sediment traps at their outlet locations. Theses sediment traps will serve to trap sediments which come from agricultural land until the agricultural and bio remediation erosion control measures fully develop and reduce sediment. Provision is made for four sediment traps at the outlets of finger gullies in the two pilot sub watersheds. Each sediment trap is equipped with a rock riprap overflow spillway and concrete pipe dewatering orifice. The spillway is designed to pass the 25-year return period design flood while the orifice is designed to empty the 10-year design flood volume in 24 hours.

Furthermore, on eroded banks of gullies and on the adjacent agricultural lands, bio-remediation and agricultural erosion control measures shall be provided. Gully banks and steep agricultural lands are proposed to be protected with provision of bio engineering (bio-remediation) and agricultural erosion control measures respectively. The main bio engineering measures proposed is planting of vetiver grass. Vetiver grass was proposed on eroded gully banks by trimming and grading steep gully banks prior to planting, while the agricultural measures focus on controlling soil loss from agricultural lands by implementing agricultural practices such as contouring, strip cropping and conservation tillage involving the community and in close consultation with farmers. The other source of sediment for Challawa Gorge Dam Reservoir is from the surrounding adjacent agricultural area and from stream bank erosion in the upland watershed as non-point sources. These non-point sources are treated by providing vegetated buffer zones.

The ESIA study for this project is carried out in a way that meets the ESAP of the AfDB, the Nigerian ESIA standards and International best practices. The ESIA analyzes the environmental and social aspects including land acquisition and resettlement sensitivities in the project area and, through the consideration of alternate project designs, to develop project proposals that avoid or minimize potential adverse environmental and socioeconomic impacts arising from the implementation of the project. The study therefore will present:

- An ESIA study report including drafting a livelihoods restoration plan for the affected subjects. Issues to be addressed include but not be limited to: Soil erosion and sedimentation in the catchment areas where the project sites are located; Flooding and

Water-logging issues; Health diseases issues; Fertilizer and pesticide applications; Effects on quality of water in downstream receptors; Involuntary displacement and re-settlement of affected population; Soil quality, ground water, biodiversity, waste inventory and management, hydrobiology and aquatic resources as well as COVID-19, HIV/AIDS, Malaria, Typhoid and etc. awareness; and other socioeconomic conditions especially gender issues.

- An Environmental and Social Management Plan (ESMP) to mitigate the negative impacts including resettlement of affected farmers based on the following points;
    - l) Critical review and analysis all available data and information relating to environmental conditions and sensitivities in and around the proposed Watershed Management intervention areas.
    - m) Carry out complementary environmental investigations through visits and discussions at environmental protection agencies and organizations and at projected development sites.
    - n) Prepare environmental questionnaires aimed at complementing and confirming the available and obtained data and information at the level of farmers and rural community residents, to be applied during the farmer and stakeholder surveys.
    - o) Execute the environmental components of the farmer and stakeholder surveys, and assembly, processing and documentation of results for use in detail assessments and in the separate subsequent environmental impact assessments.
    - p) Prepare watershed specific characterization of existing or potential environmental issues, to serve as a basis and guideline for addressing these as warranted in the preliminary project designs and feasibility assessments.
    - q) Investigate relevant environmental studies in the proposed project area and review critically to incorporate major issues appreciable
    - r) Assess all base line conditions prevailing in and around the project areas and description of pertinent regulations and standards governing environmental quality, health & safety, protection of sensitive areas, protection of endangered species, land uses control, etc.
    - s) Assess the characteristics of the pilot watersheds such as land use/land cover, topography, soils, crop and conservation factors, climatic factors, etc. to study the extent of soil erosion or land degradation.
    - t) Assessment of possible pollution of drainage water from agro-chemicals and the possible effect of reduced base flows on increasing concentrations, and determine the dilution capacity of the receiving water body.

u) Assess the impacts on flora and fauna of the project area; and assessment of the risks of proliferation of aquatic weeds, crop pests and diseases; and evaluation of any other adverse effects of those not mentioned above, on biophysical and socioeconomic environment of the project area.

v) Investigate and describe alternative environmental considerations to major activities of the proposed project including design, technology, construction techniques, operation and maintenance procedures, etc.

1.5 Scope of the ESIA/ESMP Study

The aim of the Environmental and Social Impact Assessment (ESIA) is to assess the potential environmental impacts (positive and negative) of the proposed Challawa Gorge Dam Watershed (CGDWM) project and related activities, and to propose an Environmental and Social Management Plan (ESMP) to mitigate the short and long term environmental, Social and Economic challenges arising from the project implementation. The core objective of undertaking the ESIA/ESMP study is to assist HJKYB-TF in its effort to obtain environmental clearance from the Federal Ministry of Environment (FMEnv.) and thus to secure the AfDB's commitment to finance the execution of the Watershed Management Project.

1.6 Justification for the Project

There are three main problems associated with Challawa Gorge Dam Watershed that started from watershed erosion and gully formation in the upland watershed, sediment deposition and siltation of the reservoir and sedimentation problems associated with Challawa Water Works treatment plant. These three problems are mainly due to watershed degradation in the upper reaches of the Challawa Gorge Dam Watershed. To fix these problems and extend the longevity of the reservoir to realize its purpose is the main justification for the project**.**

The main objective of the Challawa Watershed Management project is to extend the longevity of the reservoir by reducing the sediment flux into the reservoir through integrated watershed management. This will help to significantly reduce the siltation problem in the Challawa reservoir and also contribute for the soil conservation within the watershed. It will also address the problem of sedimentation at the Challawa Water Works treatment plant.

1.7 Summary of the Key Activities Undertaken in Line with the EIA Procedures in Nigeria

An outline of the regulatory requirements carried/to be carried out within the context of Nigerian Regulatory framework are summarized in Table 1.2 below.

Table 1.2: The ESIA Process in Nigeria

ESIA Step	Description	Status	Remark
ESIA registration	This step initiates the ESIA process providing draft terms of reference, a letter of Introduction from the client and a covering letter.	This step has been satisfied.	See Annexure 1.1
Authority Visit	This step provides the regulatory authorities (FMEnv, affected state and LGAs Environment Ministries and Departments, respectively) the opportunity to appraise the proposed project.	This step has been satisfied.	See Annexure 1.2
Scoping	The ESIA report was mooted as an alternative to Scoping exercise. Hence sampling was permitted. On further considerations by FMEnv, a Scoping exercise was approved. Subsequently, a Scoping workshop was conducted after the field sampling exercise.	This step has been satisfied.	See Annexure 1.3
Project Categorization	Steps 2 and the Scoping Report document provides the regulatory Ministry with the project overview, environmental settings, and stakeholder concerns/perception to be factored into the categorization process.	Official Terms of Reference was issued.	See Annexure 1.4
Data Gathering Exercise	Data gathering exercise was conducted with active involvements of FMEnv, State, LGAs and the Ministry's officials.	This was conducted from June 6 to 9th 2021	See Annexure 1.6
Submission of Draft ESIA report	FMEnv Specified copies of the draft ESIA report shall be submitted	TBD	In Progress
Public Disclosure	This step provides an avenue for the ESIA findings to be available to the wider public over a 21-working day.	TBD	Not Yet
Panel Review	This step subjects the ESIA report to experts' evaluation, assessment and evaluation of stakeholders' observations.	TBD	Not Yet
Submission of Final ESIA report	On receipt of comments from FMEnv and incorporation, a final report is developed and submitted to FMEnv within a specified time frame.	TBD	Not Yet
Issuance of Approval or	This conveys the approval to the client	TBD	Not Applicable

disapproval Certificate			

1.8 ESIA Report Structure

The structure of this ESIA report is presented below.

- Executive Summary briefly highlights the main issues considered and reported in the main ESIA/ESMP Report.
- Chapter 1. Introduction Provides a background to the proposed Project and the ESIA and provides information about the Proponent.
- Chapter 2. Policy, Legal and Administrative Framework. The Legal and Regulatory Frameworks within which the ESIA was undertaken were also stated while other environmental legislation, standards and guidelines applicable to the Project were listed.
- Chapter 3. Description of project and justification. It presents the project justification, the need/value and its envisaged sustainability as well as the project development and site/route options considered
- Chapter 4. Baseline conditions of the project environment. The chapter defines the areas of direct and indirect influence of the Project. It describes the biophysical and socioeconomic baseline of the Project's areas of influence and presents the public participation process in the ESIA.
- Chapter 5. Associated and social impact assessment. The chapter the approach and methodology for the impacts assessment process. It identifies and assesses potential Project impacts (biophysical and socioeconomic impacts).
- Chapter 6: Mitigation Measures. This chapter defines relevant mitigation measures to avoid, reduce, compensate or enhance Project impacts (as applicable).
- Chapter 7. Environmental and Social Management Plan (ESMP). It presents the Project ESMP, organizing all mitigation, management and monitoring requirements and management programs.
- Appendices. This section provides support information referenced throughout the ESIA.

CHAPTER TWO

POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

2.1 National (Country) Laws and Legislations:

- ***The Nigerian constitution***: As the national legal order, recognizes the importance of improving and protecting the environment and makes provision for it. Section 20 of the constitution makes it an objective of the Nigerian State "*to improve and protect the air, land, water, forest and wildlife"* of Nigeria. Nigeria has policy and programme instruments founded on its international, sub-regional and national commitments in the area of environmental protection, Land and water resources administration and management.

- ***The National Environment Standards and Regulation Enforcement Agency Act, 2007:*** Administered by the Ministry of Environment, the National Environment Standards and Regulation Enforcement Agency (NESREA) Act of 2007 replaced the Federal Environmental Protection Agency (FEPA) Act of 1999. It is the embodiment of laws and regulations focused on the protection and sustainable development of the environment and its natural resources. Various Legal and Legislative Instruments that are reflected in the laws that require the conduct of an ESIA to ensure that a project complies with existing environmental standards include the Environmental Impact Assessment Act, LFN, 2004; River Basin Development Authorities Act, LFN, 2004; Water Resources Act, LFN, 2004; the National Water Resources Management Policy, 2007; the Nigerian Land Use Act CAP 202 LFN 2004 and the National Resource Conservation Action Plan, 1992 among several other National, State and Local Governments Regulations.

- ***Federal Environmental Protection Agency (FEPA) Act, 1988 (Decree Nº 58) and amendment Decree Nº 59 of 1992:*** By this Decree, FEPA was strengthened and transferred to the Presidency and expanded its mandate to include the conservation of biodiversity and sustainable use of Niger preparation of a comprehensive national policy for the protection of the environment and conservation of natural resources, including procedure for environmental impact assessment.

- ***The Environmental Impact Assessment Decree No. 86 of 1992, Laws of the Federation of Nigeria:*** The law defines the fundamental principles of environmental protection. The Environmental Impact Assessment (EIA) Act Cap E12, LFN2004 which lays down the operating rules for environmental protection procedure, is one of the implementing instruments of that law which governs the whole Environmental and

Social Impact Assessment (ESIA) process. Decree 86 empowers FEPA and its custodian, to ensure that all major developments including the utilization of water resources are undertaken in a manner that does not result in unacceptable environmental impacts. In essence, the decree requires every major development projects undergoes a FEPA approved EIA process prior to its implementation. It also empowers FEPA to shut down all offending projects and prosecute the operators.

- ***The National Water Resources Law:*** *The National Water Resources Act, CAP W2, LFN 2004* on the other hand is targeted at developing and improving the quantity and quality of water resources. It vests the right to use and control all surface waters and groundwater and of all water in any watercourse affecting more than one state in the Federal Government. This act is the highest existing legislation governing water resources management in Nigeria. It confers on the Federal Ministry of Water Resources (FMWR) the responsibility for controlling the use of trans-state surface and groundwater resources throughout Nigeria. The Act represents the contemporary approach on water resources development, conservation, allocation and use that aims to optimize and sustain social, economic and environmental needs based on the IWRM approach. The importance of eradicating poverty, improving public health, and enhancing energy and food security and ensuring intergeneration of water security in the face of impending water crisis remains the central water resources development agenda of the Federal Government. The implementation of the Water Act is underpinned by the 2011 Water Sector Roadmap with specific targets for 2025 aligned with the African Water Vision including 100% coverage for water supply and sanitation, achieving the development of 95% of the hydropower potential and extension of irrigation to cover about 3.0 million ha.

- ***The National Water Resources Bill 2017:*** The National Water Resources Bill defines the powers and functions of water management institutions, the approach to water resource management and strategy development and definition of the mechanisms and procedures for implementation as well as promoting good governance in the water sector. Once enacted, the National Water Resources Act will replace Water Resources Decree 101 of 1993 and repeal and modify other related laws as defined in Part XIV of the draft National Water Bill. From the federal standpoint there are three pieces of legislations that form the core of water laws and the basis of water law administration throughout Nigeria. The relevant laws are: River basin Development Authority Act, 1976 (1990), Water Resources Act, 1993, and the Environmental Impact Assessment Act, 1992. These laws form the normative core whilst relevant rules and provisions can be found in a variety of sources including constitutional law, land law, and mining law. The Water Resources Act, 1993 vests ownership of all water courses affecting more than one state of the federation, as well as all underground water throughout the federation in the federal government of Nigeria. By virtue of this law, the waters of all Nigeria's trans-boundary rivers and lakes belong to the federal government. However, the three levels of government, Federal, State and Local, share responsibility for water Resources and environmental management in Nigeria.

- ***The National Resource Conservation Action Plan,(NRCAP) 1992:*** The NRCAP, 1992 was concerned to set out objectives for living resources conservation through, maintaining genetic diversity in order to ensure permanence in the supply of materials to satisfy basic human needs and thus improve the well-being of society; promoting the scientific value of natural ecosystems, the study of which is required to enhance conservation itself, to improve the management of man-made systems, and to provide clues to technical innovations in agriculture, medicine and industry; regulating environmental balance in such factors as carbon dioxide and radiation levels and the bio geo-chemical cycles; maintaining ecological services through the protection of catchment's areas in order to enhance water resources and check soil erosion and flooding, protection of grazing lands against desert encroachment and the stabilization of coastal zones and; Enhancing the amenities values of natural resources, including aesthetic, heritage, religious, sentimental, ethical and recreational values on which tourism may be built.

- ***The River Basin Development Authorities (RBDAs)Decree 1976:*** The RDBAs came into existence following the promulgation of Decree 25 of 1976. They were conceived as vehicles for attaining a pan Nigerian Programme of water resources development. The current law on RBDAs is the RBDA Act cap 396 Laws of the Federation of Nigeria, 1990. This statute spells out diverse functions and objectives for these Authorities from which it may be inferred that their existence nationwide propels their acceptance as an appropriate unit for water management. Section 4(1)(a)-(d) of the RBDA Act vest the Authorities with the legal powers to undertake comprehensive development of both surface and underground water, to construct and maintain dams irrigation and drainage system, to supply water to all users, and to construct and maintain infrastructural services including roads and bridges across project sites.

- **The National Inland Water Act (NIWA ACT CAP N47 LFN 2004):** The law establishing NIWA gave it the statutory roles to: Provide regulations for Inland water navigation; Ensure development of infrastructural facilities for a national inland

- waterways connectivity with economic centers using the River Ports and nodal points for inter-nodal exchanges; Ensure the development of indigenous technical and managerial skills to meet the challenges of modern inland waterways transportation; Undertake capital and maintenance dredging; Undertake hydrological and hydrographic surveys; design ferry routes; survey, remove, and receive derelicts, wrecks and other obstructions from in land waterways; operate ferry services within the inland waterways system; Undertake installation and maintenance of lights, buoys and all navigational aids along water channels and banks; Issue and control licenses for inland navigation, piers, jellies, dockyards; Examine and survey inland water crafts and shipyard operators; grant permit and licenses for sand dredging, pipeline construction, dredging of slots and crossing of waterways by utility lines, water intake, rock blasting and removal; Grant licenses to private inland waterway operators; Approve designs and construction of inland river crafts; approve and control all (i) jetties, dockyards, piers within the inland waterways; ii. advertising within the right-of-way of the waterways; (iii) reclaim land within the right-of-way; (iv) undertake the construction, administration and maintenance of inland river-ports and jetties; (v) Provide hydraulic structures for river and dams, bed and bank stabilisation, barrages, groins; Collect river lolls; (vi) Undertake the production, publication and broadcasting of navigational publications, bulletins and notices, hydrological year hooks, river charts and river maps; (vii) Carry out consultancy and contractual services; (viii) Represent the Government of Nigeria at national and international commissions that deal with navigation and inland water transportation; (ix) Subject to the provisions of the Environmental Impact Assessment Act, carry out environmental impact assessment of navigation and other dredging activities within the inland water and its right-of-ways; (x) Undertake erection and maintenance of gauges, kilometer boards, horizontal and vertical control marks; (xi) Advise government on all border mailers that relate to the inland waters; (xii) Undertake acquisition, leasing and hiring of properties; (xiii) Run cruise boats; (xvi) Carry out boat repairs, and (xv) boat construction and dockyard services; and clear water hyacinth and other aquatic weeds.

- **National Water Resources Institute (NWRI) Act, 1990:** The NWRI enabling law is the NWRI Act, Cap 284 LFN 1990. Section 2, thereof, spells out the Functions of the institute in both general and specific terms. It is empowered to perform Engineering research function related to such major water resources projects as may be required for flood control, river regulation, reclamation, drainage, irrigation, domestic and industrial water supply, sewage and sewage treatment. The institute is further charged with the performance of other functions related to planning of water resources management and river basin development.

- ***The Nigerian Land Use Policy:*** The Land Use Act CAP 202 LFN 1990 sets the legal basis for land acquisition and resettlement in Nigeria. It vests land in the Governor of each State, and provides that it shall be held in trust for the use and common benefit of all people. The administration of land is divided into urban and rural land. The urban land is directly under the control and management of the Governor of each State who would hold such Land in trust for the people and would henceforth be responsible for allocation of land in all urban areas to individuals resident in the State and to organizations for residential, agriculture, commercial and other purposes; and non-urban land, which will be under the control and management of the Local Governments.

- ***National Environmental Standards & Regulations Enforcement Agency (NESREA) Act, 2007****:* This is an agency under the Federal Ministry of Environment. It was established by Act 25 of 2007. The agency is charged with enforcing regulatory standards relating to the environment.

Table 2.1: NESREA Environmental Protection Regulations Relevant to Project

Regulation	Description
National Environmental (Wetlands, Riverbanks and Lake Shores) Regulations (No 29 of 2009 Section 1 No 26)	Provides for the conservation and managed use of wetlands and their resources in Nigeria. It ensures the sustainable use of wetlands for ecological and tourism purposes and protects wetland habitats for associated species of fauna and flora.
National Environmental (Watershed, Mountainous, Hilly and Catchments Areas) Regulations (No 27 of 2009 Section 1 No 27)	Make provisions for the protection of water catchment areas.
National Environmental (Sanitation and Wastes Control) Regulations, 2009. S. I. No. 28)	The purpose of this Regulation is to provide the legal framework for the adoption of sustainable and environmentally friendly practices in environmental sanitation and waste management to minimize pollution.
National Environmental (Permitting and Licensing System) Regulations, 2009. S. I. No. 29	The provisions of this Regulation enable consistent application of environmental laws, regulations and standards in all sectors of the economy and geographical region.
National Environmental (Access to Generic	The overall purpose of this Regulation is to

Resources and Benefit Sharing) Regulations, 2009. S. I. No. 30	regulate the access to and use of generic resources to ensure the regeneration and sustainability of threatened species.
National Environmental (Ozone Layer Protection) Regulation, 2009. S. I. No. 32.	This provision seeks to prohibit the import, manufacture, sale and use of ozone-depleting substances.
National Environmental (Noise Standards and Control) Regulations, 2009. S. I. No. 35	The main objective of the provisions of this Regulation is to ensure the tranquillity of the human environment or surrounding and their psychological well-being by regulating noise levels.
National Environmental (Soil Erosion and Flood Control) Regulations, 2010. S. I. No. 12	The overall objective of these Regulations is to check all earth-disturbing activities, practices or developments for non-agricultural, commercial, industrial and residential purposes.
National Environmental (Control of Bush/Forest Fire and Open Burning) Regulations, 2010. S. I. No. 15.	The principal thrust of these Regulations is to prevent and minimize the destruction of the ecosystem through fire outbreak and burning of any material that may affect the health of the ecosystem through the emission of hazardous air pollutants.
National Environmental (Protection of Endangered Species in International Trade) Regulations, 2010. S. I. No. 16	The major objective of this Regulation is to protect species of endangered wildlife from extinction through the prohibition of trade, importation, etc.
National Environmental (Construction Sector) Regulations, 2010. S. I. No. 19.	The purpose of these Regulations is to prevent and minimize pollution from Construction, Decommissioning and Demolition Activities to the Nigerian Environment.
National Environmental (Control of Vehicular Emissions from Petrol and Diesel Engines) Regulations, 2010. S. I. No. 20	The purpose of these regulations is to restore, preserve and improve the quality of air. The standards contained herein provide for the protection of the air from pollutants from vehicular emission.
National Environmental (Non-Metallic Minerals Manufacturing Industries Sector) Regulations, 2010. S. I. No. 21	The principal thrust of this Regulation is to prevent and minimize pollution from all operations and ancillary activities of the Non-metallic Minerals manufacturing sector.
National Environmental (Surface and Groundwater Quality Control) Regulations, 2010. S. I. No. 22	The purpose of this Regulation is to restore, enhance and preserve the physical, chemical, and biological integrity of the nation's

	surface/ground waters, and to maintain existing water uses

Source: Accessed from www.nesrea.com on 14th July 2021

2.2 The African Development Bank (AfDB) Requirements and Guiding Principle

The guiding principles for the conduct of the ESIA, ESMP and RAP shall include the use of African Development Bank Guidelines and Federal Ministry of Environment legislations. Safeguard instrument for this project shall be prepared pursuant to the requirements of the African Development Bank (AfDB) Integrated Safeguards System (ISS) 2013, and the AfDB Revised Environmental and Social Assessment Procedure (ESAP) 2015, which are the cornerstone of its strategy to promote growth that is socially inclusive and environmentally sustainable. The Banks's Integrated Safeguards System (ISS) has a set of operational safeguards (OS) applicable to the proposed project. These include policies on conduct of Environmental and Social Impact Assessment (OS1), Involuntary Resettlement, Land acquisition, Population displacement, and compensation (OS2), Biodiversity and Ecosystems Services (OS3), Pollution Prevention and Control, Green House Gases, Hazardous Materials and Resources Efficiency (OS4), and Labour Conditions, Health and Safety (OS5) (table 2.1). The AfDB Revised Environmental and Social Assessment Procedure (ESAP) spells out guidelines for Projects Environmental and Social Impact Studies and reporting.

2.2.1 The Integrated Safeguards System (ISS)

The Environmental and Social Safeguards (ESS) of the AfDB form the fulcrum of the Bank's support for inclusive economic growth and environmental sustainability in Africa. The AfDB applies the Integrated Safeguards System (ISS) for all projects. The ISS is designed to promote project outcomes by protecting the environment and people from potentially adverse impacts of projects. The ISS provides that all the projects funded or supported by the AfDB must comply with the ISS requirements during projects preparation and implementation. The aim of the safeguards includes:

- Avoidance of adverse impacts of projects on the environment and affected people while maximising potential development benefits to the extent possible;
- Minimise, mitigate, and compensate for adverse impacts on the environment and affected people when avoidance is not possible; and
- Help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage E&S risks.

The ISS consists of four interrelated components, as summarised in table 2.2.

Table 2.2: Structure of the AfDB ISS

Integrated Safeguard Policy Statement	→	Declaration of Commitment to environmental- and Social Sustainability.
Operational Safeguards	→	Short and focused Policy Statements that follow bank commitments and established operational Parameters.
ESAP Revised Procedures	→	Procedural and Process guidance (documentation, analysis, review and reporting) at each stage of project cycle.
Guidance Notes Revised IESA Guidelines	→	Detailed methodological, sectoral and thematic) guidance on Integrated Environmental and Social Impact Assessment.

2.2.2 The Integrated Safeguards Policy Statement

The Policy Statement describes the common objectives of the Bank's safeguards and lays out policy principles. It is designed to be applied to current and future lending modalities. It considers the various capacities and needs of regional member countries in both the public and private sectors. The Integrated Safeguards comprises of Policy Statement that sets out the basic tenets that guide and underpin the Bank's approach to environmental safeguards. The Bank's Integrated Safeguards Policy Statement sets out the Bank's commitments to and responsibilities for delivering the ISS in order to:

vii. ensure systematic assessment of Environmental and Social impacts and risks;

viii. apply the Operational Safeguards (OS) to the entire portfolio of Bank operations;

ix. support clients and countries with technical guidance and practical support in meeting the requirements;

x. implement an adaptive and proportionate approach to Environmental and Social management measures to be agreed with clients as a condition of project financing;

xi. ensure that clients engage in meaningful consultations with affected groups; and to

xii. Respect and promote the protection of vulnerable groups in a manner appropriate to the African context.

2.2.3 The Operational Safeguards (OSs)

The Oss consists of a set of five Operational Safeguards requirements that Bank clients are expected to meet when addressing social and environmental impacts and risks. Bank staff uses due diligence, review, and supervision to ensure that clients comply with these requirements during project preparation and implementation. The OSs is designed to:

- Better integrate considerations of E&S impacts into Bank operations to promote sustainability and long-term development in Africa;
- Prevent projects from adversely affecting the environment and local communities or, where prevention is not possible, minimise, mitigate and compensate for adverse effects and maximise development benefits;
- Systematically consider the impact of climate change on the sustainability of investment projects and the contribution of projects to global greenhouse gas emissions;
- Delineate the roles and responsibilities of the Bank and its borrowers or clients in implementing projects, achieving sustainable outcomes, and promoting local participation; and
- Assist regional member countries and borrowers/clients in strengthening their own safeguards systems and their capacity to manage E&S risks.

Table 2.3: AfDB Operational Safeguards OS1-5

Operational Safeguard	**Description**
OS 1: *Environmental and social assessment*	This overarching safeguard governs the process of determining a project's environmental and social category and the resulting social and ecological assessment requirements.
OS 2: *Involuntary Resettlement: Land Acquisition, Population Displacement and Compensation*	This safeguard consolidates the policy commitments, and requirements set out in the Bank's policy on involuntary resettlement and incorporate a few refinements designed to improve the operational effectiveness of those requirements.
OS 3: *Biodiversity and Ecosystem Services*	This safeguard aims to conserve biological diversity and promote the sustainable use of natural resources. It also translates the commitments in the Bank's policy on integrated water resources management into operational requirements.
OS 4: *Pollution Prevention and Control, Greenhouse Gases, Hazardous Materials and Resource Efficiency*	This safeguard covers the range of critical impacts of pollution, waste, and hazardous materials for which they are aligned to international conventions, as well as comprehensive industry-specific and regional standards, including greenhouse gas accounting, that other multilateral development banks follow.
OS 5: *Labour Conditions, Health and Safety*	This safeguard establishes the Bank's requirements for its borrowers or clients concerning workers' conditions, rights and protection from abuse or exploitation. It also ensures greater harmonisation with most other multilateral development banks.

2.2.4 Environmental and Social Assessment Procedures (ESAPs)

The Bank's ESAPs details the specific procedures that the Bank and its borrowers or clients should follow to ensure that Bank operations meet the operational safeguards (OSs) requirements at each stage of the Bank's project cycle.

Its adoption and implementation enhance the E&S performance of the Bank's operations and improve project outcomes. The ESAPs will help to improve decision-making and project results by ensuring that Bank-financed procedures conform to the requirements laid out in the operational safeguards (OS) and are thus sustainable. The ESAP describes how the Bank and its borrowers should work together to ensure that environmental, climate change and social considerations are integrated into the project cycle from country programming to post-completion. It represents a coordination mechanism between the Bank, relevant government agencies, and private sector entities. It plays an essential role in building the project's executing Agency's environmental, social and climate change management capacity. The Environmental and Social Assessment procedures apply during the entire project cycle, with differentiated tasks performed, roles and responsibilities for the Bank and its borrowers and clients.

Also, the Bank has an integrated system to ensure its E & S requirements are incorporated effectively into the whole programme cycle, i.e., Integrated Safeguards Tracking System (ISTS). The ISTS constitutes an integral part of the ESAP. Table 2.4 is a summary of the vital requirements of the ESAP during each project stage.

Table 2.4: Brief on the AfDBs Project Cycle and E&S Requirements

AfDB Project Cycle	Details
Country Programming Phase	• During **country programming**, the critical task is to develop and update baseline data on RMCs' E&S components, policies, programs, and capacities to better integrate E&S dimensions into lending priorities. • These are the responsibilities of the Bank's Sector Departments and Regional Departments.
Project Identification Phase	• At the **project identification phase**, the **screening exercise** focuses on the E&S dimensions of a **project to categorise it in one out of four categories** based on the potential adverse E&S impacts of the project. • The Bank and FMENnv will conduct these tasks in collaboration with the client.
Project Preparation Phase	• During **project preparation**, the **scoping exercise** helps define the Environmental and Social Assessments (ESA) scope to be completed by the Borrower based on the project category, with staff assistance

AfDB Project Cycle	Details
	from the operational departments. • The preparation of these assessments, including the development of management plans and systems, requires consultations with primary and secondary stakeholders. • Once ESAs are finalised, the review process allows operational departments to ensure that Bank's vision, policies, and guidelines were adequately considered in project design and implementation. • The clients/borrower will prepare the required studies and plans, while the Bank will review and validate them.

Project Appraisal Phase	• During the **appraisal phase**, **ESIA Summaries** shall be reviewed and cleared by the Safeguards and Compliance Department.
	• The procedures require the public disclosure of summaries under specified deadlines.
	  o All Category one (1) operations shall be disclosed for 120 days before Board deliberations.
	  o All category two operations shall be disclosed for 30 days before Board deliberations.
	• The Bank will conduct site visits and verification activities concerning the borrowers' studies, plans, and systems.

Project Implementation Phase	• At the **project implementation phase**, the Borrowers shall ensure the implementation of E&S management plans developed to address adverse impacts while monitoring the project impacts and results. • The Bank's operational staff shall supervise the Borrowers' work and verify compliance through **supervision missions, and E&S audits** whenever necessary. • Audits are undertaken during the completion phase, and post evaluations shall also aim to assess the E&S sustainability of the results.

2.3 State Laws and Legislations:

The Nigerian Constitution allows States to make legislations, laws and edicts on the environment. The FEPA Amendment Act No. 58 of 1988 also recommends the setting up of State Environmental Protection Agencies (SMENV) to participate in regulating the consequences of project development on the environment in their areas of jurisdiction. The SMENVs thus have the responsibility for environmental protection within their states. In accordance with the provisions of Section 24 of FEPA Act 58 of 1988 (Cap 131 LFN 1990) the Kano State Environmental Protection Agency Edict was enacted. The edict empowers the State Environmental Protection Agency (SEPA) “to establish such environmental criteria, guidelines/specifications or standards for the protection of the state's air, lands and waters as may be necessary to protect the health and welfare of the people." The SEPAs are empowered to undertake functions that include, routine liaison and ensuring effective harmonization with the FMEnv in order to achieve the objectives of the National Policy on the Environment; co-operate with the FMEnv and other relevant regulatory agencies in the promotion of environmental education; be responsible for monitoring compliance with waste management standards; and to monitor the implementation of the EIA and Environmental Audit Reports (EAR) guidelines and procedures on all developmental policies and projects within the State:

- ***Kano State Legislations***: The relevant Kano State Institutions charged with issues on environment include the State Environmental Protection Agency (KSEPA); the Kano State Rural Water Supply & Sanitation Agency (RUWASA) backed by the Kano State Environmental Sanitation Laws of 1985 and 2000; Kano State Public Health Law of 1999; and the Kano State Environment Pollution Control Law of 1985. The Kano State Environmental Protection Agency and the State Ministry of Environment are important stakeholders in the proposed Challawa Gorge Dam Watershed project. Other State Water Edicts and byelaws also form the legal basis and authority for water use and management as far as they relate to intrastate watercourses and water bodies. The present set up in Nigeria is such that virtually every state of the federation has a State Water Agency with its enabling laws. These agencies deal with individual aspects of water use to serve individual sectors of the economy.

- **Local Level**: At the local government level, customary laws on water use can be as important and binding as any written enactment in regulating water resources related activities especially at the level of rural community. A universally accepted principle is that all persons belonging to the community have a right to use water passing through the community. The water right so possessed by all is, however subject to reasonable use. Reasonable right entails ensuring that the quality of water is preserved.

2.4 AfDB Project Categorization Process

The ESAP also includes procedural requirements such as categorising projects, disclosing and monitoring projects during implementation and operation. All AfDB financed projects will be categorised and structured to meet AfDB ISS requirements. Under AfDB ISS, each project undergoes E&S appraisal to determine a project funding feasibility as well as ensuring that the E&S considerations are incorporated effectively in the planning, implementation, and operation of the projects. Each subproject will undergo **initial E&S screening** and be categorised accordingly at the initial stage of the project cycle to determine the nature and level of E&S investigations, information disclosure and stakeholder engagement required. The categorisation is done according to the guidelines stipulated in the AfDB ESAPs.

Based on the categorisation, the projects will then be subjected to an appropriate E&S assessment and mitigation measures will be formulated to ensure E&S considerations are incorporated in the course of the project's implementation. Table 2.5 summarises AfDB's project categorisation process (detailed in the ESAP).

Table 2.5: AfDB Project Categorization Process

AfDB Project Category	Description
Category 1	• Projects likely to cause significant E&S impacts. • Category 1 projects are likely to induce significant and irreversible adverse environmental and social impacts or significantly affect social or ecological components that the Bank or the borrowing country considers sensitive.
Category 2	• Projects are likely to cause less adverse E&S impacts than Category 1. • Category 2 projects are likely to have detrimental site-specific environmental and social impacts that are less adverse than those of Category 1 projects. • Likely impacts are few, site-specific, largely reversible, and readily minimised by applying appropriate management and mitigation measures or incorporating internationally recognised design criteria and standards.
Category 3	• Projects with negligible adverse E&S risks • Category 3 projects do not directly or indirectly affect the environment adversely and are unlikely to induce adverse social impacts. They do not require an E&S assessment. • Beyond categorisation, no action is required. • Nonetheless, to design a Category 3 project properly, it may be necessary to carry out gender analyses, institutional analyses, or other studies on specific, critical social considerations to anticipate and manage unintended impacts on the affected communities.
Category FI	• Projects involving lending to financial intermediaries (FI). • Category FI projects involve lending to financial intermediaries that on-lend or invest in projects that may produce adverse E&S impacts. • FI include banks, insurance, reinsurance and leasing companies, microfinance providers, private equity funds

	and investment funds that use the Bank's funds to lend or provide equity finance to their clients.
Subcategory FI-A	• The financial intermediary's portfolio is considered high risk. It may include projects with potentially significant adverse environmental, climate change, or social impacts and are equivalent to Category 1 projects.
Subcategory FI-B	• The financial intermediary's portfolio is deemed to be medium risk. It may include projects with potentially limited adverse environmental, climate change, or social impacts equivalent to Category 2 projects.
Subcategory FI-C	The financial intermediary's portfolio is considered low risk and includes projects with minimal or no adverse environmental or social impacts that are equivalent.

2.5 International Protocols and Agreements on Water and Sustainable Environment

It is reckoned that in many parts of the world, cooperative arrangements for trans-boundary rivers, lakes and aquifers are lacking or too weak to deal with growing water-related challenges. Therefore, establishment and/or strengthening governance arrangements for these waters is considered necessary in providing the enabling environment for integrated water resources management (IWRM) and investment, and to allow riparian countries reap the numerous shared benefits that trans-boundary cooperation can offer. In support of this, countries including Nigeria became a Party to the United Nations global water conventions, i.e. the Convention on the Protection and Use of Trans-boundary Watercourses and International Lakes (Water Convention), and the Convention on the Law of the Non-Navigational Uses of International Watercourses (Watercourses Convention). The Water Convention aims to protect and ensure the quantity, quality and sustainable use of trans-boundary water resources by facilitating cooperation. It provides an intergovernmental platform for the day-to-day development and advancement of trans-boundary cooperation. Initially negotiated as a regional instrument, it turned into a universally available legal framework for trans-boundary water cooperation, following the entry into force of amendments in February 2013, opening it to all UN Member States, Nigeria inclusive.

There are several international agreements relevant to the water resources and environment to which Nigeria is a signatory. These agreements attempt to regulate how governments relate to each other on a host of issues. Trade agreements are among the most common types of international agreements that contribute to international agricultural law.

Apart from the National Laws, Acts and Regulations, Nigeria is a signatory or party to many International Environmental Conventions and Treaties relevant to the water and environment sectors. Some of the relevant International Conventions and Treaties ratified by the Government of the Federal Republic of Nigeria are presented in table 2.6.

Table 2.6: Project Relevant International Agreements and Conventions to Which Nigeria is a Signatory

S/N	Regulations	Year Adopted
1.	Paris Agreement	2015
2.	Convention on Conservation of Migratory Species of Wild Animals	1979
3.	Agreement on Agriculture (AoA)	1995
4,	World Trade Organization (WTO)	1995
5.	United Nations Framework Convention on Climate Change	1994
6.	Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal	1989
7.	Convention on Biological Diversity (CBD)	1988
8.	Montreal Protocol on Substance that Depletes the Ozone Layer	1987
10.	Vienna Convention on the Ozone Layer	1985
11.	Convention on the Protection of the World Cultural and Natural Heritage (World Heritage Convention)	1975
12.	Convention to Regulate international trade in Endangered species of Fauna and Flora (CITES)	1973
13.	African Convention on the Conservation of Nature and Nature Resource	1968
14.	International Plant Protection Convention (IPPC)	1951
15.	International Rice Commission (IRC)	1948
16.	Food and Agriculture Organization of the United Nations (FAO)	1945

2.6 Institutional Framework

This section describes the leading institutions that are relevant to the formulation, monitoring implementation and monitoring of the resources Management at all levels. Institutional gaps and capacity constraints identified are also discussed in section 2.7.2 of this chapter. Relevant Institutions for Water Resources and Environmental Conservation

The Federal Government of Nigeria has established institutional frameworks at the national and river basin levels and at the state level with responsibilities for policy making, implementation, operation and monitoring at the federal and River Basin levels. The relevant institutions with a mandates in the various aspects of water resource development and environmental conservation are briefly discussed as follow:

- ***The National Council on Water Resources:*** this is the top-most water resources policy formulating body in Nigeria.
- ***The Federal Ministry of Water Resources (FMWR***): it is responsible for implementation of federal water policies in Nigeria. The Federal Ministry of Water Resources is the major government agency that has the statutory responsibility for policy formulation and coordination for water resources development and management throughout the country. However, due to the dependence of other sectors of the economy on this critical resource, as well as the three-tier system of government which Nigeria operates several other statutory and none statutory institutions are active players in the management of water resources. These include Federal Ministry of Environment; the Nigerian Inland Water Ways Authority (NIWA), the Hadeja-Jama'are River Basin Development Authority (HJRBDA), Chad Basin Development Authority, the governments of Kano, Katsina, and Kaduna States (as riparian states to the Challawa Gorge Dam project) through their State level ministries in charge of water resources and environment, etc. Two governmental institutions, namely Federal Ministry of Water Resources and Federal Ministry of Environment are actively involved in water resources management. The HJKYB-TF is also actively involved in the overall management of the Challawa Basin water resources. Furthermore, there are overlaps in the roles and mandates of the various governmental institutions in the basin.
- ***The Nigeria Integrated Water Resources Management Commission (NIWRMC***) under the FMWR is saddled with the responsibility of water regulation, regulation, allocation and management through catchment management programmes at river basins.
- ***The Federal Ministry of Environment***: this is the mother organ of government charged with the responsibility for management and protection of the nation's environment. It is responsible for setting up of Environmental guidelines, standards, and regulations on the country's environmental protection.
- ***The National Inland Waterways Authority (NIWA*)**, hitherto Inland Waterways Department (IWD) of the Federal Ministry of Transport, metamorphosed into an Authority vide an act of the National Assembly, CAP 47, Laws of the Federation of Nigeria (LFN), 2004 (Decree No. 13 of 1997), established with the primary responsibility to improve and develop Nigeria's inland waterways for navigation. It committed to making Nigerian Waterways Navigable & Safe.

The law establishing NIWA gave it the following statutory roles:

- Provide regulation for inland water navigation;
- Ensure development of infrastructural facilities for a national inland waterways connectivity with economic centers using the River Ports and nodal points for inter-nodal exchanges;
- Ensure the development of indigenous technical and managerial skills to meet the challenges of modern inland waterways transportation;
- There are several other functions and powers of the authority properly enunciated and documented in laws establishing NIWA (NIWA ACT CAP N47 LFN 2004)
- undertake capital and maintenance dredging;
- undertake hydrological and hydrographic surveys:
- design ferry routes:
- survey, remove, and receive derelicts, wrecks and other obstructions from in land waterways;
- operate ferry services within the inland waterways system;
- undertake installation and maintenance of lights, buoys and all navigational aids along water channels and banks;
- issue and control licenses for inland navigation, piers, jellies, dockyards;
- examine and survey inland water crafts and shipyard operators;
- grant permit and licenses for sand dredging, pipeline construction, dredging of slots and crossing of waterways by utility lines, water intake, rock blasting and removal;
- grant licenses to private inland waterway operators;
- approve designs and construction of inland river crafts;

- ***The Nigeria Hydrological Services Agency***: this is the agency of federal government with mandate for water resources data collection, monitoring and evaluation.
- ***The Federal Ministry of Agriculture and Rural Development***: is responsible for promoting agricultural development and management of related national resources.
- ***State Ministries:*** at the state level, ministries and departments having parallel structures as those at the federal levels are also responsible for setting up states policies and follow-up implementation within the States boundaries. The State Ministries of Water Resources are, for example, responsible for policy, investment and provision of water supply ***and sanitation within their state.***
- ***The Hadejia-Jama'are River Basin Development Authority (HJRBDA***) is the relevant Federal Agency responsible for implementing Federal Government policies or projects on Water Supply and Irrigation and development of related water infrastructure in the river basin. It operates and maintains facilities and Projects, and supervises them within the jurisdiction of the River Basin. The HJRBDA is also responsible for the operation of

the Challawa Gorge dam and the Tiga dam, and all the associated irrigation schemes. The HJRBDA reports to the Federal Government's MWR, Irrigation and Drainage Department.

- ***Nigeria Integrated Water Resources Management Commission (NIWRMC):*** It was established and charged with the mandate for issuing water use permits and regulations. NIWRMC consists of a central coordinating body and Catchment Management Offices (CMOs) at eight (8) hydrological areas.
- ***The National Environmental Standards and Regulations Enforcement Agency*** (NESREA): it is the agency in Nigeria responsible for elaborating and enforcing compliance with provisions of international agreements, protocols, conventions and treaties on the environment. NESREA has two National Environmental Reference Laboratories located in Kano and Port-Harcourt cities. As for water pollution, NESREA has promulgated the National Environmental (Surface and Groundwater Quality Control) Regulation, 2011.
- ***The Hadejia-Nguru Wetlands Conservation Programme***: the Hadejia-Nguru Wetlands Conservation Programme, which is based in Nguru, advocates the sustainable management of the water resources of the basin, with a more specific concern for maintaining the Hadejia-Nguru wetlands' economic functions and ecological values. It advocates the release of water from upstream dams for downstream ecological and economic uses.
- ***Water Use Associations:*** there are several Water User Groups/Associations in the HJKYB basin area. These associations manage water abstraction for irrigation mainly by constructing canals and dykes as their focal points. The associations also serve as platforms for sourcing farm inputs like fertilizers from the government.
- ***The committee for the survival of the river Yobe basin:*** constitutes opinion leaders of farmers, herders, civil servants, traditional rulers and fisher folks who originate or live downstream of wetlands. The association is a pressure group that is concerned with ensuring that water is made available for downstream communities through advocacy and execution of physical works.
- ***Local Government Authorities:*** a total of 29 local Government Authorities, all of which have a domain in the basin, are in one or other way involved in the uncontrolled abstraction of water for small irrigation purposes in the downstream part of the basin.
- ***State Ministry of Environment/ State Environmental Protection Agency:*** these agencies formulate the policies and regulations or standards and implement programs for environmental control and management at the State level.
- ***HJKYB-Trust fund:*** in light of the scattered responsibilities related to water and the biting challenges in the KY Basin, the KYB Trust Fund was formulated by the six riparian states in 2006 and started its function in May 2007. The Trust Fund was formed with the

principal aim of coordinating and sharing available water and land resources in the basin in an equitable, efficient and sustainable way among all stakeholders. It is practicing several elements of IWRM Principles, capacity building and funding in the basin.

2.6.1 *Federal Ministry of Water Resources (FMWR)*

The Ministry of Water Resources was created to provide sustainable access to safe and sufficient water to meet the cultural and socio-economic needs of all Nigerians in a way that will enhance public health, food security and poverty reduction, while maintaining the integrity of fresh water ecosystem of the nation. Mandates of the Ministry include:

- Formulation and implementation of Water Resources Policy Programme;
- Development and support for irrigated agriculture for food security;
- Collection, storage, analysis and dissemination of hydro-meteorological and hydrological data;
- Monitoring and evaluation of projects and programmes for effective performance;
- Supply of adequate and potable water for domestic and industrial uses;
- Provision of adequate sanitation and maintenance of water quality
- Exploration and development of undergrounded water resources;
- Formulation and review, from time to time, of National water legislation;
- Liaison with all relevant national and international agencies on all matters relating to water resources development; and support of studies and research on the nation’s underground and surface water resources potentials.

The ministry is also charged with the responsibility to develop and implement policies, projects and programmes that will enable sustainable access to safe and sufficient water to meet the social, cultural, environmental and economic development needs of all Nigerians. Thus it is the vehicle for the country’s integrated water resources management, contributing optimally to the socio-economic activities of the nation, facilitating and creating enabling environment for integrated conservation, development, management of various water uses for preservation of freshwater ecosystem, adequate access to safe water and sanitation, production of sufficient food and provision of employment opportunities.

2.6.2 Federal Ministry of Environment (FMEnv)

The Federal Ministry of Environment was established in 1999 to ensure effective coordination of all environmental matters, which were fragmented and scattered among different line ministries before. The creation of the FMEnv was intended to ensure that environmental matters are adequately addressed in all developmental activities in the country. In line with the above and in accordance with the administration's policy the Ministry exercises the following mandates, to:

- Prepare a comprehensive National Policy for the protection of the environment and conservation of natural resources, including procedure for environmental impact assessment of all developing projects.
- Advise the Federal Government on National Environmental Policies and priorities, the conservation of natural resources and sustainable development and scientific and technological activities affecting the environment and natural resources.
- Prescribe standards for and make regulations on water quality, effluent limitations, air quality, atmospheric protection, ozone protection, noise control as well as the removal and control of hazardous substances.
- Monitor and enforce environmental protection measures.

Some of the Laws, Policies and Regulations under the Federal Ministry of Environment include the following:

1. Environmental Impact Assessment Act;
2. The Land Use Act;
3. Harmful Waste (Special Criminal Provisions) Act;
4. Hydrocarbon Oil Refineries Act;
5. Associated Gas re-injection Act;
6. The Endangered Species Act;
7. Sea Fisheries Act;
8. Inland fisheries Act, CAP L10
9. Territorial Waters Act;
10. Nuclear Safety and Radiation Protection Act;
11. Quarantine Act;
12. River Basins Development Authority Act;
13. Pest Control of Production (special powers) Act;
14. Agricultural (Control of Importation) Act;
15. Water Resources Act;
16. Federal National Park Act;

a. **Environmental Impact Assessment (Eia) Act. Cap E12, LFN 2004.** An Environmental Impact Assessment (EIA) is an assessment of the potential impacts whether positive or negative, of a proposed project on the natural environment: The E.I.A Act, as it is informally called, deals with the considerations of environmental impact in respect of public and private projects.

   - Sections relevant to environmental emergency prevention under the EIA include:-
   - Section 2 (1) requires an assessment of public or private projects likely to have a significant (negative) impact on the environment.
   - Section 2 (4) requires an application in writing to the Agency before embarking on projects for their environmental assessment to determine approval.
   - Section 13 establishes cases where an EIA is required and
   - Section 60 creates a legal liability for contravention of any provision.

b. **Harmful Waste (Special Criminal Provisions) Act Cap H1, LFN 2004:** The Harmful Waste Act prohibits, without lawful authority, the carrying, dumping or depositing of harmful waste in the air, land or waters of Nigeria. The following sections are notable:

   - Section 6 provides for a punishment of life imprisonment for offenders as well as the forfeiture of land or anything used to commit the offence.
   - Section 7 makes provision for the punishment accordingly, of any conniving, consenting or negligent officer where the offence is committed by a company.
   - Section 12 defines the civil liability of any offender. He would be liable to persons who have suffered injury as a result of his offending act.

c. **Hydrocarbon Oil Refineries Act, Cap H5, LFN 2004**:The Hydrocarbon Oil Refineries Act is concerned with the licensing and control of refining activities. Relevant sections include the following:-

   - Section 1 prohibits any unlicensed refining of hydrocarbon oils in places other than a refinery.
   - Section 9 requires refineries to maintain pollution prevention facilities.

d. **Associated Gas Re-Injection Act, Cap 20, LFN 2004.** The Associated Gas Re-Injection Act deals with the gas flaring activities of oil and gas companies in Nigeria. The following sections are relevant to pollution prevention:-

   - Section 3 (1) prohibits, without lawful permission, any oil and gas company from flaring gas in Nigeria.
   - Section 4 stipulates the penalty for breach of permit conditions.

e. **The Endangered Species Act , Cap E9, LFN 2004:** This Act focuses on the protection and management of Nigeria's wildlife and some of their species in danger of extinction as a result of overexploitation. These sections are noteworthy:
   - Section 1 prohibits, except under a valid license, the hunting, capture or trade in animal species, either presently or likely to be in danger of extinction.
   - Section 5 defines the liability of any offender under this Act.
   - Section 7 provides for regulations to be made necessary for environmental prevention and control as regards the purposes of this Act.

f. **Water Resources Act, Cap W2, LFN 2004:** The Water Resources Act is targeted at developing and improving the quantity and quality of water resources. The following sections are pertinent:
   - Section 5 and 6 provides authority to make pollution prevention plans and regulations for the protection of fisheries, flora and fauna.
   - Section 18 makes offenders liable, under this Act, to be punished with a fine not exceeding N2000 or an imprisonment term of six months. He would also pay an additional fine of N100 for everyday the offence continues.

g. **Sea Fisheries Act, Cap S4, LFN 2004:** The Sea Fisheries Act makes it illegal to take or harm fishes within Nigerian waters by use of explosives, poisonous or noxious substances. Relevant sections include the following:-
   - Section 1 prohibits any unlicensed operation of motor fishing boats within Nigerian waters.
   - Section 10 makes destruction of fishes punishable with a fine of N50,000 or an imprisonment term of 2 years.
   - Section 14 (2) provides authority to make for the protection and conservation of sea fishes.

h. **Inland Fisheries Act, Cap I10, LFN 2004.** Focused on the protection of the water habitat and its species, the following sections are instructive:
   - Section 1 prohibits unlicensed operations of motor fishing boats within the inland waters of Nigeria.
   - Section 6 prohibits the taking or destruction of fish by harmful means. This offence is punishable with a fine of N3, 000 or an imprisonment term of 2 years or both.

i. **Mineral Oil Safety Regulations And Crude Oil Transportation And Shipment Regulations**. These Regulations prescribe precautions to be taken in the production, loading, transfer and storage of petroleum products to prevent environmental pollution.

j. **Petroleum Products And Distribution Act, Cap P12, LFN 2004.**
Under this Act, the offence of sabotage which could result in environmental pollution is punishable with a death sentence or an imprisonment term not exceeding 21 years.

k. **Territorial Waters Act, Cap T5, LFN 2004: T**he Territorial Waters Act makes punishable any act or omission committed within Nigerian waters which would be an offence under any other existing law.

l. **Nuclear Safety And Radiation Protection Act, Cap N142, LFN 2004.**
The Act is concerned with the regulation of the use of radioactive substances and equipment emitting and generating ionizing radiation. In particular:
   - Section 4 provides authority to make regulations for the protection of the environment from the harmful effects of ionizing radiation.
   - Section 15 and 16 makes registration of premises and the restriction of ionizing radiation sources to those premises mandatory.
   - Section 37 (1) (b) allows an inspector verify records of activities that pertain to the environment.
   - Section 40 clarifies that the same regulations guiding the transportation of dangerous goods by air, land or water should also apply to the transportation of radioactive substances.

m. **Quarantine Act, Cap Q2, LFN 2004.** The Quarantine Act provides authority to make regulations for preventing the introduction, spread and transmission of infectious diseases such as cholera, yellow fever, typhus, etc.
Under this Act, violation of any regulation is punishable with a fine of N200 or an imprisonment term of 2 years or both.

n. **River Basins Development Authority Act, Cap R9, LFN 2004.** The River Basins Development Authority is concerned with the development of water resources for domestic, industrial and other uses, and the control of floods and erosion.

o. **Pest Control Production (Special Powers) Act, Cap P9, LFN 2004.** The Pest Control of Production Act is concerned with export produce conditions and pest control. In particular:

- Section 1 provides an inspector authority to take emergency measures to control pest infestation of produce.

p. **Agriculture (Control Of Importation) Act, Cap A93, LFN 2004.** The Agriculture Act and its Plant (Control of Importation) Regulations are concerned with the control of the spread of plant diseases and pests.

Worth noting is:

- Section 6 which allows authorized officers to take emergency control measures, and provides for the recovery of costs and expenses incurred by the officers in controlling the situation.

q. **Animal Diseases (Control) Act, Cap A17, LFN 2004.** The Animal Disease (Control) Act makes it an offence to import any animal, hatching egg or poultry into Nigerian except under a permit. The following sections are relevant:

Section 5 provides an inspector with the authority to take emergency measures where necessary.

- Section 10 stipulates penalties for contravening any regulation.
- Section 13 requires owners of trade animals to possess a movement permit and ensure the fitness of their animals.
- Section 20 provides authority to make regulations that prevent and control the spread of animal diseases.

r. **The Federal National Parks Act, Cap N65, LFN 2004:** The National Parks Act is concerned with the establishment of protected areas used for resource conservation, water catchments protection, wildlife conservation and maintenance of the national eco-system balance.

s. **OTHER LEGISLATION:**

- ***Environmental Sanitation Law***: This is a law of Lagos State focused on environmental sanitation and protection. It punishes in varying degrees acts like street obstruction, failure to clean sidewalks, cover refuse bins or dispose wastes properly.
- ***Environmental Pollution Control Law:*** Section 12 of this law under the Laws of Lagos State makes it an offence to cause or permit a discharge of raw untreated human waste into any public drain, water course or onto any land or water. This offence is punishable with a fine not exceeding N100, 000 (One hundred thousand naira) and in the case of a company, a fine not exceeding N500, 000.

2.6.3 HJKY Basin Trust Fund (HKJYB-TF)

The Federal Government (represented by FMWR), in cooperation with the riparian States, established the Trust Fund at the Damaturu Summit in year 2006. The Trust

Fund is an innovative platform for a joint intervention by the riparian states, with the support of the Federal Government of Nigeria for augmenting line agencies in addressing land and water resources issues in the KYB. Riparian state Governors contributed the equivalent of USD 6.5 million to establish the Trust Fund. The Federal Government of Nigeria matched these funds, bringing the total amount available to establish and operate the Trust Fund to some USD 13 million.

The Governors of riparian states, in their May 2017 Summit, renewed their commitment to financially support the Trust Fund, but only FMWR and the Yobe State Government have actually disbursed their part of the pledged funds. Other state governments have approved the pledges but are yet to release funds. However, a new Board of Trustees (BOT) of the Trust Fund has been inaugurated in November 2017. During their recent meeting in April 2018, the Board undertook to persuade the remaining State Governors to provide the funds they pledged as soon as possible.

2.6.4 The Hadejia–Jama'are River Basin Development Authority

The Hadejia Jama'are River Basin Development Authority (HJRBDA) was created in 1976 along with ten other River Basin Development Authorities by the Federal Government of Nigeria under Decree 25 of 1976. Presently, the HJRBDA has the largest functional irrigation schemes among the twelve River Basin Development Authorities in Nigeria. The Authority covers an area of 45,000 km^2 (the entire area of Kano and Jigawa states, and about two-thirds of Bauchi State) with an irrigation development potential of about 240,000 hectares within the Hadejia and Jama'are River Basin. The Headquarters of the HJRBDA are located in Kano City. The HJRBDA is responsible for the development of surface and groundwater resources for irrigated agriculture, water supply and other uses within its catchment area in Kano, Jigawa and Bauchi States. The HJRBDA has continued to develop and manage dams and irrigation projects since its establishment. These projects have a significant impact on the lives of people in its catchment area and beyond. Currently the HJRBDA has developed only 22,324 ha of irrigated land out of a potential area of 240,000 ha, which is very low progress (10.3%)[3]. The financial performance of the HJRBDA has been declining in recent years, and it is expected that the mandate, roles and organization of the HJRBDA will change once the forthcoming Water Bill becomes law.

2.6.5 *State Level*

The institutional arrangements at state level in the KY Basin in general are as presented below.

i. **Borno State**:

The institutional framework includes the Ministry of Water Resources and State water agencies; Borno Irrigation Department in the Ministry of Agriculture and Natural Resources, and Ministry of Environment. In addition to state executive governor's directives, the Borno State Water Corporation Edict No. 2 (1999) regulates domestic water supply. The State Water Resources Edicts do not clearly define roles and responsibilities for the various State water agencies, with the result that available water quantity is not sustainably managed in the State.

i. **Yobe State**

The Ministry of Water Resources and State Water Board, Ministry of Agriculture and Natural Resources, and the Ministry of Environment are major managers of water resources in the Yobe State. The state activities on water issues are based on ''Water supply and Sanitation policy (January 2010) and executive governor's directives. Roles and responsibilities of the various MDAs involved in managing the waters of the Lake Chad basin are not clearly defined in terms of control, monitoring and enforcement measures on water use in the State. No water resources law in the State to complement the sustainable water charter of HJKYB-TF. Hence, available water quantity was not sustainably managed in the State.

ii. **Bauchi State**

The institutional framework in Bauchi state includes Ministry of Water Resources and State Water Agencies; Ministry of Agriculture and Natural Resources, and Ministry of Environment. In addition to state executive governor's directives, the Bauchi State government had reviewed in March 2013 the state water supply and sanitation policy.

iii. Kano State: Kano State has a Ministry of Water Resources and State Water Board; Ministry of Agriculture and Natural Resources, and Ministry of Environment. Water related activities are based on annual budgets, Water Resources and Engineering Construction Agency (WRECA) Kano State Edict 1991, and the Water Supply Edict 2013. In addition to state executive governor's directives, there is lack of State Water Resources Edicts with clearly defined control roles and responsibilities for the various State Water Agencies involved in managing the water of the Lake Chad basin. The effect was that available water quantity was not sustainably managed in the State. The State had Ministry of Water Resources and State water agencies; Ministry of Agriculture and Natural Resources, and Ministry of Environment. These MDAs activities were based on annual budgets;

iv. Jigawa State

Water Board and Sanitation Agency law 1999 (Law no. 9, 1999), and water supply and sanitation policy, in addition to state executive governor’s directives. There was lack of State Edicts Water with Resource to clearly defined control roles and responsibilities for the various State Water Agencies involved in managing the waters of the Lake Chad basin. Hence, available water quantity in the State was not sustainably managed.

v. Katsina State

Katsina State Waste Management Act provides for the effective development and maintenance of sanitation in all areas of the State. The law further provides for proper disposition of excavated silt or earth and other construction materials after any construction project or repair works. Open burning of wastes is prohibited with stipulated penalties.

2.7 Chad Basin Development Authority

The Chad Basin Development Authority (CBDA) was established to promote the development of rural communities in the Chad Basin; to promote the economic empowerment of women; to encourage the participation of rural women in adult education programmes; to engage in vocational training for he women in rural areas; to provide micro-credit facilities. The CBDA is mandated to address both agriculture and rural development. CBDA should make "Sustainable Agriculture and Rural Development" of Nigerians as its main goal. In line with this goal, the organization should have its own Vision and Mission that provide proper direction to the activities of the organization and the results it can achieve.

2.8 The African Development Bank (AfDB

The AfDB's mission is to fight poverty and improve living conditions on the continent of Africa through promoting investment of public and private capital in projects and programs that are likely to contribute to the economic and social development of the region. The primary functions of AfDB include:

- Making loans and equity investments for the socioeconomic advancement of Member Countries.
- Providing technical assistance for development projects and programs Member Countries.

- Promoting investment of public and private capital for development Member Countries.
- Assist in organizing the development policies of Member Countries.
- Giving special attention to national and multinational projects which are needed to promote regional integration.
- Promote economic development and social progress of its RMCs in Africa;
- Commit approximately $3 billion annually to African countries.

The infrastructure sector, including power supply, water and sanitation, transport and communications, has traditionally received the largest share of AfDB lending.

2.9 Policy Issues and Institutional Gaps in the Komadugu Yobe Basin

2.9.2 Policy Issues

The main policy issues of relevance to the implementation of the KY Basin development projects are as follows:

1. Conflicts between national and state priorities for investment in and development of water resources as well as between the riparian states themselves. As is often the case in river basins, the upstream users are disproportionally advantaged when compared with downstream users. This in many instances resulted in hot arguments between competing stakeholders.
2. Policymaking is still dominated by sectoral planning, with a lack of adequate coordination, and alignment between policies in interrelated sectors and areas such as agriculture, irrigation, food security and the role of private investment, as well as between riparian regions of the same watershed.
3. Unintended consequences of national policies promoting national self-sufficiency in food, e.g. imposing restrictions on imported rice and corn as an incentive for farmers to grow crops such as rice and corn, which also happen to be highly water dependent.
4. Pricing water for domestic consumption and irrigation is far below its economic value, which leads to over and misuse of water and distorts water allocation decisions.
5. The requirement for RBDAs to submit the revenue they collect to the Treasury Single Account (TSA) is a disincentive for RBDAs to improve their services and financial performance.
6. Unregulated and uncoordinated private investment in large-scale agricultural projects in the KY Basin without adequate assessment of the water requirements or environmental impact of these projects.
7. There are institutional barriers to the sharing of hydrometeorological and water resources information and data between and among organizations and projects. The Nigerian Meteorological Agency (NIMET) is making effort at providing agro climatic and Meteorological information but this is also currently inadequate at providing the needed data for effective water and agricultural planning.

8. Inadequate financial resources for developing and maintaining water resources and related infrastructure. This has necessitated the intervention of International Donor agencies like the World Bank, The African Development Bank etc,, financing water projects in the country as in the case of the Challawa Gorge Dam Watershed Management Project.

2.9.3 Institutional Gaps

There are a number of institutional issues and gaps that are relevant to the implementation of the KY Basin development projects, as identified by SMEC (2019) as follows:

1. There is a wide divergence in the level of development in the upstream part of the KY Basin in particular in Kano, Jigawa and Plateau states, compared with the state of development in the downstream/tail-end parts of the KY Basin in particular in Yobe and Borno states. This imbalance, which is exacerbated by climate change, also applies to the availability of, access to and utilization of water resources in the upstream and downstream parts of the KY Basin as well.
2. Riparian state governments, to a large extent, pursue their own development priorities and objectives, in particular in areas such agricultural development, irrigation and infrastructure, and in some cases, invite private investment to participate in development activities to compensate for the lack of public funding and expertise and other reasons.
3. Many water resources development activities in the KY Basin are being implemented by projects such as TRIMING and Fadama, which, while supporting many useful initiatives, also attract scarce skilled human resources from government line agencies and risk creating parallel organizations that hinder integration with the responsible public-sector agencies.
4. Water resources development activities in the KY Basin are at present not adequately coordinated with emergency and humanitarian assistance being provided by international donors and others to the Lake Chad Basin area and to Yobe and Borno States.

2.9.4 Institutional Gaps

There are a number of institutional issues and gaps that are relevant to the implementation of the KY Basin development projects, as identified by SMEC (2019) as follows:

5. There is a wide divergence in the level of development in the upstream part of the KY Basin in particular in Kano, Jigawa and Plateau states, compared with the state of development in the downstream/tail-end parts of the KY Basin in particular in Yobe and Borno states. This imbalance, which is exacerbated by climate change, also applies to the availability of, access to and utilization of water resources in the upstream and downstream parts of the KY Basin as well.

6. Riparian state governments, to a large extent, pursue their own development priorities and objectives, in particular in areas such agricultural development, irrigation and infrastructure, and in some cases, invite private investment to participate in development activities to compensate for the lack of public funding and expertise and other reasons.
7. Many water resources development activities in the KY Basin are being implemented by projects such as TRIMING and Fadama, which, while supporting many useful initiatives, also attract scarce skilled human resources from government line agencies and risk creating parallel organizations that hinder integration with the responsible public-sector agencies.
8. Water resources development activities in the KY Basin are at present not adequately coordinated with emergency and humanitarian assistance being provided by international donors and others to the Lake Chad Basin area and to Yobe and Borno States.

CHAPTER THREE

PROJECT JUSTIFICATION AND ALTERNATIVES

3.1 Introduction:

The Challawa Gorge Dam Watershed Management Project is one of the selected priority projects of the Hadeja Jamaare Kom adugu Yobe Basin Trust fund (HJKYB-TF). The purpose of the project is to extend the longevity of the reservoir by reducing the sediment flux into the reservoir through watershed management. The purpose for which the dam was constructed in the early-90s was built to supply drinking water to Kano city and supply irrigation water for the Kano irrigation project. However, recently, watershed degradation has set in resulting in the problems erosion in the watershed area and serious sedimentation problems in the Challawa Reservoir, thereby threatening the life of the reservoir and making water treatment very costly because of high turbidity. In addition, erosion in the upland watershed is affecting farmers' lands and encroaching towards private property and destroying critical infrastructure such as roads, bridges and the dam reservoir embankment. If unattended, the ecological, biological, social and economic benefits derived from the reservoir may be obliterated sooner than the expected lifespan of the dam. The need to implement the watershed management project therefore becomes imperative and necessary.

3.2 Justification for the Project

There are three main problems associated with Challawa Gorge Dam Watershed that started from watershed erosion and gully formation in the upland watershed, sediment deposition and siltation of the reservoir and sedimentation problems associated with Challawa Water Works treatment plant. These three problems are mainly due to watershed degradation in the upper reaches of the Challawa Gorge Dam Watershed. To fix these problems and extend the longevity of the reservoir to realize its purpose is the main justification for the project. A brief description of each problem is presented below.

3.2.1 The Watershed Management Problem

The watershed Management Project is necessitated by the general degradation of the Challawa Sub-basin watershed. This has resulted in related adverse environmental conditions threatening the life of the Reservoir.

3.2.2 The Challawa Gorge Watershed Degradation problem

Challawa Gorge Watershed Degradation is the main cause of erosion in the watershed, Sedimentation in Challawa Reservoir, and the Kano water works and treatment plants downstream. Natural and human factors are the main causes of erosion in the watershed (Fig. 3.1). Human activities resulting in Land use-Land Cover (LULC) due to agricultural and other human activities instigated by the increasing demand for food and other land resources associated with growing population coupled with poor agricultural practices, are some of the main causes of watershed degradation in the area (Fig. 3.2). Natural factors such as topography, soil type and slope of the watershed combined with rainfall have also significantly contributed towards Challawa watershed degradation by promoting runoff formation with anthropogenic interference as a catalyst to the process. In some places, it is also observed that the need for irrigated agriculture has forced farmers to remove vegetation from river banks for easy supply of water from the rivers and streams. These also result in damage of riparian stream buffers and expose them to severe stream bank erosion.

Plate. 3.1: Catchments Gully formation, Challawa Gorge Dam Watershed

Source: SMEC (2019): Hadeja Jamaare Strategic Action Plan, 2019

Plate 3.2: Riverbank Erosion and damage to critical infrastructure in Challawa Gorge Dam Watershed Area (July 2021)

Plate 3.3: Riverbank degradation, farm land erosion and Channel siltation along Gushi River, a tributary to Challawa River (July, 2020)

Plate 3.4: Uncomplimentary Land use practice, Land cover change and Riverbank erosion in the Challawa Watershed area, near Karaye Kano State, Nigeria (July, 2021)

There are three stages in a reservoir's life which are: continuous and rapidly occurring sediment accumulation; partial sediment balance, where fine sediments reach a balance, but coarse sediments continue to accumulate; full sediment balance with sediment inflow and outflow equal for all particle sizes. Evidences from previous studies and discussions with stakeholders, and corroborated by on-sport images reveal that the Challawa Gorge Reservoir is rapidly being filled up with continuous sedimentation leaving the water very turbid for the Challawa water works (Plate.3.6) and endangering the life of the reservoir. This is because of sediment transported from upland watersheds and deposited in the reservoir as point sources and erosion and sedimentation from the reservoir shore line as a non-point source. This therefore requires sustainable sediment control measures.

Plate 3.5: Farmland overtaken by gully erosion upstream of the Challawa Dam (Captured, July 2021)

3.2.3 Challawa Water Works Treatment Plant Siltation

The main water supply source for Kano City and the surrounding communities is from Challawa Reservoir. The controlled release from the reservoir flows downstream through Challawa River and reaches at Challawa raw water intake locations. The Challawa water intakes are located along the banks of Challawa River. The water pumped from the river has significant turbidity because of large amount of sediment coming from the reservoir. Previous efforts to remove sediments prior to entering the treatment plant was much beyond the capacity of Kano Water Board, because of the volume of sediment coming from the river (Plate. 3.6).

Plate 3.6: Evidence of manual evacuation of Sand deposits at Challawa Water Works Treatment plant at Panshekara for kano Municipality.

Source: SMEC (2019): Hadeja Jamaare Strategic Action Plan, 2019

Plate 3.7 Siltation at the Kano Water Treatment Plant Panshekara

Source: SMEC (2019): Hadeja Jamaare Strategic Action Plan, 2019

3.3 Potential Benefits and Beneficiaries of the Project

3.3.1 Environmental Benefits: The main objective of the Challawa Watershed Management Project is to extend the longevity of the reservoir by reducing the sediment flux into the reservoir through integrated watershed management. Thus, the project was conceived to manage environmental degradation within the Challawa Gorge Dam basin which manifests as gullies and river bank erosion. The following are the anticipated positive environmental and socioeconomic impacts of the project:

y. Reducing erodibility of the soils within the watershed and by extension reduction in siltation and sedimentation of the River Channels and the Reservoir: erosion generally increases sediment load in water and when they are generated from gully and river bank erosion, the amount of sediment load multiplies. However, with proper implementation of this project, the levels of sediment will reduce substantially by by about 75% which will in turn reduce the amount of silt and sediment in both the rivers and the reservoir.

z. *Mitigation of Climate Chang*e: through planting of trees and grasses, this will positively change the land cover from bare to forested land and also provide vegetation to absorb carbon dioxide.

aa. *Protection against Strong Winds*: if the trees are properly arranged, they will serve as wind breakers which will serve as protection against violent winds that do occur during the rainy season.

bb. *Creation of Underground Water Recharge Zone*: the trees and grasses to be planted will reduce surface flow, allowing for more penetration of water through the soil thereby creating underground water recharge zone. This water can be used by the settlements upstream that mostly depend on underground water during the dry season for both irrigation and domestic use.

cc. *Pollution control:* Has the health benefit of improvement in air and water quality with the potential of reducing incidences of air and water-borne diseases;

dd. *Water storage:* flood control, checking sedimentation;

ee. *Minimization* of over exploitation of resources;

ff. *Erosion control* and prevention of soil, degradation and conservation of soil and water;

gg. *Restoration and enhancement* of environmental aesthetics value of the environment: the natural beauty and attraction of the environment will be restored and enhanced thereby promoting tourism.

hh. A hedgerow of the vertiver grass will stay where it is planted and sediment that is spread out behind the hedgerow gradually accumulates to form a long lasting terrace with vetiver protection. When used for civil systems and designs the vertiver root is likened to a "Living Soil Nail" with an average tensile strength of 1/6 of mild steel. Thus it benefits the soil by protecting it almost on a sustainable basis, and benefits the farmer by improving farm land management, crop production and overall livelihood.

ii. Vetiver grass can be used directly as a farm income earning product, or it can be used for applications that will protect river basins and watersheds against environmental damage, particularly point source environmental problems relating to sediment flows and toxic sources.

jj. Empirical evidences of numerous trials and mass applications of vetiver grass in the last 20 years in many countries also show that the grass is particularly effective in natural disaster reduction (flood, landslide, road batter failure, river bank, irrigation canal and coastal erosion, water retaining structure instability etc.)

environmental protection (reduction of land and water contamination, treatment of solid and liquid waste, soil improvement etc.), and many other uses (Chomchalow, 2005; Nguyen Van Hon et al., 2004; and Le Van Du and Truong 2006).

3.3.2 Potential Beneficiaries

All these applications can directly or indirectly impact on the rural poor through either protection or rehabilitation of farm land, providing better moisture retention and provision of direct farm income, or indirectly by protecting rural infrastructure. Overall, it has the potential of enhancing the livelihood of the ordinary rural dwellers through improved food production, food security and income growth.

3.3.3 Bio-diversity Benefits protection and restoration

i. *Wild life preservation*; protection of endangered species including reptiles, games, soil-enhancing insects, aquatic lives, cultural and exotic vegetation species (trees and grasses) etc.

ii. *Improved Habitat;* the trees and other vegetation to be planted will improve the regional ecosystem thereby improving habitat for many endangered species like birds, reptiles, large mammals, which will translate into improvement in biodiversity of the plant and animal communities in the area.

iii. The project which may result in increase in the increase in depth of the challawa reservoir has the potential of improving habitat for fish resources in quantity and diversity. Fisheries form an important livewire of the riparian communities around challawa gorge dam. Species richness in sub-lakes is assumed to be positively associated with water depth and aquatic habitat availability *(Nazeef, Jaafar, Abubakar and Kabiru, 2021).*

3.3.4 Potential Beneficiaries: Environmental sustainability, bio-diversity protection, efficient utilization of tax payers' money and improved livelihood for the local communities both upstream and downstream.

3.3.5 Socio-economic Benefits

h. Allows the Dam to Operate at the Designed Capacity: this is particularly important if the purpose for which the dam was constructed is to be achieved, especially in terms of water storage capacity for irrigation and power generation.

i. Reduction in the Maintenance Activities on the Rivers and the Dam: managing the degraded sites in the basin may reduce unwanted materials reaching the rivers and reservoir which hitherto has hindered the optimum performance of the reservoir. This will be economically beneficial to Kano Municipal water supply system not only by reducing management cost, but also improved water quality which also has positive implication for public health in and around the city.

j. Diversification of Income: if the trees are both exotic and non-exotic, they will provide income to land owners and materials for other uses such as poles for electricity and building. The trees can also be used as collateral for loans.

k. Sources of Fuel wood for Domestic Use: the project, if well implemented, it the long term will provide fuel wood for domestic use by the people who solely depend on fire wood for cooking and other domestic use.

l. Reclaiming Lost Farmland: many wasted farmlands will be recovered consequently providing opportunity once again for the owners to begin to earn income from the land and enhance their standard of living.

m. Social Safeguards: it will reduce the number of impoverished people whose situation has been brought about by reduced land for productive activities. Therefore, it will improve the overall prosperity of the areas within the catchment.

n. To reduce the need for perennial labour emigration: long run reclamation of farm lands lost to land degradation, improvement fish and related aquatic resources in the catchments surface water system have the potential to reduce or permanently discourage perennial temporary labour temporary migration commonly known *Chin-rani* and the cases of “migrant tenant farmers” from the catchment area to other parts of Nigeria in search other means of livelihood among the Hausa people of the area.

3.3.6 Beneficiaries: the Kano state government in particular, the community of farmers, herders, fishermen, including youths, women and other vulnerable groups especially within the riparian communities are potential beneficiaries of the Challawa Gorge Dam watershed management project.

3.4 Project Sustainability

The general sustainability principles (technical, economic, environmental and social) that guided the project's design are set below**.**

3.4.1 Technical Sustainability

The proposed project is technically feasible because it is professionally designed, and the technology employed is readily available and not too complex. The timing of the project when most residents of the Challawa Dam Environment and the Kano State government are expressing concern about the continuous sedimentation of the dam with ripple effect on the water treatment plant at Panshekara supplying water to Kano Municipality and its environs.

The Hadeja Jamaare River basin Authority's pool of technical and administrative experts, and the pool of technical expert in the industrial region of Kano are encouragement for sustainability of the project. Moreover, the predominantly agricultural community of the project area constitutes a pool of employable labour to support the bio-remediation and agricultural measures components of the project because they stand to be immediate benefiaries of the project. With government political will and support the project is highly sustainable.

3.4.2 Economic Sustainability

The project is targeted to cover 985 Ha (around Reservoir, Pilot '1' and Pilot '2') and a further 500 ha of farmlands. There will be no immediate direct benefits for the 500 of farm lands, it is expected that the 985 ha will be placed under grass, trees, fruit trees and intercrops as shown in Table 3.5 below.

Table 3.1**:** Targeted Acreage for Grass, Trees, Fruit trees and Intercrops[#]

Vegetation Type	Buffer strips	Pilot Area 1	Pilot Area 2	Around Reservoir	Total (Ha)
Grass	12	166	131	160.00	469
Avocadoes	0	74	50	150.00	274
Oranges	0	26	17	65.00	108
Onions/tomatoes*	0	0	0	215.00	215
Trees/shrubs	4	10	20	100.00	134
	Buffer strips	Pilot Area 1	Pilot Area 2	Around Reservoir	Total (Ha)
Total (Ha)	16	276	218	690	1,200

* the onions and tomatoes will be intercropped with fruit trees (avocadoes and oranges) in the area around the reservoir for the first 3 years. Farmers are currently cropping in some of the targeted areas and it is assumed they will continue cropping high value vegetables (such as onions and tomatoes) until the project start realizing some harvests from the fruit trees.

[#] curled from SMEC Report 2019, pp.97-99

Cost of Production and Revenue from Grass, Trees & agricultural crops

Table 3.2 highlights a summary of expected yields and incomes for the project. Only grass and onions/tomatoes is expected to bring income in the first 3 years while fruit trees (avocadoes and oranges) will start bringing income from third year. Project income is expected to stabilize from 7th Year.

Table 3.2: Yield, Production Cost and Expected Revenues[#]

Type of Vegetation	Ha	Expected Yield year 3 (Kgs/Ha)	Expected Yield from year 7 onwards (Kgs/Ha)	Price (N/Kg)	Production Cost (N/Ha)	3rd Year Revenue (N/Ha)	Year Onwards Revenue (N/Ha)
Grass (Kgs of hay)	469	8,000	8,000	20	60,000	160,000	160,000
Avocadoes	274	7,000	18,000	250	320,000	1,750,000	4,500,000
Oranges	108	5,000	14,000	100	237,300	500,000	1,400,000
Onions/ tomatoes	215	16,000	-	120	453,250	1,920,000	-
Trees (No)	134	0	40	6,000	-	-	240,000
Total	985						

[#] curled from SMEC Report 2019, pp.97-99

Expectedly therefore, as in table 3.6:

- Yield of hay (grass) is expected to be about 8,000 Kgs/ha by third year with total cost of production being about N 60,000 per ha and total revenue N 160,000 per Ha.
- Yield of onions or tomatoes is expected to be about 16,000 Kgs/ha by third year with total cost of production being about N 453,250 per ha and total revenue N 1,920,000 per Ha. It is assumed the vegetables will be grown as intercrops until 3rd year after which fruit trees are expected to cover the ground.
- Yield of avocado will in 3rd year (at about 7,000 kgs/Ha) and reach 18,000 Kgs/Ha by 7th Year. The expected production cost and revenue from 7th year is N 320,000/Ha and N 4,500,000/ Ha respectively.
- For trees, about 40 trees (10%) are expected to be harvested from 5th year onwards bringing a net income of N 240,000 per year

Table 3.3 provides a summary of total costs, total revenues for the whole Project.

Table 3.3: Expected Project revenues and Costs#

Grass	Area (Ha)	Yield kg/ha Kg/ha	Production cost N/ha	Total project Costs N	Revenue (per Ha) N/ha	Total Projected revenue N	Gross margin (Per Ha) N/ha	Total project net revenue N
	469	8,000	60,000	28,140,000	160,000	75,040,000	100,000	46,900,000
							Gross	Total
Avocadoes	274	18,000	320,000	87,680,000	4,500,000	1,233,000,000	4,180,000	1,145,320,000
Oranges	108	14,000	237,300	25,628,400	1,400,000	151,200,000	1,162,700	125,571,600
Trees*	134	40	24,000	3,216,000	240,000	32,160,000	216,000	28,944,000
Total	985			144,664,400		1,491,400,000		1,346,735,600

*assumes a population of 400 trees per acre with only an equivalent 10 % of this (40 trees) being used as firewood every year after 5 years.

curled from SMEC Report 2019, pp.97-99

As shown in Table 3.8, it is projected that the 985Ha placed under grass, avocadoes, oranges, onions/tomatoes (intercrop) and trees/shrubs will have a total annual net revenue of about N1,346,735,600 (as at 2019) from 7th year onwards, hence the economic sustainability of the project is supported.

3.4.3 Social Sustainability

Social sustainability is contingent on social acceptability which, for the Challawa Gorge Dam, is not in doubt, judging from the ecstasy with which the communities welcomed the idea of watershed treatment for future survival of the infrastructure. Residents of Karaye and other communities in the neighborhood of the Challawa Gorge Dam in Kiru, Rogo and Turawa welcome the project which in their opinion has reduced the phenomena of temporary youth migration out of the communities for dry season job-seeking otherwise known in Hausa as *chinrani* because of the irrigation and fishing opportunities provided by the Dam. Also, the benefit to create job opportunities for unemployed indigenes especially the youths and diffusion of erosion management techniques hitherto unknown to the community of farmers would ensure social sustainability. The HJKYB-TF on the other hand nas demonstrated commitment to effective and sustained stakeholders' engagements and consultations towards the success of the watershed rehabilitation project. The proponent is also committed to complying with applicable national social laws, relevant international conventions, and AfDB safeguards requirements and training and retraining the PIU team members on environmental and social management risks.

3.4.4 Environmental Sustainability

The project is a rehabilitation activity to improve the functionality, sustainability and operational efficiency of the Challawa Gorge Dam which has been in existence since 1992. The watershed management is to enhance the ecosystem, improve biodiversity, protect the soil from further degradation, reduce or mitigate channel and reservoir sedimentation through bio-engineering techniques that are environmentally friendly, socially acceptable and economically viable. Moreover, social and environmental mitigation measures have been suggested for the identified environmental and social impacts of the watershed management project.

The proponent (HJKYB-TF) is aware of, and committed to, complying with all relevant country environmental laws, applicable international conventions and AfDB environmental and social safeguard requirements to implementing the ESMP developed to guarantee environmental sustainability. The proponent also has a department that handles environmental issues related to its activities in the discharge of it mandates. The HSE department is headed by a Director who reports directly to the Bank's senior vice president. A significant number of ESIAs and environmental audits have been conducted in the past by the proponent; hence, they have the technical skills needed to manage the mitigations determined for the identified impacts of this project.

3.5 Analysis of Project Alternatives

Watershed management technique is not a one-cap fit all-heads strategy. Several alternatives are possible. However, the choice of any approach depends much on the watershed scale (size), nature of the watershed problem, objectives of the watershed management intervention and the administrative and legal system of the management process. The cost of Watershed Management system is also a determinant of alternative choices in watershed management strategy to be adopted. Engineering and Bio-remediation options designed for the Challawa gorge dam watershed may be expensive in terms of construction, management and sustainability even though its advantages are also enormous. Alternative watershed management approaches that may be possible to address the degradation of the Challawa Gorge Dam are presented in table 3.2 and discussed in subsequent sections.

Table 3.4 Project Alternatives and benefit

	Project alternative	Description	Expected Benefits and beneficiaries		Expected Beneficiaries
			Positive	**Negative**	
1.	Participatory Watershed Management option	In order to make the watershed development and management work successful the people of the riparian communities' participate directly in the watershed management. The main objectives of participatory approach to watershed management (PWM) include: a. To involve the local communities to contribute directly in their livelihood strategies;	a. Direct involvement of associated landowners/communities residing in the watershed in management of natural resources. b. It helps in the alleviation of poverty among the rural mass. c. The overall improvement in the livelihood of rural families is made possible by this approach. d. It helps to develop a kind of coordination amongst people of diverse communities and create a sense of unity among them;. e. The speed of work progress gets increased. f. It develops a kind of friendship amongst the rural mass of the watershed; and by virtue of which the rural mass can do any kind of development work in the watershed, themselves.	a. The approach is usually most successful at a micro-watershed level. This approach does not necessarily aggregate up or capture upstream-downstream interactions. Thus not suitable for the Challawa Gorge Dam case: b. Profitability is key to engaging stakeholders in conservation, and participatory watershed management. This approach may not in itself be profitable for	• The riparian communities especially those with 1.3 kms of the project sites, especially persons whose livelihood depends on agriculture and related activities

		b. To promote collaboration amongst diverse groups of stakeholders to understand and evaluate the various water related challenges faced by the communities; c. To develop learning awareness amongst rural communities on various aspects such as traditional forest management, natural resource management, and community networking. d. To develop learning		stakeholders; c. Establishing accurate estimates of costs and benefits, both at the farm level and beyond, is always difficult. d. There is the risk that technical choices may be made without due consideration for financial profitability, or of economic value to society. e. Although poverty reduction is usually an objective of watershed management programs, empirical evidence of poverty reduction impacts is weak. f. Its economic impact may be weak; g. The poor and the landless members of	

		awareness about integrated approaches to watershed management. e. To promote interaction amongst local communities and thereby enhance a sense of community and ownership of their common resources for sustainability. f. To review the challenges of participatory watershed management practices and together proffer local solutions;		the local community may be at risk from the approach; h. Landless people dependent on common natural resources for their livelihood may suffer from the conservation of rangelands closure; i. Participation does not, guarantee specific outcomes; it involves shifts in decision making power between the state and local communities, and between different segments of the local community; j. Participatory approaches imposes a set of requirements including political commitment and equitable rules, time	

				for the process to mature, careful sequencing, inclusion of all stakeholders in the process, public agencies that understand the rationale and process of participation, and sustained capacity building at all levels for both stakeholders and public agencies (which may be difficult to realize).	
2.	Adaptive Watershed Management	• Adaptive Management is about learning through the process of management, with adjustment of management actions based on what's learned in the process over	• Initiating restoration efforts when scientific uncertainty exists. Adaptive management can commence with the early stages of a restoration initiative when scientific and programmatic uncertainties about the ecosystem and restoration process exist. Some policymakers may be reluctant to endorse a restoration initiative if there is uncertainty about how effective restoration projects will be or if there is	• Difficulty in connecting experimentation to operational changes. linking science and experimentation to operational changes is one of the biggest challenges for adaptive management going forward	• The local and wider community will be the beneficiaries of this process while the environment too will be better maintained by achieving some level of ecological balance between environmental resources and the community (Receptors).

		time. The idea in this process is about improvement in understanding through time and adaptation (the adjustment of management strategy through time as conditions evolve). The natural consequences of such an approach are to improve understanding of the resource system being managed and to improve resource management based on that improved understanding. • The adaptive	uncertainty about conditions and processes associated with the ecosystem and species. The flexibility of adaptive management may address some of these concerns. • Potential to deal with changing circumstances over large time periods. Some restoration initiatives have planned durations extending over significant time horizons extending out to 50 years or more in the future. During these periods, significant unforeseen shifts in the ecosystem can occur due to changing climatic conditions, species composition, and habitat alteration. Adaptive management can provide a formal process for addressing these uncertainties and building flexibility into the restoration plan over time. • Creation of formal monitoring networks and processes. While traditional management frameworks often require limited (or no) monitoring networks, adaptive management requires a monitoring program to track the progress of restoration. This monitoring can help	• Adaptive management lacks the ability to management conflicts and its ability to resolve major issues is limited. So in instances where stakeholders cannot agree on fundamental issues such as objectives, of watershed management, adaptive management approach should not be employed. • It generally lacks goals, or vague or undefined goals, or goals that are irreconcilable. Problems of this sort may be the result of efforts to accommodate the demands of multiple	

		watershed management follows the principle of landscape ecology in its work on watershed-wise resource management and planning. This approach simultaneously emphasizes understanding the ecological, social and economic consequences of changes in urban and rural land use in the context to watershed. • Different elements of watershed are integrated into adaptive	provide consistent, basic information about an ecosystem over time that would not have been noted otherwise. • Increasing stakeholder buy-in. If the adaptive management process has an avenue for formal stakeholder participation, then stakeholders can provide input into what changes are desirable from their perspective. • Additionally, stakeholder participation can provide societal and cultural inputs to the process through performance measures. Participation can increase stakeholder engagement and provide opportunities to keep abreast of changes. • Ability to serve as an oversight tool for ecosystem restoration initiatives. The process of adaptive management ideally stimulates processes which inform reflection on the overall progress toward a program's goals. This includes monitoring and evaluation of data and assessment of which strategies are most effective. By providing a central vehicle	stakeholders with varied interests. Without defined goals, it is difficult to monitor progress or measure success of an adaptive management effort. • Adaptive management often highlights areas of uncertainty, and the results of adaptive management experiments are rarely unequivocal. This can lead stakeholders or managers to call for more experimentation and testing of alternatives before a path to restoration can begin. Ultimately, this may create delays in decision making for a program or project	

		management strategies to achieve sounder land-use and sustainability in economic and natural resources. • To protect and restore the valuable watershed natural resources, adoptive watershed management may involve the following measures; • Classification of critical watersheds for fixing priorities regarding their conservation based development of	for the multiple stages of restoration, adaptive management has the potential to also facilitate oversight of these efforts.		

		land-use diversity and management strategies; • Identification of critical threats such as surface and groundwater pollution, soil erosion, poor eco-system etc. to protect the valuable resources and establishments of watershed. • Development of recommendations in light of watershed management to ensure sustainable and good quality water availability and to maintain the productive aquatic			

		resources. • Identification of system-wise controlling processes and mechanisms to distinguish environmental indicators for evaluating eco-system health. • Formulation of recommendations on land-use impact mitigation, habitat restoration programs, and other remediation techniques in watershed disputes. • Evaluation of socioeconomic values of watersheds and			

		their environmental services for policy development and management planning. •			
3.	Rainwater Harvesting	• Rainwater harvesting means collection and storage of rainwater by some mechanism, to make water available for future use. An appreciable amount of precipitation, which is generally lost as surface flow, can be harvested and stored for useful purposes like	• Rainwater harvesting can reduce storm water runoff from a property. The elimination of runoff can reduce contamination of surface water with pesticides, sediment, metals, and fertilizers. • By reducing storm water runoff, rainwater harvesting can reduce a storm's peak flow volume and velocity in local creeks, streams, and rivers, thereby reducing the potential for stream bank erosion. • Rainwater harvesting systems can be employed as simple and effective methods to meet a municipality's storm water management program requirements of individual properties. • It is an excellent source of water for plants and landscape irrigation since it	• High cost of construction and maintenance • Unpredictability of rainfall conditions • Storage difficulties • Not suitable for large areas such as a watershed	• Both farmlands and the farmers or land users in general will beefier from this process as it supports sustainability in water resource use and management.

		drinking and providing supplemental irrigation to the crops. While this will reduce surface run-off and soil loss, it is impracticable for a micro-watershed such as Challawa.	has no chemicals such as fluoride and chloramines (chlorine).		
4	Dredging Option	• Dredging as an option involves physical removal of sediments from the reservoir floor as well as from the treatment plant at the water treatment. These option may help in improving the water holding capacity of the dam and temporarily	• The option in the short term can reduce sediments and improve the water quality within the reservoir and at the treatment plant.	• This option must be a recurrent work that may be expensive; • The option requires constant physical removal of sediments at exorbitant cost that may not be sustainable.	•

		cleaning the water and reducing turbidity.			
5	Take no action option. Maintain the status-co	• The watershed management is left at the mercy of unorganised, uncoordinated land and waters resources management practices relying merely on indigenous knowledge. • No one takes responsibility for system decline and mitigation measure for sustainability of water and land resources;			

3.5.3 Participatory Watershed Management option:

Participatory watershed management is an option. In order to make the watershed development/management work successful the people of the riparian communities' participation is very important. The Participatory Watershed Management (PWM) approach has been proved to be beneficial in different forms and in different places e.g. India and Thailand. The main objectives of participatory approach to watershed management include:

a. To involve the local communities in management of the watershed and contribute directly in their livelihood strategies.
b. To witness the collaboration amongst a diverse group of stakeholders, and also to evaluate/examine various challenges faced by the communities;
c. To develop learning awareness amongst rural communities on various aspects such as traditional forest management, natural resource management and community networks;
d. To develop learning awareness about integrated approaches to watershed management.
e. To create awareness on how the participatory policies can affect the watershed management.
f. To promote interaction amongst local communities and thereby enhance a sense of community and ownership of their common resources for sustainability.
g. To review the challenges of participatory watershed management practices.

3.5.3.1 The main benefits of the participatory alternative

a. The management of natural resources becomes possible by the associated landowners/communities residing in the watershed.
b. It helps in the alleviation of poverty among the rural mass.
c. The overall improvement in the livelihood of rural families is made possible by this approach.
d. It helps to develop a kind of coordination amongst people of diverse communities and create a sense of unity among them;.
e. The speed of work progress gets increase.
f. It develops a kind of friendship amongst the rural mass of the watershed; and by virtue of which the rural mass can do any kind of development work in the watershed, themselves.

   In brief, the participatory watershed management practice enables the communities to remove the problems and achieve better control over natural resources and livelihoods of watershed.

3.5.3.2 Disadvantage

i. The approach is usually most successful at a micro scale level. The micro-watershed level approach does not necessarily aggregate up or capture upstream-downstream interactions. Thus, not suitable for the Challawa Gorge Dam case:
ii. Profitability is key to engaging stakeholders in conservation, and participatory watershed management intervention approach may not in itself be profitable for stakeholders;
iii. Establishing accurate estimates of costs and benefits, both at the farm level and beyond, is always difficult. There is the risk that technical choices may be made without due consideration for financial profitability, or of economic value to society.
iv. Although poverty reduction is usually an objective of watershed management programs, empirical evidence of poverty reduction impacts is weak. Its economic impact may be weak too;
v. The poor may even be at risk from the approach; landless people dependent on common natural resources for their livelihood may suffer from conservation interventions, such as rangeland closure;
vi. Participation does not, however, guarantee specific outcomes; it involves shifts in decision making power between the state and local communities, and also between different segments of the local community;
vii. Participatory approaches imposes a demanding set of requirements: political commitment and equitable rules, time for the process to mature, careful sequencing, inclusion of all stakeholders in the process, public agencies that understand the rationale and process of participation, and sustained capacity building at all levels for both stakeholders and public agencies (which may be difficult to realize).

3.5.4 Rainwater Harvesting: Rainwater harvesting means collection and storage of rainwater by some mechanism, to make water available for future use. An appreciable amount of precipitation, which is generally lost as surface flow, can be harvested and stored for useful purposes like drinking and providing supplemental irrigation to the crops. While this will reduce surface run-off and soil loss, it is impracticable for a macro-watershed such as Challawa. The benefits and shortcomings of this alternative are presented in table 4.2.

3.5.4.1 Adaptive Watershed Management option:

The adaptive watershed management follows the principle of landscape ecology in its work on watershed-wide resource management and planning. This approach simultaneously emphasizes understanding the ecological, social and economic consequences of changes in urban and rural land use in the context to watershed.

Different elements of watershed can be integrated into adaptive management strategies to achieve more sound land-use and sustainability in economic and natural resources.

To protect and restore the valuable watershed natural resources, adoptive watershed management may involve the following measures:

a. Classification of critical watersheds for fixing priorities regarding their conservation based development of land-use diversity and management strategies;
b. Identification of critical threats such as surface and groundwater pollution, soil erosion, poor eco-system etc. to protect the valuable resources and establishments of watershed.
c. Development of recommendations in the light of watershed management to ensure sustainable and good quality water availability and to maintain the productive aquatic resources.
d. Identification of system-wise controlling processes and mechanisms to distinguish environmental indicators for evaluating eco-system health.
e. Formulation of recommendations on land-use impact mitigation, habitat restoration programs, and other remediation techniques in watershed disputes.
f. Evaluation of socioeconomic values of watersheds and their environmental services for policy development and management planning.

3.5.5 Reservoir dredging option

This option is a one-time temporary solution that has more disadvantages than advantages. It is not sustainable because it has to be a recurrent phenomenon that may be expensive. In addition the option fails to treat the sources of the sedimentation which is an annual problem.

3.6 Public views and concerns of the Alternatives:

After explaining the implications of the participatory approach to a cross section of the local communities during interaction and consultations, they felt exited especially for the fact that their participation introduces a new innovation in erosion management. The idea of that farmers and local communities could participate in vertiver grass production, planting and maintenance was welcomed.

On the other hand adaptive watershed does not appear to be appealing to the public around the project area. The general feeling was that this approach is cumbersome and probably only implementable by government because of its complexity and cost implications.

The idea of drainage the reservoir appeared highly acceptable to the local communities especially fishermen who believe that the deeper the reservoir, the better the population and variety of fish species, and b implication the better their income from fishing activities.

CHAPTER FOUR

PROJECT DESCRIPTION

4.1 Background to the Watershed Management Project

The Komadugu Yobe Basin (KYB) covers an area of 84,000km^2. It is of strategic national and international importance as it supports the livelihood of over 15 million people in six Nigerian States including Bauchi, Borno, Jigawa, Kano, Plateau and Yobe who are directly or indirectly dependent on the scares water resources. The KYB which is located in the semi-arid north-eastern Nigeria represents approximately 35% of the Lake Chad Basin and is important as a trans-boundary water resource. The Federal Government of Nigeria, in collaboration with SMEC and the African Water Facility, has prepared the Komadugu Yobe Basin Strategic Action Plan (SAP 2019) as a long-term development strategy promoting the management and use of the basin water resources for inclusive and sustainable growth and development. The Strategic action plan (SAP 2019) for the water resources development in the Komadugu Yobe (KY) basin, obtained from the HJKY-TF, identified four priority Sub-Programs/Schemes, among which is the Challawa Gorge Dam Watershed Management Sub-Program.

The Government of Nigeria through funding from the AfDB is financing additional studies for the priority investment projects. The studies include Environmental and Social Impact Assessment for the proposed Challawa Gorge Dam Watershed Management Sub-Program. In this regard the HJKY-TF (which is the Implementing Agency) seeks for consultancy services to prepare the ESIA and ESMP of the Watershed Management to assess the potential (positive and negative) environmental impacts of the proposed infrastructures construction and related activities and propose a management Environmental and Social Management Plan to address the predicted impacts for the Challawa Gorge Dam Watershed Management Sub-Project.

The SAP (2019) report identified three sets of leading problems associated with the Challawa Gorge Dam Watershed component of the HJKYB development. The previous study revealed that the problems started from watershed erosion and gully formation in the uplands watershed, sediment deposition and siltation of the rivers and the reservoir (Plates 4.1 and 4.2), and sedimentation problems downstream associated with Challawa Water Works treatment plant, all arising mainly from watershed degradation in the upper reaches of the Challawa Gorge Dam Watershed Area. Thus, the project was conceived to remediate environmental degradation within the Challawa Gorge Dam area which manifests as gullies and river bank erosion, and eventually river beds and Challawa reservoir sedimentation and destruction to critical infrastructure (Plate 4.3) while also affecting biodiversity through ecosystem destabilization.

Plate 4.1 Siltation along Challawa River Channel

Plate 4.2 Challawa Gorge Dam Reservoir Sedimentation Problem

Plate 4.3: Challawa River Bank degradation and destruction of critical infrastructure

4.2 Project Location

The Project is located in Kano State Northern Nigeria, close to Karaye town about 120 km south west of Kano City, within the HJKY Basin (Fig. 4.1 and 4.2). The main Challawa Gorge Dam watershed boundary falls into three States' administrative boundaries namely Kano, Katsina and Kaduna. The project area is located in the HJKY River Basin with geographic coordinates of 11°41'21.29"N and 8° 0'49.16"E, at the Challawa Gorge Dam (figure 4.3). The watershed area covers about 3,842 km^2 with an altitude ranging between 520 to 720masl. It is a major reservoir on the Challawa River, a tributary of Kano River. The Challawa Dam itself lies astride the land areas of three riparian local government areas of Karaye, Rogo and Kiru in Kano State. Although the upper reaches of the Challawa Sub-basin watershed extends to parts of Katsina and Kaduna States, the greatest areas of the project likely to be more affected lie in Kano state, especially areas in Karaye, Kiru and Rogo Local Government Areas. The Challawa River itself forms a tributary to the Kano River which drains into Tiga Dam in Kano State and further downstream of the Hadeja Jamaare river system in Jigawa and Bauchi States.

Fig. 4.1: Map of Nigeria Highlighting Kano State

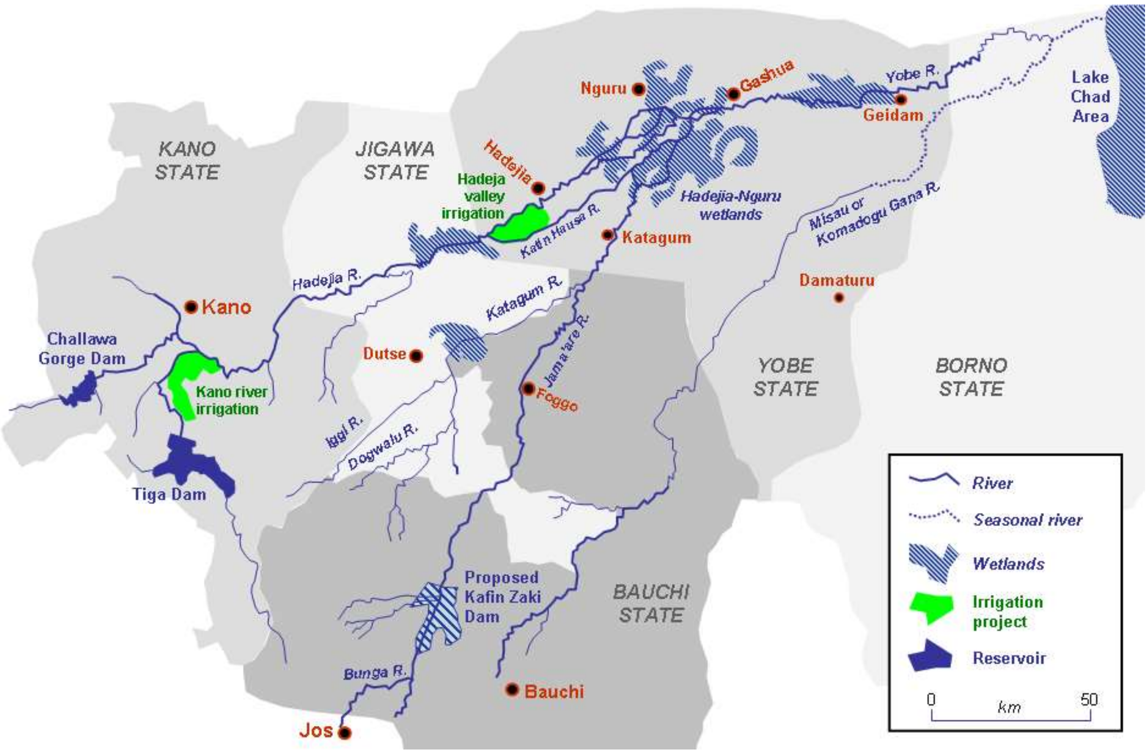


Figure 4.2: Challawa Gorge Dam within the Hadeja Jamare Komadugu Yobe Basin

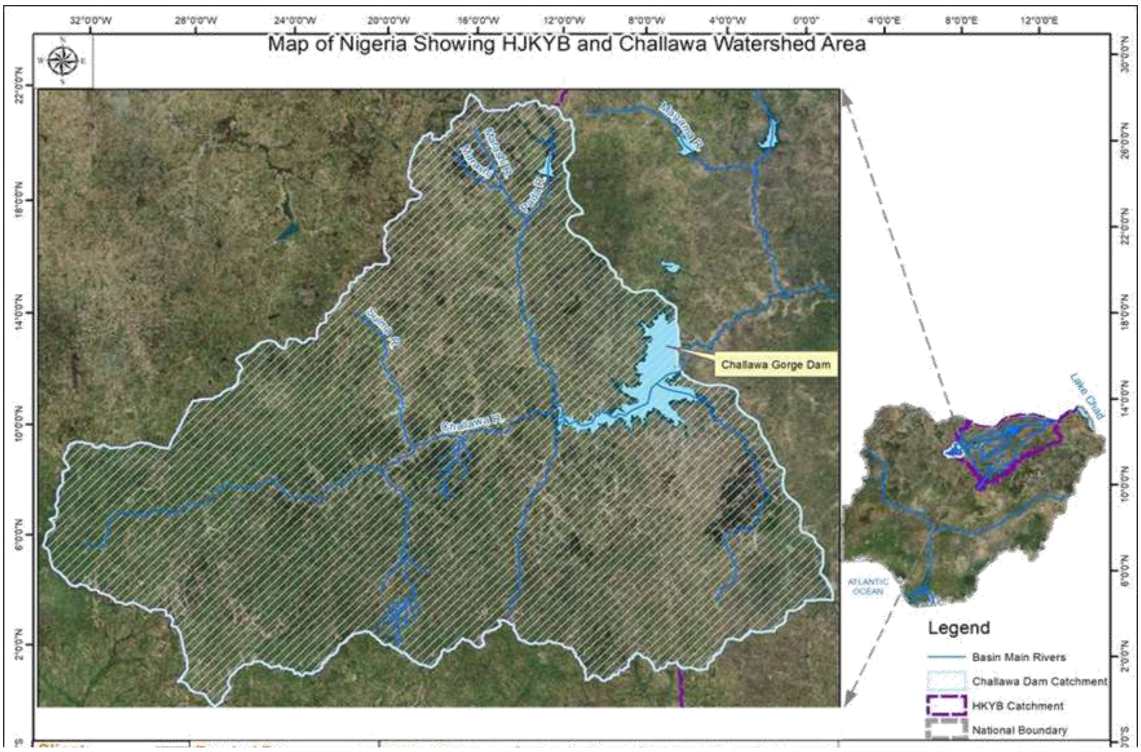


Figure 4.3: Challawa Gorge Dam Watershed Management Project Location

Source: SMEC (2019) HJKYB SAP, 2019

The project was initiated in 1975 by the Kano State Water Resources and Engineering Agency (WRECA) which was responsible for both design and construction. HJRBDA, who took over responsibility in 1977, commissioned Haskoning Company to supervise the construction of the dam in 1980 which they did until their contract expired in 1983. Construction continued at a slow pace until 1989 when Julius Berger Nigeria PLC was appointed as the contractor while Water and Dam Services Company was appointed to supervise the construction. The dam was completed in 1992 using rock fill construction. It is about 42m high and 7.8km long (Plate 4.4). The dam has a full storage capacity of 904,000,000m^3.

The main land use types in the project area are typically agricultural including crops and animal husbandry and other remotely related non-agricultural livelihood activities such trading, firewood marketing, etc. With a cumulative land area of about 2,216.2km^2 and cumulative 2021 population size of about 1,050,289 (projected from 2006 figures at the states average growth rate of 3.4%) the three Local Government Areas most affected by the project have a combined estimated population density of about 474/sq.km. (2021).

4.3 Objectives of the Challawa Gorge Dam Watershed Management Project

The Challawa Gorge Dam Watershed Management Project is one of the four priority projects selected for development by the HJKY-TF. The overall objective of the project is to extend the longevity of the Challawa Gorge Dam reservoir by reducing the sediment flux into the reservoir through watershed management, involving design of erosion control structures, provision of bioremediation and other agricultural measures; and construction of gabion check dams and sediment traps, etc. The SAP (2019) of the Challawa Gorge Dam rehabilitation project noted that the project is expected to significantly reduce the siltation problem in the Challawa reservoir and contribute significantly to soil conservation within the watershed, and also address the problem of sedimentation at the Challawa Water Works treatment plant with all the associated positive effects.

Plate 4.4. A view of the Challawa Gorge Dam Reservoir

4.4 The Project Components and Activities

4.4.1 General Site Description of the project

The Challawa Watershed management project is aimed at erosion and gully control and reducing sediment deposition in the reservoir through watershed management intervention. The proposed watershed management work largely includes provision of erosion control structures in the upland active watersheds producing large amounts of sediments. For this purpose, two pilot sub watersheds were selected and appropriate erosion control measures were designed and presented for the two sites.

The selected Pilot sub watersheds have been designated as **PSW_1** and **PSW_2**, each containing its own main and finger gullies and draining into the main rivers that later join the Challawa River (fig. 4.4). The gullies identified in the two sub watersheds (PSW_1 and PWS_2 and the works to be carried out on each are presented in table 4.1. The gullies have very steep slopes from the head to middle reach and tend to have milder slope near the outlet, forming a relatively stable and wide bed. The gullies are expanding upstream by head cutting and laterally with stream bank erosion. Urgent intervention is needed to stop the gully from developing laterally and endangering the surrounding farm land and deposition of sediments in the downstream reservoir. The gully is shallow at its tail and is deeper in the middle and head section, up to 30m depth. The width of the gully varies from

60m at shallower areas to 30m at the deeper sections. The shape of the gully is generally V-shape gully at the head and middle with a side slope ranging from 30^o to 40^o. In Pilot Sub Watershed 1 gully site, the level of gully erosion is so active that it is progressing aggressively towards the adjacent farm lands encroaching into private properties.

Table 4.1: PWS_1 and PWS_2 Main and Finger Gully Features and proposed works

Description	Length (m)	Proposed Work	Remark
MG	4,581	Bank protection, Check Dams, sediment trap and buffer	PW_1
LFG-1	1,006	Bank protection and Check Dams	PW_1
LFG-2	2,124	Bank protection and Check Dams	PW_1
LFG-3	787	Bank protection and Check Dams	PW_1
RFG1	2,612	Bank protection	PW_1
MG	8,047	Bank protection, Check Dams, sediment trap and buffer	PW_2
LFG-1	654	Bank protection	PW_2
LFG-2	760	Bank protection and Check Dams	PW_2
LFG-3	705	Bank protection and Check Dams	PW_2
LFG-4	955	Bank protection and Check Dams	PW_2
LFG-5	937	Bank protection and Check Dams	PW_2
RFG1	902	Bank protection and Check Dams	PW_2
RFG2	1,984	Bank protection	PW_2
RFG3	2,152	Bank protection	PW_2

Source: SMEC (2019) SAP Report, p.35

Note: MG = Main gully; LFG = Left finger gulley; RFG = Right finger gully;

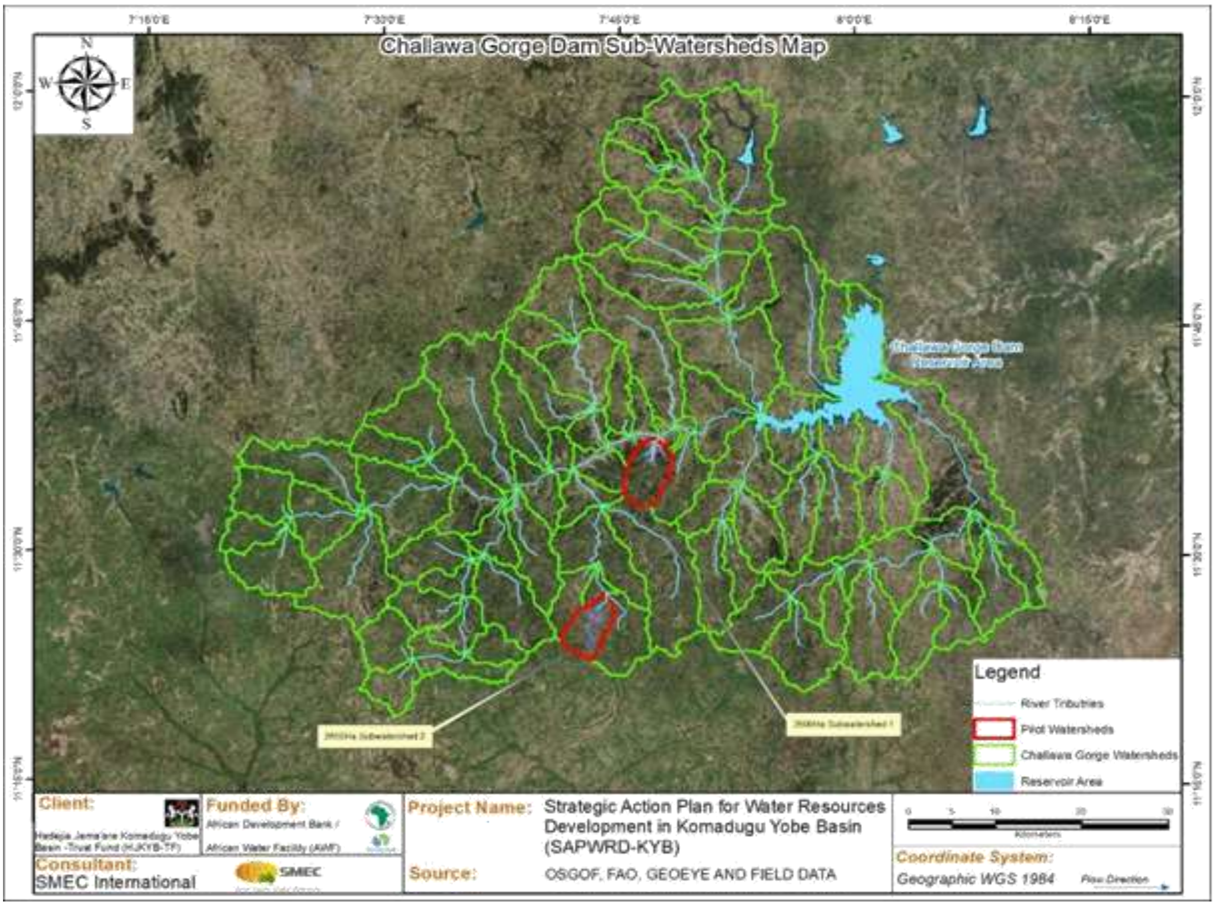


Figure 4.5: Project sites PSW_1 and PSW_2

Source: SMEC (2019) SAP Report

Table 4.2: Location and Physical Characteristics for PSW-1

Physical Feature	**Description**
Location	The location of Pilot sub watershed 1 is at the boundary of Challawa Gorge Dam Watershed with Location coordinate of *368,351.66 m E, 1,285,176.12 m N* at the outlet and *365,887.78 m E, 1,277,604.20 m N* at the head of the watershed.
Watershed area and Characteristics	The watershed is characterized by discrete watershed with most representative of the general watershed. The Watershed area for this Pilot Watershed is *3,150 ha* with regular shape and appropriate density of stream network.
Topography and Watershed Slope	The topography of the watershed is rolling in nature with *average slope of 1.5%* and generally suitable for agriculture. However, it gets steeper towards gully banks. The streams have bigger slopes in some sections with significant contribution for erosion.
Land use and Soil type	The land use is majorly agricultural land cultivated by individual farmers, which is more representative of the general watershed. The dominant soil is sandy loam soil which has high infiltration and low

	runoff potential.
Erosion nature and size	The nature of erosion is pronounced in the area which is encroaching towards the agricultural land and eroding stream banks. The extent of erosion is more representative of the general watershed area.

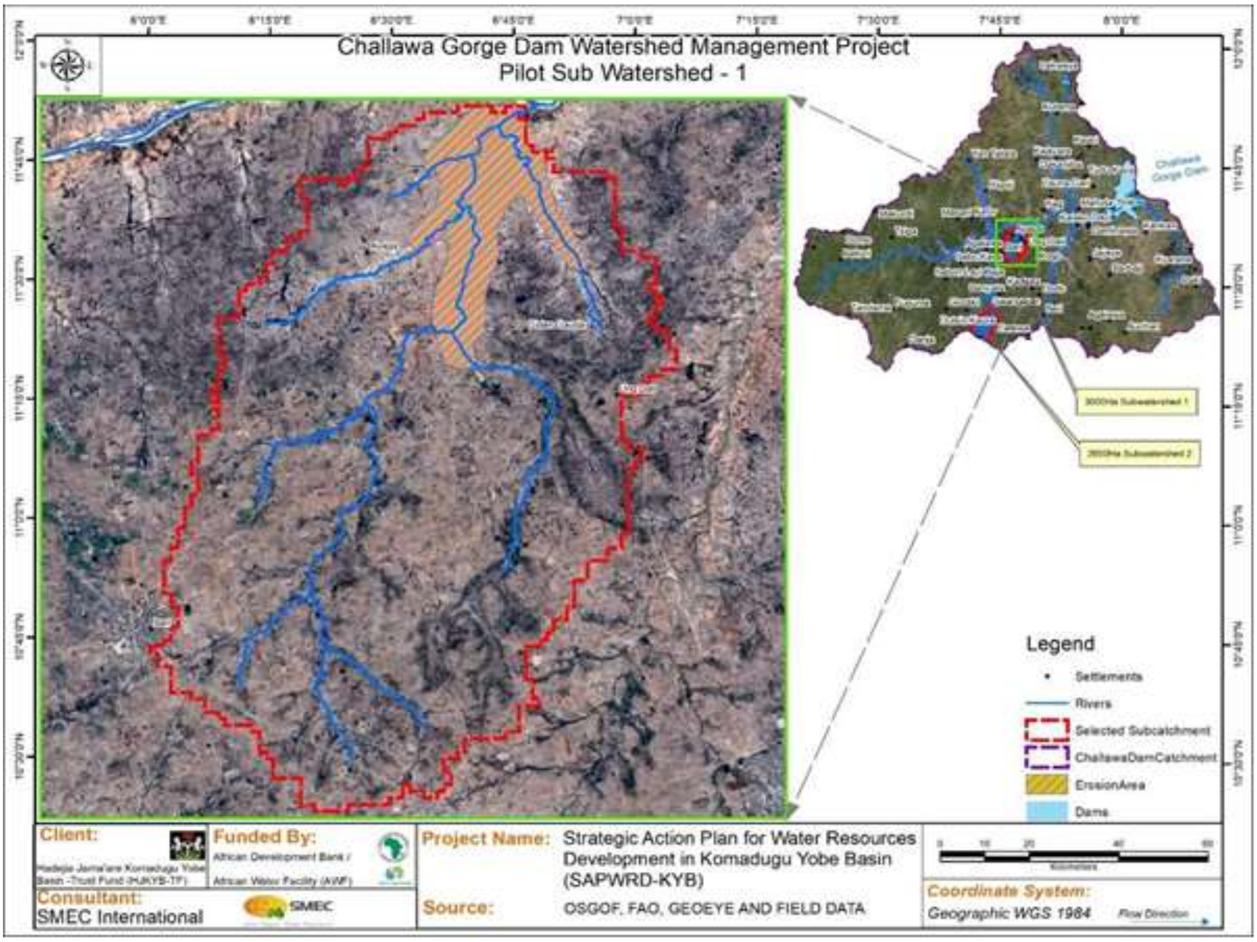


Figure 4.5: Pilot Sub Watershed 1 (PWS-1) showing mail erosion sites Source: SMEC (2019) SAP Report

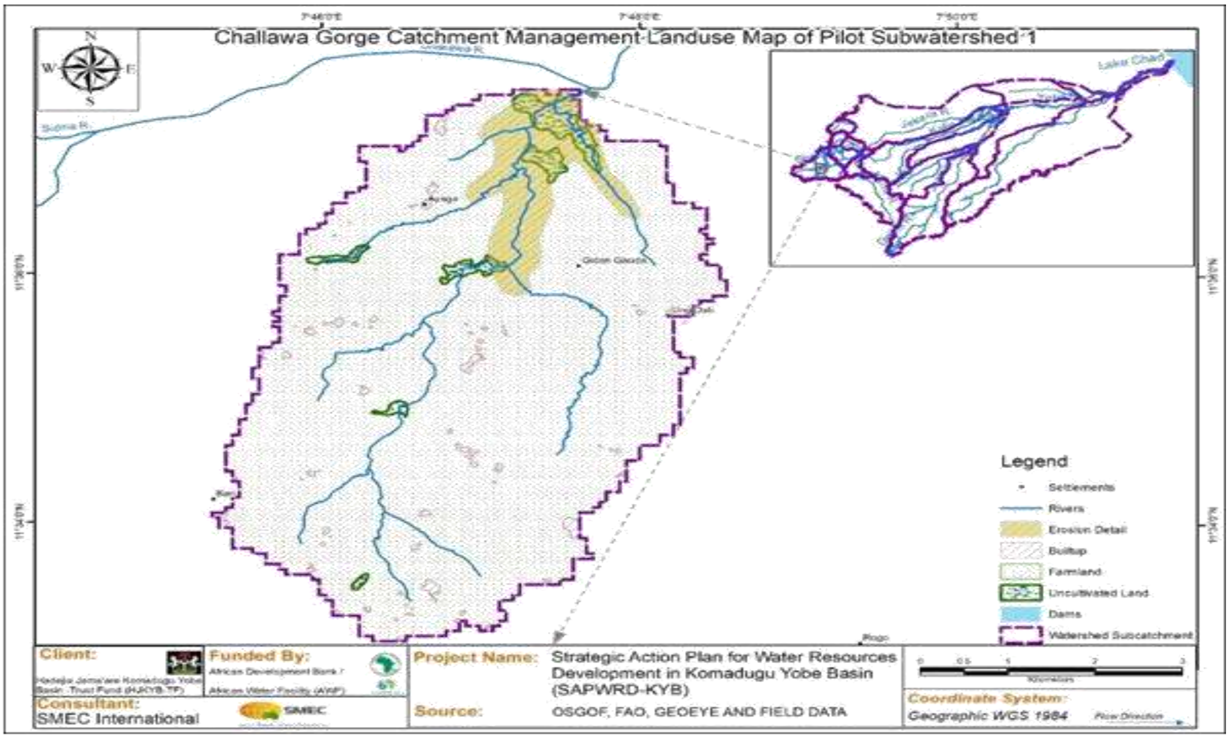


Figure 4.5: Land Use Map in Pilot Sub Watershed 1 (PWS_1)

Source: SMEC (2019) SAP Report

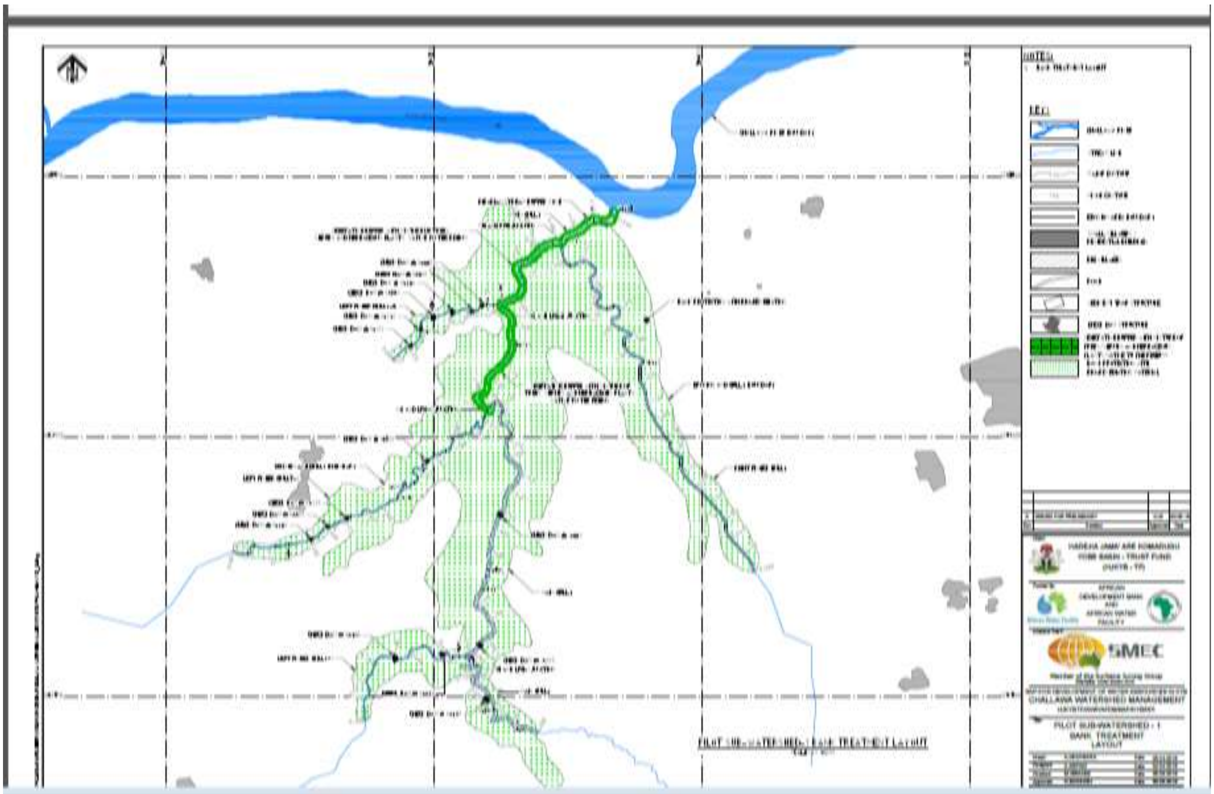


Figure 4.6: Challawa Gorge Dam Pilot Sub Watershed_1 General Layout

Source: SMEC (2019) SAP Report

(Index: Mg = Main Gulley; LFG = Left Finger Gulley; RFG = Right Finger Gulley.)

Table 4.3: Location and Physical Characteristics for Pilot Sub watershed 2 (PSW_2)

Physical Feature	Description
Location	The location of Pilot sub watershed 2 is at the boundary of Challawa Gorge Dam Watershed with Location coordinate of 362,484.24 m E, 1,266,563.85 m N at the outlet and 358,590.13 m E, 1,259,559.41 m N at the head of the watershed.
Watershed area And Characteristics	The watershed is characterized by discrete watershed with most representative of the general watershed. The Watershed area for this Pilot Sub Watershed is 2,661 ha with regular shape and appropriate density of stream network.
Topography and Watershed Slope	The topography of the watershed is rolling with average slope of 1.5% and generally suitable for agriculture. The streams have bigger slopes in some sections with significant contribution for erosion.
Land use and Soil type	The land use is majorly agricultural land cultivated by individual farmers, which is more representative of the general watershed. The dominant soil is sandy loam soil which has high infiltration and low runoff potential.
Erosion nature and size	The nature of erosion is pronounced in pilot sub watershed areas and currently is encroaching towards adjacent agricultural land and eroding stream banks. The extent and rate of erosion is more representative of the general watershed area.

Source: SMEC (2019) SAP Report

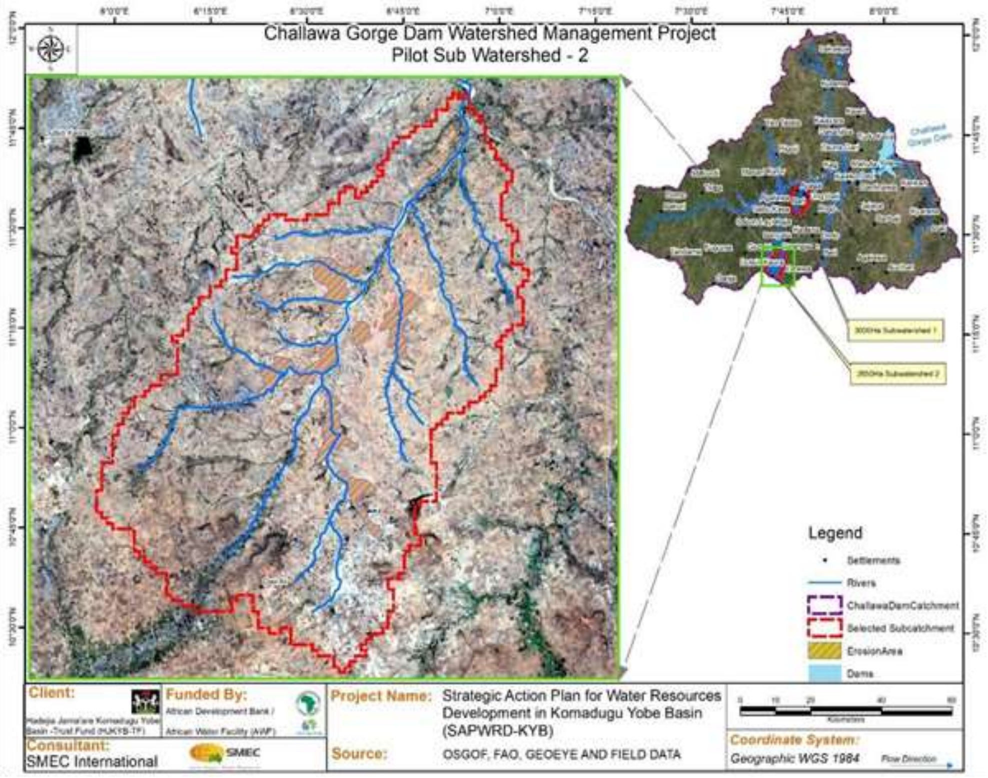


Figure 4.7: Pilot Sub-Watershed-2 showing main erosion site

Source: SMEC (2019) SAP Report

The proposed works to be carried out on the main and finger gullies of the two Pilot sub-watersheds (PWS_1 and PWS_2) are presented in table 4.3.

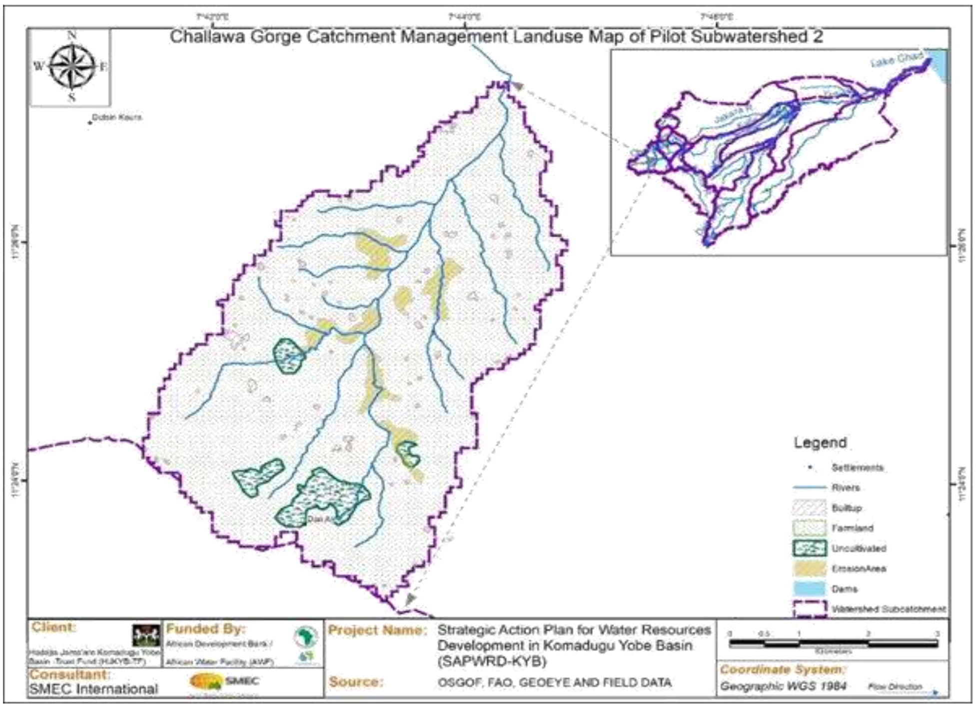


Figure 4.8: Land Use Map in Pilot Sub Watershed_2 (PWS_2)

Source: SMEC (2019) SAP Report

Table 4.4: PWS_1 and PWS_2 Main and Finger Gully Features and proposed works

Description	Length (m)	Proposed Work	Remark
MG	4,581	Bank protection, Check Dams, sediment trap and buffer	PW_1
LFG-1	1,006	Bank protection and Check Dams	PW_1
LFG-2	2,124	Bank protection and Check Dams	PW_1
LFG-3	787	Bank protection and Check Dams	PW_1
RFG1	2,612	Bank protection	PW_1
MG	8,047	Bank protection, Check Dams, sediment trap and buffer	PW_2
LFG-1	654	Bank protection	PW_2
LFG-2	760	Bank protection and Check Dams	PW_2
LFG-3	705	Bank protection and Check Dams	PW_2
LFG-4	955	Bank protection and Check Dams	PW_2
LFG-5	937	Bank protection and Check Dams	PW_2
RFG1	902	Bank protection and Check Dams	PW_2
RFG2	1,984	Bank protection	PW_2
RFG3	2,152	Bank protection	PW_2

Source: SMEC (2019) SAP Report, p.35

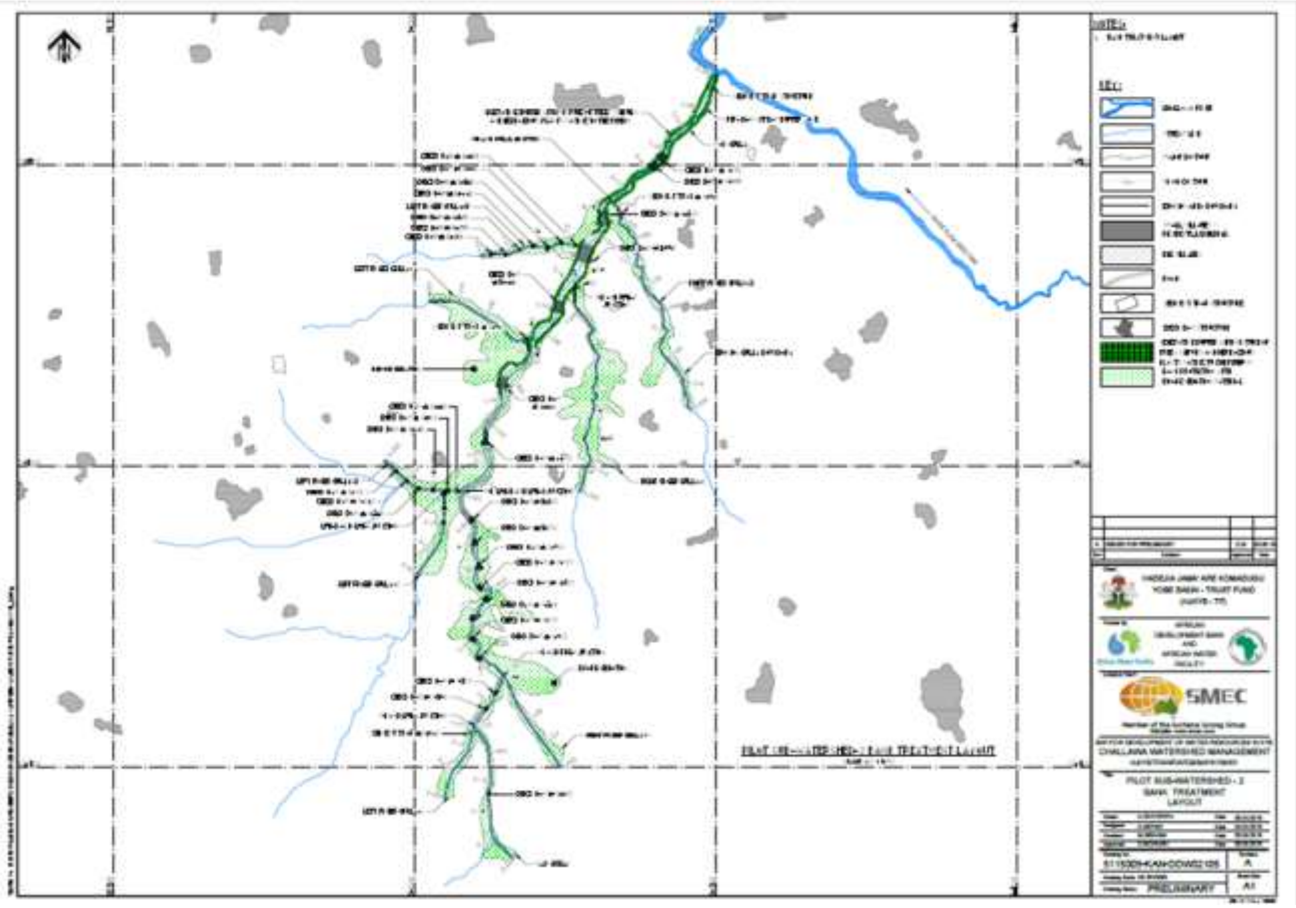


Figure 4.9: General Layout of Pilot Sub-Watershed_2 (PWS_2) Source: SMEC (2019) SAP Report

Index: Mg = Main Gulley; LFG = Left Finger Gulley; RFG = Right Finger Gulley.

Considering the nature and extent of erosion and other site-specific conditions within the sub-watersheds, check dams and sediment traps were proposed as the most feasible erosion and sediment control structures within each pilot sub watersheds. This is to be further integrated with bio engineering measures, as well as agricultural measures. The control measures are to be provided inside the main and finger gullies and on adjacent farm lands and on the eroded river banks. To do this, the gulley sections were designed to be provided with check dams to stabilize the flow and promote sediment deposition. The check dams are to serve as a grade control and energy dissipation structures along the main and finger gullies. The check dams are designed to be provided at recommended intervals to serve as grade and velocity control.

Overall, Challawa Gorge dam watershed covers an area of 3,842 km^2 but the measures proposed in this study covers two pilot sub-watersheds with an area of 3,150 ha (pilot 1) and 2,661 ha (Pilot 2). Proposed measures for control of sediment flux include:

(i) Construction of soil erosion control structures for:

- Main gullies
- Finger gullies
- Check dams
- Sediment traps

(ii) Gully bank treatment:

- Bio-remediation through planting of vetiver grass
- Agricultural erosion control methods

(iii) Buffer zones which include:

- Riparian buffer for Challawa reservoir
- Buffer zones for pilot water shed streams

The proposed measures will be undertaken in a total area of 1485 Ha as outlined below:

- Around reservoir (475 Ha)
- In Pilot area_1 (276 Ha)
- In Pilot area_2 (218 Ha)
- In Buffer strips in Pilot area ‘1’ and ‘2’ (16 Ha), and
- On Farmlands (500 Ha)

4.4.2 Project Component 1: Gully Bank Erosion Control

The watershed level of the Challaawa Gorge Dam down-cutting is causing the stream bank to become too steep for vegetation to exist, this is encroaching towards farm lands and there is little a farmer can do to protect a streamside other than temporary fixes. In addition, the erosion is also due to human activity along the riparian area, like cutting down vegetation for agriculture land and allowing livestock access along long portions of a stream (Plate 4.6). On Plate 4.6, farmers are cultivating their lands to the edge of river (A), and cattle grazing along the stream corridor (B) are common sites in the project area. The banks of the rivers are not protected with vegetation and farmers cultivate the land to edge of the river promoting lateral erosion. The components of erosion control structures proposed for the project were based on the severity of the erosion and other technical considerations (SMEC, 2019, p.38). The proposed erosion control measures include Check dams, bioengineering and agricultural measures.

Plate 4.5: Farmers cultivating land to the edge of river

Plate 4.6: Cattle grazing along the stream corridor

4.4.3 **Check Dams component**

Check dams made of gabions are one of the most practical and effective erosion control measures used for stabilisation of gullies and erosion sites. They are proposed to be provided to stabilize active gullies and steep slopes in Challawa Gorge Dam Pilot Sub-Watershed areas. Check dams are provided to stabilize the gradient of the gully beds in the steep slope reaches of **PSW_1** and **PSW_2** gullies. The check dams are proposed to promote sediment deposition and later create stable bed gradient for the gullies. A total of 50 check dams were proposed for the two pilot sub-watersheds. There are 15 proposed gabion check dams for PWS_1 and 35 for PWS_2. The approximate locations of the check dams are presented in table 4.4 below.

Table 4.5: Geo-Location Of Check Dams And Sediment Traps For Pws_1 And Pws_2

Item	Latitude	Longitude	Item	Latitude	Longitude	Description	Latitude	Longitude
cd1	11.606831	7.776074	cd1	11.44606	7.735803	sts1	11.45125	7.739148
cd2	11.608134	7.779837	cd2	11.44537	7.735207	sts2	11.44133	7.732271
cd3	11.608579	7.780711	cd3	11.44125	7.730817	sts3	11.43239	7.725455
cd4	11.611443	7.784364	cd4	11.43839	7.729352	sts4	11.40222	7.721253
cd5	11.601144	7.784772	cd5	11.43456	7.727522	gbr1	11.40604	7.726475
cd6	11.601091	7.782574	cd6	11.42844	7.723425	gbr2	11.43031	7.720823
cd7	11.609781	7.788436	cd7	11.42428	7.721939			
cd8	11.602482	7.787389	cd8	11.4208	7.719968			
cd9	11.619559	7.787111	cd9	11.42099	7.719318			
cd10	11.619215	7.786532	cd10	11.42068	7.718296			
cd11	11.619209	7.785616	cd11	11.42062	7.71729			

cd12	11.618546	7.784854	cd12	11.42126	7.716481
cd13	11.618319	7.786944	cd13	11.42127	7.715722
cd14	11.618364	7.782924	cd14	11.41842	7.720967
cd15	11.59879	7.787201	cd15	11.41678	7.721317
			cd16	11.41505	7.721619
			cd17	11.41336	7.721767
			cd18	11.41246	7.722173
			cd19	11.41105	7.7216
			cd20	11.40938	7.721001
			cd21	11.40811	7.721652
			cd22	11.40472	7.722563
			cd23	11.40358	7.721782
			cd24	11.43902	7.728819
			cd25	11.43926	7.727784
			cd26	11.43886	7.726818
			cd27	11.43867	7.725916
			cd28	11.43874	7.724863
			cd29	11.43845	7.72384
			cd30	11.43854	7.722783
			cd31	11.39766	7.722553

Figure 4.9: Water surface profiles and proposed check Dams along PWS-1 Main Gulley

Source: SMEC, 2019 SAP Report, p.41

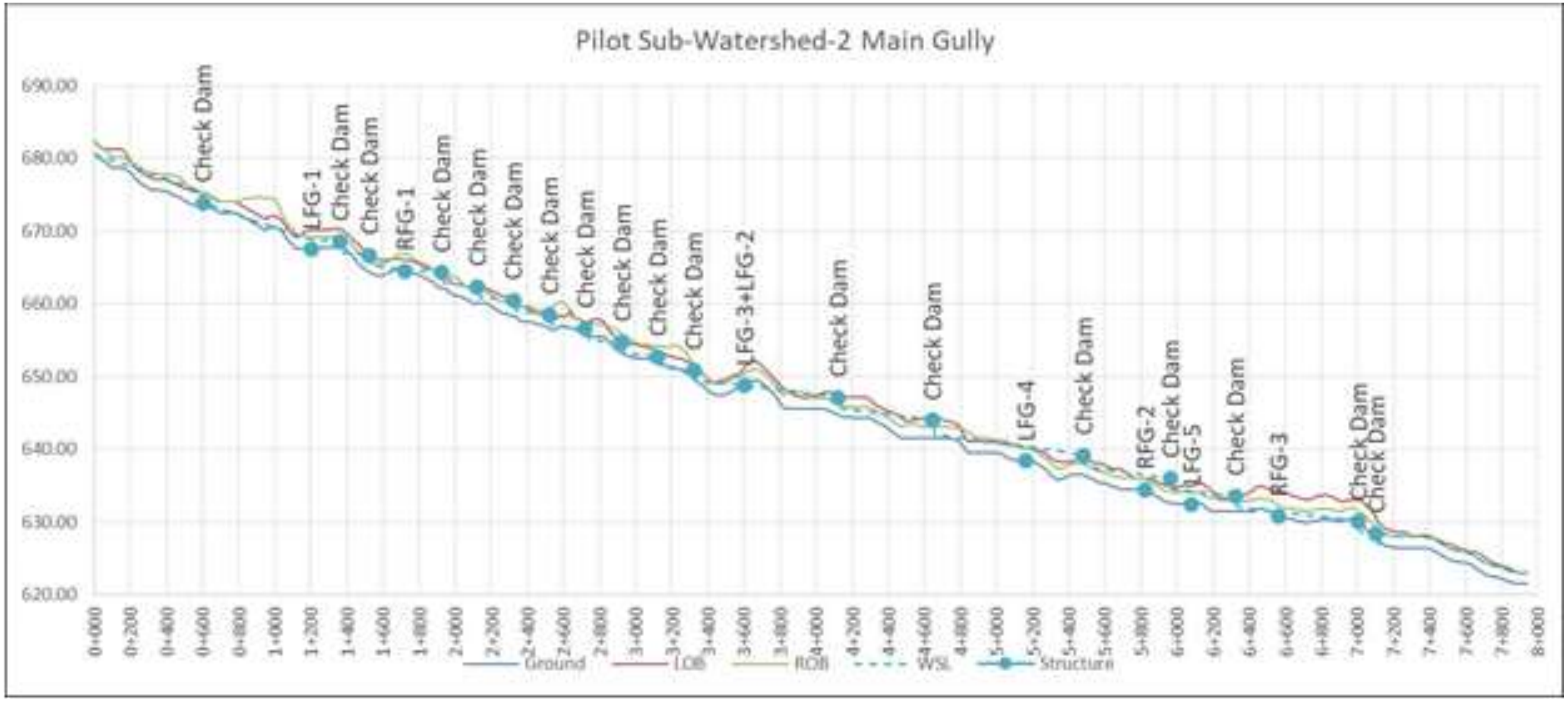


Figure **4.10: Water surface profiles and proposed Check Dams along PWS-2 Main Gulley**

Source: SMEC, 2019 SAP Report, P.41

4.4.4 Stream bank stabilization with Bio-remediation

A. Grading and trimming

The middle reach of the gully has relatively narrow and very deep exposed gully bank section with slope varying from 45 to 50 degrees. This slope is not stable for such poorly structured geological formation. Therefore, the slope of gully banks is proposed to be graded with the following recommendations:

- Provision of graded slope of 1:1.5 with 4m wide berm at the middle of the bank, the proposed graded bench is horizontal and along the contour and interceptor drainage is provided every 10m elevation interval in order to intercept the storm water and evacuate to the collector drain.
- Provision of bio-degradable geo matt on the treated surface where the gully slopes are steep and exposed the geo-matt will create a support of the banks until the bio-remediation is fully developed.

Even with bank stabilizing measures, the gully banks are still vulnerable to further erosion by uncontrolled surface stormwater runoff from the surrounding areas. Hence, protection measures are provided. After careful analysis of various types of bank protection measures, vetiver grass was selected and explanation provided in the following sub section.

Plate 4.7: Exposed Gully bank at PWS-2 Main Gully erosion site
Source: SMEC, SPA (2019) Challawa Gorge Dam

Engineering construction of erosion control structures inside the stream channels, and providing bio-agricultural measures including forest buffers along river banks and gully prone locations within the watershed (Table 3.1).

B. Bio-remediation (Vetiver grass)

The non-vegetated slopes are subject to frequent and sometimes serious erosion process, due to storm water runoff. The gully banks are exposed in active reaches of the gully and are vulnerable to surface erosion from direct rainfall. These exposed surfaces shall be covered with vetiver or other fast growing deep rooted grass in order to minimise the formation of rill type of waterways. Bio-remediation measures can be used to protect gully bank walls and prevent erosion. They provide important resistance to erosion forces and more aesthetic and environmentally friendly than other structures. Accordingly, the main bio-remedial measure proposed at Challawa Gorge Dam Pilot Sub watershed site is planting of vetiver grass on gully bank slopes of less than 40^0.

C. Measures for growing Vetiver grass

i. Description

The proposed work for gully slope stabilization consists of planting fast growing Vetiver grass.

ii. Vetiver grass

Vetiver is a perennial and fast-growing grass growing up to 2 Metres high with roots stretching down to 3 Metres deep in the ground. It has a strong dense and vertical root system and grows in extreme climate and environmental conditions. The vetiver grass can grow on deep sandy soil, under humid conditions and can survive in more than 700 mm rainfall. The whole plant is a Culm, from leaf to roots. Vetiver displays a high level of tolerance to soil acidity, salinity and acid sulphate conditions. Vetiver grass grows quickly and becomes established under hostile conditions. The very deep and extensive root system provides structural strength in a relatively short period of time. The main disadvantage of Vetiver is its intolerance to shaded areas, particularly during its establishment phase. It is also difficult to plant on very steep slopes.

iii. **Special characteristics of Vetiver grass:**

Some special characteristics of vetiver grass include:

- Given its extraordinary root depth and strength, mature Vetiver is extremely resistant to washout from high velocity flow.
- The mean tensile strength of Vetiver is about 75 Mpa at 0.7mm-0.8 mm root diameter which is common size and so its roots have been proven positive for slope reinforcement which means the increase in shear strength of soil increase in shear strength of soil.
- On steep slopes (30-60 degrees), the Vetiver spacing between rows at 1m vertical interval is very close and therefore the grass moisture uptake would be greater to offset the increase in

infiltration and further improve the slope stabilization process. However, to enhance the use of Vetiver on steep slopes in very high rainfall areas, a precautionary measure is to plant Vetiver hedges on a gradient of about 0.5% as in graded contour terraces to divert the extra water to stable drainage outlets.

iv. Gully Slope Stabilization

The vetiver vegetation is being used as a natural and effective bio-engineering tool to control erosion and stabilize slopes against sheet flow erosion:

- Vetiver roots can penetrate a compacted soil profile providing a good anchor for fill and top soil.
- Vetiver's extensive and thick root system binds the soil which makes lodgeit difficult.
- When planted closely together Vetiver plants forms dense hedges that reduce flow velocity, spread and divert runoff water and create a very effective filter that control erosion.
- Acting as a very effective filter, Vetiver hedges reduce the turbidity of surface runoff. Since new roots develop from nodes when buried by trapped sediment, Vetiver continues to rise with new ground level and terraces form at the face of the hedges. The fertile sediment typically contains seeds of local plants which facilitate their re-establishment.

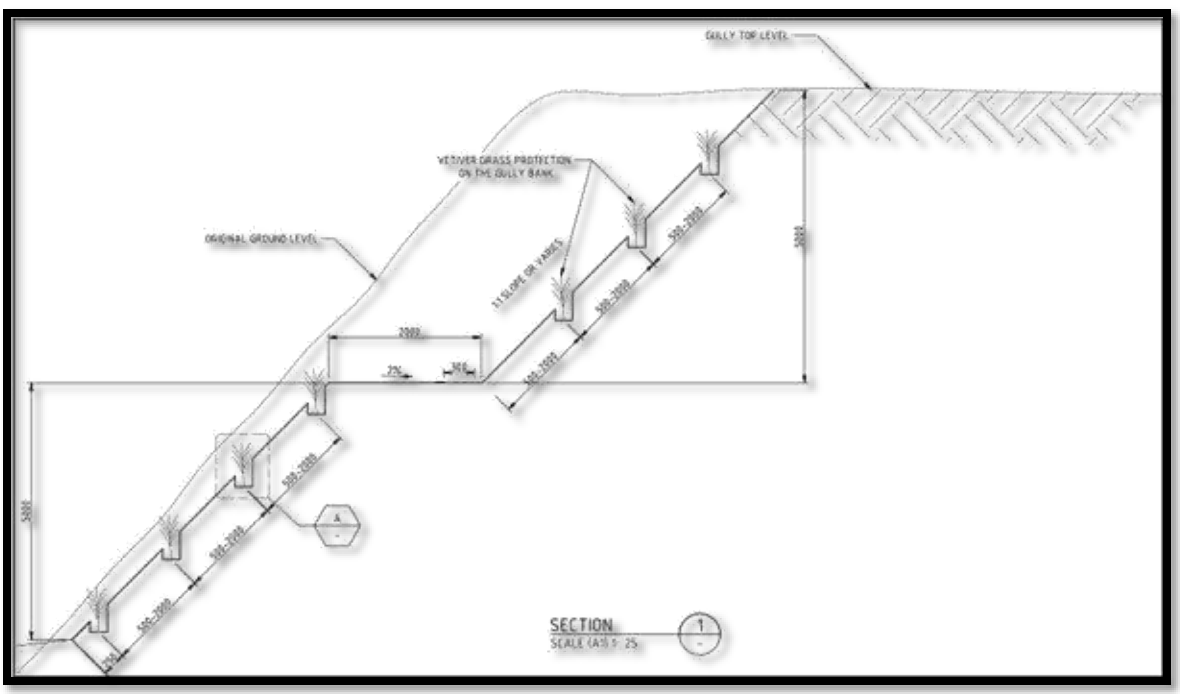


Fig. 4.11: Proposed Bio-engineering measures on gully banks with Vetiver grass

Source: SMEC SAP (2019), Challawa Gorge Dam

Table 4.6 Project Components

S/No.	Project Component	Component Description
	Erosion control structures: The Engineering Construction Component of the Project	
1	Check Dam Design	• Check dams are one of the most practical and effective erosion control measures used for stabilisation of gullies and erosion sites. • They are also provided to stabilize active gullies and steep slopes in Challawa Gorge Dam Pilot Sub Watershed areas. • Check dams are provided to stabilize the gradient of the gully bed in the steep slope reaches.
2	Sediment Trap	• At the outlet of stable bed gullies, slope of the gully tend to be milder because of significant sand deposition. • The sand deposition is lowering the channel capacity promoting lateral stream bank erosion. • Therefore, once the check dams capture a portion of sediment the remaining will be captured at sediment trap and will be used for different purpose for the community such as construction activity.
3	Sediment Trap Design	• Gullies with steeper slope and active gully bed erosion are provided with check dams to stabilise gully bed and to trap sediments upstream of check dams, while gullies with relatively stable slopes are provided with sediment traps at the outlet. • Theses sediment traps will serve to trap sediments which comes from the agricultural land until the agricultural and bio-remediation erosion control measures will fully develop and reduce sediment.
4	Dewatering Orifice	Basin dewatering will be done with orifice structure provide at the downstream direction. The discharge orifice should be sized to dewater the live storage zone within a stated time period 24 hours
	Bank stabilization with Bio-remediation	
5	Grading and trimming	• The middle reach of the gully has relatively narrow and deep very exposed gully bank section; the existing slope is from 45 to 50 degrees. This slope is not stable for such poorly structured geological formation. Therefore, the slope of gully banks is proposed to be graded with the following recommendations:

		• Provision of graded slope of 1:1.5 with 4m wide berm at the middle of the bank, the proposed graded bench is horizontal and along the contour and interceptor drainage is provided every 10m elevation interval in order to intercept the storm water and evacuate to the collector drain. • Provision of bio-degradable geo-matt on the treated surface where the gully slopes are steep and exposed, the geo-matt will create a support of the banks until the bio-remediation is fully developed.
6	Bio-remediation (Vetiver grass)	• Even with bank stabilizing measures, the gully banks are still vulnerable to further erosion by uncontrolled surface storm water runoff from the surrounding areas. Hence, protection measures are to be provided. After careful analysis of various types of bank protection measures, vetiver grass was selected. • The non-vegetated slopes are subject to frequent and sometimes serious erosion process, due to storm water runoff. The gully banks are exposed in active reaches of the gully and are vulnerable to surface erosion from direct rainfall. These exposed surfaces shall be covered with vetiver or other fast growing deep rooted grass in order to minimise the formation of rill type of waterways. Bio-remediation measures can be used to protect gully bank walls and prevent erosion. • Vertiver grass provides important resistance to erosion forces and more aesthetic and environmentally friendly than other structures. • Vertiver grass is to be planted on gully bank slopes of less than 40^0.
7	Gully Slope Stabilization	• The vetiver vegetation is being used as a natural and effective bio-engineering tool to control erosion and stabilize slopes against sheet flow erosion; this because: • Vetiver roots can penetrate a compacted soil profile providing a good anchor for fill and top soil. • Vetiver’s extensive and thick root system binds the soil. • When planted closely together Vetiver plants forms dense hedges that reduce flow velocity, spread and divert runoff water and create a very effective filter that control erosion.

		• Acting as a very effective filter, vetiver hedges reduce the turbidity of surface runoff. Since new roots develop from nodes when buried by trapped sediment, Vetiver continues to rise with new ground level and terraces form at the face of the hedges. The fertile sediment typically contains seeds of local plants which facilitate their re-establishment.
	Agricultural erosion control measures	
8	Erosion Control measures on Farm: Contouring	This is the practice of orienting field operations such as ploughing and planting along the contour. • Contours are level lines across a slope at a constant elevation. • It reduces surface runoff by trapping water in small depressions and decreases the incidence of rill formation. • Contouring is proposed in steep cultivated lands of Pilot sub watersheds with slope exceeding 5%. • Vegetative barriers (such as grassy strips) will be located on the contour to control soil erosion. • Water flowing down the slope picks up soil. When it reaches a contour barrier it slows down, the soil particles settle out, and more water enters into the soil.
9	Strip Cropping	• For water erosion control the strips may be aligned along the contour and the crops follow a different rotational sequence so that the entire field is never bare. • Buffer strips may also be used to protect sensitive areas of the field from erosion, or to create areas which will retard runoff and trap sediment.
10	Conservation Tillage	• One of the most important agricultural conservation measures being adopted in many areas of the world in recent years is the reduction in tillage (turning of the soil). • Under conservation tillage, the crop stubble is left standing and residue is evenly spread across the field as mulch instead of being ploughed under. • Weeds are controlled by cutting and herbicide. • Compared to conventional tillage, conservation tillage can increase soil organic matter, reduce erosion by as much as 90%, enhance infiltration, and reduce moisture loss. • When implemented across a watershed, the enhanced

		infiltration can reduce peak discharge and downstream flood damages.
11	Grassed Waterways	• This is a shallow drainage way in which vegetation protects the channel against erosion, thereby increasing the permissible (non-erosive) velocity compared to bare soil; • Maximum permissible velocities depend on the type of grass, but are generally limited to about 1.2 m/s and slopes not exceeding 5%. • For streams that have a base flow, a stone centre is provided. Scour resistance may be enhanced by geo-synthetic reinforcement;
12	Terraces	• Terraces work against gravity, interrupting the tendency of water to flow down- slope. • It is recommended to use stiff grass hedges in Challawa Watershed area by planting a dense hedge of stiff grass on the contour, which retards runoff and causes water to pond and deposit sediment on the uphill side of the hedge. • Because it is living, the grass hedge will become stronger with time and can grow as sediment collects and the terrace height increases. • Deposited sediment fills in low spots, runoff tends to become more evenly dispersed and less erosive with time, and the hedge tends to naturally build terraces that follow the contour.
Buffer zones construction		
13	Riparian buffers	In the Challawa Gorge Dam watershed, provision of riparian buffer around the reservoir and maintenance of existing riparian buffers in their natural condition has been identified as one of the most effective means of protecting Challawa Gorge Dam reservoir sedimentation, including water quality, hydrology, natural communities, and watershed ecosystem function. *Objective of the buffer strips* • Reduce erosion runoff of sediment, nutrients and other potential pollutants • Remove pollutants from water runoff • The objectives of proposed buffer strip are mainly to: • Intercept sediments and remove nutrients and other non-point

		source pollutants from surface runoff and also serve to prevent erosion of soil through soil stabilization. • Attenuate runoff. Maintenance of riparian vegetation or stream buffer strips and reduction of erosion lowers the potential for substance movement by surface runoff, thereby reducing the potential for water quality degradation. • Enhance the landscape diversity, providing visual appeal and also serve to conserve and/or supplement open space. • Reservoir buffers are recommended in different widths around the reservoir as per the required purpose. In order to design and maintain an effective buffer it is important to assess the physical condition of the reservoir corridor. However, for this preliminary design a reservoir buffer width of 30m is recommended, as per literature, is proposed.
14	Stream Buffer Strip design .	• The spatial placement of buffer strips within a watershed can have profound effects on water quality. • Riparian buffers in headwater streams (i.e., those adjacent to first-, second-, and third-order systems) have much greater influences on overall water quality within a watershed than those buffers occurring in downstream reaches; • Downstream buffers have proportionally less impact on polluted water already in the. On the other hand, buffer strips on the downstream rich of the river will have significant impact for stream bank erosion. *Location within Watersheds* • The location of the buffer strip depends on its objective and purpose. The main purpose of stream buffer strips in this Project is for stream banks stabilisation. This will focus on the reach of the stream where bank erosion is active; • Therefore, buffer strips are provided at downstream reaches of gullies.

4.4.5 Erosion control structures: The Engineering Construction Component of the Project

Structural (engineering) measures to control gully formation and check channel and reservoir siltation are to be constructed inside the gullies while bio-remediation and agricultural measures are to be provided on eroded gully banks and adjacent farm lands respectively to stabilize soil, and reduce surface flow. Gabion check dams and sediment traps are the main structural measures to be provided at selected sites. Selection was done in an earlier study (SMEC, SAP 2019) after proper identification of erosion processes and hydraulic phenomena, including water surface and velocity profile inside gully channel. Comparison was made in the existing and stable slope. The unstable section of gully is designed to be provided with check dams to stabilize flow and promote sediment deposition upstream of check dams. Check dams are designed for 10-year return period design floods and their stability is checked for a 25-year return period. Generally, over 50 Gabion check dams (Plate 4.7), differing in size, are to be provided in Pilot sub watersheds of the Challawa Gorge Dam.

Gullies with relatively stable slopes will be provided with embankment filled sediment traps at their outlet locations. Theses sediment traps will serve to trap sediments which come from agricultural land until the agricultural and bio remediation erosion control measures fully develop and reduce sediment. Four sediment traps at the outlets of finger gullies are also to be provided in the two pilot sub watersheds. Each sediment trap is equipped with a rock riprap (Plate 4.8) overflow spillway and concrete pipe dewatering orifice. The spillway is designed to pass the 25-year return period design flood while the orifice is designed to empty the 10-year design flood volume in 24 hours.

Plate 4.8: Gabion Check Dam to counter erosion

Plate 4.9 River Rock Riprap for Stream Bank Erosion Control

Source: Accessed on June 15, 2021 at *www.riparian+buffer+zone+definition&sxsrf*

4.4.6 Gully Bank Treatment with Bio-Remediation and Agricultural Measures

On eroded banks of gullies and adjacent agricultural lands, bio-remediation and agricultural erosion control measures are to be provided. Gully banks and steep agricultural lands are proposed to be protected with provision of bio engineering (Bio-remediation) and agricultural erosion control measures respectively. Bio remediation focuses on provision of vetiver grass on eroded gully banks with trimming and grading steep gully banks prior to planting, while the agricultural measures focuses on controlling soil loss from the agricultural lands with provision different agricultural practices such as terracing and strip cropping measures. The following subsections discuss these two major erosion control measures and their preference in the Challawa Gorge Dam pilot sub watershed areas. Slopes of gully banks are proposed to be graded with the following:

i. Provision of graded slope of 1:1.5 with 4m wide berm (i.e. a flat strip of land, raised bank, or terrace bordering a river or canal) at the middle of the bank. The proposed graded bench is horizontal and along the contour and interceptor drainage is provided every 10m elevation interval in order to intercept the storm water and evacuate to the collector drain.

ii. Provision of bio-degradable geo matt on the treated surface where the gully slopes are steep and exposed the geo-matt will create a support of the banks until the bio-remediation is fully developed.

However, even with these bank stabilizing measures, the gully banks may still be vulnerable to further erosion by uncontrolled surface storm water runoff from the surrounding areas. Hence, additional protection measures are to be provided. After careful analysis of various types of bank protection measures, vetiver grass and agricultural measure were selected as most suitable options. while the agricultural measures are to complement vertiver grass focusing on controlling soil loss from agricultural lands by implementing agricultural practices such as contouring, strip cropping and conservation tillage involving the community and in close consultation with farmers.

1. **Vetiver grass**

Vetiver grass is a perennial and fast-growing grass growing up to 2 metres high with roots stretching down to 3 metres deep in the ground (Plate 4.9; Plate 4.10; Fig.4.12; and 4.13). The vetiver vegetation is being used as a natural and effective bio-engineering tool to control erosion and stabilize slopes against sheet flow erosion. It has a strong dense and vertical root system and grows in extreme climatic and environmental conditions. Vertiver grass is proposed to be planted on eroded gully banks by trimming and grading steep gully banks prior to planting.

The vetiver grass can grow on deep sandy soils, under humid conditions and can survive in more than 700 mm rainfall. The whole plant is a Culm, i.e. aerial or above-ground stem of a grass or sedge), from leaf to roots. It displays a high level of tolerance to soil acidity, salinity and acid sulphate conditions. It grows quickly and becomes established under hostile conditions. The very deep and extensive root system provides structural strength in a relatively short period. The main disadvantage of Vetiver is its intolerance to shaded areas, particularly during its establishment phase.

Plate 4.10 Vertiver Grass: For Soil stabilizer and erosion and sediment flow control
Source: Accessed on June 15, 2021 at *www.riparian+buffer+zone+definition&sxsrf*

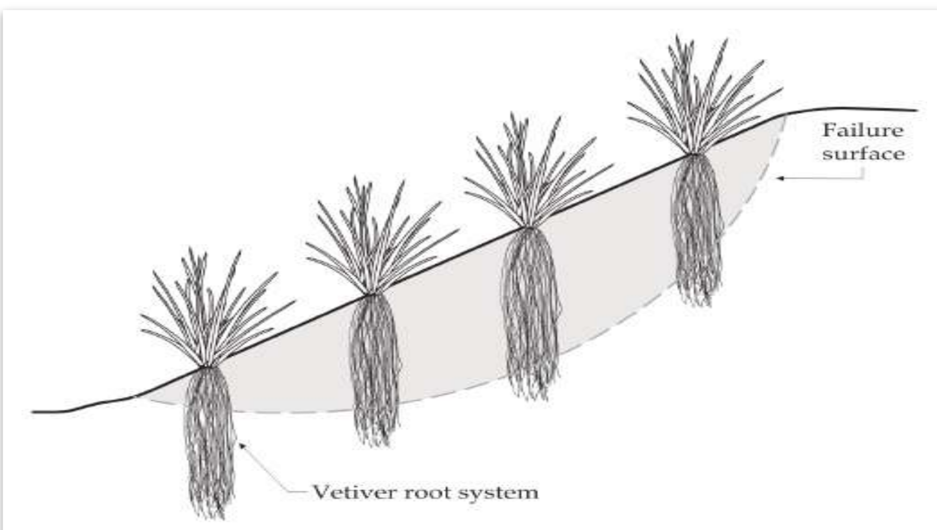


Figure 4.12: Schematic Representation of Soil Reinforcement by Vertiver Grass roots to Minimize
Source: Accessed on June 15, 2021 at *www.riparian+buffer+zone+definition&sxsrf*

Plate 4.11 Vertiver Grass Planting on Riverbank

Source: Accessed on June 15, 2021 at *www.riparian+buffer+zone+definition&sxsrf*

Some other special characteristics that make it suitable for erosion control is that:

a. Given its extraordinary root depth and strength, mature vetiver is extremely resistant to washout from high velocity flow.
b. The mean tensile strength of vetiver is about 75 Mpa at 0.7mm-0.8 mm root diameter which is common size and so its roots have been proven positive for slope reinforcement which means the increase in shear strength of soil.
c. On steep slopes (30-60 degrees), the vetiver spacing between rows at 1m vertical interval is very close and therefore the grass moisture uptake would be greater to offset the increase in infiltration and further improve the slope stabilization process. However, to enhance the use of vetiver on the steep slopes in very high rainfall areas, a precautionary measure is to plant vetiver hedges on a gradient of about 0.5% as in graded contour.
d. Vetiver roots can penetrate a compacted soil profile providing a good anchor for fill and top soil. Vetiver's extensive and thick root system binds the soil which makes it difficult to dislodge.
e. When planted closely together Vetiver plants forms dense hedges that reduce flow velocity, spread and divert runoff water and create a very effective filter that control erosion.
f. Acting as a very effective filter, Vetiver hedges reduce the turbidity of surface runoff. Since new roots develop from nodes when buried by trapped sediment, Vetiver continues to rise with new ground level and terraces form at the face of the hedges. The fertile sediment typically contains seeds of local plants which facilitate their re-establishment.

2. **Vetiver Nursery** The success using vertiver grass in this project would depend on good quality and sufficient numbers of Vetiver slips/tillers. The community nursery individual farmer households can set up vetiver nurseries. The nursery owners will be contracted (as out-growers or contract farmers) and paid by the project for supply of veriver seedlings (and therefore serves as a source of income for participating farmers). For effective planting at field, the local people can also be encouraged to participate in raise awareness and ensure the slips/tillers protection from animals. Nurseries will require more care to ensure good growth and multiplication of the slips/tillers. Participation of the locals is important for sustainability as they become partners' in ownership of the project. Due to the large volume of vetiver plants required, it is recommended to have one nursery per gully. This strategy will reduce transport costs and allow local communities to participate in the nursery enterprise while it also allows for some degree of equitable participation of the local community throughout the project area. Most of the proposed seedlings will require at least four months maturing (to be ready for planting). The establishment of these nurseries must therefore start immediately alongside start of construction. Planting time. Vetiver generally needs 3-4 months to become established and is fully effective at the age of 9-10 months. Mass planting should follow the construction schedule. If it occurs during the dry season, the contractor should provide adequate watering. If during the rainy season, the plants should be protected with synthetic mats. In both cases protection from animals is necessary.

3. **Suitable Period for Planting**

Planting should follow the proposed work schedule. However, if planting occurs during the dry season, adequate watering should be provided by the contractor. The following points should be considered in the implementation of Vetiver grass:

- Spacing of Vetiver rows varies from 50-200 cm and depends on the soil conditions.
- Drainage system i.e. interceptor ditch and drain chute are also necessary.
- The planting rows spacing can be 50-100cm apart in erosion prone areas and 1-2m in areas less vulnerable to erosion.
- In order to achieve better performance of Vetiver for civil work protection, planting can be done along with civil works with less interference between them. Planting can be started at an early stage in stable locations of the buffer areas.

4. Layout Specifications

To stabilize the gully slope, the layout specifications are as follows:

- Gully slope should not exceed 1H: 1V or 45 deg. Shallow gradients are recommended whenever possible, especially on erodible soil and or in high rainfall area.
- Vetiver should be planted across the slope on contour lines with a vertical interval between 1m-2m apart, measured down the slope. Spacing of 1m should be used on highly erodible soil, which can increase up to 1.5-2m on more stable soil.
- The first row should be planted on the top edge of the batter and the bottom row at the bottom of the slope. Between these rows, Vetiver should be planted as specified above.
- Benching or terracing 1-3m in width for every 5-8m vertical interval is recommended for slope that is taller than 10m.

5. Planting specification

The procedures for planting the Vetiver:

- Vetiver requires a clean and moist field;
- The contour lines shall be prepared before planting the tillers and then a trench (15-20 cm deep & wide) should be prepared to place the Vetiver.
- If the plants are from poly bags, tear the poly bags;
- Dip the root part in dung/slurry (soil manure mixture) to initiate the first development of roots.
- Plant 3-4 tillers per station along the contour at an interval of 5-10cm when the ground is wet and moist.
- Cover roots with 20-30mm of soil and compact firmly, fertilize with nitrogen and phosphorus and water within the day of planting.

4.4.7 Riparian Buffer Strip

The other source of sediment for Challawa Gorge Dam Reservoir is from the surrounding adjacent agricultural lands and from stream bank erosion in the upland watershed as non-point sources. These non-point sources are to be treated by providing vegetated buffer zones. Buffer zones refer to lands directly adjacent to water bodies such as reservoirs and streams. These areas have a significant impact on controlling non-point source pollution by trapping suspended sediments and stabilizing stream banks. The ability of buffer strips to meet specific objectives is a function of their position within the watershed, the composition and density of vegetation species present, buffer width and length, and slope. Accordingly, in this project, 15m and 30m wide vegetated buffer zones are to be established along the main streams banks of the Watersheds and around Challawa Reservoir area respectively.

The Riparian buffer (fig.3.2) shall consists of an area of trees and other vegetation located in areas adjoining and up gradient from surface water bodies and designed to intercept surface runoff, wastewater, subsurface flow, and deeper groundwater flows from upland sources for the purpose of removing or buffering the effects of associated nutrients, sediment, organic matter, pesticides, or other pollutants especially from agricultural activities, prior to entry into surface waters and groundwater recharge areas. The three vegetated riparian buffers zones, shall include a zone of stabilization at the stream edge, a tree and shrub area, and an area of dense grasses. The first zone next to the stream should be 15 feet wide, measured perpendicular to the stream to be comprised of the tree shrub vegetation used in stream stabilization. The second zone consists of an area with a minimum width of 60 feet, measured wide and on the land side of the first zone. It consists of trees, shrubs, and their litter of leaves and branches as an energy source to capture agricultural chemicals that pollute streams.

i. Width of Riparian Buffer

Buffer width, as defined herein, is measured beginning at the top of the bank or level of bank full discharge. Width recommendations for buffer strips are either fixed or variable in nature. Fixed-width buffer strip recommendations tend to be based on a single parameter or function. Therefore, in the design of stream buffer zone for Challawa Gorge Dam Pilot sub watershed the objective is single and clearly defined. It is planned to protect the stream bank erosion.

Table 4.7: General Riparian Buffer Strip recommended in as per various Guidelines

Function	Description	Recommended width
Stream Stabilization	Riparian vegetation moderates soil moisture conditions in stream banks, and roots provide tensile strength to the soil matrix, enhancing bank stability. Good erosion control may only require that the width of the bank be protected.	10 to 20m

There are many factors that influence the effectiveness buffers. These include slope, rainfall, and the rate at which water can be absorbed into the soil, type of vegetation in the buffer, the number of impervious surfaces, and other characteristics specific to the site. Based on the recommendation given in Guidelines and the actual site condition, the nature and extent of bank erosion in the specific site a stream buffer width of 15m on both side is provided in both Pilot 1 and 2, as shown in Figure 3.2 below:

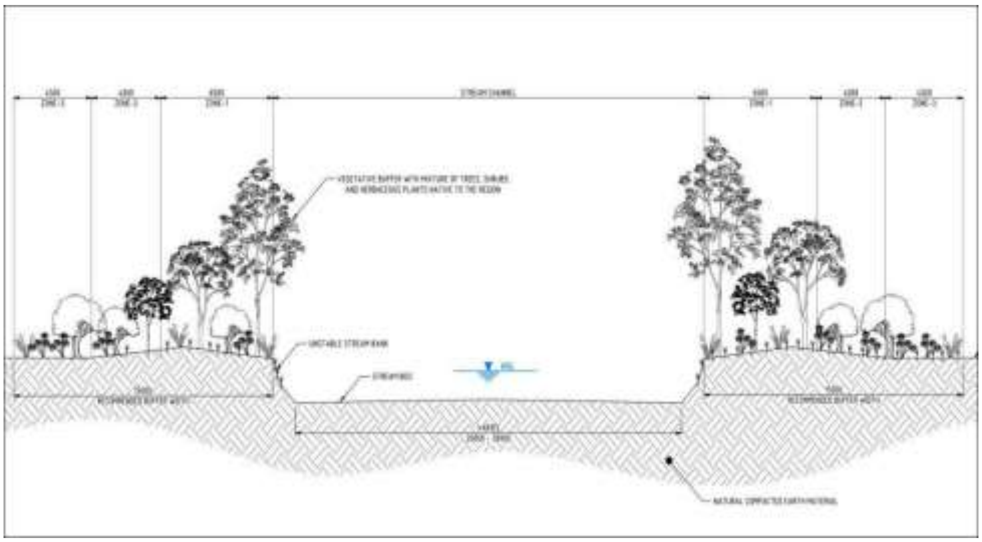


Figure 4.13: Proposed three-zones forest buffer width for Pilot Watershed 1 and 2

The 15m buffer width proposed has three different zones each having different vegetation planning and purpose. The vegetation planning is discussed in the following section.

ii. Vegetation planning for stream buffer zones

Most of the focus on buffer design is the needed width; however, the vegetation assemblage, layout, and length are also key design parameters. The riparian buffer planting will have a direct relationship with the design and vegetation selected for the planting. Trees, shrubs and grasses vary in the kinds of benefits they provide to the buffer structurally**.** diverse riparian buffers, i.e. those that contain a mix of trees, shrubs and grasses, are much more effective at capturing a wide range of pollutants than a riparian buffer that is solely trees or grass.

The most effective riparian buffers should include a mix of trees, shrubs and herbaceous plants native to the region and appropriate to the environment in which they are to be planted. When planting buffers, it is best to use adjacent reference riparian buffers as the basis for selecting floral composition. Since different vegetation have different benefit in buffer zone, careful selection of riparian vegetation is essential. Figure 7.8 shows the relative effectiveness of these different vegetation types in providing a variety of benefits. For stream buffer strips designed for Pilot sub watersheds, the width of buffer is divided in to three zones as shown in Figure 4.14. Vegetation composition of each riparian buffer zone is explained below along with their objectives:

Zone 1.

This zone begins at the stream edge and is the area that provides streambank stabilization and bank erosion protection as well as habitat for terrestrial animals. Primary functions of this zone include provision of shade helps reduce flood effects, stabilize stream banks, and remove some sediments and nutrients. Vegetation should be composed of native, non-invasive trees and shrubs of a density that permits understory growth; it should also tolerate frequent inundations. The width of this zone typically varies between 5 and 8 m or more. In this specific design considering the objectives and practicality it is designed to be 6.5m.

Zone 2.

This zone extends upslope from Zone 1 from a minimum of 3m up to 5m, depending on objectives, stream type, soil type, or topography. The objective in this zone is to provide a managed riparian forest with a vegetation composition and character similar to natural riparian forests in the region. Therefore, a width of 4m is provided. Species of vegetation used in this zone should be reasonably flood- and drought-tolerant. The primary function of Zone 2 is to remove sediments, nutrients, and other pollutants from surface and groundwater.

Zone 3.

This zone typically contains grass or herbaceous filter strips and provides the greatest water quality benefits by slowing runoff, infiltrating water, and filtering sediment and its associated chemicals. The minimum recommended width of Zone 3 is 4.5 m when used in conjunction with Zones 1 and 2. The primary concern in this zone is initial protection of the stream from overland flow of pollutants such as herbicides and pesticides applied to agricultural fields. Properly designed grassy and herbaceous buffer strips may provide quality habitat for several upland wildlife species.

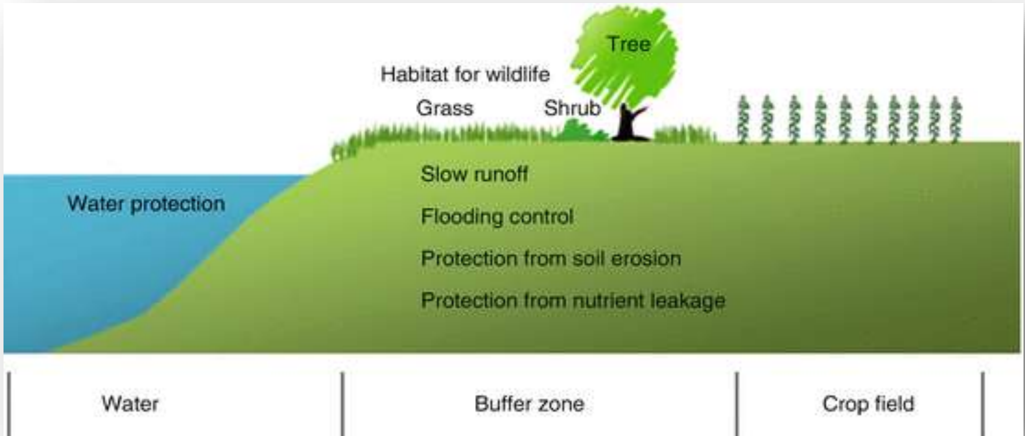


Figure 4.14 Typical Riparian Buffer Vegetation Zoning for Erosion and stream water quality control
Source: Accessed on June 15, 2021 at *www.riparian+buffer+zone+definition&sxsrf*

The first zone next to the stream should be 15 feet wide, measured perpendicular to the stream. The second zone consists of an area with a minimum width of 60 feet, measured wide and on the land side of the first zone. It consists of trees, shrubs, and their litter of leaves and branches as an energy source to capture agricultural chemicals that pollute streams. Livestock are to be restricted from zones one and two. Maintenance of zones one and two, especially after very high stream flows, is necessary. Zone three should be approximately 25 feet wide and contain natural grasses. This zone is an important area for infiltration of water during heavy storms. Livestock grazing over zone three should be limited to ensure adequate grass cover.

Specifically, riparian buffers provide the following benefits:

a. *Water Quality Protection*: Pollutants and nutrients from pesticides, fertilizers, and livestock practices can leach from farmland and be transported in surface runoff, which may damage aquatic ecosystems. Riparian buffers are physical barriers between streams and developed land, which trap these pollutants and decrease their harmful effects. Nutrients found in most fertilizers and animal waste—nitrogen and phosphorus—often bind to soil particles causing them to be trapped in the buffer. Once in the soil, both microorganisms and plants transform these pollutants into less harmful forms and/or store them as biomass. Specifically, it has been found that 50-100% of the sediments and nutrients can be trapped or absorbed in riparian buffers

b. *Bank Stabilization and Erosion Control:* Plant roots grow down into stream banks, creating a complex system that holds soil and makes the bank more secure and stable. Plant stems and other debris work to deflect the cutting action of water from high stream flows and runoff, which decreases erosion

c. *Shade and Wildlife Habitat*: Aquatic habitats are improved by increasing water quality, steadying water flow, and introducing shade. Shade produces regions of cooler water, which can hold more oxygen and lead to reduced stress on aquatic organisms. Additionally, the buffer acts as a source of woody debris that provides shelter for fish, invertebrates, and amphibians, provide habitat for various terrestrial species like water fowl, nesting animals, and browsing herbivores, as well as cover for predators, thus promoting ecosystem biodiversity.

d. *Groundwater Recharge and Flood Control:* Buffers work to slow the rate at which water enters a stream or river. This prevents surface runoff from entering the stream too quickly and allows water to percolate into the soil. The reduction of fast-flowing water decreases the chances of flooding while allowing more water to be transferred into the ground, thereby recharging the groundwater.

e. Helps cool the stream temperature, which improves insect and fish habitat.

f. Establish complex root system from trees, shrubs, and grasses, which helps retain soil.

g. Naturally removes phosphorous and nitrogen products from runoff water.

h. Increases infiltration of water into the soil and slows the runoff.

i. Decreases stream sediment load.

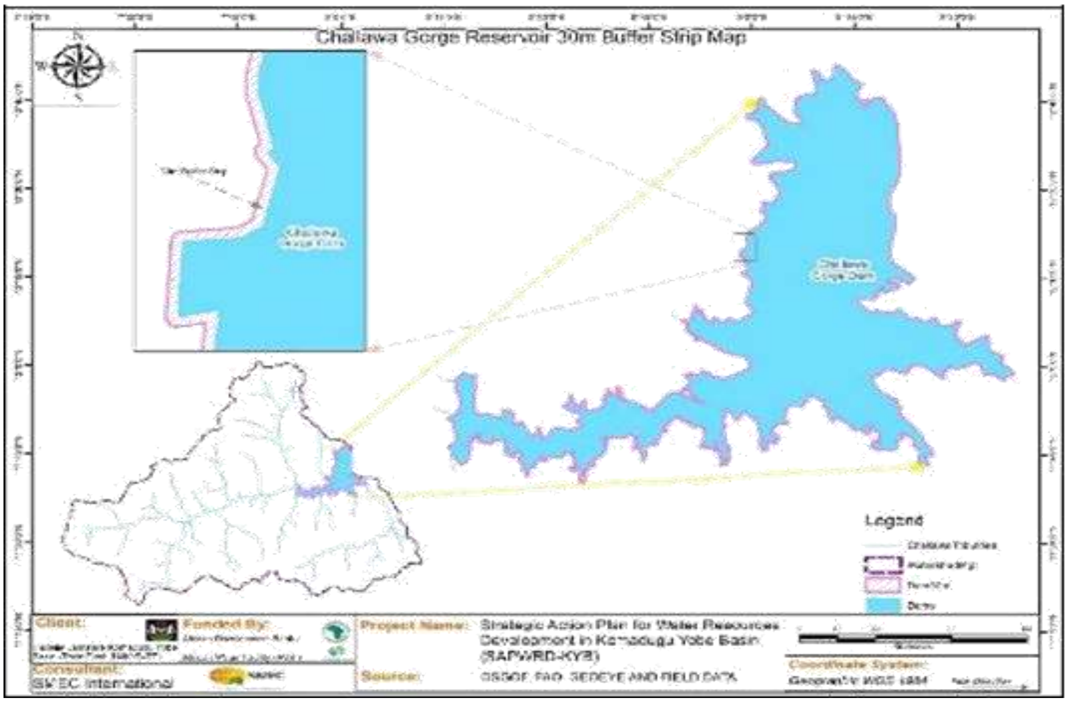


Figure 4.15: Challawa Gorge Dam reservoir area and proposed buffer zone
Sources: SMEC (2019) Strategic Action Pan, Challawa Gorge Dam Watershed Management

4.4.8 Agricultural erosion control methods component

This section provides a brief description of basic agricultural erosion control methods proposed to be used within agricultural lands of the Watershed. As the major land use in the watershed is agricultural land for subsistence farming, the provision of farm erosion control measures targeting small holder farms is desirable. Several types of farm level erosion control techniques have been developed to fit soil, climate, crop, and socioeconomic conditions around the world. Local sources have been consulted for information on indigenous knowledge about techniques proposed in the area to protect land against erosion.

When an erosion problem is identified in a watershed, there is usually effort to develop and implement a "soil conservation" program. However, this top-down approach has largely been ineffective against erosion, as evidenced by the failure of projects of this type worldwide. Farmers control the use of the land they till, and are rarely willing to implement costly soil conservation measures, or change their production practices, unless there are tangible benefits to themselves and their families. The application of structural erosion-control measures on subsistence farmers has often been unsuccessful; the measures have not been maintained, and in some cases, they were even dismantled by the people they were supposed to benefit.

This and other similar experiences noted in the literature underscore the importance of the socioeconomic aspect of erosion control and involvement of the local people. An important challenge is to develop conservation practices that not only reduce erosion but also increase land productivity. Successful erosion control projects will focus on practices that improve the farmer's condition while simultaneously conserving soil and water. Conservation measures are most likely to be profitable, and thus implemented, when they are cheap and simple, or, when they allow improved agronomic practices to be implemented. Even when the principal impact of soil loss is offsite (such as Challawa Gorge Reservoir), the farm-level approach is still appropriate because conservation measures must be implemented and sustained by farmers themselves. Accordingly, the following farm level erosion control measures are designed to tackle soil erosion and increase productivity in the farm level with in the pilot sub watersheds.

i. **Erosion Control measures on Farm**:

   a. *Contouring*: The practice of orienting field operations such as ploughing and planting along the contour is called contouring. It reduces surface runoff by trapping water in small depressions and decreases the incidence of rill formation. Contouring is proposed in steep cultivated lands of the watersheds with slope exceeding 5%. Contours are level lines across a slope at a constant elevation.
   b. *Vegetative barriers* (such as grassy strips) will be located on the contour to control soil erosion. Water flowing down the slope picks up soil and when it reaches a contour barrier it slows down, the soil particles settle out, and more water enters into the soil.

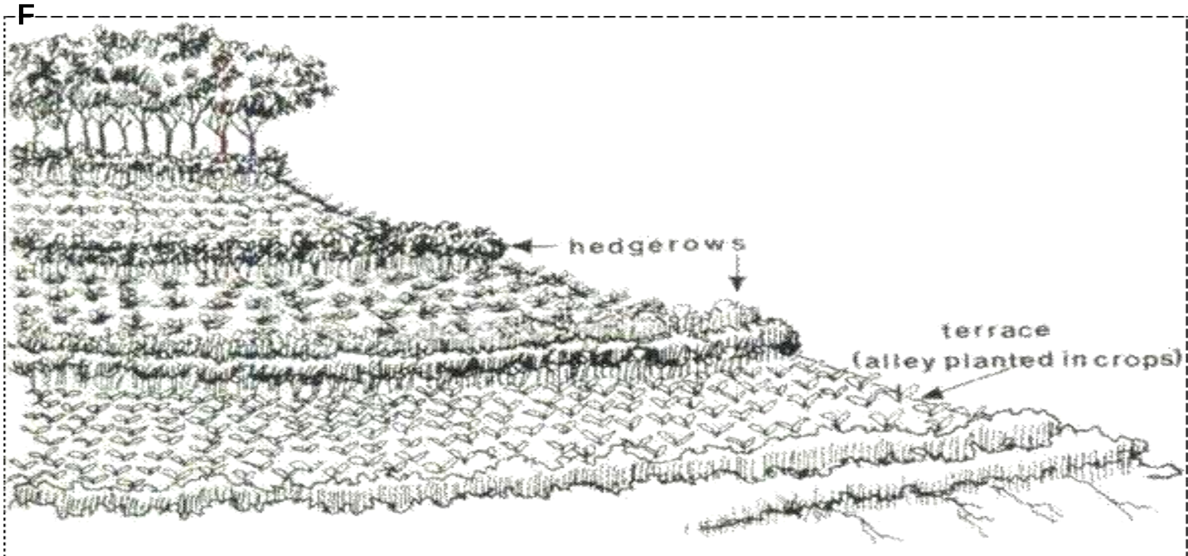


Figure 4.16 Typical Contour in a sloping agricultural farm land

Source: Adopted from SMEC, 2019), p.61.

c. *Strip Cropping*: The practice of growing alternate strips of different crops in a field is called strip cropping. For water erosion control the strips may be aligned along the contour and the crops follow a different rotational sequence so that the entire field is never bare. Buffer strips may also be used to protect sensitive areas of the field from erosion, or to create areas which will retard runoff and trap sediment. Strip cropping used as a technique for erosion control is a most effective method in certain soils and topography. This method becomes more effective for erosion control, when it is followed with crop rotations in the area where terraces are not practically feasible due to the fact that the length of slope is divided into different small segments.

The strip crops check the surface runoff and force them to infiltrate into the soil, thereby facilitating conservation of rain water. Strip cropping is a more intensive practice for conserving the rain water than contouring (i.e. about twice as effective as contouring) but it does not involve greater effect on soil erosion as terracing and banding. Generally, the use of strip cropping practice for soil conservation is decided in those areas where length of slope is not too long and where it will be encouraged for rain water harvesting considering water scarcity in the area.

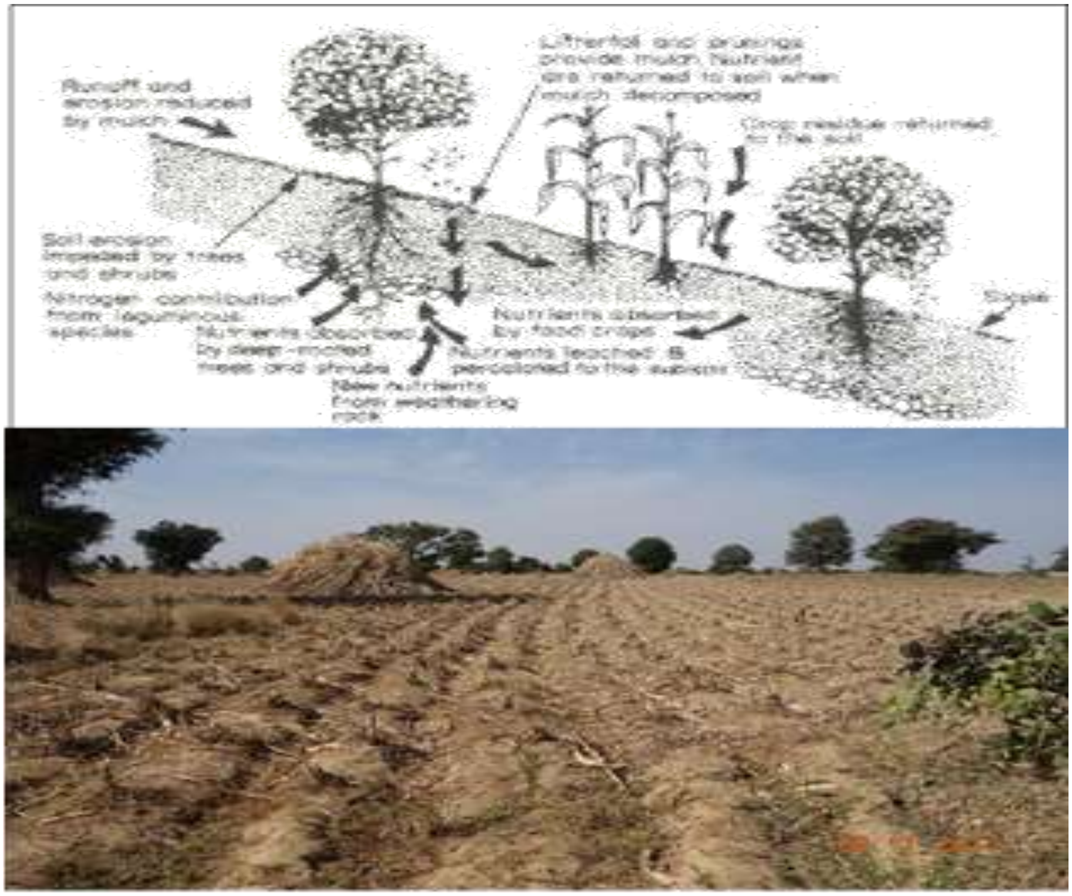


Figure 4.12: Proposed Strip Cropping and Existing farming in the watershed adopted from SMEC (2019)

d. *Conservation Tillage*: One of the most important agricultural conservation measures being adopted in many areas of the world in recent years is the reduction in tillage (turning of the soil). Under conservation tillage, the crop stubble is left standing and residue is evenly spread across the field as mulch instead of being ploughed under. Weeds are controlled by cutting and herbicide. Compared to conventional tillage, conservation tillage can increase soil organic matter, reduce erosion by as much as 90 percent, enhance infiltration, and reduce moisture loss. When implemented across a watershed, the enhanced infiltration can reduce peak discharge and downstream flood damages. The most important, from the standpoint of sustained implementation, are the tangible short-term benefits to the farmer.

e. *Terraces*: The use of terraces is an ancient technique. Terraces work against gravity, interrupting the tendency of water to flow down- slope. The layout and configuration of terrace systems or earthen bunds will depend on the farming system, soils, crops, climate, etc. Terraces are normally designed to discharge the collected runoff to a lined channel or drain which carries excess water downslope. Because structural terraces collect and concentrate water, the failure of a terrace can release a concentrated flow of water which can cause gullying. While terraces can be highly efficient at trapping both soil and water it is required for sustained production on steeply sloping soils, structurally formed terraces of earth or stone are costly to construct and maintain.

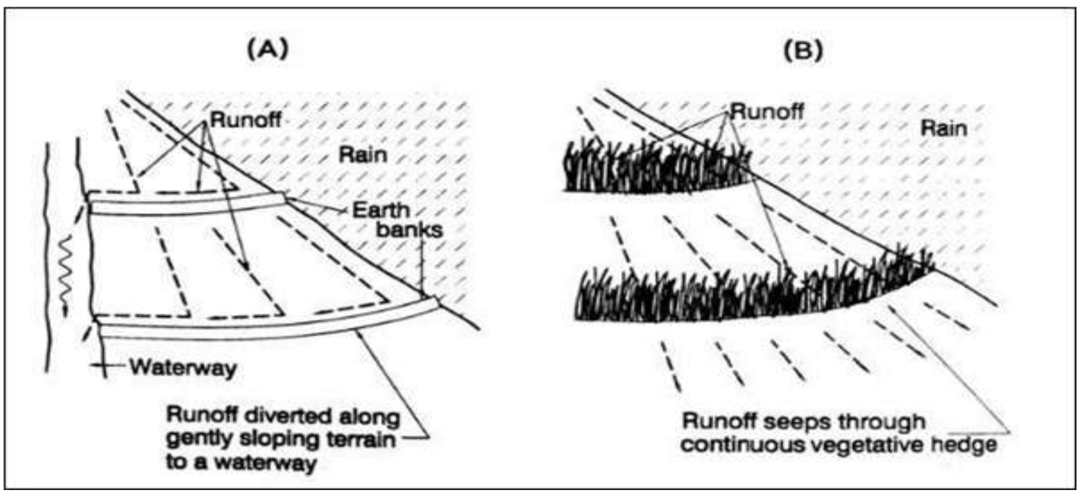


Figure 4.18: (a) Terraces using structural terraces (b) and contour stiff grass hedge (b)
Source: Adopted from SMEC (2019

Because structural measures are costly to construct and will fall into disrepair and fail without continual maintenance, considerable attention has been given recently to the use of self-sustaining stiff grass hedges. It is also recommended to use stiff grass hedges in Challawa Watershed by planting a dense hedge of stiff grass on the contour, which retards runoff and causes water to pond and deposit sediment on the uphill side of the hedge. Because it is living, the grass hedge will become stronger with time and can grow as sediment collects and the terrace height increases. Deposited sediment fills in low spots, runoff tends to become more evenly dispersed and less erosive with time, and the hedge tends to naturally build terraces that follow the contour.

4.5 Construction Activities

The construction activities shall be handled by competent professionally skilled contractor to handle the Engineering, Bio-engineering and Agricultural components of the project. The project proponent i.e. the Hadeja Jamaare Komadugu Yobe Basin Trust Fung (HJKY-TF) is not equipped technically and professionally to execute the construction work due to absence of the required manpower. Thus, the contractor may have to import professionally skilled man power from outside the project area while some component of the unskilled labour input may be attracted from the local communities of the project area. The contractor must consider and apply legally binding labour regulations of the country including minimum wage standards and in accordance with global best practices.

Construction material both physical and biological available in the project area is inadequate and must be provided from outside the project area. While rock materials may be carefully mined from the local environment that is charaterised by rock out crops and granitic beds for the construction, the extraction of such materials must be done considering environmental sustainability with minimum encroachment on farmlands or developed areas and without further damaging gully prone sites. Veriver grass seedlings may have to be raised in nurseries and natured for transplanting. Vertiver grass can grow over a short period of 45 -60 days with good husbandry practice. However, vertiver seeds may not be available within the project area and must be acquired from outside the watershed region.

Subsisting land tenure laws of the country described in section 2.2 of this report is to guide land acquisition for the project and where necessary adequate compensation should be granted all affected land owners/user for any land and or crops affected by the project. The more likely groups to be affected directly and indirectly by watershed remediation activity are the members of the local community (land owners, farmers, animal herders etc.) in the project area especially in Rogo, Karaye and Kiru Local Government Areas of Kano State.

4.6 Activity Phases

Project activities are phased for ease of construction and monitoring progess. The phases are discussed under the following sub-headings:

- Mobilisation or preconstruction phase,
- Construction phase,
- Operation/Maintenance Phase, and
- Decommissioning phase

The proposed project involves Gully bank stabilization, erosion control, sediments control on main and some of the Challawa river tributaries and ecosystem enhancement of the Challawa Gorge Dam watershed.

4.6.1 Preconstruction (mobilization) Phase)

This phase entails mobilising labour force, equipment, materials and acquisition of various permits as required by the country laws and AfDB guidelines. Other activities during this phase include topographical survey, hydrological survey, geotechnical investigation, identification of sources of construction materials, such as rocks for gabions, riprap, sources of vertiver grass, required tree species and seedlings, land for raising trees and vertiver grass nurseries, storage etc. (Table 4.7).

i. Duration

The mobilisation activities are expected to be achieved within one to two months of project inception. Types, Quantities and Sources of material requirements during the preconstruction phase of the project are shown in Table 4.8.

Table 4.8: Types, Quantities and Sources of Materials for Preconstruction Phase

Requirements	**Type**	**Source**	**Estimated Quantity Required**
Raw Materials (inorganic)	Rock boulders	From the nearby existing commercial quarries	64,000m^3
	Gabions	Same as coarse aggregates	50,000 m^3
	Cement	From commercial suppliers	104,000 m^3
	Coarse rocks	From commercial suppliers	40,000 m^3
	Rock Shingles	Local cement depot	78,809 tons
	Iron bars	reinforcements are readily available in local iron and steel stores	
Bio-Engineering	Early Maturing Mango seedlings	Locally and from Agricultural Research institutes in Nigeria	
	Early maturing Avocadoes seedlings	Locally and from Agricultural Research institutes in Nigeria	
	Orange seedlings	Locally and from Agricultural Research institutes in Nigeria	
	Exotic fruit-yielding trees seedlings	Locally and from Agricultural Research institutes in Nigeria	

	Shrubs seedlings	Locally and from Agricultural Research institutes in Nigeria	
	Spear grass seedlings	Locally and from Agricultural Research institutes in Nigeria	
	Onions seeds	Locally and from Agricultural Research institutes in Nigeria	
	Tomatoes seeds, etc.	Locally and from Agricultural Research institutes in Nigeria	
Manpower	Skilled	Contractor	Men and Women
	Un skilled	Locals in the project area	200	100
Equipment	Dump trucks	Contractor	5
	Dozers	Contractor	5
	Water Boozers	Contractor	2
	Lorries	Contractor	5
	Excavators	Contractor	3

Source: Fieldwork, 2021

ii. Transportation of equipment and materials

Materials necessary for the construction works will be transported by trucks to the construction site including cement and reinforcement bars, rocks etc. will be transported by Lorries to the construction site.

iii. Storage

All materials will have to be stored at the designated laydown areas onsite and adequate security to be provided. Fuel/oils will be stored in drums, which shall be kept in bunds (well-paved areas that do not allow fluids to come in to contact the soil).

4.6.2 Construction Phase

The major construction activities, requirements and estimated cost are highlighted in Table 4.9.

- ***Duration:***

The duration of this phase will be one (1) year.

Table 4.9: Project activities summary of requirements and estimated capital cost#

Item	Description	Amount (N)
	A. Earthwork and Excavation	
1.	Clearing of Site	8,512,434.06
2.	Excavate over site to strip topsoil a maximum depth of 150mm	48,642,480.35
3.	Excavate any material except rock in cuttings and lined drains	8,711,264.77
4.	Backfill, shape and compact with approved imported laterite material behind structure walls.	45,953,754.92
	Sub-total	111,819,934.11
	B. Gabion and Reno mattress works	
1.	Level and compact the bottom of the excavations for placing gabion box.	24,321,240.17
2.	Galvanized gabion box and Reno mattress filled with durable rocks for gabion check dams.	1,089,686.95
3.	Non-woven Geotextile at the back and bottom of Gabion Check dam and Reno Check dams.	48,041,035.72
4.	400mm Rock Riprap at the Spillway and entrance section of sand trap width D50 200mm.	5,223,209.43
5.	50mm sand filter beneath rock riprap	712,255.83
6.	Concrete grate C15 in Excavations	10,000.00
7.	Grade C30 reinforced concrete to dewatering orifice head wall rate to include formwork	380,000.00
8.	Reinforcement to dewatering orifice head rate to include formwork	180,000.00
	Sub-Total	**1,168,766,428**
	C. Bio-Engineering measures and Buffer-strip	
1.	Placement of sand bags and planting of fast growing grass (including Mtce for at least 3 months	2,471,799,125.50
2.	Planting of trees, shrabs, and grass along the stream and reservoir buffer.	1,502,640,000.00
3.	Implement agricultural practices such as contour, strip cropping and conservation tillage.	1,125,000,000.00
	Sub-Total	5,099,439,126.00
Grand Total		**6,380,025,488.00**

Estimates from SMEC 2019 Report Vol. 2 Priority Projects Preparation Report: Vol. 1A - Challawa Gorge Dam Watershed Management Project March 2019, pp.95-96.

Overall, it is estimated that the project will cost a total of Naira N6,380,025,488 (US $20,918,120). Bio-engineering, agricultural measures and buffer strips accounts for close to 80 % (N 5,099,439,126) with the bulk of the cost (N 2,471,799,125.50) going to placement of sand bags and planting of fast growing grass such as vetiver, elephant grass etc. on the slopes. However this does not include cost of operation and maintenance.

- ***Transportation of equipment and materials***

Materials necessary for the construction works will be transported by trucks to the construction site including cement and reinforcement bars, rocks etc. will be transported by Lorries to the construction site.

4.6.3 Operation/Maintenance Phase

The actual usage of the infrastructure is expected to immediately commence after the construction works. The design period is 25 years. However, within the period, there will be routine maintenance of the Dam. Maintaining the trees, shrubs and grasses, monitoring the gabions, riprap and sediment traps. Marketing of fruits from the trees, (avocadoes, mangoes, oranges etc. to raise income. Other activities may include dredging, water supply, routine maintenance of gabions, ripraps, sediment traps, and constant protection of planted trees and grasses from unapproved interference, monitoring and evaluation of project conditions.

i. Duration

The duration of this phase will be throughout the 25 years life of the protective measures carried out in the watershed.

ii. **Complementary Requirements**:

Constant monitoring by the dam authorities, the HKJYB-TF and the HJKYB Authority,

4.6.4 Decommissioning Phase

Activities include proper demobilisation and dismantling of unwanted structures and proper restoration of the site. Other activities would include rehabilitation of service facilities and other structures nearer to the original condition, clearance of all sorts of wastes, including used oil, sewage and solid wastes (plastics, wood, metal and papers). All wastes shall be deposited at authorised dumpsites and contracts terminated in accordance with legal contract agreement after fulfilling all terms and conditions of the contract

i. **Duration**

Decommissioning stage will last for at least six (6) months.

Types, quantities and sources of project requirements during the decommissioning phase are shown in Table 4.7.

Table 4.10: Types, Quantities and Sources of Project Requirements during the decommissioning Phase

Requirement	Type	Source	Quantity Required
Manpower to maintain the trees, grasses and gabions	Skilled	Contractor to train KYB staff	50
	Unskilled	Locals in the project area	To be determined by the Proponent
Equipment	Bulldozer	Contractor	3
	Motor Grader	Contractor	3
	Roller Compactor	Contractor	2
	Plate Compactor	Contractor	2
	Tippers/lorries	Contractor	4

Source: Fieldwork, 2021

CHAPTER FIVE:
DESCRIPTION OF PROJECT ENVIRONMENT AND BASELINE CONDITIONS

5.1 Introduction:

The purpose of the baseline data acquisition was to establish, the status of the various environmental components that are likely to be affected by the proposed project. In order to achieve this, environmental parameters were determined from literature survey, fieldwork, laboratory and data analyses. The components of the environment evaluated covered biophysical, social and health. The ESIA study of the project incorporated data from already approved Environmental Impact Assessment reports as secondary data which include amongst others, the Challawa Gorge Dam Rehabilitation Project Strategic Action Plan 2019, and the ESIA for the 330/132/33kV Transmission Substation New Kano, Kano State.

The Challawa Gorge Dam Management project is designed to be carried out in three pre-selected areas which are typically representative of the entire sub-watershed in terms of physical (topographic, drainage, soil and vegetation) as well as their human occupancy, land use and agricultural practices. The details of Pilot sub-watershed selection process are clear defined in an earlier Strategic Action Plan Report for this project (SMEC 2019, Volume 1 A). The general environmental, ecological and social conditions of the project site made up of (i) Dam Site, (ii) Pilot Sub watershed_1 (PWS_1) and (iii) Pilot Sub-watershed_2 (PWS_2), are described below. The Project Area of Influence (AOI) i.e. the geographic area likely to be affected by the project is also highlighted.

5.2 General Overview of Conditions of Project Sites

The pilot catchment management sites are located in a remote area which has an undulating and heavily rugged topography (Plate 5.1) with isolated hills. The area is situated within the southern guinea savannah region, with two distinct climatic seasons; wet and dry seasons. The area receives plentiful sunshine all year round, ranging from 11 to 13 hours per day.

The main river that drains the area is River Challawa. The river is seasonal and the quantity and quality of the water reduces drastically during the dry season. The flow of water from the dam is regulated to allow water flow downstream during the dry season for domestic use and irrigation farming. The water for domestic use at Kano is pumped to Panshekara, at the outskirts of Kano where the water treatment plant is located. The irrigation component is yet to be developed.

Recently, the Kano state government announced expansion of use of the dam to cover power generation, with some slight modification of the dam required to accommodate the power plant.

Plate 5.1: Topography of the Project Sites
(Credit, SMEC Report, 2019, P. 75)

The soils surrounding the sites are of different types and can be generally classified as sandy in nature and relatively deep in most places, as evinced at the gully sites, though there are isolated small rocky outcrops scattered around the two sites. A cursory look at farm lands also reveal that the soils are mostly sandy loamy because of the various management practices put in place by the farmers including intensive cultivation without fallow period, ploughing, application of farm yard manure etc., to improve soil for better crop harvest (Figure 5.2). There are a few boreholes and several tube wells located within the nearby settlement and along the roads, for both domestic and agricultural use. The existing land use of at the pilot sites are mainly agriculture for both crop farming and animal husbandry. Other minor land uses are settlements, roads, and for social services like schools, health care centres and open play grounds. The crops produced include maize, guinea corn, groundnuts, beans, soya beans, rice, potatoes, sugar cane, cassava, and other vegetables such as tomatoes, onion and pepper. The animals (usually few in number) raised by individuals include cows, goats, sheep, horse and donkeys. At the settlements, poultry such as fowls, chickens, turkey and ducks were found roaming around freely.

Plate 5.2: Topographic and Soil type observation around Ayaga Kwari area of PSW_1
(Source: Field Visit guided by Mai’unguwa of Ayaga Kwari Community, Thursday September 2, 2021 12:29 AM)

There are also several species of birds, reptiles, snakes, insects, rodents (like rats and squirrels) observed in the project area. The Rivers and the reservoir provide habitation for fish during the rainy season which allows fishermen to make business by selling, smoked fish and fried fingerlings at markets and highways near the rivers for their livelihood (Plate 5.3).

Plate 5.3: Fried fish (fingerlings on highway near Gumshi River Bridge

5.3 Location and Physical Characteristics Project Sites

Tables 5.1and 5.2 highlight the geographic characteristics of the Pilot watershed for the project.

Table 5.1: Location and Physical Characteristics of PWS_1

Physical Features	Description
Location	The location of the pilot sub-watershed 1 is at the boundary of Challawa Gorge Dam Watershed with location coordinates 368,351.66 m E, 1,285,176.12 m N at the outlet and 365,887.78 m E, 1,277,604.2 m N at the head of the watershed.
Watershed Area and Characteristics	The watershed is characterized with discrete sub-watershed with most characteristics representative of the general watershed. The watershed area for this pilot watershed is 3,150 ha with regular shape and appropriate density of streams network.
Topography and Watershed Slope	The topography of the watershed is rolling in nature and with average slope of 1.5% and generally suitable for agriculture. However, it gets steeper towards gully banks. The streams have bigger slopes in some sections with significant contribution for erosion.
Land use and Soil type	The land use is mainly agricultural land cultivated by individual farmers and has characteristics representative of the entire watershed. Predominantly the soil is sandy loam which has high infiltration and low runoff potentials.
Erosion nature and size	The nature of erosion is pronounced in the area of which encroaching towards the agricultural land and eroding stream banks. The extent of erosion in this pilot sub-watershed is representative of the general watershed area.

Table 5.2: Location and Physical Characteristics of PWS_2

Physical Features	Description
Location	The location of the pilot sub-watershed 2 is at the boundary of Challawa Gorge Dam Watershed with location coordinates 362,484.24 m E, 1,266,563.85 m N at the outlet and 358,590.13 m E, 1,259,559.41 m N at the head of the watershed.
Watershed Area and Characteristics	The watershed is characterized with discrete sub-watershed with most characteristics representative of the general watershed. The watershed area for this pilot watershed is 2,661 ha with regular shape and appropriate density of streams network.
Topography and Watershed Slope	The topography of the watershed is rolling in nature and with average slope of 1.5% and generally suitable for agriculture. However, it gets steeper towards gully banks. The streams have bigger slopes in some sections with significant contribution for erosion.
Land use and Soil type	The land use is mainly agricultural land cultivated by individual farmers and has characteristics representative of the entire watershed. Predominantly the soil is sandy loam which has high infiltration and low runoff potentials.
Erosion nature and size	The nature of erosion is pronounced in the area of which encroaching towards the agricultural land and eroding stream banks. The extent of erosion in this pilot sub-watershed is representative of the general watershed area.

5.4 Area of Project Influence (API)

The area of Potential Project Influence (API) both direct and indirect is identified in terms of coverage or extent of the impact, is determined as the degree, extensiveness or scale of influence. The Project's API is the geographic area where direct or indirect impacts are likely to be experienced. In other words, areas where primary or secondary effects resulting from the project are likely to happen.

Overall, the Challawa Gorge dam watershed covers an area of 3,842 km^2 but the measures proposed cover two pilot sub-watersheds with a total area of 3,150 ha (about 31.50 Km^2 or about 0.82% of the watershed) for pilot_1) and 2,661 ha (26.61km^2 or 0.69% of the watershed) for Pilot _2. The API is estimated base on three considerations in terms areal extent from the end point of buffering/bioremediation, i.e. from a maximum of 60m from Reservoir and gulley banks which make up the footprints of the erosion control measures. viz:

d. On site (within 500m^2)

e. 3 km-5km^2

f. Beyond 5 km^2.

Thus the area of influence is expected to go beyond 5km from the project footprint which includes the 1458 Ha covered by the direct project, out of which 500 Ha will be on farmlands belonging to individual farmers. All project activities will be carried within the footprint area defined below.

- Around reservoir (475 Ha) at 60m from Reservoir embankment;
- In Pilot area _1 (276 Ha) along gully banks, at 30 m-60m from gully banks;
- In Pilot area (218 Ha along gully banks, at 30 m-60m from gully banks;
- In Buffer strips in Pilot area_1 and Pilot area_2 (covering 16 Ha), along main and finger gully banks, at 15m-30m from gully banks; and
- On farmlands (500 Ha).

The Project's Areas of Direct Influence (ADI) within and outside of the footprint area includes the biophysical and socioeconomic impacts. The Project's ADI is therefore demarcated as in figure 5, a schematic representation of the areas of influence. The influences can be categorised into two: Biophysical and Socioeconomic influences. Figure 5.1 provides a graphical illustration of the Areas of Influence.

- **Biophysical environment**: it is expected that all direct and indirect biophysical influences resulting from project development and operation may not extend beyond the 3km radius from the project footprint. This extent would experience temporary movements of men, machines, equipment and materials to project sites; top soil excavations and movement; temporary disturbance to both land and water species habitats etc. Beyond the 500m radius of the project footprint direct biophysical impacts are unlikely to be experienced. Any such effect felt beyond the 3km distance may be regarded as secondary.
- **Socioeconomic environment**: Socioeconomic influences of the project are expected to be *directly felt by the persons residing or working within 0.5km - 3km radius of the project footprint on either side of the gulley banks and those around the reservoir both upstream and downstream.

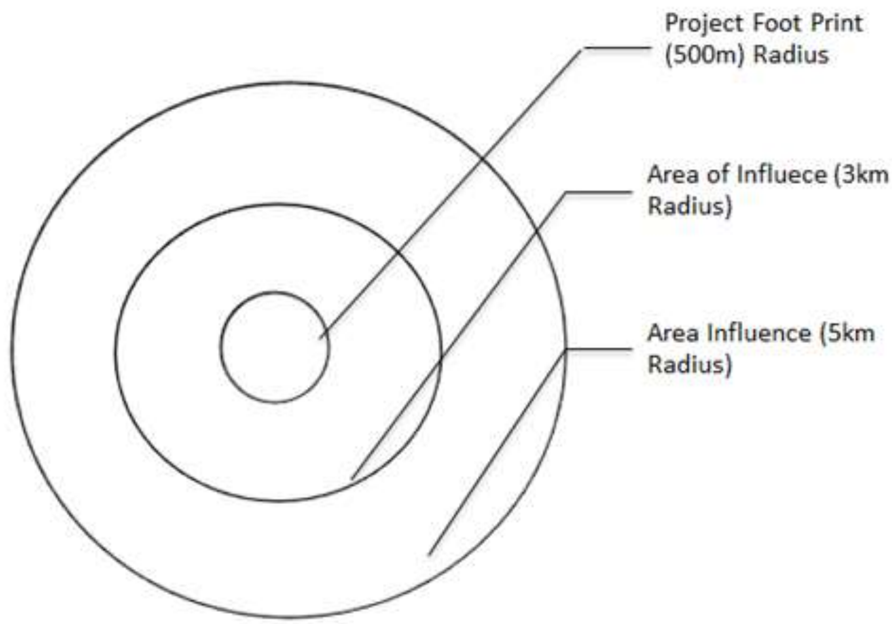


Figure 5.1: Schematic Representation of Project Area of Influence

5.5 Geographic and Environmental Settings of the Project

Baseline information describes the general physical and socioeconomic conditions of the project environment.

Sampling Procedure

The sampling procedure was established during Scoping. These measurements were made in situ to establish the Environmental Baseline:

- Meteorology
- Air Quality and Noise
- Soil, Land use and land cover
- Vegetation and Wildlife
- Geology/Hydrogeology
- Surface water
- Socio-economics
- Health

The Sampling Specifications are presented in Table 5.3.

Table 5.3 Sampling Specifications

S/N	SAMPLE	SAMPLE TYPE/DURATION
1.	Soil	Composite : Surface (0-15cm) and Subsurface (15-30cm)
2.	Sediment	Grab
3.	Surface Water	Grab
4.	Groundwater	Grab
5.	Vegetation	Transect area
6.	Wildlife	Transect/Visual Observation/Interviews
7.	Air Quality	Spot Measurement : Twenty-five (25) minutes per station

The Federal Ministry of Environment representatives were present during the sampling to ensure that environmental samples were collected and preserved (where necessary) according to recommend procedures and practices for environmental data collection in Nigeria. The environmental components and indices for the Biophysical Baseline Assessment are as presented in Table 5.4.

Table 5.4 **Environmental Indices for Biophysical Baseline Analysis**

Environmental Component	**Environmental Aspect**	**Data Acquisition**	**Potential Environmental Impact Indicator**
Climate/ Meteorology	Microclimate/Regional Climatic features	In situ measurement,	Temperature, Rainfall, Relative humidity, Wind direction and speed, visibility.
secondary data			
Air Quality	Local and Regional	In situ / laboratory analysis	• Particulate, NOx, SOx, CO2, CO, VOC, H2S • Heavy metals (Fe, Cd, Cr, Pb, Ni, Vn, Zn)
Noise	Local	In situ measurement	Ambient noise level dB(A).
Surface Water (storm water) / Sediment	Hydrology/ Hydrodynamics	In situ /secondary data	Flow direction, flow rate, Drainage characteristic, erosion pattern
Characteristics	Physicochemical Features	In situ measurements, Composite samples for laboratory analysis	Colour, alkalinity, TDS, TSS, Turbidity, EC, THC, pH, DO, Redox potential, BOD5, COD, Oil & Grease, PCB, Anions/Cations, NH4+, NO3, NO2, PO4, SO4, SiO2, Na, K, Ca, Mn, Mg, Heavy metals (Fe, Cd, Cr, Ni, V, Pb, Zn, Hg).
	Hydrobiology	Composite samples for laboratory analysis	Species composition, distribution, diversity and abundance and seasonality of Phytoplankton, Zooplankton, Benthos
Surface Water (storm water) / Sediment Characteristics	Fisheries	Direct observations/interview, In situ measurements, composite samples for laboratory analysis	Fishery activities

	Microbiology (surface water)	Composite samples for laboratory analysis	Total heterotrophic bacteria, fungi, Total hydrocarbon bacteria and fungi, total and faecal coliforms.
	Sediments	Composite grab samples for laboratory analysis	Colour, Texture, Temperature, pH, Redox potential, THC, Oil & Grease,PCB, Sediment geochemistry (Fe, Ni, V, Cd, Cr, Pb, Zn, Hg), Sediment microbiology
	Water Use	Direct observation/ interviews	Traditional use of rivers and water bodies (navigation, sand mining, food processing, aquaculture, domestic etc)
Ground Water Characteristics	Physicochemical Features	In situ / laboratory analysis	Colour, odour, alkalinity, TDS, TSS, Turbidity, EC, THC, DO, pH, Redox potential, BOD5, COD, Oil & Grease, Anions/Cations, NH4+, NO3, NO2, PO4, SO4, SiO2, Na, K, Ca, Mn, Mg, Heavy metals (Fe, Cd, Cr, Ni, V, Pb, Zn, Hg).
Ground Water Characteristics	Microbiology Groundwater dynamics Hydrogeology	Composite samples for laboratory analysis In situ Laboratory analysis, secondary data sources	Total heterotrophic bacteria, fungi, Total hydrocarbon utilizing bacteria and fungi, total and faecal coliforms. Static Water Level (SWL), Flow direction/ Flow Rate. Stratigraphy, Aquifer characteristics
Geology Soil	Local and Regional Physical characteristics	Secondary data, laboratory analysis In situ/ composite auger samples for lab analysis, Soil profile pits	Regional geology, Stratigraphic/Lithologic properties etc Permeability, porosity, bulk density, texture (grain size), colour,
Environmental Component	Environmental Aspect	Data Acquisition	Potential Environmental Impact Indicator

	Chemical Characteristics	Composite samples for laboratory analysis	pH, Anion, Cation and Cation exchange capacity (CEC), THC,PCB, heavy metals, Soil capability
	Soil microbiology	Composite samples for laboratory analysis	Total heterotrophic bacteria, fungi, Total hydrocarbon bacteria and fungi.
Land Use/Cover	Satellite Imagery of Land use/Land cover	Secondary data sources	Land Use types: Recreational, agricultural, forestry, industrial, residential, institutional, commercial. Trends and time-lapse mapping.
Biodiversity Status & issues relevant to biodiversity	Wildlife	Transect, direct observation, interviews, secondary data sources	Species composition/distribution (vegetation map of locality), seasonality, exploitation methods/level (kill rates/month/year, estimates of wildlife population etc). IUCN categorization
	Vegetation Conservation	Transect, herbarium studies, tissue analysis In situ observation, interviews, secondary data	Habitat status, floral composition, density and distribution, vegetation structure, plant pathology Conservation status (rare, threatened and endangered species), conservation areas (forest reserves etc), environmentally sensitive areas –wetlands and swamps), local conservation practices.

Source: Federal Ministry of Environment Standard ESIA Parameters (Nigeria).

5.6 Geographic and Environmental Settings of the Project

Baseline information describes the general physical and socioeconomic conditions of the project environment.

Sampling for Physical Characteristics study

The field sampling program took place in July – August 2020 as shown in table 5.6. Parameters such as temperature, pH, turbidity, electrical conductivity and dissolved oxygen were determined *in situ* because of their rapid change on storage. For other parameters samples which could be subject to microbial degradation and transformation were preserved, stored and analysed at minimum time after collection. This combined Work Plan/Field Sampling and Analysis Plan (FSAP) addressed the field sampling, analytical, quality control, and data review procedures for the collection and analysis of sample.

For Climatic data

Samples Collection and Analytical Methods

Baseline data for the study area were generated using a combination of literature survey, field studies; analysis of maps, review of background project documents; site reconnaissance surveys; structured and semi-structured interviews via engagements with the affected riparian communities, focus group discussions (FGD), Key Informants Interviews (KII) as well as a collection of field baseline data for a number of indicators using in-situ measurement methods.

Part of this section relies on existing data as surveyed from relevant literature sources as well as field study and data analysis. Dry and wet season data were obtained from the extensively available literature (SMEC 2019; SMEC, 2015 ESIA for the Proposed 330/132/33kV Transmission Substation New Kano, Kano State Olofin 1987; Waziri, Zakaria and Audu 2015). Since the ESIA study is a one-season (rainy season) study, field sampling survey was used to generate current information (rainy season) for the project area. Dry season data were derived from similar approved ESIA report for the region (Kano Region) (SMEC, 2015)

For the purpose of both physical and socioeconomic sampling, a system of square grids was superimposed on the study area to randomly select sampling locations for air, water and soil studies. A total of 20 sites were sampled in the three project areas namely PSW_1, PSW_2 and Dam Site. However, samples were collected from 10 sampling points around PWS_1 and the Dam site. The PWS_2 sites could not be visited due alleged prevailing insecurity associated with banditry in the remote area. Samples were therefore collected around 10 village areas including Rogo, Turawa, Sakarma, Daura Gari, Yola, Gumshi, Dam Site, Jerre and Challawa. Locations of the sampling points with their coordinates are presented in the Plate. 5.6 and Table 5.5 below.

Table 5.5 Sampling Locations

S/N	Sample site	Latitudes (X)	Longitudes (Y)	Sampling Locations/Area
1	SS1	11°46'17.73"N	8° 1'42.71"E	Karaye
2	SS2	11°47'24.93"N	8° 7'27.15"E	Outside-Community
3	SS3	11°37'19.10"N	7°53'14.77"E	Rogo
4	SS4	11°45'4.73"N	7°57'18.74"E	Ganji
5	SS5	11°38'31.06"N	8° 3'1.67"E	Sakarma
6	SS6	11°45'7.30"N	8° 6'54.66"E	Outside-Community
7	SS7	11°36'50.98"N	7°57'28.42"E	Daminawa
8	SS8	11°46'26.44"N	7°58'17.24"E	Outside-Community
9	SS9	11°42'48.73"N	8° 2'44.25"E	Turawa
10	SS10	11°41'50.65"N	7°56'52.19"E	Daura-Gari

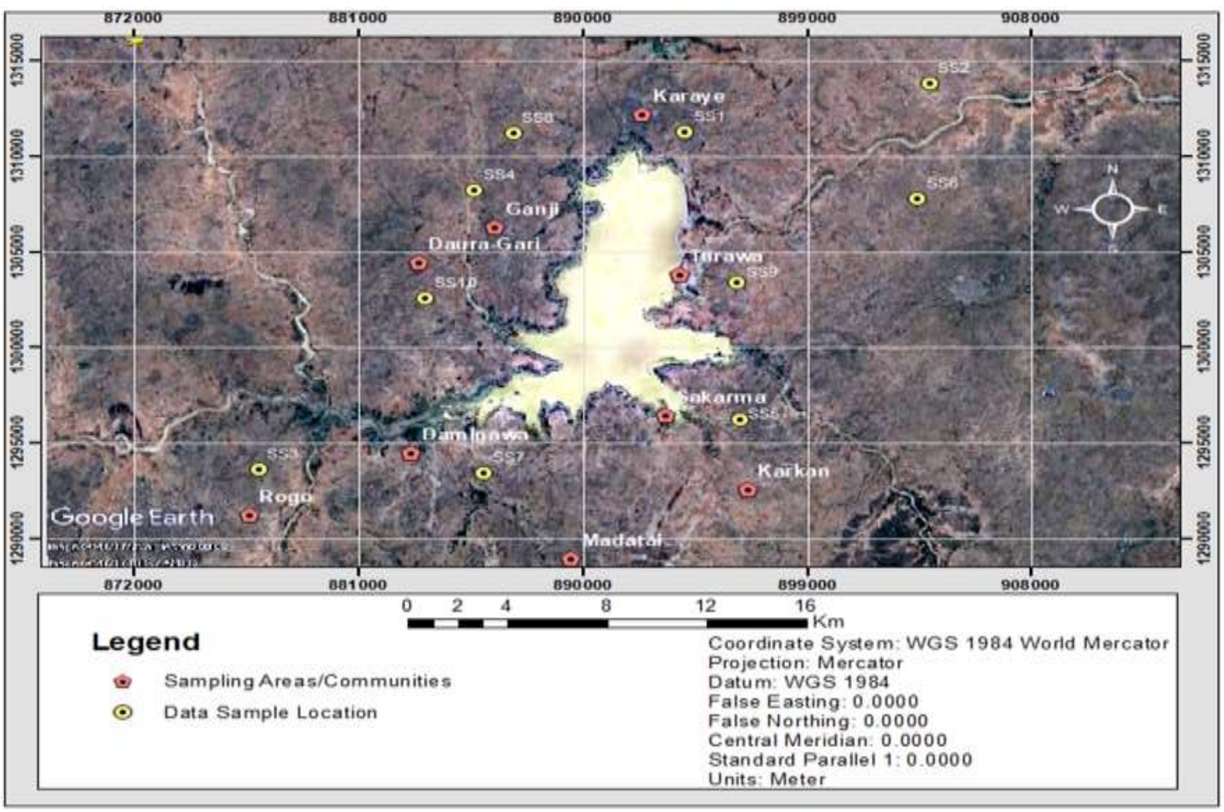


Plate 5.4: Geo-location Pattern of Sampling points

5.7 Air Quality & Noise Studies

Sampling was for a period of eight hours per day with readings of all the parameters determined every hour. The eight-hour monitoring period was carried out from day to day so that reading could be taken from early morning to late at night over the monitoring period. Information on air quality along the route was generated by on site monitoring of air quality at the proposed route locations. This data was supplemented by desk based assessment of historical data from various locations.

Plate 5.4: Air quality sampling station at the location of the proposed Project

Air Quality Parameters

A Portable AeroQual Series 300 Monitor and a Portable Environmental Sensor meters (ASTM D3249-95) were used. Air was pumped continuously from the atmosphere and a portion of the sample automatically sent to the analyzer for the determination of the gaseous pollutants of interest. The analyzer contains modules of each gas that analyzes the quality of the gases in the ambient air. It is a digital meter, which reads parameters at a time weighted average. (NOx, model Z-1400; SOx model Z-1300; NH_3 model Z-800; H_2S model Z-900; CO model ZDL-500 all manufactured by Environmental Sensors Ltd and VOC using AeroQual monitor).

Suspended Particulate Matter

Suspended Particulate matter were determined using Met one instrument, Met One Aerocet 531 Mini volume portable Air sampler manufactured in USA, (ASTM D4096-91).

Table .5.6: methods for measuring Air Quality and Meteorological Parameters

Ambient Air quality: AeroQual and Environmental sensor	Series 300 and Z-Series	Gas analyser automatically extracts atmospheric air sent through the analyser gas sensors for the determination of the various gases.
Suspended particulate matter (SPM): Met one Instrument	Met One Aerocet 531 Mini volume portable Air sampler	With the aid of a pump and a flow-regulating device, air samples were pumped at a flow rate of 5 LPM at ambient conditions. Particle size separation was achieved by impaction and an impactor of 10-micron cut-point was employed.
Noise: Extech Instrument	407730 Sound meter	Noise level at each point was measured with a pre-calibrated digital readout noise meter. The sensor of the noise meter was directed towards the source of noise and the average reading over a period of ten minutes was taken to be the Noise-level at each point. The noise levels were measured in decibels (dB).

Wind direction and speed: Kestrel pocket weather Tracker	4500	A combined Wind Vane and Anemometer is used in determining wind direction and speed. The wind speeds were measured in m/s.
Ambient Temperature, Atmospheric Pressure and Relative Humidity: Kestrel pocket weather Tracker	45000	The multi-parameter digital meter was used to measure temperature in ^{o}C, Atmospheric pressure in hPa and relative humidity as %/ The logger is equipped with an atmospheric pressure probe (Barometer), relative humidity (Hygrometer) and a temperature probe (Thermometer).

5.8 Noise Level

Noise levels at the different sampling points were measured with the aid of a pre-calibrated digital readout noise meter. The noise sensor of the meter was directed towards the source of noise and the average reading over a period of 5 minutes was measured in decibels (dB). An EXTECH INSTRUMENT (China), model 407730 Sound level meter with measuring range of 40 dB (A) – 130 dB (A), accuracy of ±1.5 dB (A) was used for the monitoring.

5.9 Microclimatic Data Collection

Microclimatic Data was gathered using a calibrated hand held and battery powered high precision Kestrel 4500 pocket weather Tracker for wind speed, humidity, temperature and wind direction.

Climatic and meteorological data were obtained through field measurement of some of microclimatic conditions (including relative humidity, wind speed and direction, ambient air temperature), and the climatic and metrological conditions from secondary sources including the Nigerian Meteorological Agency and other online weather trackers. For the ambient microclimatic conditions field survey, an automatic mini weather weather station was set up in an open ground at various sampling station and allowed to run for a minimum of 30mins in order to establish a microclimatic baseline of that particular station. All precautions usually taken when setting up a weather station and during measurements were observed for the onsite measurements. These include setting up the weather station away from obstacles like buildings and tall vegetation, using an instrument shelter to display all temperature sensitive instruments, orienting the instrument shelter so that the sun's radiation does not fall directly on the instrument during reading and setting up the weather station in an area representative of the study area's totality, as prescribed by the World Meteorological Organization (WMO) standard. The instruments and methods used for monitoring the microclimatic parameters are highlighted in Table 5.7.

Table 5.7: Instrumentation and Method of Observation for Climatic and meteorological parameters

Climatic Variable	Instrumentation	Record Availability	
		Onsite	Synoptic
Air temperature	Dry bulb thermometer	**	**
Relative humidity	Psychrometer/hygrometer	**	**
Wind speed	Anemometer	**	**
Wind direction	Wind vane	**	**
Cloud cover	Direct observation	**	**
Rainfall	Rain gauge	**	**

5.10 Soil

Soil samples were collected from each of the stations with the aid of a Dutch Hand Auger, Hand gloves, a spool and hammer at depths of 0-15cm and 15-30 cm, representing top and sub-surface samples from eight (10) locations (Plates 5.5 (a) and 5.6 (b). These depths correspond with the depths at which most (>80%) of the plants roots and soil micro-organisms are concentrated.

A **B**

Plate 5.6 (a): Soil Sampling at a sampling location (near Turawa community)
Plate 5.6 (b): Soil Sampling at a sampling location (near Karaye).

Sampled points were geo-referenced on the field using the Garmain Global Positioning System (GPS) Equipment. The physic-chemical properties of the soil including appearances depth, texture, pH levels, hydrocarbons, microbial contents etc., were also examined, alongside the land use practices. All soil samples connected were analyzed in the laboratory using standard methods. The following sub-samples were taken at different depths (0-15m; 15-30m depth), namely;

- Samples for physico-chemical parameters which were put into polythene bags;
- Samples for hydrocarbon analysis which were put into glass bottles;
- Samples for microbiological analysis collected McCartney bottles and stored in ice-packed coolers

5.11 Vegetation Studies

Vegetation studies were conducted at the same sampling locations as those for soil studies to determine the species composition, diversity and population of plant species. The density and percentage of the major tree species and the herbaceous layers were determined. In addition, the rare and endangered plant species as well as plants of special significance to the ecosystem and the local economy were classified.

Plant species diversity determined as the ratio between the number of species and “importance value” which, for the purpose of this study, were taken as the number of individuals per quadrant (Odum, 1971). The vegetation studies were carried out using a combination of line transects and quadrant sampling techniques. At each sampling location, two quadrants measuring 10m x 10m and 1m x 1m were used to study trees and shrubs, and herbs respectively. The plant community structure was observed and the plant species within each quadrant were identified. The floral and vegetative parts of unidentified plant species were collected, pressed in the field with herbarium press, and taken to the laboratory for herbarium

5.12 Wildlife

Wildlife studies involved a census/count of mammals, birds’ reptiles and amphibians sited around the project area. Direct count using a pair of binoculars for sighting was employed for the census of reptiles, birds and other animals that readily appeared during the investigation. The presence of some of the animals was ascertained by probing such habitants like logs, heaps of dead decaying leaves, vegetated areas, ponds and burrows etc. The wildlife sighted, were identified on the spot to ease with help of field guides. Survey of literature relevant to the project environment in (the ESIA Report for the Hadejia Jama'are Sub-Basin with Kano River Irrigation Scheme (KRIS) and Hadejia Valley Irrigation Scheme (HVIS) 2017; and (ESIA) for the Proposed 330/132/33kV Transmission Substation New Kano, Kano State, SMEC March, 2017) also provided opportunity to supplement information on wildlife existing in the area.

5.13 Aquatic Studies

Physico-chemical Characteristics

Acquatic studies include study of Surface and Groundwater water in the project area. Samples were collected from 4 existing sources including the Challawa Reservoir, Gumshi river, Jerry River, and upstream of Challawa River. Ground water was collected from boreholes in the area.

A water sampler was used to collect water samples at designated locations. Samples for Total Hydrocarbon Content (THC) measurements were placed in 1liter glass containers concentrated hydrochloric acid (HCl) added and sealed with aluminum foil. While the samples for the heavy metal analyses were placed in 150ml plastic container concentrated nitric acid (HNO_3) added to adjust the pH to 2. Biochemical oxygen demand (BOD) samples were collected in 250ml brown reagent bottles, sealed to exclude air bubble while the dissolved oxygen (DO) samples were fixed immediately with Winkler's I and II reagents. Unstable physiochemical parameters of water such as pH, DO, temperature, salinity, turbidity and conductivity were measured in-situ using pre-calibrated portable digital meters (Plate 5.7). All samples were preserved in a cool box and transported to the laboratory for analyses.

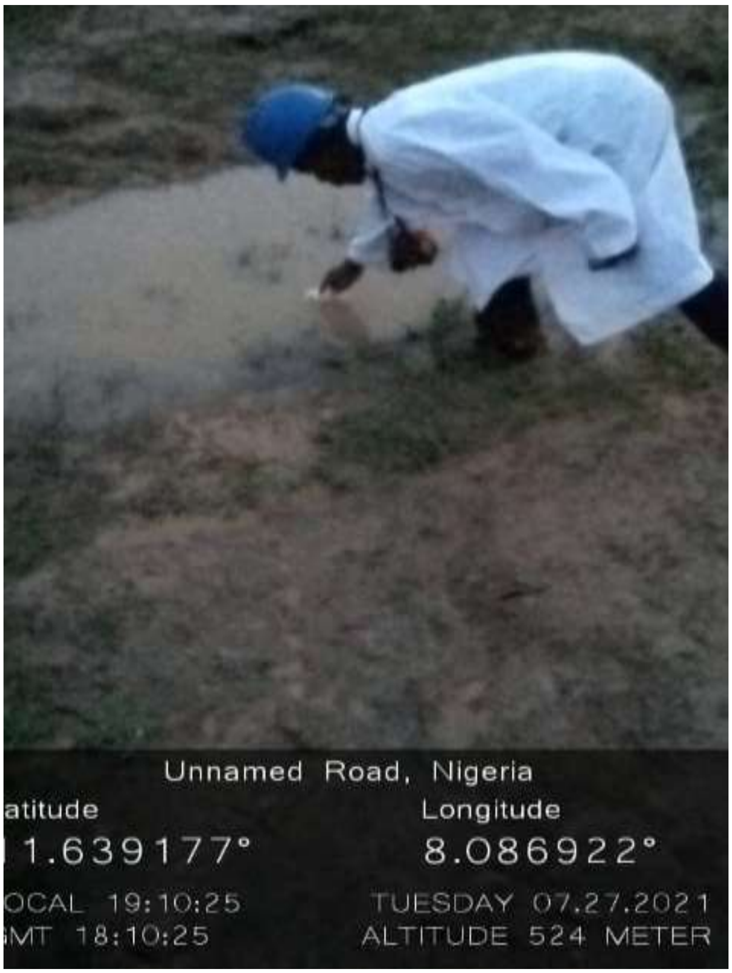


Plate 5.7: Surface water sampling

Sediment Physical-chemical analysis

Sediment samples were collected by means of Eckman grab submerged into the water to collect sediment samples. The sediment study was to understand the history of waste load discharges of the aquatic environment over an extended period of time. Sediment (bottom of the surface water body) serves as a sink for contaminants from the overlying waters. The physical-chemical characteristics of the sediment are an indication of the pollution level and the type of pollutants that has been in the overlying surface water. Several physical-chemical parameters for recovered sediment samples from the water bodies in the study area were conducted. Some of the parameters include the pH, total Hydrocarbon (THC), nitrates, phosphates, sulphates, magnesium, sodium, potassium, calcium and about 10 heavy metals.

5.14 Design of the Socioeconomic Survey

Several techniques and methods were adopted forb the socioeconomic baseline data collection. These include the use of interview schedules/questionnaire, Key Informant Interviews (KII) and Focus Group Discussion (FGD) as primary sources. In addition, and very importantly, as a primary technique of data gathering, community consultations. Visitations were also carried out on the existing social infrastructural facilities and services, e.g., education and health care infrastructure for necessary information on education and health. As a survey instrument and primary data gathering method, the questionnaire was structured such that binary, optional and open-ended questions were raised to solicit the necessary answers to questions from the community members who were on ground.

Study Population

The study population comprised of all the individuals making up the *de facto population* of the riparian communities within the Challawa Gorge Dam area. Sample Size Determination: Taro Yemani's (1997) criteria $n=N/(1+N)(e)^2$ for Population of up to 250000 : Sample Size = 250. Administration of Research Instrument at 9 Village Areas was assisted by 5 enumerators; Key Informants Interview including the Operators of the Chgallawa Gorge Dam, officials of the HJKYB-TF and selected community leaders in the project area. Four FGD sessions was held with four community groups. Questionnaire administration was conducted at 10 Village Areas.

A random sampling technique was used in selecting respondents from the surveyed communities (Rogo, Turawa, Sakarma, Daura Gari, Yola, Gumsi, Dam Site, Jerry and Magaji Haji communities) for the communities' interactions (Key Informant Interviews) as well as during the cross session of respondents within the community with the adult population as the target.

Socio-economic Data Analysis and Presentation

Various statistical techniques and tools were used in the report. The most common were summary percentages, ratios and averages. The data were presented mostly in tables and charts. Population sizes and relevant distributions were determined using the following formulae:

a. Population projection using the exponential model

$P_t = P_o (1 + r)^t$; where P_t is the estimated population at time ,t, (i.e current year population) and P_o represents the population at the base year. And 'r' is the population growth rate.

b. Sex Ratio = $\frac{\text{Number of males in the LGA}}{\text{Number of females in the LGA}} \times 100$

c. Dependency Ratio = $\frac{\text{Population} \leq 14\text{years} + \text{population} \geq 65\text{years}}{\text{Population aged 15-64years}} \times 100$

d. Crude Birth Rate (CBR) = $\frac{\text{Number of births in the community in one-year}}{\text{Mid-year population}} \times 100$

e. Crude Death Rate (CDR) =

$$\frac{\text{Number of deaths in the community in one-year}}{\text{Mid-year population}} \times 100$$

Health-Impact

An integrated descriptive, cross-sectional study design was adopted for the community health survey. It involved community-based households and facility-based surveys. Quantitative data was complimented by qualitative information by way of key informant interviews of opinion leaders of the community to understand other socio-cultural and economic characteristics of the people that influenced their health statutes. Specifically, in depth interviews of the nurses in private and government medical centres were conducted.

Sampling Techniques

The cluster sampling technique was adopted for the baseline survey. The technique has an advantage of being easier and faster to complete as the study populations occur in cluster and is often more acceptable to local communities. Four clusters were identified, out of which households were sampled using a random technique. In each cluster households were listed and the required number of households determined by a simple random method. This procedure was continued until a desired sample size was obtained.

In a household selected for the study, the heads of the household was interviewed by means of structured questionnaire and was physically examined. The examination consisted of blood pressure (BP) measurements, Ear, Nose and Throat (ENT) examinations, Hearing tests, Skin and Eye examinations. Children ages 0-59 months were measured for heights and weights mid-upper arm circumference.

5.15 Land Use

Land use refers to the use of a given parcel of land is put into. On the other hand, the utilization of a parcel of land for any given purpose determines the use in which that land is put into. The land use types found in the proposed project environments were observed directly from the field and what is reported in literature (Abubakar *et al 2018)*. Figure 5. provides an overview of land use in Kano region that hosts the Gorge Dam. Land use types of the sampled communities were collapsed into one i.e., within a given local government area, all the land use types were valued and put together and the average considered for analysis and discussion.

5.16 Quality Assurance/Quality Control

Standard field methods were used in the sample collection at the site as recommended by FEPA (1991). To ensure the integrity of some unstable physicochemical parameters *in-situ* measurements of temperature, pH, electrical conductivity (EC), dissolved oxygen (DO), turbidity, salinity and total dissolved solids (TDS) were carried out in the field using water quality checker Horiba U-10. To maintain analytical accuracy, duplicate and blank samples were included in the analyses. Distilled water used for analysis conforms to ASTM D 1193 Type 1. Only qualified and trained personnel were employed in the laboratory work.

Sample Preservation and Storage

The water samples collected were stored in ice-packed coolers and preserved in accordance with Department of Petroleum Resources and Federal Ministry of Environment Guidelines and Standards. All water samples for heavy metals were preserved by the addition of concentrated HNO_3, while to the samples for total hydrocarbon concentrated HCl was added.

Laboratory (Analytical) Procedures

Laboratory analyses of the physicochemical parameters were carried out in keeping with standard practice specified in FMEnv Environmental Guidelines and Standards (FEPA 1991). Except otherwise stated, the laboratory methodologies for wastewater are from Standard Methods for the Examination of Water and Wastewater 19th Edition, 1998. Investigation involving the heavy metals concentrations was carried out using atomic spectrophotometer (AAS Unicam 969). Exchangeable cations and anions measured using flame photometer and UV/Visible spectrometer (Unicam Helios Gamma, UVG 073201; Spectronic 21D). Briefly, the methods employed are as follows:

pH, Electrical conductivity, Turbidity, Dissolved solids, Temperature and Salinity

Measured using Horiba Water Checker (Model U-10) after calibrating the instrument with the standard Horiba solution. The units of measurement are µS/cm, NTU, mg/l, ^{0}C and ‰; respectively for conductivity, turbidity, temperature and salinity.

Dissolved Oxygen (APHA-4500 C)

The dissolved oxygen (DO) was determined by the Modified Azide or Winkler's method (APHA 1998). To a 70ml BOD bottle filled with sample. 0.5ml manganous sulphate (Winkler I) solution and 0.5ml alkali-iodide-azide reagent (Winkler II) were added, stopper (excluding air bubbles) and mixed by several inversions. After about 10minutes, 0,5ml conc. H_2S0_4 is added, re-stopper and mixed for complete dissolution of precipitate. The fixed sample is taken to the laboratory for further analysis.

Biochemical Oxygen Demand (APHA-5210-B)

Known portion of the water sample collected is diluted with oxygenated and incubated at $20^{0}C$ for five days. At the end of the incubation period the samples were treated in the same manner as the DO samples stated above. Detection limits 2.0mg/l.

Total Alkalinity (API-RP 45)

Bicarbonate determination is by titration with 0.02N H_2SO_4 using methyl orange indicator. The detection limit is 1.0mg/L as $CaCO_3$ (APHA, 1985).

Chloride (APHA 4500 – Cl^- B)

Chloride is titrimetrically determined by the Argentometric method in the presence of potassium chromate as indicator. Limit of detection is 1.0mg/l

Sulfate (APHA 4500-SO_4^{2-} E/AST MID 516)

Sulphate determination is by the turbidimetric method (APHA 1998). To a 50ml sample or portion diluted to 50-ml contained in a conical flask, 2.5-ml of conditioning reagent (i.e. a mixture of 50ml glycerol with a solution of 30ml concentrated hydrochloric acid, 300ml distilled water, 100ml 95% ethanol and 75g sodium chloride) and a quarter spatula full barium chloride ($Bacl_2$). The mixture is swirled for a minute and the barium sulphate ($BaSO_4$) turbidity read at fifth minute on Spectronic 21D at 420nm against water. Sulfate level was read from a calibration curve prepared for known sulphate standards treated the same way as the samples. The detection limit is 1.0mg/l.

Phosphate (APHA 4500-P E/ASTM D 515)

Phosphate is determined using the stannous chloride method (APHA, 1998). To 50ml sample, the following were added with mixing 2.0ml ammonium molybdate reagent and 0.2ml stannous chloride reagent. After 10 minutes but before 12 minutes from addition of stannous chloride, the absorption of the treated sample is read on Spectronic 21D at 690nm. Phosphate level is obtained by reading off absorption level from standards curve of known standards treated as the samples. The detection limit is 0.05mg/l.

Nitrate

Nitrate measurement is by Ultraviolet Spectrophotometric screening method. To 50ml clear sample, 1ml HCl solution was added and mixed thoroughly. Absorbance measurements made at the wavelength of 220nm and the nitrate concentration obtained from the standard curve. Limit of detection is 0.05mg/l.

Total Hydrocarbon Content (THC) ASTM D3921 (Extraction/Spectrophotometry)

A known volume of the sample was well agitated and poured into a separatory funnel. A known quantity of sodium chloride was added to prevent emulsification. 50ml of xylene was added to the sample container and then shaken properly to rinse the container before transferring into the separatory funnel. The funnel was corked and shaken vigorously for about 1 minute. The mixture was allowed to stand for separation. The sample portion was run-off by opening the tap and then the extract transferred into a 100ml centrifuge tube by passing it through a filter paper containing 1g of sodium sulphate. The extraction process was repeated with another 50ml of xylene. The xylene layer was then collected into same centrifuge tube containing the first extract.

The separatory funnel was rinsed with 10ml xylene before transferring into the centrifuge tube. The extract was centrifuge for 15mins at 1500 rpm and placed in a standard cuvette with a light path of 10mm. The spectrophotometer was standardized and sample readings taken. THC concentration was calculated with reference to the standard curve and multiplication by the appropriate dilution factor. Detection limit is 0.01mg/l.

Heavy metals (Cr, Cu, Pb, Fe, Cd, Ni, Zn) APHA 3111-B (AAS)

Heavy metals were determined using an Atomic Absorption Spectrophotometer (AA) as described in APHA 3111B and ASTM D3651. This involved direct aspiration of the sample into an air/acetylene or nitrous oxide/acetylene flame generated by a hollow cathode lamp at a specific wavelength peculiar only to the metal programmed for analysis. For every metal investigated, standards and blanks were prepared and used for calibration before samples were aspirated. Concentrations at specific absorbance displayed on the data system monitor for printing. Limit of detection is <0.01mg/l.

5.17 Microbiology

Methods of Sample Collection

a. Water samples were collected in accordance with the procedures described in standard methods for water and wastewater analysis (APHA, 1998). The same is accepted and adapted by FMEnv as standards for Nigeria. According to the procedure, 200ml of sterilized sample bottle was used for collecting water sample.

(b) The samples were preserved in an ice-cooled container and transported to the laboratory for analysis. All analysis was carried out at the Kano State Ministry of Environment Laboratory, Kano, Kano State.

Quality Control Measures

i) Clean sterile containers were used for sample collection to avoid external contamination of the sample.

ii) Sample was transported in an ice packed cooler to the laboratory and analyzed within 2 hours of collection or stored in refrigerator for analysis at other days.

iii) Procedures for sample collection were done aseptically and in accordance with standard procedures.

5.18 Methods of Sample Analysis

(a) Enumeration of Bacteria

Serial dilution procedure as described by Obire and Wemedo (1996); Ofunne (1999) was employed for cultivation and enumeration of bacteria and fungi in the water samples. The ten-fold serial dilution was used to obtain appropriate dilutions of the samples. Aliquots of the required dilutions were plated in duplicates onto the surface of dried sterile nutrient agar (for total heterotrophic bacteria). In case of total/faecal coliform bacteria, the most probable number (MPN) technique described by Collins and Lyne, (1980) was employed for estimation of their numbers in water. Appropriate volumes of undiluted water samples were inoculated into test tubes of MacConkey broth medium. All inoculated media were incubated at 37^0C for 24 hours or 3-7 days except for faecal coliform bacterial set up incubated at 44.5^0C.

(b) Media used for enumeration of microoganisms

(i) Nutrient agar medium used for enumeration of total heterotrophic bacteria prepared according to the manufacturer's specifications.

(ii) Mac Conkey broth medium for estimation of total faecal coliform bacteria in water.

(c) Quality Control Measures

(i) Samples were analyzed in standard microbiological laboratory in accordance with standard procedures.

(ii) Procedures for cultivation and enumeration of bacteria were carried out aseptically to avoid contamination from external sources.

(iii) All media and glass wares used were sterilized in an autoclave at 121^{o}C for 15 minutes.

Chain of Samples Custody Procedure

There is a Master Register for all samples brought into the laboratory. Following registration of the sample, a Sample Data Sheet containing pertinent information on the sample was opened for each sample. The information includes:

f) sample reference number;
g) nature or type of sample;
h) site of collection;
i) date and time of collection; and
j) Mode of preservation (depends on nature of material) and analytical data from the field.

Appropriate methods were used in storing the remaining stock materials and sub samples. Samples for storage were kept in labelled compartments on shelves in a storage room. Samples sent to co-operating laboratories were recorded in the Master Register and accompanied by essential data pertaining to the sample material.

5.19 Description of Baseline Biophysical Environment

5.19.1 Climate/Meteorology

Climate

Climatic factors are the main determinants in the catchment hydrology, runoff formation and erosion process. This study relied on secondary climate data derived from literature survey and supplemented by field observations and measurement of other factors including air quality and noise. Additional climate data were collected from weathersparc.com (at https://weatherspark.com/y/58575/Average-Weather-in-Karaye-Nigeria-Year-Round) and CLIMWAT and gridded climate data were also abstracted from available global data sources. Rainfall and temperature data for Karaye both dry and wet seasons (the location of the dam reservoir) were adopted from dataset provided by SMEC 2019 report.

Precipitation (PPT)

A *wet day* is one with at least *0.04 inches* of liquid or liquid-equivalent precipitation. The chance of wet days in Karaye varies very significantly throughout the year. The *wetter season* lasts *4.6 months*, from *May 18* to *October 4*, with a greater than *41%* chance of a given day being a wet day. The month with the most wet days in Karaye is *August*, with an average of *25.0 days* with at least *0.04 inches* of precipitation.

The *drier season* lasts *7.4 months*, from *October 4* to *May 18*. The month with the fewest wet days in Karaye is *December*, with an average of *0.0 days* with at least *0.04 inches* of precipitation.

Among wet days, we distinguish between those that experience *rain alone*, *snow alone*, or a *mixture* of the two. The month with the most days of *rain alone* in Karaye is *August*, with an average of *25.0 days*. Based on this categorization, the most common form of precipitation throughout the year is *rain alone*, with a peak probability of *82%* on *August.*

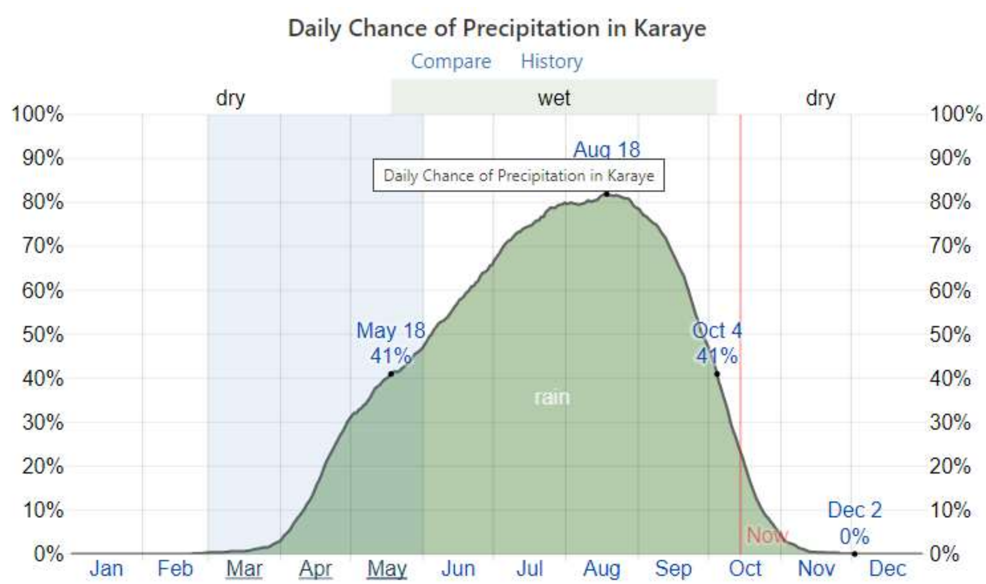


Figure 5.11: Daily Chance of Precipitation around Karaye, Kano State

Source: https://weatherspark.com/y/58575/Average-Weather-in-Karaye-Nigeria-Year-Round

Cloud Cover:

In Karaye, the average percentage of the sky covered by clouds experiences significant seasonal variation over the course of the year. The clearer part of the year begins around November and lasts for about 4 months, ending around March. The clearest month of the year around the project area is January, during which on average the sky is *clear*, mostly clear, or partly cloudy 64% of the time. The cloudier part of the year begins around March and lasts for 8 months, ending around November, while the cloudiest month of the year in Karaye is May, during which on average the sky is overcast or mostly cloudy 74% *of* the time and signals the commencement of the rainy season (Figure 5).

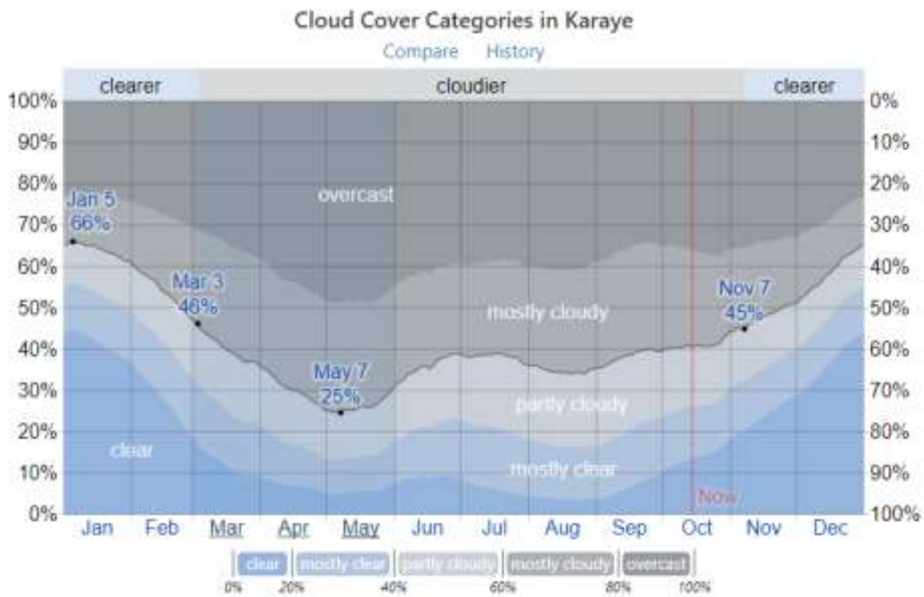


Figure 5.12: Cloud Cover Categories in Karaye

Source: https://weatherspark.com/y/58575/Average-Weather-in-Karaye-Nigeria-Year-Round

Rainfall

The climate of the project area is dominated by rains from June to September. The seasonal rainfall is characterized by a single wet season from June to September displaying a monomodal pattern whereby monthly rainfall varies from 113 mm in June, 262 mm in August declining through to 153 mm in September. On average 85 % of the annual total rainfall falls during the wet season.

The annual rainfall for the period 1970 to 2016 varies from a minimum of 453 mm recorded in 1973 to a maximum of 1,799 mm in 1998. A slightly increasing trend in annual rainfall prevails in the region as the data in fig. 5.2 reveals. Drought occurred for four years out of 47 years which is on average once every 12 years.

The climate of the project area is dominated by rains from June to September. However, the annual rainfall is less than the mean in 27 years out of the 48 years and occurred consecutively showing the persistence of drought. The deviation of the annual rainfall from the annual mean are plotted in Figure 5.12 and fig. 5.14 and show that in the 1970s and 1980s drought was persistent. However, in the 1990s normal rainfall years were observed. In recent years droughts occur less frequently, where drought year is followed by normal year.

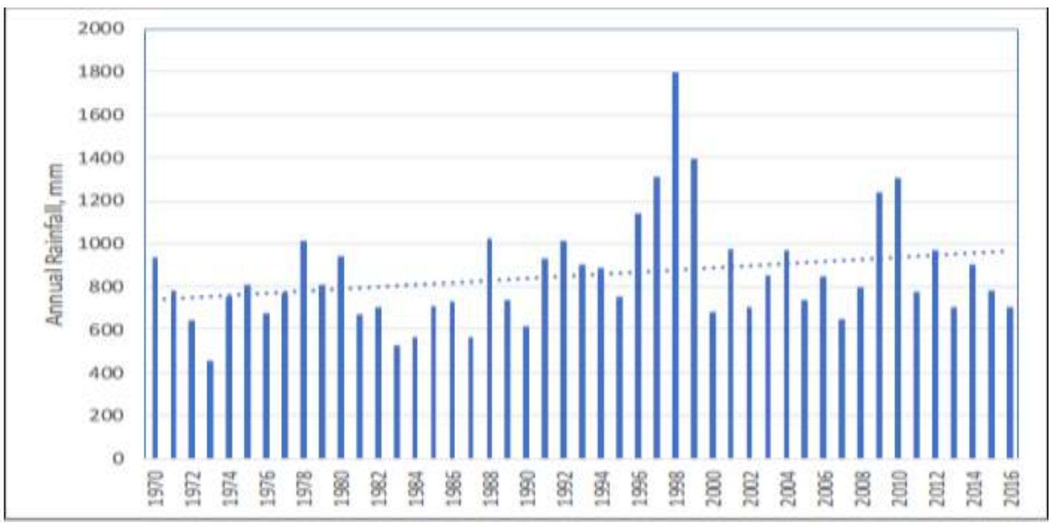


Figure 5.13 Annual Rainfall Data at Karaye Grid point

Source: SMEC SAP Report 2019

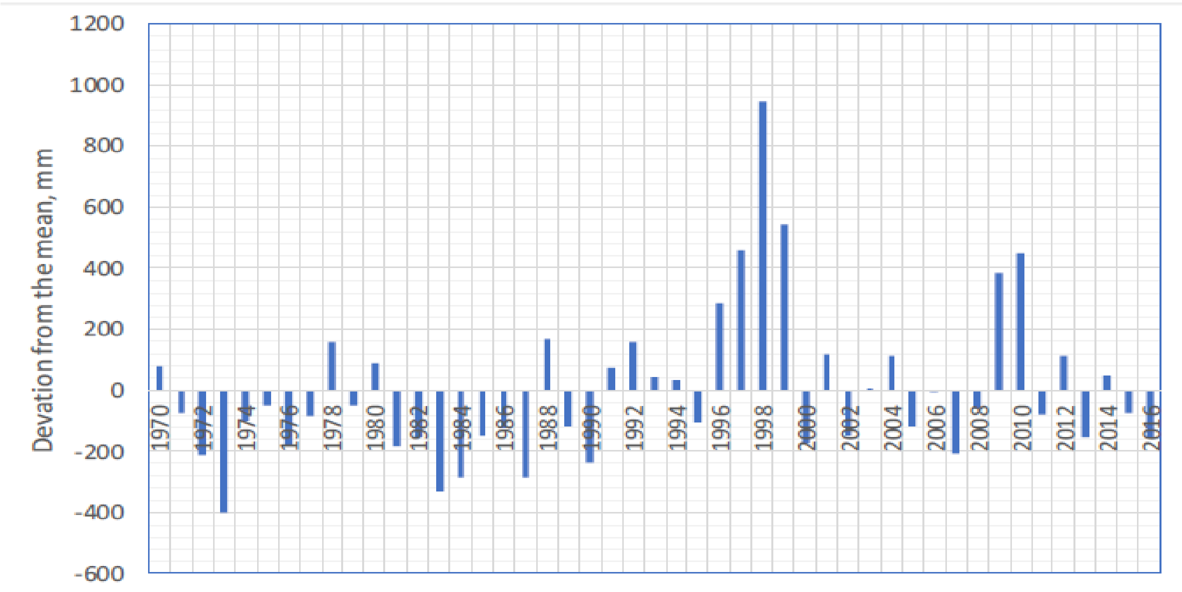


Figure 5.14: Deviation plot of annual rainfall from the annual mean (Karaye grid point)
Source: SMEC SAP Report 2019

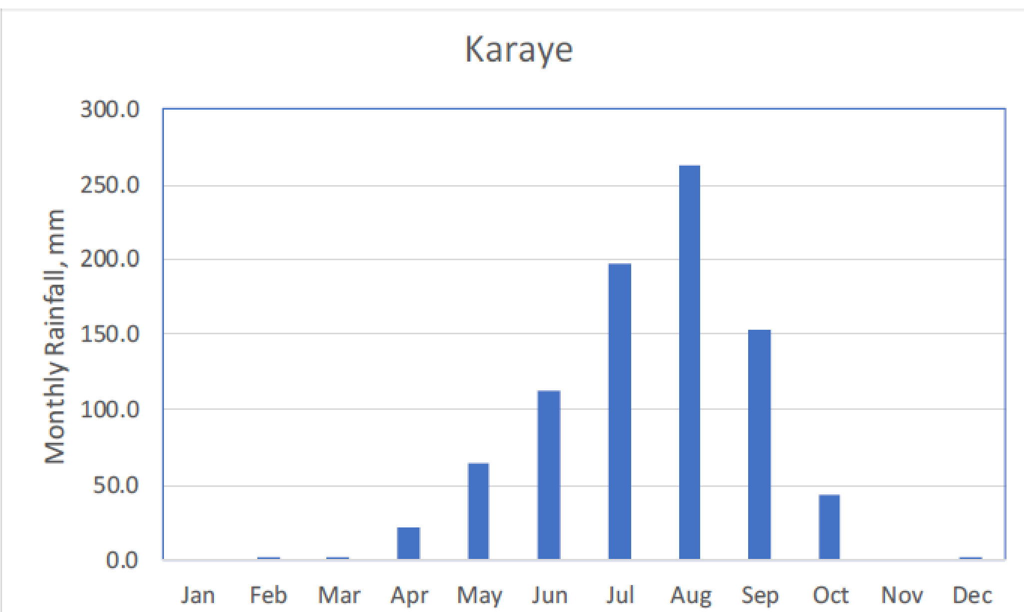


Figure 5.15 Long Term Average (LTA) Monthly rainfall at Karaye Grid point
(Source: SMEC SAP Report 2019)

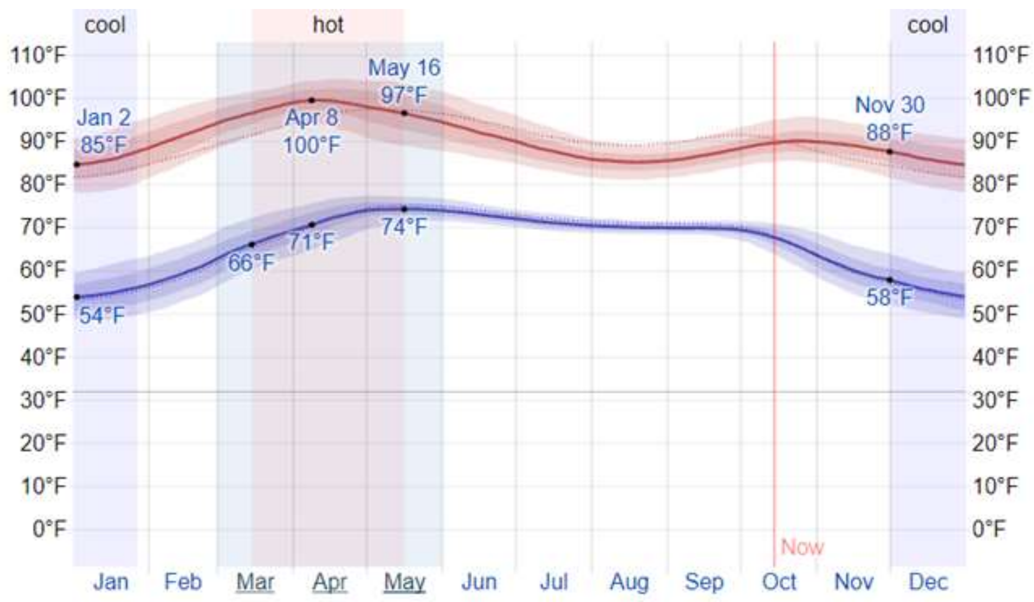
The mean LTA monthly rainfall in the area that usually comes around July and August can be as high as 330 mm while there can be months with no rain at all especially around November to March.

Temperature

Kareye, the headquarters of Karaye Local Government that hosts the Challawa Gorge Dam has climatic conditions similar to what obtains in the North Central part of Nigeria. The LGA is located some 120km south of Kano city and boarders Rogo, Kiru and Getso Local government Areas. The area experiences the usual wet and dry climate. The wet season is oppressive and mostly cloudy, the dry season can be partly cloudy, and it is hot year round. Over the course of the year, the mean annual temperature varies from 12^0C to 37.3°C.

The project area experiences relatively high temperatures for most of the year from January to December. The hot season lasts for about 2.0 months, usually March to May, with an average daily high temperature of above 36°C. The hottest month of the year in Karaye is April, with an average high of 37.2°C. The cool season lasts for 1.9 months, from November 30 to January 27, with an average daily high temperature below 31.1°C. The coldest month of the year in Karaye is January, with an average low of 12.8°C and high of 31°C.

Daily high temperatures increase from 31.1°C to 34.4°C. Fig. 5.5 shows the daily average high (red line) and low (blue line) temperature, with 25th to 75th and 10th to 90th percentile bands. The thin dotted lines are the corresponding average perceived temperatures. Figure 5.16 shows a compact characterization of the hourly average temperatures for all the months January to December. The horizontal axis is the day of the year, the vertical axis is the hour of the day, and the color is the average temperature for that hour and day. The average hourly temperature, color coded into bands. The shaded overlays indicate night and civil twilight.

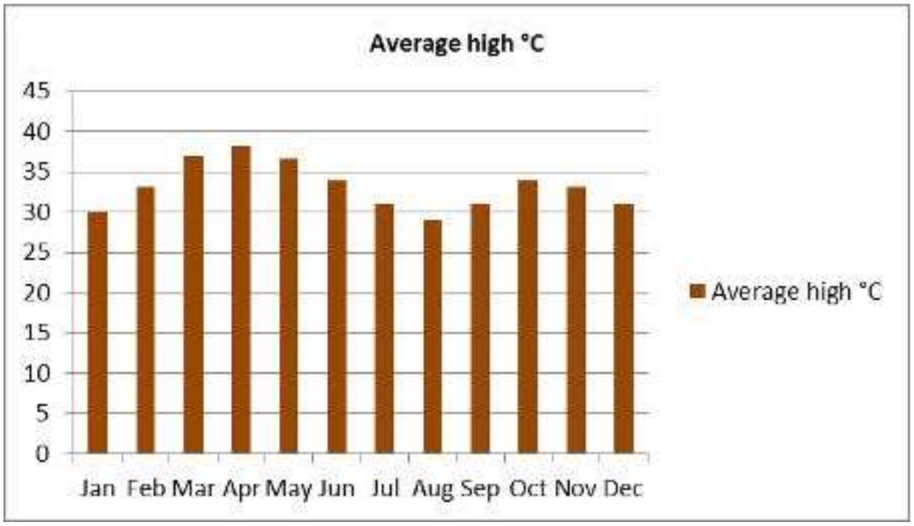


Average	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
High	86°F	92°F	97°F	99°F	96°F	92°F	88°F	85°F	87°F	90°F	89°F	86°F
Temp	69°F	74°F	81°F	85°F	85°F	82°F	79°F	77°F	78°F	78°F	74°F	69°F
Low	55°F	60°F	67°F	72°F	74°F	73°F	71°F	70°F	70°F	67°F	60°F	56°F

Figure 5.16: Average high and low temperatures in Karaye
(Sourcehttps://weatherspark.com/y/58575/Average-Weather-in-Karaye-Nigeria-Year-Round)

Linked is to Harmattan, from December to February, which marks the main dry season in the area, both low maximum and low minimum monthly temperatures are observed. From March to April average temperatures reach a maximum because of high day maxima and limited night cold (thus very low diurnal temperature range), while wind speed is also at a maximum. In July/August, the daily variation of temperature is low and wind speed is low. Kano region is typically very hot throughout the year, though from December through February, ambient temperature is noticeably cooler. Nighttime temperatures are cool during the months of December, January and February, with average low temperatures of 11°-14 °C. Historically the recorded temperature averages 26.1°C. (Fig. 5.17)

For the Challawa sub-basin area, monthly and long-term average temperatures reach highest levels from March through to June, with lows in January when the Harmattan weather persists throughout the dry season. A maximum monthly temperature of 33.5 °C occurs in the middle of the dry season in April with a low of 14.5°C in January at the height of the Harmattan season. Monthly average maximum temperatures vary from 26.3°C in January to 33.5°C in April. Wind speed varies from 1.73 – 2.95 m/s and averages 2.35 m/s with high wind speeds from November through to a peak in February. Sunshine hours vary from just 11.26 hours in January to 12.6 hours in June



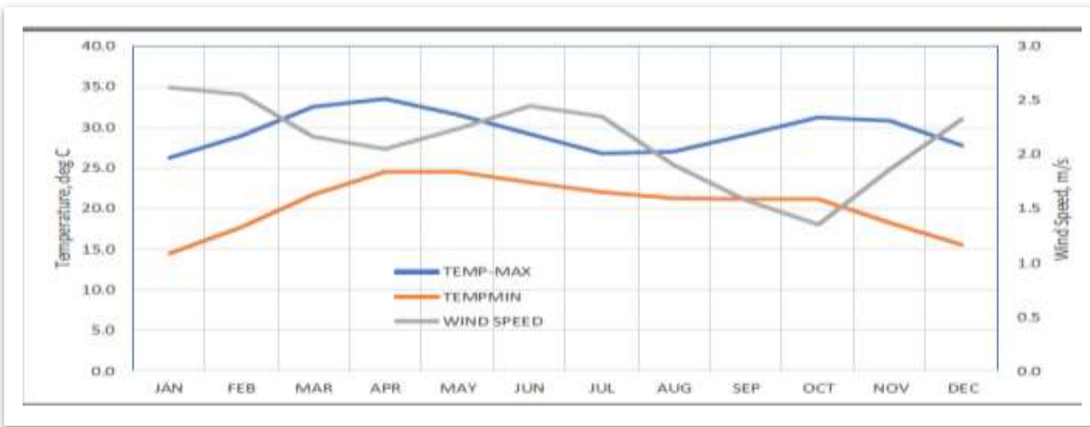


Figure 5.17: Maximum Temperature per month

(Average over 1981 –2010)

(Source: SMEC (2015) ESIA Report for the New Kano 330KVA Power line.

Figure 5.18: LTA maximum temperature, minimum temperature and wind speedSource: SMEC SAP Report 2019

Figure 5.19 shows a compact characterization of the hourly average temperatures for all the months January to December. The figure shows cool and comfortable morning hours 12am until about 11 am daily for most of the year except the period from middle of March to Middle of July which corresponds with the vernal equinox usually from March 20 -21 until June 23.

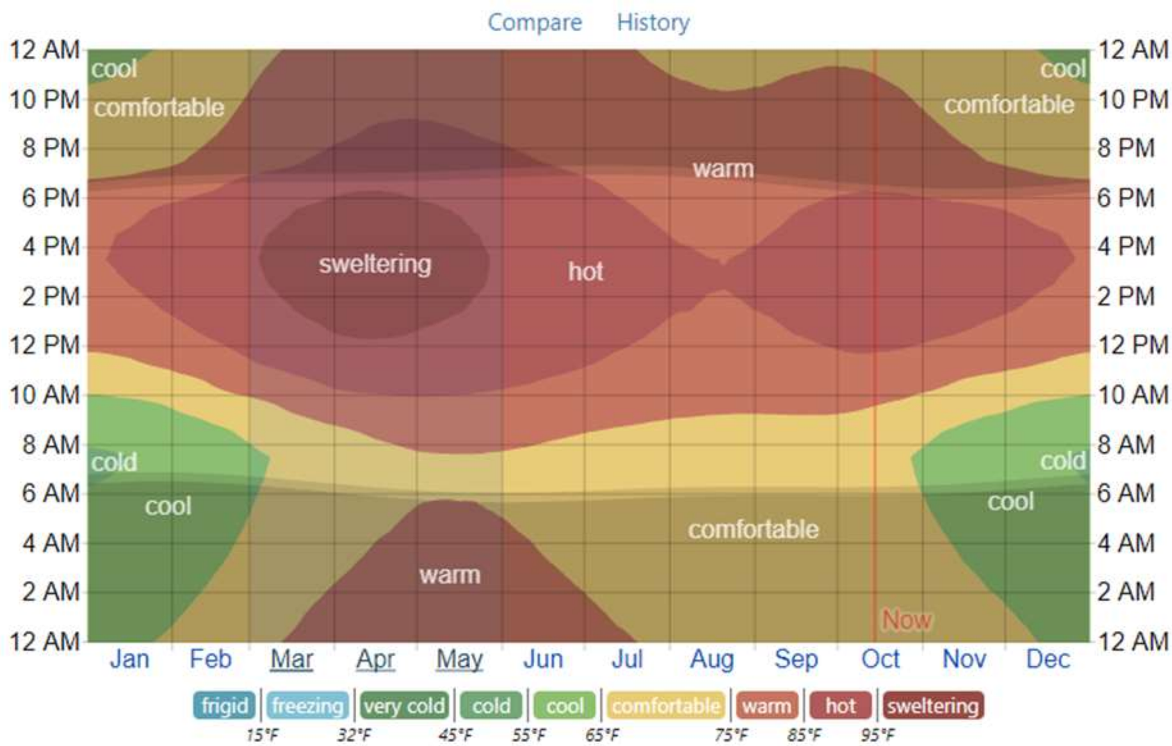


Figure 5.19: Average Hourly Temperature at Karaye Station
(Source: https://weatherspark.com/y/58575/Average-Weather-in-Karaye-Nigeria-Year-Round)

Wind Speed and Direction

When the ITCZ is to the south of the equator, the prevailing north-easterly winds dominate the region bringing with it the dry-season condition which lasts from November to March each year. From late March to late September the south westerly winds prevails bring rainfall and thunder storms marking the rainy (wet) season. At the time of field investigation conducted in July-August wind direction was generally in the Field measurements made on site, the prevailing wind was south westerly, with wind speeds of 0.8 –1.6 m/s.

Relative Humidity

The Saharan air causes the dry season which is accompanied by low relative humidity and intense aridity that makes the atmosphere very dusty while the rainy season follows the advancing Atlantic Maritime Air accompanied by high humidity in the rainy season. Relative humidity measured on site ranged from 62.0 – 87.0 %. This is not surprising as the measurements were made on separate days in the middle of August. By November tp late February relative humidity could go below 20% due to desiccating effect of the dry Harmattan winds that blows over the region from the Sahara desert. The low humidity periods therefore correspond with the low or no rainfall period in the region (fig.5.21). The implication for people's livelihood activities is that agricultural activity which is the dominant livelihood support for over 80% of the rural communities is at its lowest leaving only a small percentage of farmers engaging in irrigation farming especially near rivers and the Fadama plains where the ground water level is high enough to support irrigation. The Challawa Gorge Dam reservoir therefore also provides good irrigation opportunities for the local communities at this time of water scarcity for agriculture.

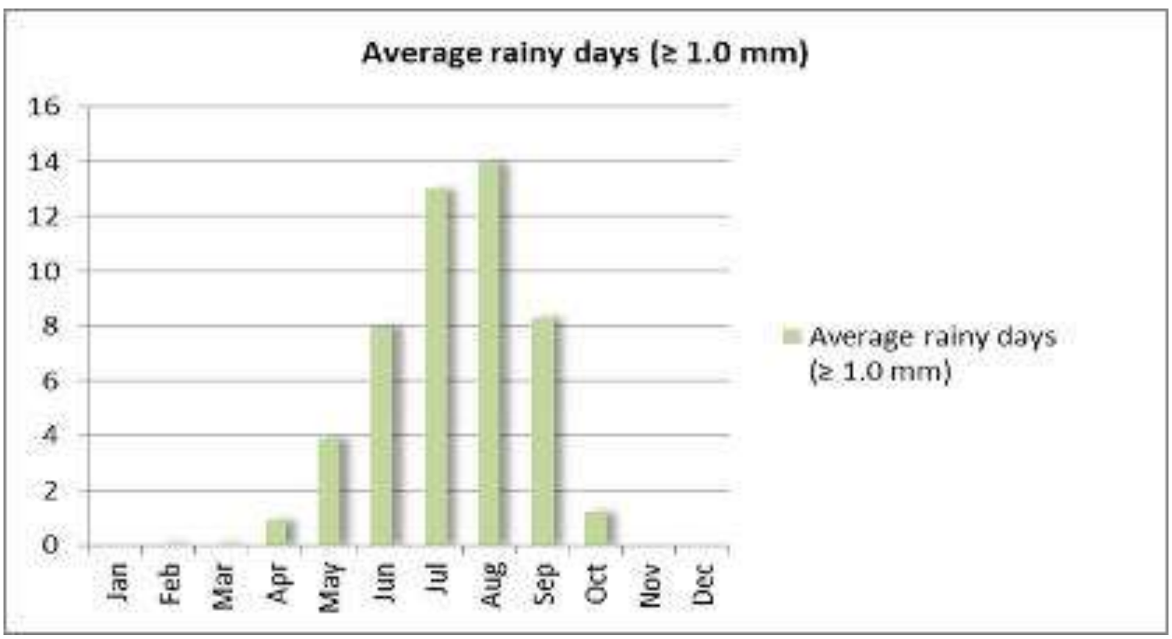


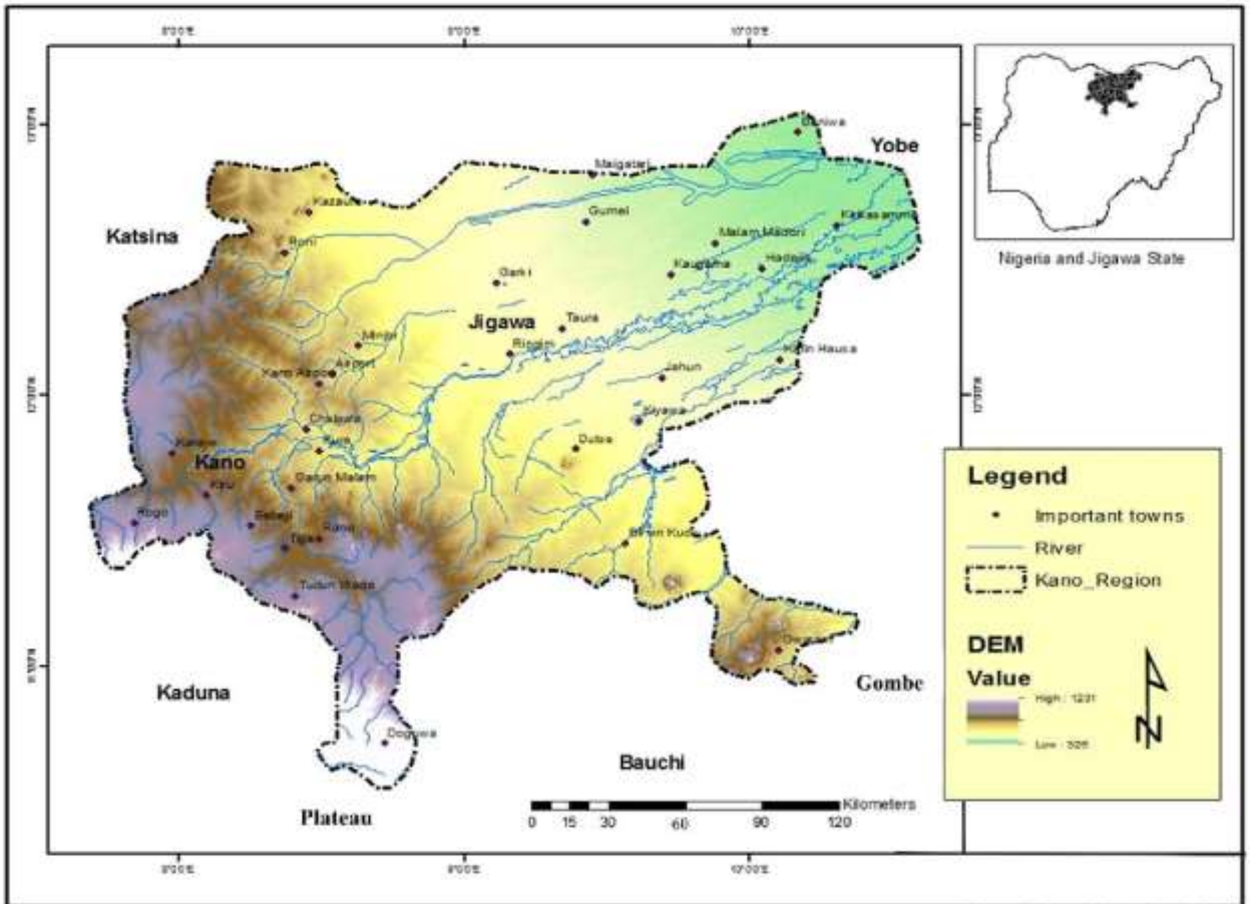
Figure 5.21. Average Rainy Days (≥ 1.0mm (1981 –2010)

5.20 Relief and Drainage

Drainage Pattern

Three main rivers of the entire HJKY basin are the Hadejia and Jama'are rivers that meet in the Hadejia-Nguru wetlands to become the Yobe River, and the Komadugu-Gana River which meets with the Yobe River near Damasak (Fig. 5.22 The river then flows eastward, ending in Lake Chad. Historically the Yobe River contributed only 1% of the total inflow into the Lake Chad (Mott MacDonald, 1993). The Hadejia River splits into three channels in the Hadejia-Nguru Wetlands (see Figure 2.23); the old Hadejia River which subsequently joins up with Jama'are River, the Marma channel which flows into non-returning Nguru Lake and the relatively small Burum Gana River which re-joins the old Hadejia River further downstream. The Hadejia River system is more than 70% controlled by Tiga Dam (in operation since 1974) on the Kano River and Challawa Gorge Dam (in operation since 1992) on the Challawa River. The Jama'are River System is presently uncontrolled, but plans exist since over 30 years ago to build a dam at Kafin-Zaki. Construction started two times but has since stopped due to conflicts from downstream users.

Both river systems are gaining flows down to the geological division between the Basement Complex rocks and the Chad Formation. Downstream of this divide the rivers begin to infiltrate into the permeable sediments. In the nearly flat middle and lower parts of the Basin, the rivers spill into the flood plains during the wet season (June to October). The land surface area of the KYB within Nigeria is around 116,293km^2 and contributes only 2.5% of the total runoff to Lake Chad.



Source: Dept. of Geog. BUK (2015)

Figure 5.22: Topography and Drainage

Source: Department of Geography, Bayero

5.21 Environmental Quality Studies

Laboratory Analysis: Laboratory analyses of environmental samples (soil and groundwater) collected during the field sampling exercise was carried out at Kano State Ministry of Environment Laboratory accredited by the Federal Ministry of Environment. Table 5.8 highlights the analytical method applied for environmental studies.

Table 5.8: Analytical methods for Environmental Studies

S/N	PARAMETERS	METHOD OF ANALYSIS
1	Temperature (oC)	APHA 2110B
2	pH	APHA 4500H+B
3	Turbidity (NTU)	APHA 2130B
4	Salinity (mg/l)	APHA 2520B
5	TSS (mg/l)	APHA 2540D
6	TDS (mg/l)	APHA 2510A
7	Conductivity (µS/cm)	APHA 2510A
8	THC (mg/l)	ASTM D3921
9	DO (mg/l)	APHA 4500-O G
10	BOD (mg/l)	APHA 5210A
11	COD (mg/l)	APHA 5220D
12	Nitrate (mg/l)	EPA 352.1
13	Phosphate (mg/l)	APHA4500-P D
14	Ammonium (mg/l)	APHA 4500-NH3
15	Calcium (mg/l)	APHA 3111B/ASTM D3561
16	Magnesium (mg/l)	APHA 3111B/ASTM D3561
17	Potassium (mg/l)	APHA 3111B/ASTM D3561
18	Sodium (mg/l)	APHA 3111B/ASTM D3561
19	Lead (mg/l)	APHA 3111B
20	Total Iron (mg/l)	APHA 3111B
21	Copper (mg/l)	APHA 3111B
22	Zinc (mg/l)	APHA 3111B
23	Manganese (mg/l)	APHA 3111B
24	Cadmium (mg/l)	APHA 3111B
25	Total Chromium (mg/l)	APHA 3111B
26	Arsenic (mg/l)	APHA 3030B/3114B
27	TOC (mg/kg)	BS 1377
28	Conductivity (mg/kg)	APHA 2510B
29	THC (mg/kg)	ASTM D3921
30	Nitrate (mg/kg)	EPA 352.1
31	Phosphate (mg/kg)	APHA 4500-P D/CAEM
32	Sulphate (mg/kg)	EPA 9038
34	Magnesium (mg/kg)	APHA 3111B/ASTM D3561
35	Calcium (mg/kg)	APHA 3111D

36	Potassium (mg/kg)	APHA 3111B/ASTM D3561
37	Sodium (mg/kg)	APHA 3111B/ASTM D3561
38	Zinc (mg/kg)	ASTM D5198/APHA 3111B
39	Lead (mg/kg)	ASTM D3111B /D5198
40	Arsenic (mg/kg)	APHA 3030F/3114B
41	Total Iron (mg/kg)	APHA 3111B/ASTM D5198
42	Copper (mg/kg)	APHA 3111B/ASTM D5198
43	Cadmium (mg/kg)	APHA 3111D/ASTM D5198
44	Polychlorinated biphenyls (PCBs)	EPA 9078
45	Total Chromium (mg/kg)	APHA 3111B/ASTM D5198

Ambient Air Quality for Wet season

The Federal government of Nigeria established the Federal Environmental Protection Agency (FEPA) in 1988 to protect, restore and preserve the ecosystem of Nigeria. To improve the quality of the environment and prevent the occurrence of pollution related environment hazards, the FEPA established environmental guidelines and standards for the abetment and control of all forms of pollution. This involved the setting up of the Nigerian Ambient Air Quality standards (NAAQS) to protect public health and the environment. The ambient air quality index is shown in Table 5.9.

Table 5.9: The ambient air quality index is shown

Good	Moderate	Unhealthy for sensitive groups	Unhealthy	Very unhealthy	Hazardous
1 - 50	51 - 100	101 - 150	151 - 200	201 - 300	301 - 500

It is against this background that the quality of air around the Challawa Gorge Dam Watershed was monitored to ensure its quality and to for the planned watershed management activity falls within the approved acceptable environmental limits of air and noise quality of the project environment.

The air quality monitoring for this ESIA for the rainy season was done in two phases. Over a period of 5 minutes at each of the sampling locations, *in-situ* air quality monitoring was carried with pre-calibrated portable ambient air quality meters to measure the following parameters: Sulphur (IV) Oxide (SO2), Nitrogen (IV) Oxide (NO2), Carbon Monoxide (CO), Volatile Organic Compounds (VOC), and Particulate Matters(pm). The gaseous pollutants measured are summarized in Table 5.10. Result of air quality analysis showed that none of measured pollutants was found to be significant at all sampling locations. The measured levels of Suspended Particulate Matter (SPM) were within the regulatory standards. Therefore, it is safe to conclude that the background air quality in the project area is generally good.

Table 5.10: Ambient Air Quality Analysis Wet Season

Sampling Location	Location Coordinate		Air Quality Parameter												REMARK
			HCH4 mg/l	**TVCO mg/l**	**RH (%)**	**TEMP. ^{0}C**	**$PM_{2.5}$ (µg/m^3)**	**$PM_{1.0}$ (µg/m^3)**	**PM_{10} (µg/m^3)**	**H_2S (ppm)**	**CO (µg/m^3)**	**NO_2 (µg/m^3)**	**NH_3 (ppm)**	**SO_2 (µg/m^3)**	
FMEnv.			N/A	N/A	N/A	N/A	80	250	N/A	0.008	10	0.06	N/A	0.002	NORMAL
WHO			N/A	N/A	N/A	N/A	75	0.15 – 0.25	150	N/A	N/A	0.04 – 0.06	N/A	0.002	NORMAL
ASP_1	11°46'17.73"N	8° 1'42.71"E	0.210	01.67	66	26.8	31	15	98	0	0	0	13.0	0.00	Satisfactory
ASP_2	11°47'24.93"N	8° 7'27.15"E	0.210	0.167	66	26.7	98	31	150	0	0	0	13.0	0.00	Satisfactory
ASP_3	11°37'19.10"N	7°53'14.77"E	0.341	0.167	65	27.5	65	23	180	0	0	0	13.0	0.00	Satisfactory
ASP_4	11°45'4.73"N	7°57'18.74"E	0.610	0.544	65	25.7	15	19	189	0	0	0	18.1	0.00	Satisfactory
ASP_5	11°38'31.06"N	8° 3'1.67"E	0.610	0.176	63	17.6	10	7	18	0.1	0	0	17.4	0.00	Satisfactory
ASP_6	11°45'7.30"N	8° 6'54.66"E	0.100	0.176	75	25.7	18	6	13	0.1	0	0.1	15.4	0.10	Satisfactory
ASP_7	11°36'50.98"N	7°57'28.42"E	0.131	0.176	65	27.8	18	13	54	0	0	0.1	17.4	0.00	Satisfactory
ASP_8	11°46'26.44"N	7°58'17.24"E	0.131	0.176	65	25.6	48	33	58	0	0	0	17.4	0.00	Satisfactory
ASP_9	11°42'48.73"N	8° 2'44.25"E	0.000	0.000	68	25.8	10	31	71	0.3	0	0	0.0	0.10	Satisfactory
ASP_{10}	11°41'50.65"N	7°56'52.19"E	0.131	0.176	65	25.6	48	43	165	0	0	0.3	17.4	0.30	Satisfactory

Source: Field work, 2021

Air Quality (Dry Season)

Dry season information on air quality was based on a proxy data from an ESIA on a project located close to the Challawa Watershed Management Project (Century Mining Limited, Tin and Zink Mining, kano State. Proxy data was used because this ESIA is mainly a wet season report as per terms of the Study. The result of air pollution measured during the dry season is shown in Table 5.11. The results indicate that all pollutants measured were within regulatory limits of FMEnv indicating that the air quality of the area is excellent. Noise level ranged from 36.8dB (A) – 56.2dB (A). The highest noise value was recorded during vehicular movement. The values were below the regulatory levels for noise values which is 70dB (A) for industries and 50-60 residential and small-scale industries areas, over a period of 8 working hours.

Table 5.11: Air Quality Result of Project Area (Dry Season)

SITE ID	CODE	Sampling Coordinates		Parameters in **μg/m³**						
		Northings	Eastings	NO_2 **(ppm**	SO_2 **(ppm**	CO **(ppm**	H_2S **(ppm**	**NH_3 (ppm)**	SPM **(ppm**	VOC **(ppm**
	AQ1	10.41575^0	8.67620^0	9.2	3.46	<0.01	<0.01	<0.01	75	<0.01
	AQ2			8.31	5.39	<0.01	<0.01	<0.01	69	<0.01
	AQ3			7.08	4.11	<0.01	<0.01	<0.01	61	<0.01
	AQ4	10.42014^0	8.78923^0	11.20	3.46	<0.01	<0.01	<0.01	75	<0.01
	AQ5			12.31	5.39	<0.01	<0.01	<0.01	69	<0.01
	AQ6			10.08	4.11	<0.01	<0.01	<0.01	61	<0.01
FMEnv Limit in **μg/m³**				75 - 113	26.0	11.4	0.008	**	**	**

Source: Air Quality obtained from ESIA for the Proposed Mining Project by Century Mining Company Ltd, at Riruwai Community Doguwa LGA, Kano State (2021)

Ambient Noise Level Assessment

Ambient Noise levels at different points were measured using sound level meter with a detection range of 40dBA to 130dBA. Noise level measurements were taken at a height of approximately 2m above ground level and the response time was set to slow and read on the ‘A’ frequency weighting scale in unit decibels. The result shows that the is generally within the acceptable limits prescribed by NESRIA (Table 5.12).

The results of the ambient noise levels assessment during field work are as shown in Table 5.12. Higher noise levels were recorded noise in three different locations during the sampling: viz. 56.5dB(A), 61.0dB(A) and 62.3dB(A) which were higher than the NESREA Limits for residential area (55dBA). These high noise levels are as associated with vehicular movements. The NESREA Limits are in Continuous Equivalent Sound Level "Leq". This is a geometric average of the noise levels over the period of monitoring. This allows occasional peaks above the standard noise level which are compensated by occasional dips below the standard. Infrequent vehicle movements are typical examples which do not infringe on noise standard. Most of the noise levels are within acceptable levels. In general, the measured noise levels are representative of a typical rural environment.

Table 5.12: Ambient Noise Level Measurements (Wet Season)

Sampling Location	**Location Coordinate**		NOISE QUALITY	
	Northing	**Easting**	Lowest dB(A)	Highest d(BA)
AQC			51.2	54.9
Range	-	-	40.1-52.9	44.2-62.3
NESRIA Limit	-	-	55	55
ASP_1	11°46'17.73"N	8° 1'42.71"E	52.9	61.0
ASP_2	11°47'24.93"N	8° 7'27.15"E	40.7	45.3
ASP_3	11°37'19.10"N	7°53'14.77"E	47.8	44.2
ASP_4	11°45'4.73"N	7°57'18.74"E	47.3	59.2
ASP_5	11°38'31.06"N	8° 3'1.67"E	52.2	56.5
ASP_6	11°45'7.30"N	8° 6'54.66"E	37.1	62.3
ASP_7	11°36'50.98"N	7°57'28.42"E	44.2	46.9
ASP_8	11°46'26.44"N	7°58'17.24"E	43.0	47.3
ASP_9	11°42'48.73"N	8° 2'44.25"E	40.1	44.5
ASP_{10}	11°41'50.65"N	7°56'52.19"E	41.0	43.6

5.22 Geological, Hydrology and Geomorphic Characteristics

5.22.1 Geology of the Project Location

The literature survey suggests that the project area in fig. 4.2 is geologically characterized by mainly impermeable basement complex rock formations. Bawden, *et al*. (1973) described the region as being part of the northern plains which is largely characterized by extensive very gently undulating plains sloping gradually from over 600 meters above sea level south and west of Kano and to over 1,000masl north of Jos to less than 300masl towards the Lake Chad. The river systems in the area provide extensive flood plains that are used for livelihoods.

Pre-Cambrian rock of the basement complex which comprises of gneisses, amphibolite, marbles and the older granites which underlie large parts of Nigeria including the Kano Region (Adamu *et al*, 2014). The Granites are generally Gneissic and commonly developed in a mixture of Pegmatite of schist granite, Gneiss and irregular mass of pegmatite. The Aeolian sand derived from wind deposits cover most part of the area with thickness of about 5 meters in the upland and 10 meters along the lowland plains (Olofin, 1987). The geological structure influences the relief as well as landforms which are relatively flat, with some undulation especially around upstream of the drainage system of the area. The relief of the area has been categorized into four types comprising south and south eastern highlands; the middle and western high plains; the central lowlands and the Chad plain. The highlands occupy more than 50% of the surface area of the region and lies on an elevation ranging between 450 to 650masl. The high plains consist of areas of low relief, usually less than 20masl and areas of grouped hills where the hill may rise higher than 100m above the plains. The plains are developed on rocks of the Basement Complex.

The Hadeja Jamaare Basin is geologically underlain by Basement Complex upstream and the Chad Formation to the middle and downstream. While the upstream part of the basin is characterized by mainly impermeable Basement Complex rocks covered by the permeable quaternary sediments which consist of fine to coarse grained sand, with intercalation of sandy clay, clay and diatomite, the dunes in the middle part of the basin and alluvial deposits along the river systems are superficial deposits lying on the Chad Formation. The river alluvium deposits consist of sands, silts and clays with occasional existence of coarse sands and gravel along younger river channels.

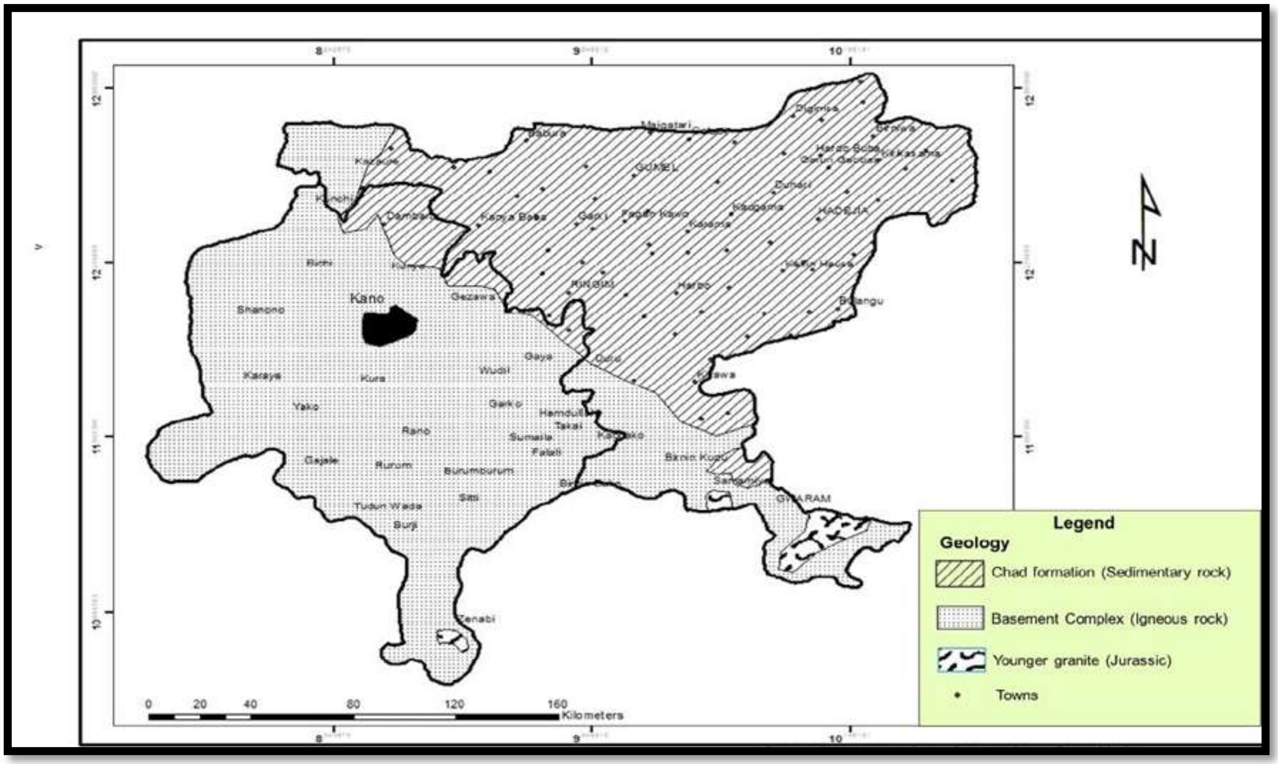


Figure 5.23: Geology of Kano State

5.22.2 **Hydrology of the project location**

Nigeria has extensive surface water resources, including the perennial Niger and Benue rivers and their tributaries. Groundwater is widely used for domestic, agricultural and industrial supplies. Most rural areas are dependent on groundwater, and a number of towns and cities**.**

5.22.3 **Surface Water Occurrence**

Surface water in the area occurs in rivers and streams, with River as Challawa the only perennial river (Garba, 2009). All others are either intermediate or ephemerals in nature. Surface water also exists in impounding reservoirs of four earth fill dams (colloquially called dams) constructed on these rivers. These are Challawa Gorge Dam constructed on River Challawa in 1992, Guzu-Guzu dam constructed on River Guzu-Guzu, Magaga dam on River Magaga and Kusalla dam on River Kurma at Karaye town.

The Komadugu-Yobe Basin is the primary source of water for domestic water, industrial and agricultural development within the 6 riparian states and Lake Chad. SMEC, 2019 estimated the outflows from each of the main sub-basins using available hydrological data (Fig. 5.24). The estimates show that the two largest sub-basins i.e. Hadejia and Komadugu-Gana, have very low “annual runoff coefficients” being about 7 % and 3 %, respectively. These figures are exceptionally low and are due to small annual rainfall and high potential evapotranspiration rates in the Basin; and the losses due to large wetlands and groundwater recharge in the sub-basins (Fig. 5.25).

The area lies within the Hausa plains and highest elevation is in the area is about 564masl above sea level, and a minimum elevation of 488masl down south of the area and with an average height of 526masl. Drainage in the area is largely influenced by the relief; lowland areas have the Rivers and streams. River Challawa is the only big River with tributaries, Magaga, Takwami, Gunshi, Jerry, Guzu- Guzu, Kutumbule, Iyaka, and the likes. The rivers are now mostly dammed. The area has a drainage density of 1.46Km/Km2 as calculated by the author. The general pattern of drainage in the area is dendritic mostly running in the north south direction (Garba, 2009).

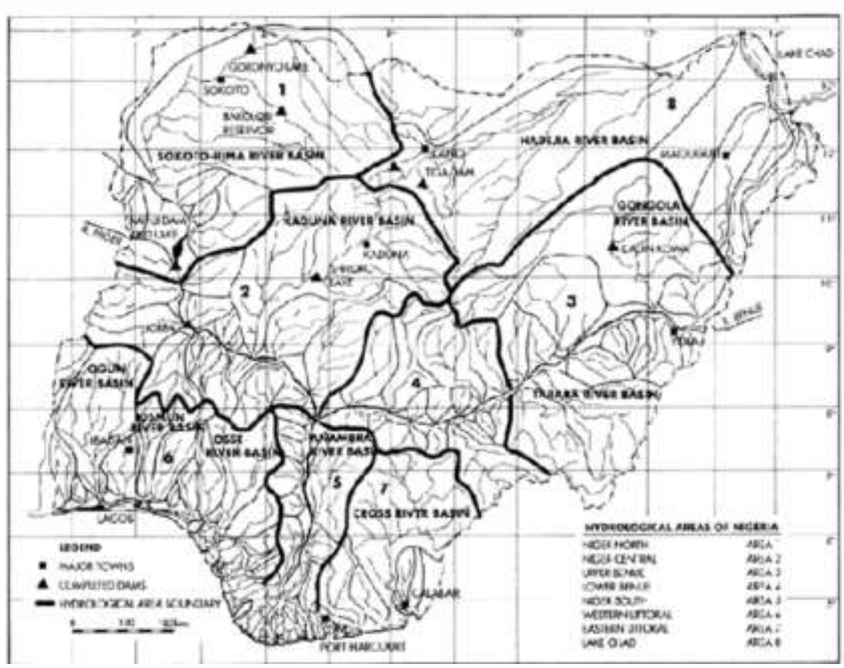


Figure 5.24: Map of Nigeria showing the Hydrological areas and Drainage network.

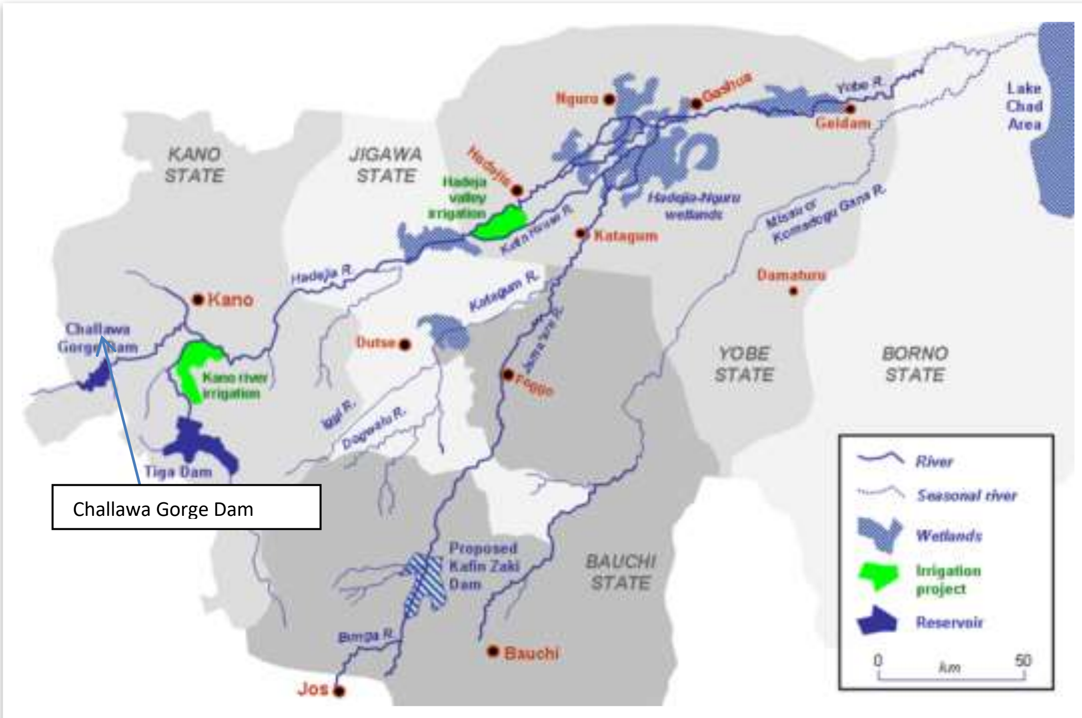


Figure 5.25: Hydrological Map of Hadeja-Jamaare-Komadugu- Yobe Basin, showing challawa Sub-Basin

5.22.4 **Groundwater Availability and Uses**

Groundwater availability varies in the region. Various factors affect its availability. The most recognized and important one is the geological differences. In their study Abubakar et, al (2018) revealed that, the volume of groundwater decreases from the Chad Formation to the Basement Complex region, with Birniwa area in the Chad formation region and Zarewa in the Basement Complex region where this project area lies, having volumes of $9.363.0m^3$ and $49.0m^3$ of groundwater respectively. Thus, groundwater availability is much higher in the Chad Formation than in the Basement Complex.

The Chad Formation in the Kano region is one of the largest accessible stores of fresh groundwater, and for that groundwater is often considered a logical resource in the region. Conversely, in the Basement Complex region, rapid rising population growth in association with urbanization and climate change have led to intensive exploitation of groundwater through construction of boreholes, principally for domestic water supply. Groundwater in the urban Kano area for instance appears to be a common and low-cost alternative to surface water for many uses because it occurs generally in a more potable quality compared to surface water.

However, despite the growing dependency upon groundwater for different uses in the Kano region, concerns remain over the sustainability of this resource principally in terms not only of the rate of abstraction but also in terms of the quality and quantity because the area is underlain by igneous structure.

Groundwater utilization in the study area varied from commercial, domestic and agricultural uses. In most parts of the study area, appeared to be the only alternative and reliable source of water for various agricultural activities, especially, the floodplain (fadama) irrigation agriculture. While rain-fed agriculture lasts for about three to four months in the area, floodplain irrigation is well practiced throughout the dry season lasting for six to nine months. Thus, groundwater from fadama aquifer is extracted by tube wells and wash bores to support irrigation in the dry season from the end of the rainy season, which provides opportunities in terms of agricultural diversification than in the southern region and enables for double or triple cultivation in one single year. In the southern part of the region, however, groundwater becomes virtually the most reliable source of fresh water for domestic and commercial activities. Increase in the level of demand and consumption of water leads to the drilling of boreholes by individuals, government and private companies. Consequently, thousands of commercial water companies have emerged increasingly particularly in the urban areas of the region to exploit principally groundwater as the main source of potable water. The reliance of groundwater in the study area is also partly due to the siltation at of the Kano Water Treatment plant at Panshekara ear Kano, which not only increased the cost of water treatment and reticulation but also labour demand on the part of the workers of the Water Works who are responsible for treating and managing the scheme.

The findings of Ayoade (1988) on groundwater availability in the region, revealed that the mean groundwater recharge contributed by river flow and rainfall accounted for 33% and 13%, respectively. The study further revealed, that groundwater beneath the floodplains dropped from 9000 MCM in 1964 to 5000 MCM in 1987 (a drop of about one half of its initial value). In the same development, the finding of Tanko, (2014) on the variation of groundwater levels in the same region of Kano revealed a positive relationship between rainfall and groundwater level variation. Thus, the study revealed a steady annual decrease of groundwater level from 2010 to 2013 in the area (Figure 5.26).

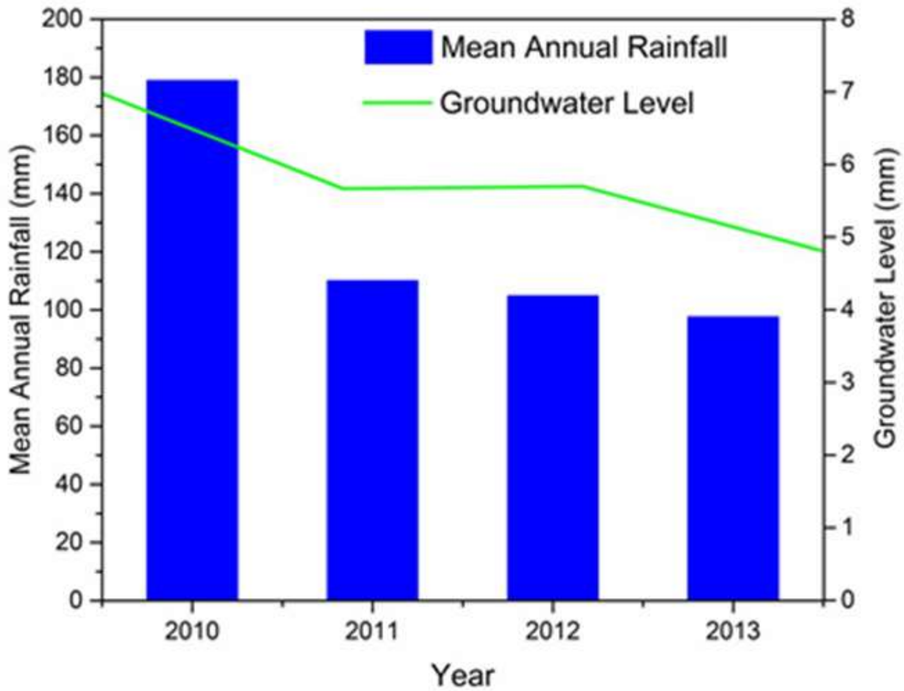


Figure 5.26: Annual trend of rainfall and groundwater level in the Hadeja-Jamaare Basin Area.

5.23 Soils

Reference to the 1:650,000 “Generalized Soil Map of Nigeria” shows eight soil types according to the FAO soil classification, including Cambisols, Regosols, Luvisols, Fluvisols Vertisols, Acrisols, Latosols and Nitisols were identified, with Luvisols having a major occurrence in the basin. In particular however, the soils of Challawa Gorge Dam sub-watershed reflect the general soil condition in Kano Region.

Soil was investigated through visual observation and sampling using variations in ecological features such as topography, geomorphology, hydrological characteristics, and land use patterns. Four composite soil samples were obtained from each of the 10 sampling stations Hand auger of uniform cross section was used to ensure that uncontaminated reproducible units of soil samples were collected from depths of 0-15cm (topsoil) and 15-30cm (subsoil). This ensured high quality representative data collection. Surface litter of un-composed plant materials were removed to ensure that uncontaminated soil samples were collected.

Sediment samples were also obtained from all surface water sampling points. Sediment sampling was carried out using the Eckman Grab sediment sampler. Several grab bites were done to collect enough samples for the different analyses. All the samples were collected in plastic bags and stored in ice-packed boxes at 4^{o}C and subsequently transferred into refrigerators in the laboratory. Sediment samples for microbial analysis were collected in well-labeled aluminum foil plates and preserved in an ice-packed cooler at 4^{o}C for transmission to the laboratory. Generally literature suggests that matured soils occupy the plains and the immature ones are found on hill slopes, foot slopes and valley-bottoms. The influence of topography and wind-drift materials from the desert is what shapes the aggregate of the soil structure in the region, although, the matured soils are of ferruginous type (Olofin, 1987). Adamu et al (2010) reported the soil type in the region as generally Sandy Loam (Table 5.7). A total of four (10) representative sediment samples were collected for laboratory analyses of the various soil parameters (Table 5.13).

Table 5.13: Proportion of Soil type at 11 sampling site in Kano Region

Sample Site	Sand %	Silt %	Clay %	Soil Type
S1	80.7	14.0	5.3	Sandy Soil
S2	57.7	32.3	10.1	Ligh t Loam
S3	80.7	14.3	5.3	Sandy Soil
S4	4.3 1	4.0	80.5	Clayey Soil
S5	80.7	10.2	5.3	Sandy Soil
S6	57.6	14.0	10.1	Light Loam
S7	57.6	32.3	10.1	Sandy Soil
S8	80.7	32.3	5.3	Loamy Sand
S9	79.5	14.0	5.1	Loamy Sand
S10	79.5	15.4	5.1	Loamy Sand
S11	57.6	15.4	10.1	Light Loam
S12	80.7	32.3	5.3	Sandy Soil

Source: Adamu et al, (2014)

5.23.1 **Physicochemical Properties of the Soils**

Methodology

Ten (10) units were sampled for soil sample collection and analysis. The sampling units were the same for all samples collected for this ESIA study. Stainless steel, handheld Dutch type Soil Auger was used to collect soil samples at each soil sampling station (Plate 5.6) . At each sampling station, soil depth 0-15 cm and 15-30 cm for topsoil and subsoil levels were collected. The method of soil analysis for all parameters is as presented in table 5.4.

Plate 5.8: Soil Sample Collection at a location at the project environment

5.23.2 Results of Soil Analysis

A Summary of the results of soil analyses including physical and chemical properties are presented in table 5.16. The detail result of analysis are attached as **Appendix 5.** The detailed analysis with respect to the physic-chemical properties is also presented below:

Table 5.14: Summary Results of Soil Quality Analysis

S/N	PARAMETERS	SUMMARY OF RESULTS	REMARKS
1	Temperature (^oC)	30.5	Satisfactory
2	PH	7.13	Satisfactory
3	Potential difference (MV)	58.23	Satisfactory
4	TDS(mg/kg)	-	Satisfactory
5	Conductivity us/cm	142	Satisfactory
6	Colour (PtC_OU)	Redish brown	Satisfactory
7	DO_2 (mg/kg)	4.7	Satisfactory
8	BOD (mg/kg)	1.2	Satisfactory
9	COD (mg/kg)	16.78	Satisfactory
10	Alkalinity (mg/kg)	76.6	Satisfactory
11	Phosphate (mg/kg)	32	Satisfactory
12	Hardness (mg/kg)	154	Satisfactory
13	Carbonate (mg/kg)	0.05	Satisfactory
14	Salinity (mg/kg)	134.5	Satisfactory
15	TSS (mg/kg)	----	Satisfactory
16	Total Organic Carbon(mg/kg)	0.23	Satisfactory
	EXCHANGEBLE CATIONS		
17	Na^+ (mg/kg)	143	Satisfactory
18	K^+ (mg/kg)	1.08	Satisfactory
19	Mg^{2+} (mg/kg)	0.24	Satisfactory
20	Ca^{2+} (mg/kg)	1.34	Satisfactory
	EXCHANGEBLE ANIONS		
21	Sulphate as SO_4^{-2} (mg/kg)	54	Satisfactory
22	Nitrate as NO_3^{-1} (mg/kg)	2.76	Satisfactory
23	Nitrite as NO_2^{-1} (mg/kg)	1.67	Satisfactory
24	Ammonium as NH_4^+ (mg/kg)	0.50	Satisfactory
25	Nitrogen as N_2 (mg/kg)	1.67	Satisfactory
26	Phosphate (mg/kg)	6.0	Satisfactory

27	Chlorine as Cl_2 (mg/kg)	1.4	Satisfactory
	HEAVY METALS		
28	Chromium as Cd (mg/kg)	0.01	Satisfactory
29	Zinc as Zn (mg/kg)	2.3	Satisfactory
30	Iron as Fe(mg/kg)	3.1	Un Satisfactory
32	Copper as Cu(mg/kg)	1.3	Satisfactory
34	Nickel as Ni (mg/kg)	0	Satisfactory
35	Lead as Pb (mg/kg)	0.02	Satisfactory
36	Manganese as Mn (mg/kg)	0	Satisfactory
37	Barium as Ba (mg/kg)	0	Satisfactory
38	Arsenic as As (mg/kg)	0	Satisfactory
39	Mercury as Hg (mg/kg)	0	Satisfactory
40	Cadmium as Cd (mg/kg)	0.01	Satisfactory
	SOIL CHARACTERISTICS		
41	Texture	Sandy /Loamy	Satisfactory
42	Grain Size (Mm)	0.71	Satisfactory
43	Porosity (0/0)	32.0	Satisfactory
44	PERMIABILITY (Cm/Hr)	15.2	Satisfactory
45	BULK DENSITY (G/Cm^3)	*	Satisfactory
46	Erosion Potential	*	Satisfactory
47	Moisture Content (%)	0.31	Satisfactory

Soil pH

Soil reaction (pH) is a measure of acidity/alkalinity of the soil in terms of the free H+ ion concentration of soil solution. It influences the availability of certain elements in the soil. As shown in table 5.7, top soil had a pH ranging of 7.13 to 8.4 with an average value of 7.83. The bottom soil was found to have pH values ranging from 7.15 to 8.31 with a mean value of 7.68. Soils can be classified according to their pH value. A pH value of 6.5 to 7.5 is considered neutral, over 7.5 is alkaline and less than 6. Is acidic, and soils with pH less than 5.5 are considered strongly acidic. In the case of the project site the mean pH values for both top and bottom soils fall in the range of 7.68 to 7.83 and can be described as Alkaline.

Electrical Conductivity

The electrical conductivity of a soil expresses the soil's total ionic strength, both cations and anions. Low total ionic strength of soil solution indicates low dissolved salts, and vice – versa.

The electrical conductivity of the topsoil of the project area ranged from 125 to 321 with an average conductivity of 158.9 while that of bottom soil ranged from 121 to 321 with average of 168.1. This is a measure of one of the macro plant nutrients in the soil that influences plant growth more than most plant nutrients, and it is the most important element in plant growth.

.

Soils were also collected from the study area and analyzed for heavy metals to determine their concentration. Low levels of many heavy metals are naturally present in most soils. Vanadium, Lead, Cadmium, Arsenic, and Mercury were not detected both in top and bottom soil samples. Oil and Grease content from samples collected from along the project axis were below the detection limit of the analytical equipment in top and surface soils.

Soil is of vital for the survival and welfare of the people especially rural communities whose livelihood depends more on quality and agricultural productivity of the soils. Thus any change in soil quality may have telling effects on livelihood sustainability in the rural areas. This is therefore highly significant for the project environment. Moreover, the project involves planting of exotic economic trees and grasses to stabilize soil, increase the surface cover, reduce soil erosion and by extension reduce load density of the rivers and the Challawa Reservoir. These changes degrade soil quality and alter physical and chemical parameters. Assessing the physicochemical properties of the soil of the project environment is therefore not only desirable, but also necessary.

Total Organic Carbon (TOC %): The soils exhibited wide variability in terms of total organic carbon content. In the top soil, TOC ranged from 0.2% to 1.3%, with a mean value of 0.75% and the sub soil percentage TOC ranged from 0.1 to 1.3%. The production, accumulation and degradation of organic matter are greatly dependent on climate. Temperature, soil moisture and topography are the major factors affecting the accumulation of organic matter in soils.

Organic matter tends to accumulate under wet or cold conditions where decomposer activity is impeded by low temperature (Buol, 1990) or excess moisture which results in anaerobic conditions (Trofimov et al 2008). Conversely, excessive rain and high temperatures of tropical climates as in the present assessment enables rapid decomposition of organic matter and leaching of plant nutrients. Excessive slope may encourage the erosion of the top layer of soil which holds most of the raw organic material that would otherwise eventually become humus.

In view of the observations during the field studies, the present variability in total organic carbon content of the soils could be attributed to its high accumulation around the densely vegetated and unhampered secondary forest portion of the area. The other areas possess less dense vegetation cover leading to reduced rate of plant residue returns and accumulation with inherent high decomposition rate on the sandy, loamy sand texture soil.

Total Nitrogen: Total nitrogen content varied between 10.1% and 18.6% with a mean value of 14.35%, while the subsoil total nitrogen content ranged from 10.2% to 18.9%. The total nitrogen content of soil depends on the climate, vegetation, topography, age and soil management. Usually, more nitrogen is under grassland than under forest. Humans formation promotes nitrogen immobilization.

Cultivation decreases soil nitrogen by exposing soil to more air which bacteria can use and no-tillage maintains more nitrogen than tillage. In the present study, the reasons given for the trend in the observed in the total organic carbon content in the soils is also applicable to the total nitrogen content in the soils.

Cation: Sodium, Calcium, Potassium and Magnesium: In the top soil, the mean levels of these cations in dry were generally low as follows; Sodium (82.5mg/kg); Calcium (1.52mg/kg), Potassium (1.56mg/kg) and Magnesium (2.535mg/kg) respectively while in the subsoil, Sodium (80mg/kg); Calcium (1.52mg/kg), Potassium (1.53mg/kg) and Magnesium (2.09mg/kg) respectively.

Anions: Sulphate, Phosphate, Nitrate and Nitrite: In the top soil, the mean levels of these anions in were as follows; Sulphate (38mg/kg); Phosphate (52.5mg/kg), Nitrate (13.8mg/kg) and Nitrite (0.66mg/kg) respectively while in the subsoil, Sulphate (38mg/kg); Phosphate (55.5mg/kg), Nitrate (14.54mg/kg) and Nitrite (0.72mg/kg) respectively.

Organics (mg/kg)

Oil and Grease values were below detection limit for both top and sub. Polynuclear Aromatic Hydrocarbon values ranged from 1 to 1.6mg/kg for top soil while it ranged from 1.2 to 1.3mg/kg. Total Petroleum Hydrocarbon Content on the other hand, ranged from 0.18 to 0.45mg/kg for top soil and ranged from 0.16 to 0.31mg/kg for sub soil.

Heavy metals: In the top soil, the mean concentration of the heavy metals n and related soil micronutrient elements were as follows; Iron (4.8mg/kg), Zinc(6.45mg/kg), Lead (0.01mg/kg), Copper (1.4mg/kg), Cadmium(0.015mg/kg), Nickel(1.18mg/kg), Barium(0.7mg/kg). In the sub soil, the mean concentration of the heavy metals and related soil micronutrient elements were as follows; Iron (5.0mgmg/kg), Zinc(7.35mg/kg), Lead (0.015mg/kg), Copper (1.55mg/kg), Cadmium(0.025mg/kg), Nickel (1.085mg/kg), Barium(0.7mg/kg). For both top and sub soils, Manganese, Arsenic and Mercury values were below detection limit.

Soil Texture:

Texturally the result of the physical analysis shows that the general soil type is Sandy Loam. This result is corroborated by the findings of Adamu *et al* (2010) earlier reported in table 5.7.

5.24 Sediment Physical-chemical analysis

Sediment samples were collected by means of Eckman grab submerged into the water to collect sediment samples. The sediment study was to understand the history of waste load discharges of the aquatic environment over an extended period of time. Sediment (bottom of the surface water body) serves as a sink for contaminants from the overlying waters. The physical-chemical characteristics of the sediment are an indication of the pollution level and the type of pollutants that has been in the overlying surface water. Several physical-chemical parameters for recovered sediment samples from the water bodies in the study area were conducted. Some of the parameters include the pH, total Hydrocarbon (THC), nitrates, phosphates, sulphates, magnesium, sodium, potassium, calcium and about 10 heavy metals. The result of sediments analysis is presented in table 5.15. The laboratory result was compared with the Limits set by the Federal Ministry of Environment. The exampling points were found to be same as that of the surface water.

Table 5.15: Results of Sediment analysis

Sample Station	**SD1**	**SD2**	**SD3**	**SD4**	**SD5**	**SD6**	**CONTROL**	**ISQG LIMITS**
Parameter	**SAMPLES FROM CHALLAWA GORGE DAM**							
PH (H_2O) @24.2^0	6.6	7.01	6.69	6.43	6.43	6.25	5.3-5.8	6.0-9.0
Culous	Light grey	Light grey	Dark grey	Dark grey	Dark grey	Light grey		NA

THC (Mg/kg)	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0.5	NA
Ext, Nitrates (Mg/kg)	9.7	15.3	12.9	16.3	6.62	16.8.	0.10-0.18	NA
Ext, Sulphate (Mg/kg)	2.0	17.6	160	120	188	130	0.12-0.5	NA
Ext. Phosphate (Mg/kg)	3.86	8.9	<0.02	13.4	12.2	<0.02	0.25-2.45	NA
Total Iron (Mg/kg)	4.573	4.077	7.869	5.834	9.745	4.201	55.0-95.80	NA
Coper (Mg/kg)	17.3	7.69	9.4	10.3	9.5	29.9	2.35-9.35	35.7
Lead (Mg/kg)	13.5	8.10	15	13.8	15.8	10.02	0.01-0.05	35.17
Nickel (Mg/kg)	8.2	4.8	4.9	6.8	9.4	5.8	0.42-0.50	18-61
Zinc (Mg/kg)	33.3	33.4	24.3	18.4	28.8	24.9	0.20-1.56	123-540

Table 5.16: Statistical Summary of Physico-chemistry and Microbiology of Soil

Parameter	Top Soil (0-15)					Sub Soil (15-30)				
	Min	**Max**	**Ave**	**Stdev**	**Control**	**Min**	**Max**	**Ave**	**Stdev**	Control
Temperature (^{O}c)	27.5	33.1	30.3	2.8	27.5	27.5	33.2	30.35	2.85	27.5
pH	7.2	8.1	7.65	0.45	7.4	7.1	7.8	7.45	0.35	7.45
Potential Difference (Mv)	65	89	77	12	70.5	67	87	77	10	56
Conductivity us/Cm	89.5	211.1	150.3	60.8	150.35	71.9	178.6	125.25	53.35	178.5
Alkalinity (mg/kg)	123	271	197	74	165.5	131	276	203.5	72.5	0
Hardness (mg/kg)	1.3	18.9	10.1	8.8	19.55	1.5	19.7	10.6	9.1	72.5
Carbonate (mg/kg)	0.3	3.8	2.05	1.75	2.4	0.3	3	1.65	1.35	18
Salinity (mg/kg)	114.1	181	147.55	33.45	133	114.2	131	122.6	8.4	2.35
Total Organic Carbon(%)	0.2	1.3	0.75	0.55	0.1	0.1	1.3	0.7	0.6	189
Grain Size (Mm)	0.72	47.5	24.11	23.39	16.9	0.71	64.2	32.455	31.745	0.2
Porosity (%)	25.2	32.5	28.85	3.65	34.1	30.1	31.2	30.65	0.55	
Permiability (Cm/Hr)	12.2	26.9	19.55	7.35	26.8	10.5	24.6	17.55	7.05	35.85
Moisture Content (%)	0.24	3..1	0.24	0	3.4	0.41	3	1.705	1.295	30.5
Na^{+} (mg/kg)	37	128	82.5	45.5	39.5	32	128	80	48	28.4
K^{+} (mg/kg)	1.31	1.81	1.56	0.25	1.505	1.23	1.82	1.525	0.295	
Mg^{2+} (mg/kg)	0.27	4.8	2.535	2.265	3.6	0.28	3.9	2.09	1.81	
Ca^{2+} (mg/kg)	1.22	1.81	1.515	0.295	1.33	1.22	1.82	1.52	0.3	3.3
Sulphate As So_4^{-2} (mg/kg)	35	41	38	3	39.5	34	42	38	4	44
Nitrate As No_3^{-1} (mg/kg)	11.1	16.5	13.8	2.7	13.7	10.78	18.3	14.54	3.76	1.44
Nitrite As No_2^{-1} (mg/kg)	0.12	1.2	0.66	0.54	0.16	0.14	1.3	0.72	0.58	3.3
Ammonium As Nh_4^{+} (mg/kg)	0.13	0.81	0.47	0.34	0.23	0.17	0.82	0.495	0.325	1.33
Nitrogen As N_2 (%)	10.1	18.6	14.35	4.25	17.05	10.2	18.9	14.55	4.35	40

Phosphate (mg/kg)	13	92	52.5	39.5	65	13	98	55.5	42.5	16.15
Chlorine As Cl_2 (mg/kg)	1.3	2.5	1.9	0.6	2.45	1.3	2.8	2.05	0.75	0.47
Cadmium As Cd (mg/kg)	0.01	0.04	0.025	0.015	0	0.01	0.04	0.025	0.015	0.31
Zinc As Zn (mg/kg)	1.2	11.7	6.45	5.25	10.4	1.2	13.5	7.35	6.15	17.45
Iron As Fe(mg/kg)	1.8	7.8	4.8	3	2.5	2.4	7.6	5	2.6	71.5
Copper As Cu(mg/kg)	1	1.8	1.4	0.4	1.3	1.1	2	1.55	0.45	2.15
Nickel As Ni (mg/kg)	0.34	2.02	1.18	0.84	0.16	0.14	2.03	1.085	0.945	0
Lead As Pb (mg/kg)	0.01	0.01	0.01	0	0	0.01	0.02	0.015	0.005	10.4
Manganese As Mn (mg/kg)	0	0	0	0	0	0	0	0	0	2.55
Barium As Ba (mg/kg)	0.1	1.3	0.7	0.6	0.3	0.2	1.2	0.7	0.5	1.35
Arsenic As As (mg/kg)	0	0	0	0	0	0	0	0	0	0.16
Mercury As Hg (mg/kg)	0	0	0	0	0	0	0	0	0	0
TPH (mg/kg)	0.18	0.45	0.315	0.135	0.165	0.16	0.31	0.235	0.075	0
Oil & Grease (mg/kg)	0	0	0	0	0	0	0	0	0	0.65
PAH (mg/kg)	1	1.6	1.3	0.3	1.3	1.2	1.3	1.25	0.05	0
Benzene (mg/kg)	0.01	0.06	0.035	0.025	0.045	0.01	0.07	0.04	0.03	0
Toluene (mg/kg)	0.01	0.03	0.02	0.01	0.005	0.01	0.04	0.025	0.015	0.165
Ethylbenzene (mg/kg)	0	0	0	0	0	0	0	0	0	0
Xylene (mg/kg)	0.01	0.05	0.03	0.02	0.04	0.01	0.05	0.03	0.02	1.6

5.25 Groundwater and Surface Water Quality

Groundwater Availability

Ground water is a major source of water in the Challawa sub-basin of the Hadeja Jamare Komadugu Yobe Basin. In some areas, especially in the study area, it is the leading source of water for domestic and other non-domestic uses. It is a basic resource that is for livelihood sustainance. High groundwater use occurs in the eastern part of the Basin by exploitation of the shallow unconfined and deep confined sedimentary aquifers. In the eastern part of the Basin, surface water use is limited due to low rainfall, flat topography and high infiltration rates which limit construction of surface water impoundments. Groundwater recharge in this part of the Basin is enhanced by riverbed and flood infiltration along the river valleys during time of flooding and releases from the Challawa Gorge and Tiga dams). Estimated annual groundwater availability varies from 2,317MCM/yr in 2018 to 1,279MCM/yr in 2019 (SMEC 2017. It is estimated that by 2040, annual sustainable groundwater availability will decrease to 70% of the current estimated volume due to climate change, assuming a decrease in rainfall.

Groundwater occurrences revealed the hydrogeological maps compiled for this study revealed that groundwater is available in three media which are: - Alluvial Aquifer, Soft Overburden Aquifer and Fractured Crystalline Aquifer. The Alluvial Aquifer are found in Rivers e.g. River Kurma, River Takwami, and River Magaga, which are perennial containing water during the dry season. These aquifers are important for small scale irrigation by shadoof system called *Jigo in Hausa* to water crops and vegetable like onions, tomatoes etc. during the dry season.

Soft overburden aquifer consists of saprolite and regolith and is derived from the weathering product of the Basement Complex rocks of elluvial and alluvial origin which makes it heterogeneous. Most of this aquifer are tapped by hand-dug wells and are seasonally bearing water in wet seasons and some at end the of the dry season. . This aquifer covers most parts of the Project area with a minimum depth of 6 m to maximum of 32 m. On the other hand the Fractured Crystalline Aquifer is also perennial and continuous throughout the year and can be tapped by borehole.

5.26 Baseline Groundwater Quality

The Physico-chemical analysis results of groundwater collected in the project area during wet and dry seasons are presented in ***Appendix 5.*** The quality of the groundwater samples was compared with WHO drinking water quality index, with most of the parameters recorded to be within WHO drinking water quality index. The water is generally clear and unobjectionable in terms of odour and other physical appearances.

Physico-chemical Description of groundwater (Wet Season)

The ground water pH for the wet season ranged was 7.34 while the control value was 7.83. (***Appendix 2).*** These values show that groundwater around the project area were slightly basic and were within the WHO limit of 6.5 – 8.5 for drinkable water. The water temperature ranged from 28.9 – 32.70 ^{O}C. The water Total Dissolved Solid was 561mg/L while the control was 812 mg/L. Total Suspended Solids was 11 mg/L while the control was 15mg/L. The TSS values were below the 30mg/L limit by FMEnv. Electrical conductivity varied between 1270 and 1681 µS/cm for the sample and control sample.

The groundwater Dissolved Oxygen (DO) recorded was 4.90mg/ while the control was 4.40mg/L. The groundwater Chemical Oxygen Demand (COD) values as an indicative measure of the amount of oxygen that can be consumed by reactions in a measured solution were generally low. The groundwater Biological Oxygen Demand (BOD_5) as the amount of dissolved oxygen needed (i.e. demanded) by aerobic biological organisms to break down organic material present in a given water sample at certain temperature over a specific time period has a value of 2.40mg/L while the control was 1.40mg/L.

The groundwater water cations were dominated by Sodium (Na), Calcium (Ca) and Potassium (K) as presented in Table 5.11***.*** Sodium was 45mg/L while the control value was 28.00mg/L. Calcium was 1.67mg/L while the control value was 0.23mg/L. Magnesium was 3.67mg/L while the control value was 0.41mg/L. Also Potassium was 2.61mg/L while the control value was 1.20mgL. During the study, the heavy metal concentration values were low in all the sampling locations except for Iron in the control site which was in excess of the recommended state (Table 4.4). This may be attributed to the local geological variation in the area.

Groundwater hydrocarbon concentration is a very important quality monitoring parameter for oil and gas activities, as it can be used to detect any oil related ground water pollution. Hydrocarbon concentration of the ground water was generally low during dry season study, and not even detected in most sampling locations during wet season *(Table 5.17).* This is an indication of no oil pollution in the project area. Both seasons' hydrocarbon concentrations are within FMEnv limits.

Table 5.17: Statistical Summary of Physico-chemistry and Microbiology of Ground water

PHYSICAL TEST

S/NO	PARAMETER	FMEnv LIMIT(mg/l)	GW1	REMARKS	GW Control	REMARKS
1	Colour	NS	Unobjectionable	Satisfactory	Unobjectionable	Satisfactory
2	Odour	NS	Unobjectionable	Satisfactory	Unobjectionable	Satisfactory
3	pH	6-9	7.34	Satisfactory	7.82	Satisfactory
4	Conductivity (µS/cm)	NS	1270.00	Satisfactory	1681.00	Satisfactory
5	Total Dissolved Solid	2000	561.00	Satisfactory	812.00	Satisfactory
6	Total Suspended Solid	30	11.00	Satisfactory	15.00	Satisfactory
7	Dissolved Oxygen	2-8	4.90	Satisfactory	4.20	Satisfactory
8	Temperature ^{o}c	Ambient	28.90	Acceptable	32.70	Acceptable

CHEMICAL TEST

S/NO	PARAMETER	FMEnv LIMIT(mg/l)	GW1	REMARKS	GWC1	REMARKS
1	Total Hardness	150	6.76	Satisfactory	1.27	Satisfactory
2	Calcium	200	1.67	Satisfactory	0.23	Satisfactory
3	Magnesium	200	3.67	Satisfactory	0.41	Satisfactory
4	Potassium	NS	2.61	NS	1.20	NS
5	Sodium.	NS	45.00	NS	28.00	NS
6	Total Chlorine	1	0.09	Satisfactory	0.01	Satisfactory
7	Ammonium	600	0.76	Satisfactory	15.00	Satisfactory
8	Total Phosphate	NS	45.00	Acceptable	35.00	Acceptable
9	Nitrate	20	9.00	Acceptable	10.00	Acceptable
10	Sulphate	NS	43.00		35.00	
11	Nitrite	1	0.00	Satisfactory	0.40	Satisfactory

12	BOD	40	2.40	Satisfactory	1.40	Satisfactory
13	COD	50	0.00	Satisfactory	0.00	Satisfactory
ORGANICS						
S/NO	**PARAMETER**	**FMEnv LIMIT(mg/l)**	**GW1**	**REMARKS**	**GWC1**	**REMARKS**
1	Oil and Grease	10	0.00	Satisfactory	0.00	Satisfactory
2	Phenol	0.5	0.00	Acceptable	0.00	Acceptable
HEAVY METALS						
S/NO	**PARAMETER**	**FMEnv LIMIT(mg/l)**	**GW1**	**REMARKS**	**GWC1**	**REMARKS**
1	Chromium	<1	0.01	Satisfactory	0.00	Satisfactory
2	Iron	20	2.78	unsatisfactory	120.00	unsatisfactory
3	Lead	<1	0.00	Satisfactory	0.00	Satisfactory
4	Cadmium	<1	0.01	Satisfactory	0.00	Satisfactory
5	Zinc	3	0.23	Satisfactory	0.10	Satisfactory
6	Arsenic	0.01	0.00	Satisfactory	0.00	Satisfactory
7	Mercury	0.001	0.00	Satisfactory	0.00	Satisfactory
8	Cobalt	NS	0.02	Satisfactory	0.01	Satisfactory
9	Copper	1	0.18	Satisfactory	0.10	Satisfactory
MICROBIOLOGICAL ANALYISIS						
S/NO	**PARAMETER**	**FMEnv LIMIT(mg/l)**	**GW1**	**REMARKS**	**GW Control**	**REMARKS**
1	Total Coliform Count, MPN/100ml	400	4.00	Satisfactory	100.00	Satisfactory
2	Total Aerobic Mesophilic	NS	0.00	Acceptable	0.00	Acceptable

Bacteria	Plate
Count,CFU/100ml	

Source: Fieldwork 2021

5.26.1 *Soil Physical and Chemical Properties (Dry Season)*

The soil pH ranged between 7.31 –8.02 and falls within the pH values recommended by FAO (6-9) for optimum crop production. The Electrical Conductivity of the soil samples ranged between 103 –174.6 µS/cm. Sodium concentration is very low and ranged between 0.4 –0.55mg/kg indicating low soil salt content as was also recorded during the wet season. In general, the concentration of soil anions, cations and nutrients in the soil samples were lower than those of the wet season except for Manganese, indicating lower soil fertility during the dry season. The concentration of organic carbon ranged from 1.33 –2.32% higher than those of the wet season. The concentrations of heavy metals were generally lower in dry than wet season as most of the metals including Cu, Cd, Cr, As and V were not detected in dry season soil samples. The concentration of Ni was 8.02mg/kg, Pb ranged from 0.86 – 3.12mg/kg while Zn ranged from 137.7 –213.7mg/kg, Zn being the only metal with higher concentration during the dry season (Table 5.18).

Table 5.18: Results of Physical and Chemical Characteristics of Soil Samples (Dry Season)

	Site ID: BTF001463	**Site ID: BTF001464**
Site Coordinates	10.41575N; 8.679620E	10.42014N; 8.689230E
pH	7.31	8.02
Conductivity (µS/cm)	103	174.6
Chloride (mg/kg)	42.1	24.1
Nitrate (mg/kg)	0.31	0.83
Sulphate (mg/kg)	24.1	31.62
Potassium (mg/kg)	1.55	0.33
Sodium (mg/kg)	0.55	0.431
Magnesium (mg/kg)	0.905	0.241
Calcium (mg/kg)	1.33	0.004
Total Hydrocarbon (%)	0.43	0.201
Nickel (mg/kg)	8.02	8.02
Copper (mg/kg)	ND	ND
Lead (mg/kg)	3.120	0.86
Zinc (mg/kg)	137.7	213.7
Manganese (mg/kg)	86.24	87.00
Cadmium (mg/kg)	ND	ND
Chromium (mg/kg)	ND	ND

Total Organic C (%)	1.33	2.32
Vanadium (mg/kg)	ND	ND
Arsenic (mg/kg)	ND	ND

ESIA for the Proposed Tin Mining Project by Century Mining Company Ltd at Riruwai Community, Doguwa LGA, Kano State

5.27 *Groundwater microbial analysis*

Both the total coliform count and aerobic mesophilic bacteria count are within the satisfactory and acceptable limits in both the project control sites (Table 4.4). This indicates that the groundwater which is the major source of water in the project area had not been significantly contaminated.

Quality of drinking Water

The global indicator for tracking progress towards the SDG drinking water target (SDG 6.1) is the use of 'safely managed drinking water services', defined as an improved drinking water source that is accessible on premises, available when needed and free from contamination.

The Nigeria MICS 2016-17 recorded whether households used sources located on premises, whether water sources provided water every day in the last two weeks and also included direct measurement of microbiological quality of drinking water at both the source and the household level. Microbiological characteristics of drinking water are used to describe the presence or absence of microbiological organisms and water - borne pathogens. E.coli is a member of the faecal coliform group and is a more specific indicator of faecal pollution than other faecal coliform and often used to measure the degree of pollution and sanitary integrity of drinking water.

The presence of E. coli in water has adverse health effects on infants, the elderly and those with compromised immune systems. In extreme cases some pathogens may infect the lungs, skins, eyes, nervous system, kidney or liver and the effects may be more severe, chronic, or even fatal including stunting among children. Aside disease-causing pathogens there are also physical, chemical, trace elements (heavy metals) and organic contaminants that its presence in drinking water may have profound aesthetic and harmful effects on public health. Achieving water quality standard that meets Nigerian Standard for Drinking Water Quality: NIS-544- 2007, revised 2015, is a mandatory prerequisite for water destined for human consumption.

Also, Sustainable Development Goal 6 is access to safe clean water and sanitation for all and sound management of freshwater ecosystems is essential to human health and environmental sustainability and economic prosperity. The bacteria species Escherichia coli (E. coli) is the most commonly recommended faecal indicator, and many countries including Nigeria have set a standard that no E. coli should be found in a 100 mL sample of drinking water.

Tables 5.12 report the levels of contamination of drinking water from a glass within the home and from a water sample obtained from the water source. It also combines information on the quality, availability and location of drinking water sources to provide estimates of safely managed drinking water services for Nigeria.

Sources and Quality of household drinking water

Over fifty percent of the population has access to improved drinking water sources (Figure 5.27). This access was made possible through water vendors that supply pipe borne water to various households in the area.

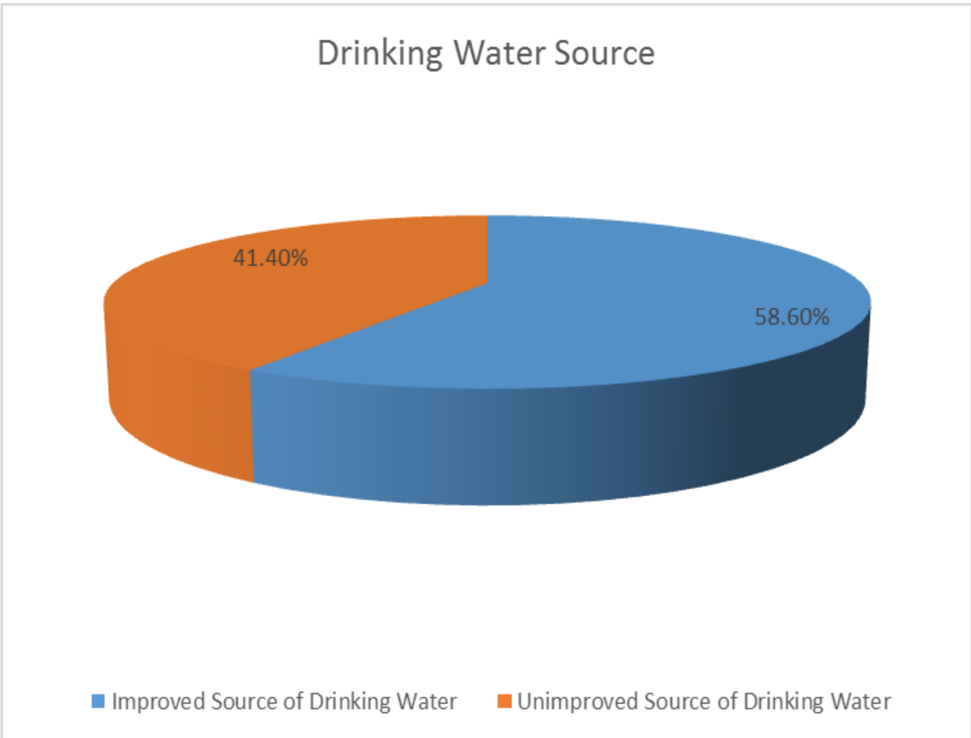


Figure 5.27: Water Sources in Kano State (NDHS, 2018)

However, according to the Kano State Multiple Indicator Cluster Survey 2016-17 Final Report May 2018, about 97 percent of rural household members drink water contaminated by E-Coli.

This is of public health concern as almost everybody in Kano drinks faecal contaminated water which has an adverse health effect. The source of water can also determine the level of contamination in household drinking water. E-coli contamination is lowest in a household where they drink sachet and bottled water (78.7 percent) and highest among those who fetched drinking water from well and springs (100 percent). Although there is a marginal difference in all social group in Kano State, faecal contamination of household drinking water is 100 percent in Kano North, well and spring source of drinking water (protected and unprotected), where household head is not educated, and poorest to middle wealth index quintiles.

In about four out of 5 households in Kano State, drinking water is contaminated by E-coli at the source. This occurred more if they drink water from sources such as well and spring (protected or unprotected), rainwater collection and tanker-truck with cart. E-coli contamination at the source of drinking water is also high in the urban areas, where household head is not educated and poorer wealth index quintile households (Table 5.19 and Plate 5.9). Table 5.21 shows the Percent distribution of household population according to faecal contamination risk as assessed by levels of E. coli in household drinking water, and percent of household population with E. coli in drinking water Nigeria, 2016-17 Kano State.

Table 5.19: Percent distribution of household population according to faecal contamination risk as assessed by levels of E. coli in, Kano State 2016-17

	Percentage drinking water contaminated by E. Coli in the household drinking water[1]	Percentage drinking water contaminated by E. Coli at the source of drinking water[2]	Percentage with an improved drinking water source located on premises, free of E. coli and available when needed[3]	Number of household members with information on water quality
Total	97	88	**0.2**	**639**
Senatorial district				
Kano Central	98.3	93.8	0.6	284
Kano North	100	82.6	0	131
Kano South	93.6	83.8	0	224
Residence				
Urban	97.2	96.5	0.9	176
Rural	96.9	84.8	0	463
Main source of drinking water				
Piped water	95.8	95.3	0	101
Tubewell/borehole	94.8	74.1	0	272
Protected wells and springs	100	100	0	32
Unprotected wells and springs	100	100	0	227
Sachet and bottled water	78.7	0	100	2
Other	100	100	0	6
Education of household head				
None	100	100	0	19
Non-formal	100	89.5	0	410
Primary	71.5	100	0	56
Secondary	98.7	70.6	1.6	99
Higher	92.6	91.6	0	56
Wealth index quintile				
Poorest	100	88.2	0	124
Second	100	83.2	0	113
Middle	100	89.5	0	90
Fourth	93.1	86.4	0	202
Richest	95.2	94.3	1.4	110

[1] MIC Indicator 4.51: Quality of drinking water at the household
[2] MIC Indicator 4.52: Quality at the source of household drinking water
[3] MIC indicator 4.53, SDG 6.1.1: Use of safely managed drinking water sources

Source: Nigeria: Kano State Multiple Indicator Cluster Survey 2016-17 Final Report May,2018).

Plate 5.9: Sources of Drinking Water In Karaye/Rogo Community of the project Area

5.28 Vegetation Characteristics

The vegetation of the area was originally a type of Savanna, typical of the savannah vegetation of Northern Nigeria made up of various species of grasses, bushes and trees. Overtime however, intensive cultivation has considerably changed the natural vegetation, which now only exists in relatively small pockets in non-arable areas. The bulk of Kano state where the project area mainly lies is classified as the Sudan Savanna Zone. However, the northern part of the state is markedly drier than the project area which is more southerly. Park land trees are common in the project area but the numbers of such trees are rapidly reduced due to cutting for firewood. In the especially as witnessed in the pilot sub-watershed 1 (PSW_1) project area coppice-type vegetation growth is common, resulting in a reduction in the amount of grass and an increase in the amount of woody shrubs, thereby making animal grazing difficult. More over the intensive and space-wide cultivation common in the project area further complicates the opportunity for open grazing especially during the growing season as virtually no part of the lands are left uncultivated, sparing only bush paths.

Vegetation of the Area was originally defined as undisturbed Sudan savanna and guinea savanna. The normal vegetation has always been the dry Guinea in the southern fringe and the Sudan in the larger part of the region (Olofin, 2008). The vegetation has now been subjected to destruction through fuel wood extraction, urban encroachment and population pressure; thereby result in the formation of four vegetation zones in the region namely: Sudano Sahelian Savanna, Sudan Savanna, Open Guinea Savanna and Protected Guinea Savanna (Adamu, 2004).

There are thorny shrubs and small tree species which normally cover the forested area of the basin and abandoned areas of irrigation cultivation. Peculiar among the thorny shrubs are *Isoberhnia, Acanthospermum hispidum* and *Guiera Senegalensis* to mention but a few. Grasses are the main species of vegetation that dominate both cultivable and uncultivated lands, and these include *Striga gesneriooles, Pennisetum pol ystachion,Cyperus rotundus* and many others. Some of these grasses as well as tree species are regarded as cultural vegetation. These include neem, guava, mango and cashew. These vegetation species dominate most parts of the channel width with average height of 1.5m, while mango, guava and cashew are purposely planted for sale as cash crops in irrigation plots. The neem trees are found in the rural settlements and sometimes in the upland farms to provide shades for the farmers.

The type of trees in Sudano Sahelian Savanna of Kano Region include A nilotica.(bagaruwa) Neem (Darbejiya) and adansonia digitata (Kuka). Both trees, shrubs and grasses are scattered, the dominant tree Species is Azadaradita indica (Neem). While the Dominant grass is *Cassia tora* (Tafasa) and thorny Shrubs like *Zizuphus Jujube* (Magarya). Most of the trees are adapted to drought condition for the fact that they are large and have leathery leaves. Some of threes include *Parkia biglabosa (*Dorawa), *Tamarindus indica* (Tsamiya) and *Mangifera indica* (Mango). *Cassia tora* (Tafasa) and *Senna occidentalis* (Rai-rai) are the grasses of this area.

Within the region, there is disparity between the northern and southern parts. In the southern part more intensive agricultural activities is practiced both in the dry and rainy seasons, while in the northern part there is low vegetation growth. There is high level of vegetation setback along Hadejia Jama’are wetland as well as the challawa dam site caused by emergence of *Typha grass*. (Dakata and Yelwa 2012).

Field observation and public consultation also revealed a good number and variety of plat species found and used in the area. These are summarized in table 5.20 below.

Table 5.20: List of common woody plant species of the project areas

S/N	Scientific name	Common name	Habit	Local uses
1	*Acacia nilotica*	Acacia	Shrub	Source of Gum and Tannin
2	*Acacia sengal*	Acacia	Tree	Source of Gum and Arabic
3	*Adansonia digitate*	Baobab	Tree	Edible leaves and fruits
4	*Afromosia laxiflora*	Makerfo (Hausa)	Tree	Fuel wood
5	*Afzelia Africana*	Gawo (Hausa)	Tree	Fodder for livestock
6	*Albizia chevalieri*	Albizia	Tree	Shade plant
7	*Andropogon gayanus*		Grass	Cattle feed
8	*Anogeissus leicarpa*	Marike (Hausa)	Tree	Chewing stick, medicinal
9	*Aristodo sp*		Grass	Livestock feed
10	*Azadirachta indica*	Neem	Tree	Fuel wood, medicinal
11	*Bauhinia refescens*		Tree	Livestock feed
12	*Bombax costatum*	Red silk cotton	Tree	Edible leaves and fruits
13	*Borassus eathiopum*	Ron palm	Tree	Edible fruits
14	*Brachiarias sp*		Grass	Cattle feed
15	*Burkea Africana*	Barkin makarfo (Hausa)	Tree	Source of Tannin, fish poison
16	*Ceiba pentandra*	Silk cotton	Tree	Edible leaf, Timber
17	*Cochlospennum sp.*		Shrub	
18	*Combretum micranthum*	Woody climber	Liana	
19	*Daniellia oliveri*	Maje (Hausa)	Tree	Fuel wood
20	*Digitaria sp*		Grass	Cattle feed
21	*Eucalyptus camaldulensis*	Eucalyptus	Tree	Planted shelter tree
22	*Hymenocardia acida*	Janyaro (Hausa)	Tree	Fuel wood
23	*Hyphaene thebaica*	Dum palm	Tree	Fruit for livestock feed and medicinal
24	*Isoberlinia doka*	Doka (Hausa)	Tree	Fuel wood
25	*Khaya senegalensis*	Mahogany	Tree	Timber tree
26	*Mangifera indica*	Mango	Tree	Fruit edible and medicinal
27	*Parkia biglobosa*	Locust bean	Tree	Fruit edible

28	*Phoenix doctylifera*	Date palm	Tree	Edible fruit
29	*Piliostignia reticulatum*	Kalgo (Hausa)	Tree	Fruit eaten
30	*Senna occidentialis*	Coffee senna	Herb	Leaves edible
31	*Tamarindus indica*	Tsamiya (Hausa)	Tree	Fruits for preparing drinks and also eaten by cattle
32	*Terminalia avicennoides*	Boushe (Hausa)	Tree	Fuel wood
33	*Vitellaria paradoxa*	Shea butter tree	Tree	Edible fruit and vegetation oil

5.29 Fauna Characteristics

The site is characterized with few vertebrate species comprising of white egret and agama lizards (Table 5.21. The low fauna diversity could be attributed to the industrial land use that dominates the study site.

Table 5.21: Fauna Composition

Common name	Scientific name
Aves (Birds)	
White Egret	*Ardeola sp.*
Reptilia (Reptiles)	
Agama Lizard	*Agama agama*

Biodiversity of fish species from Challawa Gorge Dam

In a recent study of fish species diversity of Challawa, Nazeef and Ibrahim (2018) identified not fewer than 10 species belonging to nine families over a six months study period including both dry and rainy seasons March to August (Table 5.10 and Table 5.11).

The authors based their findings on a sample of three fish landing sites (Feginma, Turawa, and Sakarma). Samples were obtained from the local fishermen at each of the landing sites. Fishing gears that were used by the local fishermen includes gill and cast nets of different mesh sizes (2, 2.5, and 3 inches). Findings show that fish family *Mormyridae* had the highest number of species represented by *Marcusenius isidori and Marcusenius senegalensis,* while other families were represented by one species each. Family *Bagridae* was represented by *Bagrus bayad macropterus.* Family *Latidae* represented by *Lates niloticus*, family *Alestidae* was represented by Brycinus nurse, while *Oreochromis niloticus* represented family *Cichlidae*, family *Claridae* was represented by *Clarias lazera*. *Auchenoglanis occidentalis* represented the family *Claroteidae,* whereas *Synodontis schall* represented family *Mochokidae*. And *Schilbe mystus* represented the family *Schilbeidae.* (Table 5.22).

Table 5.22: Fish species identified in Challawa Dam

Family	Species	English name (Common Name)	Local name (Hausa)
Bagridae	*Bagrus bayad macropterus*	*Silver catfish*	*Ragon ruwa*
Latidae	*Lates niloticus*	*Nile perch*	*Giwan ruwa*
Alestidae	*Brycinus nurse*	*Silversides fish*	*Kawara*
Cichlidae	*Oreochromis niloticus*	*Nile tilapia*	*Karfasa*
Claridae	*Clarias lazera*	*Catfish*	*Tarwada*
Claroteidae	*Auchenoglanis occidentalis*	*Bubu, armored Catfish*	*Buro*
Mochokidae	*Synodontis schall*	*Wahrindi*	*Karaya*
Mormyridae	*1. Marcusenius isidori* *2. Marcusenius senegalensis*	*Trunkfish*	*Farinwata Data*
Schilbeidae	*Schilbe mystus*	*Butterfish*	*Balo*

Source: Nazeef S. and Ibrahim M. (2018)

Assessment of fish biodiversity revealed 10 species belonging to 9 families with the mormyrids (*Marcusenius isidori and Marcusenius senegalensis)* being the dominant species. *Lates niloticus* has the least distribution, and it is carnivorous. The least number of *Lates niloticus* can serve as to checkmate on the *proliferous mormyrids* species. Condition factor (K value) of fish species identified revealed that 50% of the species investigated had their K value below 1, whereas the remaining 50% had above these values represent below and average wellbeing of fish (Nazeef and Ibrahim, 2018). The most abundant species are *Marcusenius senegalensis* (32.6) and *Marcusenius isidori* (21%). Fishspecies abundance also vary with season, with the Rainy Season especially May to July recording more species than was found in March to April.

Table 5.23: Fish Species diversity of Challawa Gorge Dam

Species/Month	March	April	May	June	July	August	Total	Abundance %
Auchenoglanis occidentalis	0	0	31	56	20	16	123	2.87
Bagrus bayad Macropterus	3	31	49	46	55	59	243	5.67
Brycinus nurse	1	63	187	35	42	30	358	8.35
Clarias lazera	14	41	63	49	35	19	221	5.15
Lates niloticus	1	30	15	29	27	04	106	2.47
Marcusenius isidori	6	177	204	319	186	10	902	21.05
Marcusenius senegalensis	6	297	402	390	294	08	1397	32.60
Oreochromis niloticus	9	104	228	109	58	26	534	12.46
Schilbe mystus	2	28	69	49	67	37	252	5.88
Synodontis schall	2	30	54	38	11	14	149	3.47

Source: Nazeef S. and Ibrahim M. (2018)

The maintenance of good Physico-chemical parameters and their influx into water system, sufficient regulation of fishing and its practices, non-selective gears restriction and enforcement by relevant authorities and public enlightenment on the dangers of biodiversity loss can greatly enhance and maintain the dynamics of the dam. In addition the present knowledge of diversity of fish species in the Challawa water may serve as bases for future audit of likely effect of the project on biodiversity.

5.30 Land Use

In most parts of Nigeria, land use had been determined by tenurial systems evolved over time and determined by the perceived demand as well as the potential and actual social pressures associated with its supply and use (Powell, 1995; Swallow and Kamara, 2000). Land use in the study area comprises the built environment including residential and nonresidential buildings, industrial buildings, cultural lands such as religious grounds, cemeteries, recreational grounds, roads and paths, market places etc. Other land uses include agricultural lands, forest cover, etc.

The project site and its environ were visited to obtain familiarity with the landscape and surrounding countryside areas. Field studies have included the recording of landscape features, the evaluation of landscape character and quality, and establishment of representative viewpoints. Desk studies have been carried out including a study of the local topography and land use using maps, aerial photographs and photographs taken during field studies and reference to other ESIA reports for projects around the study area (including ESIA (2017) for the Hadejia Jama'are Sub-Basin with Kano River Irrigation Scheme (KRIS) and Hadejia Valley Irrigation Scheme (HVIS), and the ESIA for Transmission Company of Nigeria Project Management Unit (TCN-PMU for the 330/132/33kV Transmission Substation New Kano, Kano State SMEC March, 2017).

The land cover on farms is mainly crops grown by farmers with scattered trees of average to large height and size. The trees are mainly locust bean, tamarind, local mahogany, guava, neem (*darbejia*), and mangoe trees. The uncultivated patches of land around the settlements, there are other species such as Dorawa, Dinya, Kanya (Hausa names for the trees) and many others of economic and medicinal values. The tree density improves and in some cases forms clusters on uncultivated/uncultivable lands especially around the main and figure gully banks. There are shrubs and grasses that grow freely in several locations within the area. Figure 5.28 and figure 5.29 fairly depict the land use/land cover types in the two pilot sub watersheds of the project area. On both pilot sub-watersheds, the lands are intensively under crop cover especially in the rainy season, while eroded areas are generally uncultivated or uncultivable. There are patches of built up areas of small to medium size settlements on both pilot sub-watersheds.

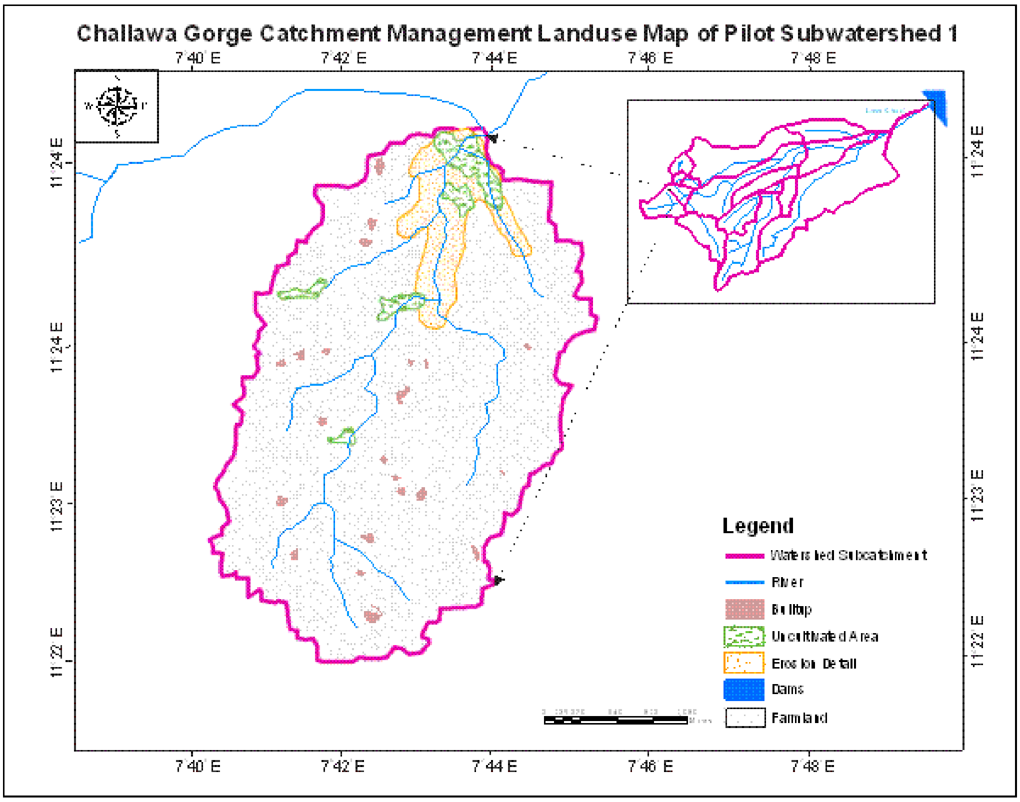


Figure 5.28: Land use Map of the Study Area Pilot Subwatershed_1

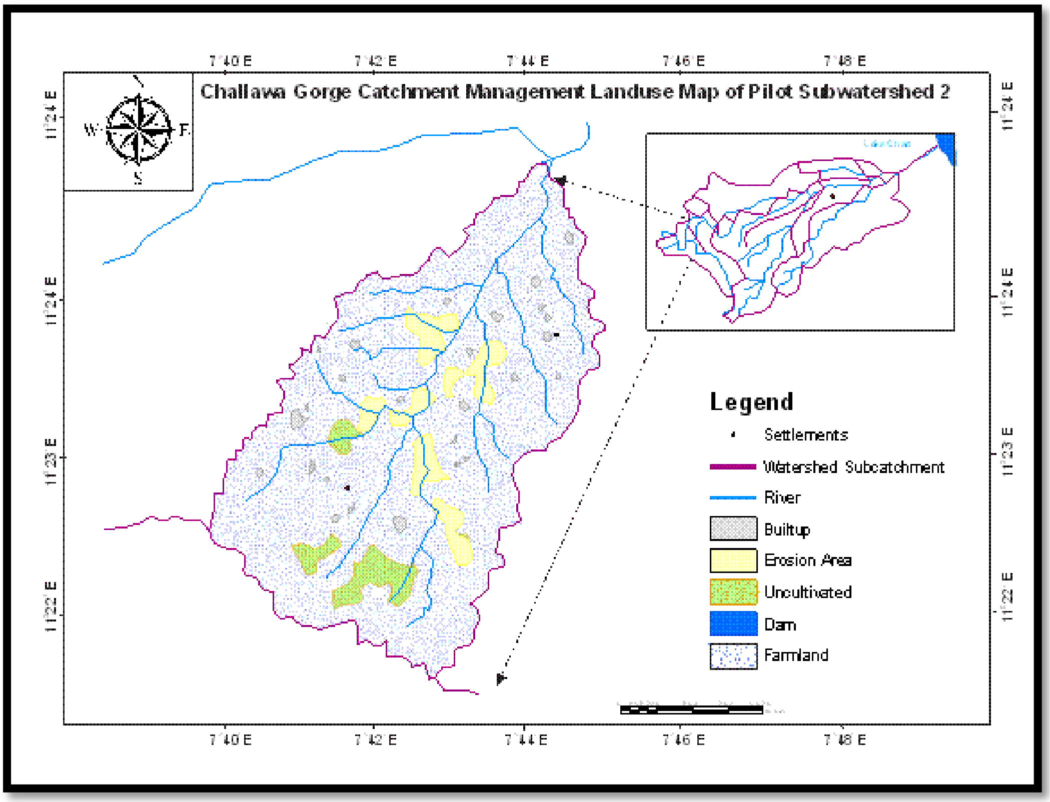


Figure 5.29: Land use around Pilot Sub-Watershed_2

The settlement system consists of permanent structures made from grass, wood and sand (Plate 5.10) and, in a few cases, concrete blocks and iron roofs (Plate 5.11). The main settlements are Karaye and Rogo which are LGA headquarters. Several other towns such as Tsara and Soho Rogo are fairly big towns with many other smaller villages and Fulani herdsmen huts scattered around.

The estimated population of the area is around 250,000 people. The estimated population age structure the pilot areas and in the immediately surrounding hamlets is on average between 30-40 years. The area is also doted by small hamlets mostly made up of 2 to 5 families per hamlet, with demographic structure of more children and youths compared to adults and with fewer males than females. The family system is mainly monogamous but it is mostly dictated by economic resources of the man. The average number of births per woman is six and each household has about eight to ten people.

Plate 5.10.: A typical building made of wood, sand and grasses in the project site

Plate 5.11.: A typical building made of sand and corrugated iron sheets at the Dam site Area.
Source: Field visit on Saturday, June 26, 2021 3:05 PM

5.31 Socio-Economic Environment

A socioeconomic assessment of the project area gives an insight into the social, cultural and economic conditions in the project area. A blend of methods including the following, were adopted for data to gathering.

v. Review relevant literature;

vi. Review of existing, reports of Nigeria Demographic and Health Survey ;

vii. Reconnaissance survey to identify the focal communities (Karaye, Rogo, Kiru L.G.As) and the likely adjoining communities that might be directly or indirectly affected by the proposed project;

viii. Focus Group Discussions (FGDs) with stakeholders and project affected peoples (PAPs) in areas closest to the footprint locations of the project.

The focus group discussions were held at various times and in different areas of proposed project site between May and July 2021. The stakeholders during the FGD are shown in Plates 5.12(a, b and C).

Plate 5.12 (a): Formal Stakeholder Sensitization and Consultation

Plate 5.12 (b): Formal Stakeholder Sensitization and Consultation

Plate 5.12 (c): Informal Rural Stakeholder Sensitization, FGD Sessions

Population

The age and sex structure of population in Kano state (Tables 5.12; 5.13 and Fig. 5.30) depicts the unique outlook of the state's population. About 47% of the population is aged 0 – 14years, 48% 15 to 59years, while the remaining 5% are 60years and above. This suggests not only the youthful nature of the population but also its vulnerability to rapid growth.

Moreover, the sex ratio is moving concurrently between male and female with a slight difference of 1.6% in 1991 and about 2.5% in 2006 (See Table 5.24). Thus the sex distribution index (number of males per 100 females), depicts an inconsiderable excess of males in the state.

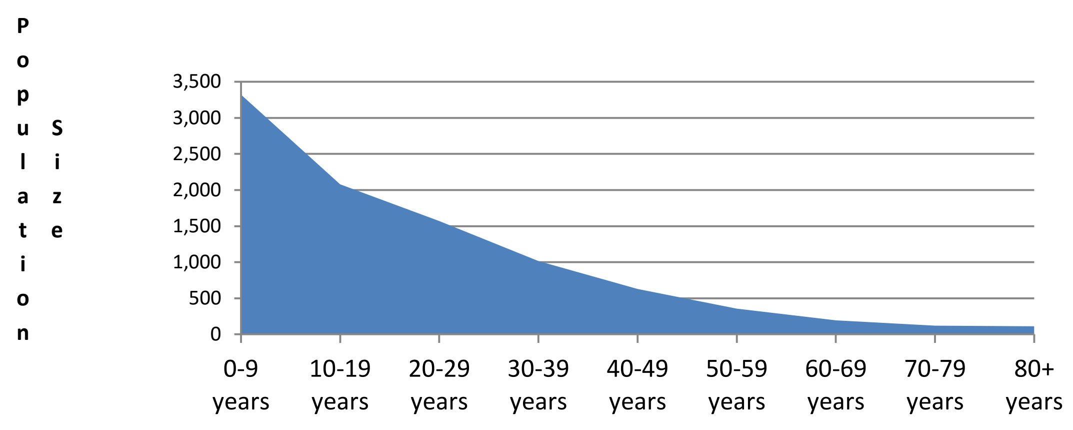
Table 5.24 Age Structure of Population, Kano State 2006

Age Group	Population	Percent (%)	Cumulative %
0-9 years	3,322,489	35.3	35.3
10-19 years	2,079,592	22.1	57.4
20-29 years	1,570,195	10.8	68.2
30-39 years	1,015,902	16.7	84.9
0-49 years	629,731	6.7	91.6
50-59 years	356,584	3.8	95.4
60-69 years	194,580	2.1	97.5
70-79 years	120,312	1.3	98.8
80+ years	111,903	1.2	100
Total	9,401,288	100	

Source: NPC, 2006 Census

Another remarkable issue is the population - land ration. With a total land area of 21,276.87Km^2, Kano state had in 1991 contained an average of 273 persons per square kilometre but in 2016, the density had increased by about 1.6 times (over 150%) with a density of about 441/Km^2.

Figure 5.30: Population Age Structure, Kano State, 2006



Source: Data in Table 5.24

Table 5.25: Population Structure in Kano State by Sex and Age: 1991 to 2006

State	1991 Census					2006 Census				
	Total Pop.	Male	%	Female	%	Total Pop.	Male	%	Female	%
Kano	5,810,470	2,958,736	50.9	2,851,734	49.1	9,383,682	4,844,128	51.6	4,539,554	48.4
1991 Census						2006 Census				
Age	Total %	Male %		Female %		Total %	Male %		Female %	
0 –14	42.8	22.1		20.7		47	25.1		21.9	
15- 59	50.8	26.5		24.3		48	24.8		23.2	
60+	6.4	3.9		2.5		5	2.7		2.3	
Total	100	52.5		47.5		100	52.6		47.4	

Source: 1991 & 2006 Census Data

Table 5.26: Projected Population for three riparian Local Governments of Challawa Gorge Dam Project Area

Local Government Area	**Projected Population Size (2016)***	**Land Are (km^2)**	**Population density/ km^2**
Karaye	200,400	419.9	477.3
Rogo	316,600	801.8	394.8
Kiru	371600	937.1	396,5
Total	888,600	2158.8	411.6

NB:- *3.4% Annual Population Change 2006 → 2016) base year 2006.

Three most central local government area that make up over 80% of the Challawa Gorge Dam Watershed area are Karaye, Rogo and Kiru LGAs with a total projected 2016 population of 888,600 and total land area of 2158.8 km^2. The projected population density of 411.6/ km^2 for the three riparian Local Government Areas is in agreement with the estimation of Adamu (2016). The implication is that both positive and negative impacts of the Watershed management project may cascade to affect a fairly large number of people and therefore will require a well-designed ESMP plan.

Settlement Characteristics

The settlements system consists of permanent structures made from grass, wood and sand and, in a few cases, concrete blocks and iron roofs. The main settlements are Karaye, Rogo and Kiru which are LGA headquarters. Several other towns such as Tsara, Turawa and

Soho Rogo are fairly big settlements with many other smaller villages such as Unguwan Datti, Dayi and temporary Fulani herdsmen huts scattered around.

The estimated 2016 population of the most affected areas is 888,600 people. The estimated population structure of the people living in the area and in the immediately surrounding hamlets was an average of 30-40 people, mostly constituted of 2 to 3 families per hamlet, with demographic structure of more children and youths compared to adults and with the less males compared to females. The family system is mainly monogamous but it is mostly dictated by economic resources of the man. The average number of births per woman is six and each household has about eight to ten people. The economic activities are mostly farming and commerce. Both men and women participate though with different roles. On the farm, the men mostly do the tedious jobs of cultivation, making of ridges/canals for water reticulation and transportation of harvested crops to markets for sales and to homes for food, while the women participate in planting, weeding and harvesting. In families that have no men, the women do all the tasks.

The 2015 population and average population density for each of the four main sub-basins is given in Table 4.1 of the HKY Basin is about 200 persons/km^2. This indicates that the Basin is the most populated area in the northern region of the country. The Challawa Gorge Dam Sub-basin area which lies within the Kano Close Settled Zone with its high population density is exerting pressure on the water resources of the area. The population of the region is mainly engaged in both rain fed and irrigation farming, in addition to other non-agricultural commercial activities including marketing of agricultural commodity.

Land Tenure: Land ownership is vested in the state. Farmers hold usufructuary rights, and the rights to a particular piece of land can be passed on by inheritance, sale or rental. The land owned by a particular family is often in fragmented holdings within a varying radius of the village. Islamic inheritance law has resulted in continuous subdivision of existing holdings among family members. The two main customary forms of land tenure are gandu, under which the land right is vested in the family head but the land is worked and its produce shared by all family members, and gayauna, under which the land is worked by the family member who has the right to its use. The gandu is of particular importance as it enables the individual to hold off-farm employment while still enjoying the benefits of agriculture. Land pressures have mounted due to population growth, continual, land accumulation by wealthy individuals, and public requirements (roads, schools, irrigation schemes, etc.)

Land Use, Farm Structure & Farm Enterprise:

It is estimated that over 60% of Kano State's 43,000 km2 land area, some 2.6 million ha, is under cultivation. In the densely populated areas of Karaye, Rogo, Challawa, `80-90% of the cultivable land in the area is cultivated. The bulk of the agricultural lands are upland and used for rainfed crops such as sorghum, millet, cowpeas, groundnuts, maize, and cotton. In addition to the upland areas, a considerable agricultural potential does exist in the valleys along the main river systems (Challawa, Gumshi, Tankwarya etc), known as fadama lands. Accurate data are not available but it has been estimated that the main fadama systems and their floodplain areas cover about 48,000 ha in the project area. During the rainy season rice, maize, sugarcane, sorghum, and some tobacco are grown in the fadama lands, while onions, tomatoes, other vegetables, and wheat are grown during the dry season under irrigation. This is very common around challawa gorge dam site and near major tributaries to the challawa river especially Gumshi river bank. On the fringes of the fadama lands, sorghum and maize are the main crops.

Farming System: Cultivation is overwhelmingly carried out by hand, although tractors are also used in some cases especially by large scale farmers.

Work-oxen are very common both as a tool for farming and beast of burden to convey agricultural products, firewood, etc. from the farms to home. Fadama areas are worked intensively to produce high value cash crops, but most farm enterprises are rainfed. There is no evidence of any particular rotational system, because intense land pressure has reduced or eliminated the fallow period in virtually all parts of the project area.

Individual farm holdings vary in size from as small as 0.2 ha in areas near major settlements such as Karaye, Kiru, Rogo, Tsoho Rogo, Zarewa, and Getso and on Fadama lands, to land holdings in excess of 20 ha. The average farm holding (both family and individual holdings) in the area is about 2.5 ha. Farms are generally fragmented and the sizes vary significantly due to the influence of population expansion and inheritance system under Islamic laws. Most of the cultivators (75%) are Hausa, the remainder generally being settled Fulani pastoralists (who now cultivate crops as well as keep animals, and other migrant ethnic groups from other parts of the country including Kanuri and people of Yoruba extraction. Families generally have 5 - 8 members with a mean of 7.4 persons per family in the project area.

Farm Labor: Family members provide about 85% of total on-farm labour input on an average traditional farm. Non-family labor is provided by hired laborers, engaged at rates ranging from N700 to N1000 per day depending on the type and intensity of work, or on a piece-rate basis, and in some instances by traditional reciprocal labor *(Gaiya)*.

Religious and social restrictions tend to limit adult female input to threshing and processing of agricultural produce in the family compound. The bulk (55-60%) of family labor input to on-farm activities is provided mainly by adult males. The share of children-supplied labor is minimal generally restricted to tendering for domestic livestock, gathering firewood and fetching water. In a few instances some children and the adolescents are involved in planting, weeding and harvesting on farms. On-farm activities on the traditional farms are highly seasonal, with 90% of family labor input being supplied from June to November.

Crop Production: The bulk of agricultural production comes from manually cultivated rainfed crops. Fadama areas contribute substantially to the farmer's income as they produce most of the cash crops, mainly during the dry season. The most important crops produced in the area where rainfall is higher, maize, cowpeas, guinea corn, groundnuts and sweet potatoes are popular.

Intercropping of two or more crops is very common. About 85% of the farmers reported that mixed cropping or intercropping of two or more crops on the same piece of land is highly beneficial as it permits filling-in of a crop which may not have germinated well, increase the average cropping density on the farm and therefore provides better utilization of available soil and allows adjustment to uncertainty in the event that one crop may fail due to unexpected drought, insect pest attack, and other unforeseen environmental events. Farmers start the season by planting food crops first, usually millet, which may have sorghum or other crops subsequently planted with it. For most (87%) farmers interviewed, there appears to be no evidence of any particular rotational system practiced. Rather, the choice of crops mainly depends on the farmer's particular food needs, market conditions, agro climatic conditions and location of fields in relation to their houses.

Levels of Education

It is evident that the trend of educational development in kano state deliver a sound labour force in the near future. Analysis of educational attainment of the subjects in the region reveals about 46% uneducated persons (Table 5.29 and 5.30). Thus, there is a large size of unskilled labour that possibly relies mainly on agriculture and other unprofessional livelihood activities. This probably partly explains the relatively low cost of labour (less than about #2000/8 work hours) in a day in the area. In fact this scenario is corroborated by Maigari (2012) that the cost of a day man-work (8 hours; 8.00am to 4.00pm) is generally low, ranging from =N=500.00 to =N=2,000.00, while wages and salaries of casual workers ranges from =N=6,000.00 to =N=20,000.00 per month.

Table 5.27: Percentage Distribution of Educational Attainment 6 Years and Above

Educational Status	**Kano State**		
	Male %	Female %	Total %
None	21.4	24.6	46
Nursery and Above	31.5	22.5	54
Total	52.9	47.1	100

Source: Census, 2006

Table 5.28: Population Enrolment in Schools: Nursery to Postgraduate Levels

Sex	Total	None	Nursery	Primary	JSS /Modern School	SSS/SEC /TTC	OND /NCE	University Graduate/ HND	Post Graduate	Other
Male	3,815,650	1,543,189	540,642	433,963	312,085	636,338	155,635	89,424	28,363	76,011
Female	3,398,298	1,778,064	444,000	377,417	208,016	447,414	54,525	24,803	7,230	56,829
Total	7,213,948	3,321,253	984,642	811,380	520,101	1,083,752	210,160	114,227	35,593	132,840
As %	14,427,896	46%	13.6%	11.2%	7.2%	15%	2.9%	1.6%	2.2%	1.8

Source: National Population Census, 2006

Gender

Gender inequality continues to be linked to various traditional practices of many cultural groups in Nigeria. Many cultures promote the belief that, women do not have an identity of their own but those derive from men. The different ethnic groups engage in practices which degrade and discriminate women. In Nigeria, the belief that male issues are more important than female is rampant. Even in issue of education, some families prefer to educate male child at the expense of the female. This is one of the reasons why illiteracy rate is higher among women than men especially rural dwellers in Nigeria. Studies across gender issues in Nigeria disclosed the following factors as major contributors for the prevalence of gender inequality in the basin: Environmental Factors: the environment in Northern region of Nigeria, in general, and HJKYB in particular is not favourable to the development of women due to the problems of desertification and drought and all these are gradually heighted by the impact of climate change. In the North, men and women play different roles in the family.

Women are engaged in the household subsistence activities and highly depend on the environment for their tasks; they are expected to cater for the welfare of their children in polygamous marriages. The traditional division of labour gives the rural women in the North responsibility for providing and managing natural energy sources required for the maintenance of the family household, desert encroachment and drought in the northern region places a special extra burden on her. Poor supply of food and water due to environmental factors increases the women hours she will devote to fetching clean drinkable water, gathering forest and water products, which are crucial for food supplement, and firewood for domestic use.

5.32 Economic activities and sources of income

A socioeconomic assessment of the project area gives some insight into the social, cultural and economic conditions in the project area. A blend of formal and informal interviews, FGD and stakeholder engagements methods, which include the following, were used to acquire the socio-economic data.

Kano is the commercial and investment hub of Northern Nigeria and probably the largest non-oil and gas economy in Northern Nigeria. The Economy of Kano state is driven largely by commerce, manufacturing and subsistence agriculture. Predominantly however, the population in Kano State and the project area in particular, is engaged in agriculture either as full time or as a vocation, in addition to other livelihood businesses. The sample survey shows agriculture engages up to 70% of the population directly or indirectly. The informal sector is strong and diverse, with numerous Micro, Small and Medium Scale Industries (MSMEs) and the informal sector (hawking, show-shining, cobbler, road-side food vending (especially by women), etc. across all economic activities and across all the local government areas, contributing approximately 60 – 70% of output and employment (Public Consultation views).

The State has historically been a major commercial and manufacturing centre in the West African sub region in general, and Nigeria in particular even before the incorporation of the country into the European System of global commerce. It has been a major entry port and southern hub of the trans-saharan trade route for centuries.

Economic activities are mostly farming, commerce/trading, informal businesses such as hawking of processed food by young girls and other forms of street food vending by older females including married women within the settlements, shoe shining by young uneducated youths, water vending etc. On the farm, the men mostly do the tedious jobs of cultivation, making of ridges and irrigation canals for water reticulation and transportation of harvested crops to markets for sale and to home for food, while the women participate in planting, weeding and harvesting. In families that have no active men, the women do all the tasks.

Animal husbandry is not very common and stocks are very few averaging 2-10 per family. Bulls are more common because they serve as farming tools and transporting goods and materials. The bulls used for ploughing on farms also serve as means of income where they are used in ploughing for pay/cash. The children, boys only, attend to the animals mostly while the women household domestic duties including fetching firewood, participating in weeding on farms (Plate 5.13) and harvesting and processing crops for food and for sale at the local markets. The commercial activities are mostly smaller trading with some bigger traders selling grains and animals.

Plate 5.13: Women weeding rice farm at Unguwan Gauda Community

The major communities are serviced by grade three tarred roads mainly within the town and highways traversing the settlements. Many of the roads are dilapidated while most of the remote areas have no roads at all. Where there are roads they are accessed by laterite surfaced roads, or dry season motor roads and in several cases bush paths. (Plate 5.14).

Pl

ate 5.14: Laterite surface road Traversing a village area

There are several public primary schools, junior and senior secondary schools, primary health care facilities and television viewing centres with enrolments ranging from 50 in the smaller settlements to a few hundreds in the major towns (LGA Headquarters).

Plate 5.15: Public Secondary School at Rogo

There is public power supply system from the national grid in the main towns but no power supply to the smaller villages in the project area. Consequently, the major source of power is fuel wood and farm waste which are sourced from dead trees, shrubs and cornstalks. Some utilize generators and solar panels but mostly for commercial phone charging. There are periodic markets (Plate 5.16) gathering after every seven days which is typical of most periodic markets in the Kano Region and in Northern Nigeria, police stations and local cinemas (privately owned commercial television viewing centres) at some strategic locations. The tarred roads and paths that exist are plied by trucks and animals for the transportation of goods to and from farms, and to local markets.

Plate 5.16: Village Periodic Market looking deserted on a non-market day

Wealth Distribution

Wealth distribution in Kano State according to the Nigerian Demographic and Health survey Report (2018) has a Gini coefficient of 0.26, indicating that wealth is unevenly distributed in the area as over 50% of the population falls in the second and lowest quintiles. This is attributed to diversity in earning potentials of the various occupations people engaged in (fig. 5.31).

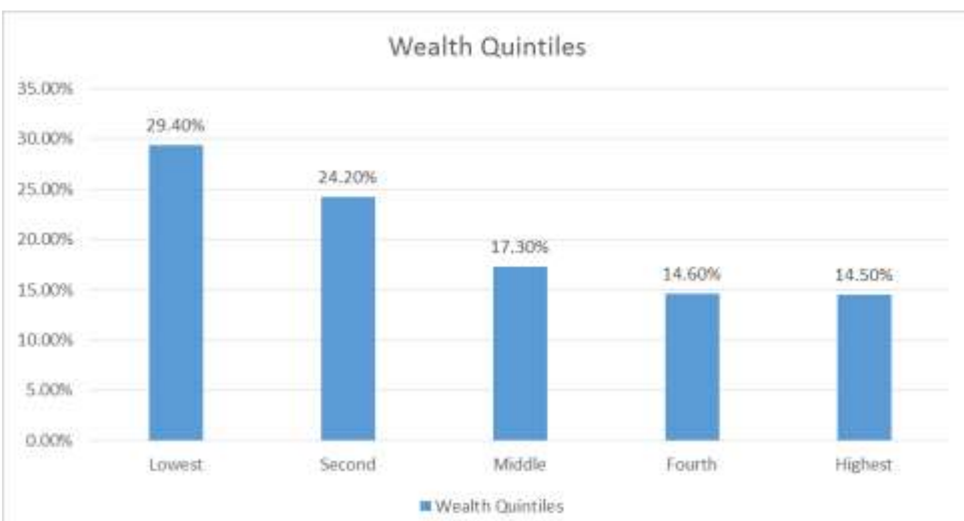


Figure 5.31: Wealth Quintiles (NDHS, 2018)

5.33 Religion and Believes and Languages Spoken,

Religion: A large number of the Hausa population is Muslim practicing Islam, based off the teachings of the prophet Muhammad and the instructions of the Holy book, Qur'an. It is said that the religion was brought to them by traders from North Africa, Mali, Borneo, and Guinea during their trade exchanges, and they quickly adapted the religion. Muslims pray five times a day, fast during the month of Ramadan and strive to make the pilgrimage to the holy land in Mecca.

Conservative estimate put the population of Muslims in Kano State to about 90% followed by Christians mostly non-hausa. Since the penetration of Islam into Hausa land in the mid-14th century, most Hausa have become extremely devoted to the Islamic faith. Muslims believe in Allah and Mohammed as his prophet. They pray five times each day, read the holy scriptures, fast during the month of Ramadan, give alms to the poor, and aspire to make the pilgrimage (hajj) to the Muslim holy land in Mecca. The religion affects nearly all aspects of Hausa behavior, including their dress, art, house types, rites of passage, and laws.

In the rural areas, there are still a few communities of people who do not follow Islam. These people are referred to as *Maguzawa,* who are linguistically and culturally Hausas, but they worship nature spirits known as *bori* or *iskoki*. *Bori* cults are built around spirit possession and exorcism and are especially attractive to women and the socially marginalized peoples. A number the *Maguzawas* practice the Christian faith. Within the Challawa project area the *Maguzawa* community are found in small farming villages of Rogo Local Government Area.

Hausa language: was described as the most important indigenous lingua-franca in West and Central Africa, spoken as a first or second language by about 40–50 million people. It belongs to the Western branch of the Chadic language superfamily within the Afro-Asiatic language phylum. The territories of the Hausa people lie on both sides of the border between Niger. About one-half of the population speaks Hausa as a first language, and in Nigeria, where about one-fifth of the population speaks it as a first language. The Hausa are predominantly Muslim. Their tradition of long-distance commerce and pilgrimages to the Holy Cities of Islam has carried their language to almost all major cities in West, North, Central, and Northeast Africa.

The official language of Kano State is English but the Hausa language is commonly spoken. The state is mostly populated by Hausa people. Kano state located at the north western part of Nigeria is inhabited natively by Hausa and Fulani ethnic groups. Hausa is the most widely spoken language in the state. One can find it extremely difficult to live in the state without being able to speak at least some few Hausa life-saving words and phrases. Kano is the home of Hausa, everything about the language is being set here. There are however, vibrant communities of all the ethnicities of Nigeria and some neighboring countries speaking various languages including Igbo, Yoruba, Igala, Idoma, Kanuri, etc among several other Nigerian Languages. On the other hand too, there Lebanese, Syrians, Indians and Chinese among other foreign nationals are visible in the state.

The Hausa are predominantly Muslim. Their tradition of long-distance commerce and pilgrimages to the Holy Cities of Islam has carried their language to almost all major cities in West, North, Central, and Northeast Africa. The Project environment lies at the heart of Hausa language zone and may have significant implications for the Challawa Gorge Dam Watershed management project execution and implementation especially in terms of labour hiring and human relations.

Culture and tradition: The Hausa people have unique cultural practices that have stood the test of time regardless of the colonization of the British. This is attributed to the fact that their political and spiritual leaders did not compromise the standards they were well acquainted with; this is why they still maintain their ways of life t in traditions, belief system, values, religion and economy to date.

Culture and Rites: Encyclopedia.com, (an open source Journal) has chronicled the Hausa culture lucidly in the following ways. Culture *(al-ada* in Hausa) is one of many features that distinguish a Hausa person from members of other ethnic groups, in addition to his origin *(asali*), his adherence to the Islamic religion *(addini),* and his mastering the Hausa tongue *(yare*). Hausa culture includes the Hausa mode of dressing, particularly the big gown and cap, along with several other customs, such as dancing and marriage ceremonies. The Hausa also identify closely with their music, particularly that of the praise-singers who sing about community histories, leaders, and prominent individuals. Hausa culture also includes individual character, known as *mutumci* or *hali*. In their personal dealings, Hausa seek to strike a balance between being assertive and being thrifty, which benefits them in their business dealings, and having a strong sense of shame *(kunya)* and respect among strangers as well as kin just like their Fulani counterparts.

The Hausa calendar follows the Islamic calendar. Feast days *(Id)* take place following the month of fasting *(Ramadan),* following the pilgrimage to Mecca *(hajj),* and on the birthday of the prophet Mohammed *(Maulud)*.

At this time, families usually sacrifice a ram in thanksgiving, celebrate with their relatives and friends, and give each other gifts. Hausa also observe the national holidays of Nigeria.

With a population of over 30 million, the Hausas are one of the largest ethnic groups in West Africa. They are a people of diverse cultural practices with similar homogeneous beliefs and customs exclusively found among their people. Here’s everything you need to know about their diversity. The Hausas are concentrated mainly in the northern part of Nigeria, as well as the adjoining south eastern Niger. They also populate parts other countries including Cameroon, Ghana, Chad, Togo, Senegal, Côte d’Ivoire, Sudan and Gabon.

The Hausa states, also known as the Hausa land, were independent political entities founded by the Hausa people, and situated between the River Niger and Lake Chad. It was a political entity with no central authority, isolated up until the mid-14th century. Irrespective of their placements, they had a common language, laws, and customs. The Hausas specialized in blacksmithing, fishing, hunting, agriculture, and salt-mining. By around the 1500s, the northern city of Kano had become the most powerful, and was a major trading center in ivory, gold, slave trade, salt, cloth, leather, and grains. Due to their lack of military expertise and a central governing body, they were regarded as loose alliances by the neighboring towns—which made them prone to external domination. All the states remained independent until they were conquered by a prominent Islamic scholar, Usman dan Fodio, in a Holy Jihad (war) between 1804 and 1815, which created the Sokoto Caliphate. It was later abolished when the British defeated the caliphate in 1903 and named the area Northern Nigeria.

Marriage: The Hausa traditional marriage is mostly based on Islamic, and not as time consuming or expensive like the Igbo and Yoruba traditional marriage ceremonies. However, the process leading up to the marriage is slightly similar to what obtains in the other regions in Nigeria.

When a man sees the woman he wants to marry, he has to first of all seek permission from her parents. The family of the bride-to-be will then conduct an investigation on the background of the man to determine his religious beliefs, ethics, moral and family customs, as well as every important detail concerning his upbringing.

The groom-to-be if approved by the woman's family, is allowed to see her briefly but any form of physical contact, romance or courting before marriage is highly discouraged. Once the woman accepts the marriage offer, the man sends his parents or guardians as well as elderly relatives to formally ask for her hand in marriage. However, this may not be the same for all the tribes in the Hausa communities, as each of them have different customs regarding marriage rites, though the process mentioned above is the most common method. On their trip to the bride's family home to seek her parent's consent, the groom's family take along items such as kolanuts, bags of salt, sweets, etc. It is during this visit that the groom's parents will make their intentions known. *Gaisuwa* is a kind of formal approval from the bride's family to the groom's. This is where the bargain for the bride's dowry begins.

Usually, the bride price starts from a minimum amount known as 'Rubu Dinar' in Hausa, an Arabic phrase which means 'quarter kilogram of gold piece', to the highest amount the groom can afford to pay. It is most preferred for the bride price to be as low as possible, because according to Islamic teachings, the lesser the amount paid as the bride's dowry, the more blessings that will come to the marriage. Payment of the dowry is known as *Sadaki.* Also, the wedding date is fixed during this visit, by both families. The process of setting the date is called *Sarana.* The wedding day is called *Fatihah*, and it is the day of joining the two families.
As part of Hausa tradition, it is the duty of the husband to provide a house for the couple to live in, while furnishing the house is the full responsibility of the bride's family. At the wedding *Fatihah*, women are to remain indoors preparing the bride for her new life as a wife, which is referred to as *Kunshi.* The *Kunsh*i is similar to a bridal shower. The wedding reception is known as Walimah, and it is carried out according to the taste of the families involved. It is usually held after the *Fatihah,* and it goes on for a whole day with food and drinks available for family, friends and well-wishers. At the end of the celebration, the bride is taken to her husband's house after receiving pieces of marital advise from parents, aunts, uncles, parents-in-law.

Household Composition and Size: Typically a household unit in the study area consists of the Household Head (HHH), and members including wife or (wives because the area is Polygamous), the children and children of relations, sometimes family friends, all dining from the same pot. The house hold type in many cases is the compound type where more than one family or household (HH) share a compound but eating from different pots. On average, a HH is made up of and average of 5 persons. For the Study area an average HH size was (7.5 members) indicating fairly large family sizes, and about 65% (162 respondents) had more than one wife.

This includes younger (male) adults aged 30-40 years. Generally only about 4% of the household were headed by aged females, and this mainly arose from widowhood.

Rites of Passage: About a week after a child is born it is given a name during an Islamic naming ceremony. Boys are usually circumcised at around the age of seven, although there is no rite of passage associated with this. At around this same age, both boys and girls start studying the Qu'ranic scripture, which they must learn by the age of 13.

In their mid- to late- teens, young men and women may become betrothed in marriage also following the Islamic culture. The marriage ceremony may take place over several days, first among the bride and her family and friends, when she is prepared for marriage. Male representatives of the bride's and the groom's families contract the marriage according to Islamic law, usually at the mosque. Shortly thereafter, the couple will be brought together, often with a small celebration (Smith, 1965).

Hausa Folklore: The Hausa has a rich system of folklore, some of which has been influenced by the Islamic religion. The system includes stories *(tatsunya)*—of animals, men and women, young men and maidens, and heroes and villains—which usually have a moral. Many include proverbs and riddles to help convey a message to the audience, which is often comprised of children. The stories sometimes involve a trickster who appears as a spider and demonstrates both cunning and greed. Hausa folklore also includes exaggerated stories or traditions *(labaru)* of important figures or events in the Hausa past (such as battles or notable rulers). In these, folklore merges with history. The Hausa origin myth includes Bayajidda the serpent slayer who was rewarded by marriage the Queen of Daura, who, in turn, had the founding sons of the Hausa's seven original towns.

Leadership structure:

Traditional Leadership Hierarchy: In Hausa Land, the emir is assisted by District Heads, Village Heads and Ward heads *(Mai Ungwa's)* and family heads. The Emir and District heads, unlike other functionaries, do not exercise political power but serve as custodians of culture and advisers to the government on traditional affairs. They are quite influential in mobilizing people in their various emirates and districts. All the Emirs are first class title holders.

Traditional Governance: In terms of traditional administrative duties and with reference to the family lineage level, the family head presides over family meetings. During such meetings, family, land disputes and other minor disputes between family members are resolved. Above the family level is the ward head. If issues referred to him could not be resolved, such issues are referred to the village head. At the village level, the Village Head presides over meetings. Above the Village level, is the District Head and he exercises administrative and judicial authority over his district. Issues are referred to His Royal Highness the Emir from the court of the district heads. The Emir's council has authority to settle all forms of conflict. The economic base of the chieftaincy in the study area consists of tributes, gifts, fees, fines, compensations and money accruing from settlement of cases.

***Social Organization*:** One of the most salient principles in Hausa society is the segregation of adults according to gender. Throughout Hausa land, seclusion of married women is normative, and the extra domestic impact of sexual segregation and stratification is that women are legal, political, and religious minors and the economic wards of men. Although women are central to kinship matters, they are excluded from extra domestic discussion and decision making. Both within the household and in the public domain, patriarchal authority is dominant and reinforced by spatial separation of the sexes.

The senior wife of the compound head, the *mai gida*, is the *uwar gida*. She may settle minor disputes among residents and give advice and aid to the younger women. Domestic authority rests with the male head of compound/household.

From childhood, males and females develop bond friendships with members of the same sex, a practice continued into adulthood and marked by reciprocal exchanges. Given their seclusion, women tend to formalize their bond ties more than men do. Formal relationships that emphasize differences in status (patron/client) are also established by women, as they are by men.

Political Organization: Organizational structure is hierarchic; the centralized kingdoms, known as emirates, are the primary groupings; districts are secondary and village areas tertiary. The institutions of kinship, client-ship, and office (and, in the past, slavery) in the emirates, have provided the fundamentals of Hausa government from the sixteenth century until the middle part of the twentieth century. Rank regulates relations between commoners and rulers.

“Traditional and modern government proceeds through a system of titled offices each of which is in theory a unique indissoluble legal corporation having definite rights, powers and duties, special relations to the throne and to certain other offices, special lands, farms, compounds, horses, praise songs, clients, and, formerly, slaves" (Smith 1965, 132). In most states, major offices are traditionally distributed among descent groups, so that rank and lineage intertwine. The traditional offices differed in rewards, power, and function, and were territorially based with attendant obligations and duties. Within communities, the various occupational groups distribute titles, which duplicate the ranks of the central political system.

Figure 5.32 highlights the leadership hierarchy system of the project Area. The Emir is the Paramount ruler followed by the District Head (Hakimi), Assisted by the Village Head (Miajimilla), who also supervises the Mai unguwa. There are other title holders such as Sarkin Noma (Chief Farmer), Sarkin Aska or Sarkin Wanzamai, Sarking Fulani (Leader of Fulani Pastoralist), etc. These are put in place to assist the Emir in managing administrative, cultural, and security issues among other of his function including conflict management and arbitration on local disputes between parties, groups or communities.

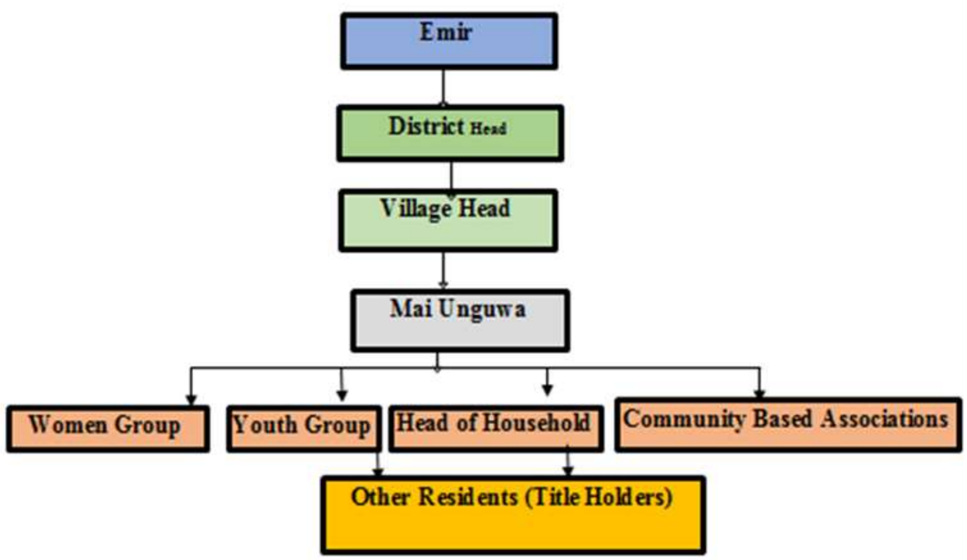


Figure 5.32: Traditional Leadership Hierarchy in the Study Area

Client-ship links men of unequal status, position, and wealth. It is a relationship of mutual benefit, whereby the client gains advice in his affairs at the minimum and protection, food, and shelter at the maximum. The patron can call upon the client to serve as his retainer.

In applying his notion of government to Kano, the Fulani religious and political leader Usman Dan Fodio, when he launched his successful jihad against the king of Gobir in 1804, he followed the basic premise of a theocracy within a legalistic framework; government, and its chief agent, the emir, were perceived as custodians of the Islamic faith.

Social Control: Legal affairs fall under the jurisdiction of the emir, and he is guided by Islamic law. The Quran, the word of Allah, and its hadith, the traditions of the Prophet Mohammed, along with the dictates of secular reasoning provide answers to legal questions. The Sharia, the canon law of Islam, is fundamentally a code of obligations, a guide to ethics. Sanctions of shame and ostracism compel conformity to Hausa and Islamic custom.

Conflict Management: When disputes arise, the Hausa man may opt to go to court, submit to mediation, or leave it to Allah. The basic process involves deference to mediation by elders.

5.34 Public Health

Malaria has been a leading cause of morbidity and mortality in KYB, for many years, accounting for 79 per cent of the disease burden in KYB. Most parts of the country including the KY Basin have reported malaria transmission throughout the year, although it increases during and soon after the rainy season. Data and information collected as part of the Health Thematic Report indicate that diarrheal disease continues to be a major public health problem. It accounted for 16 % of the disease burden in last three years (since 2018). Cholera was the third major public health problem with 3 % of the disease burden in 2018. Lack of proper sanitation represents the greatest challenge to public health in the KY Basin. Increased food insecurity and malnutrition are also likely to decrease human disease resistance and human labour productivity and increase human deaths. The following factors will increase vulnerability to health and public safety problems:

- Lack of access to safe drinking water.
- Inadequate health services especially in areas which are far from main roads.
- Inadequate public awareness of disease risks associated with the use of water.

Health Facilities and prevalence diseases

There are primary Healthcare Clinics (PHC) in some of the surrounding communities. The PHCs are headed by Community Health Officer (In-Charge) with 5-7 staff each comprising of Community Health Assistants, Laboratory Assistant, one or two cleaners and at least two security men working on shifts. The clinics need may need at least one well-trained Nurse since the PHCs are not served by resident doctors. The clinics are generally inaccessible for many communities.

Interactions during FGDs with various respondents the reveal the common diseases in the study area include malaria, typhoid, cholera, pneumonia, tetanus and injuries arising from use of traditional working tools especially farm implements, measles, dysentery/diarrhea etc. Other injuries from the use of farm and other associated implements, all other diseases are caused by environmental factors. Since access to portable clean water is a challenge in many of the communities the occurrence of environment-related diseases becomes obvious.

The FGD survey also revealed alternative sources of treatment of the various ailments to include visits to medicine stores and in severe cases visiting hospitals in the Local Government Headquarters. Essentially, visits to health centres and hospitals for treatment are always the last options due to high cost of treatment and long queues in general hospitals. Patent medicine stores and itinerant drug vendors are therefore popular medicare avenues and thus enjoy a lot of patronage especially on markets days.

However, the FGD also reveals that the cost of medical care generally affordable by most families induced by poverty are necessitated to partronise traditional herbs for treatment of simple diseases such as malaria, typhoid fever, cholera, high blood pressure and hyperglycemia (diabetes). Herbs used for such treatments include Neem Leaves; Paw Paw leaves and seeds; Moringa leaves seeds; the leaves and bark of guava leaves; as well as hibiscus flour etc.

Causes of Morbidity and Deaths

The main causes of death in Nigeria in 2019 were neonatal disorders. More specifically, 12.25 percent of all deaths were reported to have been due to neonatal disorders. Other common causes included malaria, diarrheal diseases, and lower respiratory infects. Figure 5.33 shows the distribution of frequency of morbidity and mortality in Nigeria based on causes. Most causes of deaths and morbidity are preventable.

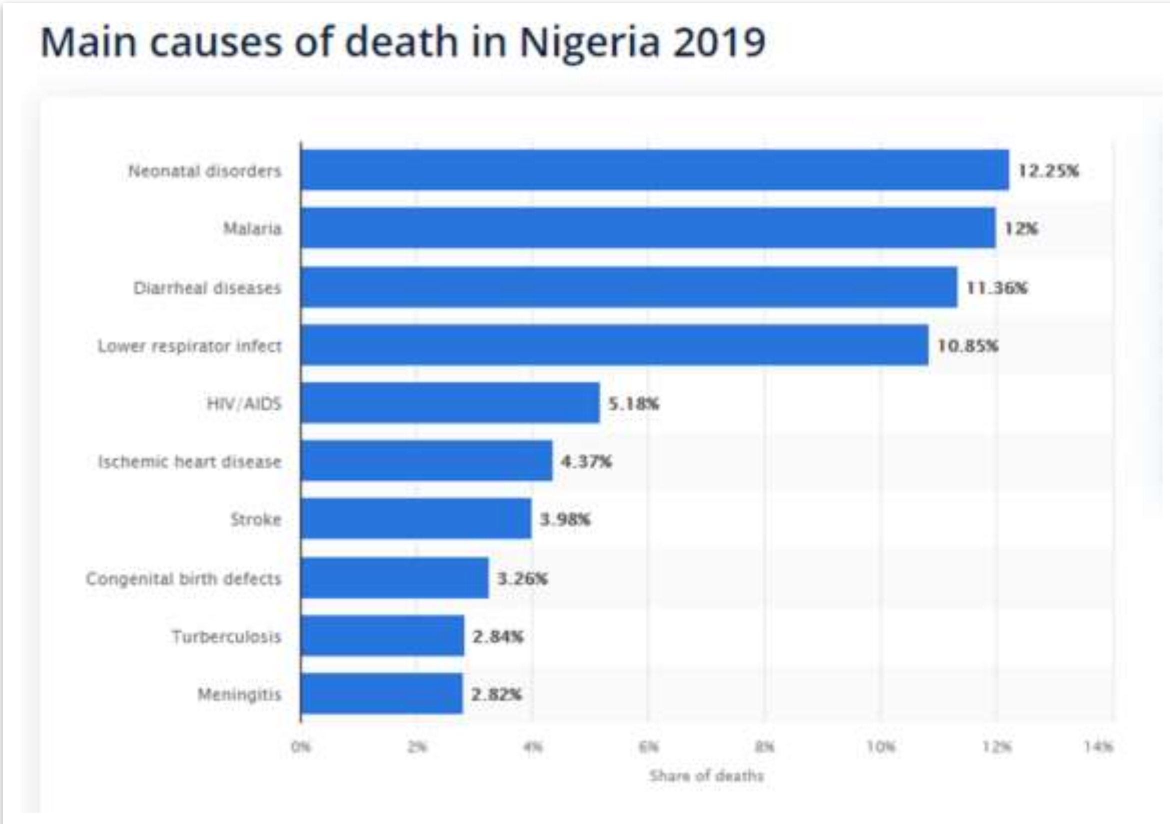


Figure 5.33: Main Causes of Deaths in Nigeria, 2019

Source: STATISTA. https://www.statista.com/statistics/1122916/main-causes-of-death-and-disability-in-nigeria/

Zubairu, Isa, and Auwal (2010) in a review of admission and deaths in Hospital in kano, Nigeria reported that adolescents age range 15–45 years had the highest number (57.9%) of admissions followed by 1–4 years (11.7%) and < 1 year (11.3%) age range. On the other hand, age range 15–45 years recorded the highest number (37.7%) of deaths followed by the 46–64 (23.8%) and the > 65 years (16.1%) category. However, the age range > 65 years recorded the highest number of deaths per admission giving rise to 16.5% mortality rate. The mortality rate increased as the age increased. Mortality rates for the years 2012, 2013, 2014, 2015, 2016 and 2017 were found to be 3.6%, 3.9%, 4.1%, 4.2%, 6.1% and 5.1% respectively.

Disease diagnostic category (ICD-10 code)	Children (0–14 years)		Adult (≥15 years)		Total Adm.	Total death
	Admission	Death	Admission	Death		
Infectious and parasitic diseases	3,332	106	1,578	392	4,910	498 (22.7)
Neoplasms	86	8	1,303	110	1,392	118 (5.4)
Disease of blood & blood forming organs	549	6	415	61	964	67 (3.0)
Endocrine, nutritional & metabolic diseases	859	24	857	90	1,716	114 (5.2)
Mental and behavioral disorders	11	0	82	13	93	13 (0.6)
Diseases of the nervous system	276	27	539	106	815	133 (6.0)
Eye and adnexa diseases	162	0	300	0	462	0 (0.0)
Ear and mastoid process	97	1	31	0	128	1 (0.0)
Circulatory system diseases	239	27	2,301	321	2,540	348 (15.8)
Respiratory system diseases	3,382	40	595	78	3,977	118 (5.4)
Diseases of the digestive system	325	17	1,839	165	2,164	182 (8.3)
Diseases of the skin and subcutaneous tissue	300	9	277	31	577	40 (1.8)
Diseases of musculoskeletal system & connective tissue	114	10	282	13	396	23 (1.0)
Diseases of the genitourinary system	299	17	1,397	105	1,626	122 (5.5)
Pregnancy, childbirth & puerperium	10	1	16,108	18	16,118	19 (0.9)
Condition originating in the perinatal period	2,497	123	1,752	2	4,249	125 (5.7)
Congenital malformations	330	33	76	6	406	39 (1.8)
Symptoms, signs and abnormal clinical and laboratory findings	636	15	639	88	1,275	103 (4.7)
Injury and poison & other external causes	575	24	1,800	83	2,375	107 (4.9)
Factors influencing health status & contact with health services	331	7	2,773	21	3,104	28 (1.3)

Adm.: admission

https://doi.org/10.1371/journal.pone.0237313.t003

Figure 5.34: Causes of Mobidity by age groups in Kano State

Source: Zubairu, Isa, and Auwal (2010)

Zubairu, Isa, and Auwal (2010) also reported a mortality rate of 7.8% from hospital records in Kano State. Specifically, the report showed that of the 15,484 males admitted, 2,361 died giving a mortality rate of 15.2% while of the 36,491 females admitted, 1,668 died giving a mortality rate of 4.6%. The median age for all patients that died was 32.4 years, with 36.1 years for the male and 29.3 for the female subsets. The ten most common causes of mortality were HIV/AIDS (8.3%), Septicaemia (6.8%), cerebrovascular disease (6.3%), and chronic renal failure (3.9%) chronic liver disease (3.3%), diabetes mellitus (3.2), neonatal jaundice (2.9%), severe birth asphyxia (2.6%), prematurity (2.5%) and bronchopneumonia (2.4%). Thus, mortality rate and causes of death are comparable to similar centres within the state and in Nigeria. Regular mortality audits could identify management errors and prevent recurrence of avoidable deaths.

Zubairu Iliyasu, Isa Sadeeq Abubakar, and Auwal Umar Gajida (2010): Nigerian Journal of Medicine. Oct-Dec 2010; 19(4):400-6. doi: 10.4314/njm.v19i4.61964.

Refuse Disposal System: The most common refuse disposal system in the host community of the proposed project is through open burning within the community or compound of each household. These are later transported to farmlands and used as soil conditioner at the onset of farming season. About 75% of the respondents have disposal pits dug in their compounds while 25% disposes indiscriminately in unauthorized refuse dumps. The most common type of toilet facility in about 95% households in the study area is the traditional pit latrine (covered or uncovered) and about 5% still go to the bush.

Household Assets: The most commonly owned asset in the area is the farming bull and household items such as radio (76%); television set (69%), motorcycles (79%). A household cannot do without at least one motorcycle or bicycle as they are the most common means of transportation within the community.

5.35 Security

The study area, like most communities in northern Nigeria, witnessed serious violent attacks from various terrorist groups and armed bandits between in the last ten years, where even the late Emir of Late Kano was attacked during Friday prayer. While it is difficult to estimate the number of serious security breaches that occurred in the area over the period, the episodes in neighboring Katsina to say the least is numerous ranging armed banditry, cattle rustling, kidnaping other forms of violent criminality. The Challawa Gorge Dam Watershed which traverses areas in Kano, Katsina and to a small extent Kaduna States, were banditry and terrorism cases have been reported can be said to be entirely free. For example, during public consultations, it was reported that areas of pilot sub-watershed 2 including Bari, Dutsen Kura and the neighborhoods of Palgore are areas to watch in terms of kidnaping and other forms of criminality.

Recently, the governor Kano State Government has shut down 10 boarding schools in the outskirts of the metropolis, due to the rising number of abductions of school children in neighbouring states. The government also announced other measures among which were the suspensions of sales of animals at markets in fourteen Local Government Areas of the state. And in the neighbouring Katsina State, the Governor reported that 10 out of the 34 Local Government Areas in the state were under severe attack daily by the bandits. While security breaches have become a common denominator in many northern states, it is hoped that the situation will contimue to improve before commencement of this project.

5.36 Consultations and Stakeholders Engagement and Perception

As a requirement and to be in line with international best practices, consultations were held at different levels and times using a participatory approach in this ESIA process. This is necessary to allow the concerned public/critical stakeholders to be part of the decision-making process towards the project development and operation. The process will also serve to ensure fulfillment of the community's expectations for a sustainable and environmentally friendly project development. Public participation in also deliver some beneficial information to the ESIA process that may enhance project benefits and minimizes any inadvertent but adverse outcomes of the project. Thus to make project development and operation transparent, public consultation is necessary, and continuous throughout the life of the project. Stakeholder consultations on the proposed project activities at the very early stage of decision-making may help to prevent or mitigate unexpected negative outcomes such as conflicts and adverse environmental impacts of the project decisions and to enhance the positive outcomes.

The project proponent, HJKYB-TF, the funding Agency (AfDB), the Federal Ministry of Environment and the Nigerian legal system regard consultation as a requirement for project development especially of the magnitude of a watershed. This is because it is Important to notify the stakeholders about the nature, magnitude, and scheduling of the proposed project, thereby eliminating any fears or apprehension.

Information dissemination and consultations with stakeholders, especially the Project Affected Persons (PAPs) means transfer of information from Project proponents to the affected population. It provides an opportunity for all the communities in the areas to raise issues and concerns pertaining to the project, and allow the identification of alternatives and recommendations.

Specific objectives of the public consultations and information campaign include to:

i. Fully share information about the ongoing project, its components and its activities with the affected people;
ii. Obtain information about the needs of the affected people and their reactions towards the proposed activities;
iii. Ensure transparency in all activities related to land acquisition and compensation payments;

iv. To get the opinions of local residents especially the interested and affected parties about the problems anticipated with the project and how these can best be overcome.
v. To ensure that stakeholder comments have been considered and addressed;
vi. To draw on indigenous knowledge in the process of identifying environmental and social concerns associated with the proposed project, and to involve stakeholders in identifying ways in which these can be addressed;
vii. To comply with the local legislative requirements;
viii. To incorporate international best practices;
ix. To satisfy AfDB requirements as contained in the its Operational Safeguards.

5.36.1 **Public Consultation Process**

The consultation process ensured that all those identified as stakeholders were consulted. This started with the scoping exercise and includes Focus Group Discussions, meetings with community leaders, and community members in various locations of the project area as well as other concerned community members at separate times. Furthermore, especially with the PAPs One-to-one meeting was used during the survey of the socio-economic activities along the project corridors. The Stakeholder/Public Engagement process is summarised graphically in Figure 5.35; the same approach was used during the Scoping and ESIA phases.

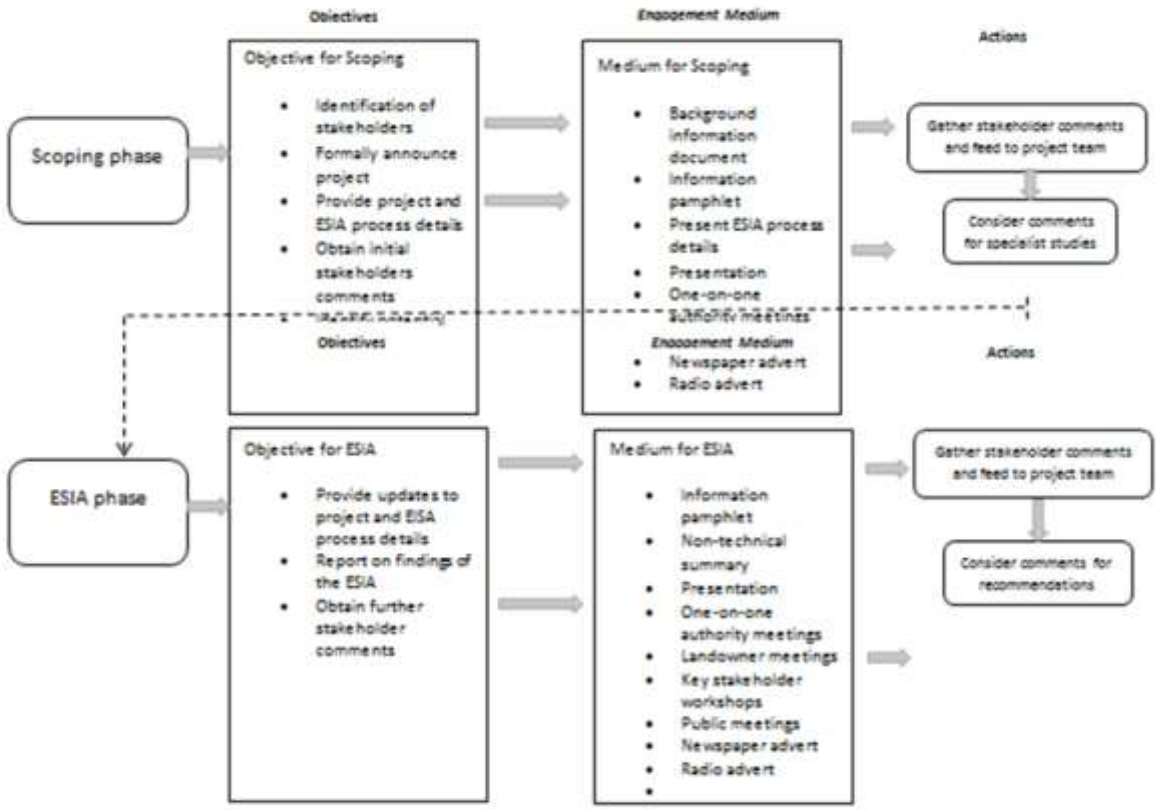


Figure 5.35: Stakeholders' Engagement Process

5.36.2 **Discussion with Stakeholders and Summary of Outcome Conclusion**

During the meetings, the general overview of the project was presented to the various stakeholders. In addition, the challenges emanating from the implementation of the project and the support needed from all parties to ensure effective project development and successful implementation were also presented and discussed. A key point mostly pointed out was the fact that the project was designed to benefit the government and the people especially those close to the project site and those downstream of the gorge dam. It was also clarified to the community members the benefits that may accrue to them from the implementation of the project such soil and gully stabilization leading to protection of their farm lands from river bank erosion and other forms of destructions arising from surface run off; introduction of exotic plant species especially the vertiver grass, fruits-bearing economic trees etc. It was also stressed that the proposed watershed management activity may create employment opportunities for the local community during the construction phase and facilitate for them innovative erosion control and management practices to enhance farm productivity and food security. Stakeholders emphasized the need to source for local workforce and labor from qualified personnel within the communities affected should the need arise.

Table 5.29: Queries/Observation and the response given bythe Stakeholders

S/No.	Comments/Issues Raised by Public	Responses
1.	This is commendable an appropriate thing to do and we appreciate that there are programs as such to assist us.	We are more than happy to assist as much as we can. It is designed to improve and provide support to affected areas and communities. Thanks.
2.	Are there going to be workers from other places coming to do the work, we want our young men to do work during the project execution.	Part of this program is to employ able bodied men and women and any other willing individuals from within the local community during the civil works. It gives a sense of involvement and serves to benefit members of that community. So, when there is a need to employ contractors, you will be notified.
3.	What happens if the project is not completed or what happens to people having their farms unused due to delay in project excavation or construction work? Can we go back to use our lands for raising crops?	Firstly, the project has been backed and given a green light by the Federal Government of Nigeria through the HJKYB-TF. The HJKYB-TF has a good organizational structure to ensure full and timely completion of the project. The project has a well organised structure and set timeline. The AfDB as the funding body has rules and guidelines to ensure project completion and on schedule Further backing is being provided by the African Development Bank. Every project aspect will be set according to the Nigerian regulations and standards. However, it may not be feasible to allow people take back and cultivated their lands after they must have been compensated or settled.
4.	What will you offer to the people whose properties have been destroyed	Such persons might not be directly considered. But there is an inbuilt mechanism to involve

	by the gully erosion?	farmers on erosion control and its management on their farms through extension support. There is a component of the project for on-farm bio-remediation using beneficial agricultural techniques such as planting of grasses, mixed cropping of vegetables, contour ploughing etc, that the farmers will be assisted to practice on their farms. In any case they will have substantial project benefits.
5.	How about including our Village Heads and Community Leaders?	Of course, Village Heads and community heads have a vital role to play in project developments by assisting the Project implementation Unit in the area of security, Hiring of trusted labour force, identification of PAPs in times of Compensation etc. Involving them will boost trust and a sense of commitment in the project.
6.	How soon will the project start?	As stated earlier the project has been designed to follow due process and timelines. This is very important when discussion on start date for the project. The HJKYB-TF is fully of commencing project activities as soon as all due processes are fully met.
7.	Will persons without legal property titles be included within the project? That is will they be part of the any resettlement plan?	Yes. Preference for land-for-land compensation, land of equal or equivalent value. If not, cash at full replacement value, including transfer costs will be paid to the verified project affected persons.
8.	What will happen to our fruit-bearing trees that we have been harvesting for all the years past?	The project is targeting planting more economic trees both exotic and local species. These include Avocado, Orange, and other economically beneficial trees. Trees in the project area will be preserved as much as possible while new ones will be planted.

9.	Shall we be allowed to graze our livestock on the planted grasses?	Not likely since the idea is to keep the planted grasses alive and. However there will still be enough space for animals grazing outside the project corridor.

The concerns and issues that raised by the stakeholder during public and stakeholder consultations are not exhaustive. Consultation is a continuous process and therefore shall be sustained throughout the lifecycle of the Challawa Gorge Dam Project Development and Management.

Plate 5.17: Photo of participants at scoping Workshop at Challawa Gorge Dam, Kano State

Plate 5.18: Cross section of community members at consultations

Plate 5.19: (a) Public Consultation and (b) Site visit at Rogo and Ayaga Communities assisted by Mai Unguwa Murtala

CHAPTER SIX

MITIGATION/ENHANCEMENT MEASURES

6.14 Introduction

This chapter identifies and presents the impacts mitigation and enhancement measures arising from the ESIA outlined in the previous chapters. The mitigation measures are guides on what is required to avoid/minimize the likely negative environmental, social and economic undesirable consequences of the project implementation and how to enhance the positive impacts.

The ESIA is an instrument used to identify, predict and assess the likely environmental, climate change and social consequences of a proposed development project in order to ascertain the means through which to avoid, minimize, mitigate, compensate/offset and/or monitor adverse impacts, and increase development benefits. This ESIA therefore assesses the direct, indirect and cumulative impacts of the Challawa Gorge Dam Watershed Management Project in its area of influence; examines project alternatives; and determines the significance of each of the impacts identified. The ESIA identifies ways of improving project selection, design, siting and implementation in order to avoid or mitigate and manage adverse environmental and social impacts that may arise from the project activities.

The broad approach (and methods) adopted for assessing the impacts of the proposed Challawa Gorge Dam Watershed Management project on the physical, biological and social environments is hinged on the Federal Ministry of Environment ESIA Guidelines and the AfDB guidelines contained the AfDB's revised operational safeguards and sustainability series, Volume 1 - Issue 4 (November 2015). Furthermore, the primary information obtained during field data gathering in the project area (including information gathered from members of affected communities and other stakeholders during consultations), secondary information from existing relevant literatures as well as professional experience and judgments of the multidisciplinary ESIA team formed the bedrock upon which the potential impacts were identified and evaluated. In line with the above, impact assessment was carried out in stages as follows:

- Impact Prediction: this entails prediction of changes to the environment that could result from the proposed watershed management project.

- The prediction of these changes will be based on the identification of potential interactions between the project and the physical, biological and social resources/receptors.
- Impact Characterization: which entails characterizing/forecasting the nature, scale, extent, duration, frequency of the impacts. Characterization will essentially help to determine the magnitude of impacts and degree of change the impact is likely to have on the receptor.
- Impact Evaluation: this entails determination of the significance of impacts based on the magnitude, value, sensitivity/fragility and recoverability of the affected receptors. This requires an in-depth appraisal of the attributes of potential receptors which has been carried out in the baseline studies and presented in Chapter 5 of this report.

The Chapter also presents the approach adopted for the mitigation of identified impacts and outlines the approach for predicting any residual consequences after the application of mitigation measures. The short-term (preconstruction, construction and decommissioning phases) and the long-term (operational phase) were considered. Provision of the assessment methodology used in evaluating impact significance, considering the impact magnitude and sensitivity of receptors and resources affected, is also outlined.

As part of the impact assessment process, the primary Project activities (source of potential impacts) considered, and the environmental and social aspects and receptors assessed for possible effects during the construction and operational phases of the development are presented in Table 6.1.

Table 6.1: Indicative Project Activities and Environmental/social Receptors Assessed

Aspect	Phases	Activities
Indicative project activities	**Pre-Construction Phase**	Consultation with Project Affected Persons, Construction site clearance, Establishment of nurseries for raising seedlings Transportation of materials and men
	Construction Phase	Establishment of a construction yard; Mobilisation of machineries and equipment for construction; Use of natural resources (water, energy sources); Disposal of waste generated from construction activities, and Non-routine events (e.g. spills, traffic, accidents,

Aspect	Phases	Activities
		occupational health & safety incidents).
	Operation Phase	Stabilization of planted trees, shrubs and grasses surrounding the dam and buffer strips along different tributary gullies and finger gullies; Construction of check dams and other erosion regulation structures; Regular maintenance of the trees, shrubs and grasses till maturity;
Environmental indicators, or resources receptors considered in the impact assessment	**Construction and Operations**	**Biophysical Environment:** Air quality; Noise; Soils; Surface Water; Vegetal Resources Wildlife Resources Fisheries and aquatic Resources. **Human Environment** Water borne diseases; Resettlement Issues; Effects on transportation Effect on health pattern;

For each environmental component, the associated potential impacts of Project activities are identified and the significance of the effects assessed. A summary table of all potential impacts with their significance is presented in Tables below:

6.15 Impact Assessment Approach and Methods

This section describes the overall approach used for the assessment of impacts. Topic-specific methodologies are described under each section of the impact assessment. The assessment of impacts follows an interactive process involving the following key elements:

- Prediction of potential impacts and their magnitude (i.e., the consequences of the proposed on the natural and social environment);
- Evaluation of the significance of impacts taking into consideration the sensitivity of the environmental resources or human receptors into account;

- Develop mitigation measures to avoid, reduce or manage the impacts or enhancement measures to increase positive impacts; and assess significant residual impacts after applying mitigation and enhancement measures.
- Where significant residual impacts remain, further options for mitigation may be considered and impacts re-assessed until they are as low as reasonably practicable for the Project.

A graphical overview of the impact prediction and assessment procedure adopted is presented in Figure 6.1.

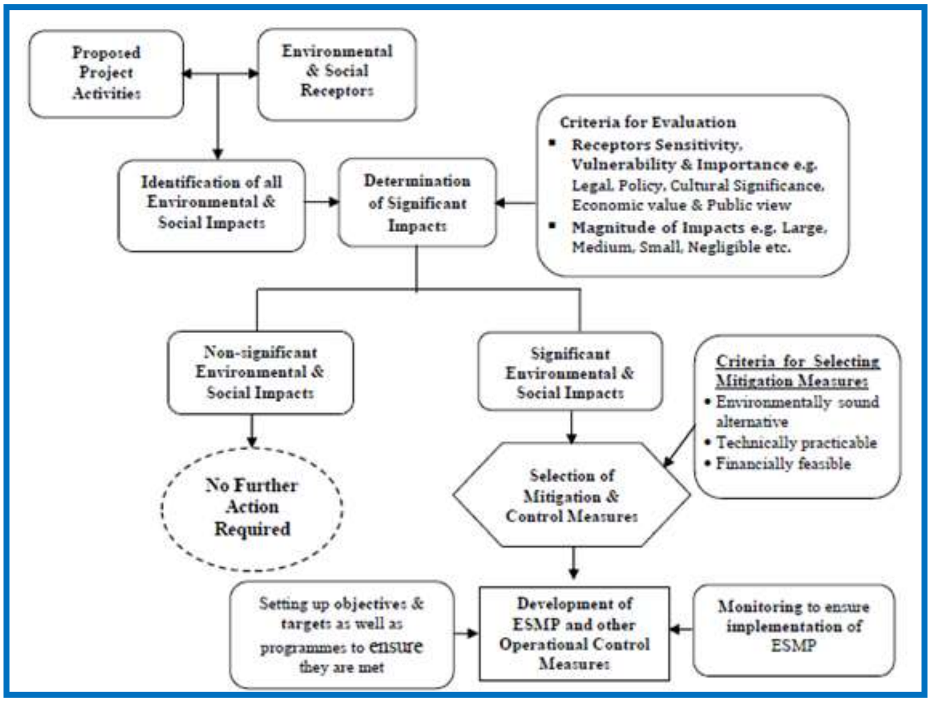


Figure 6.1: Impact Prediction and Assessment Procedure

6.16 Definition of Impact Terminologies

Nature/Type of impacts

There are several ways that impacts may be described and quantified. Table 6.2 provides definitions of terms used in this section.

Table 6.2: Definition of Impacts

1	**NATURE OF IMPACT**: An impact is essentially any change to a resource or receptor brought about by the presence of a project component or by the execution of a project related activity. Negative – an impact that represents an adverse change from the baseline or introduces a new undesirable factor. Positive – an impact that represents an improvement to the baseline or introduces a new desirable factor.
2	**TYPE OF IMPACT**: • Direct (or primary) – impacts that result from the direct interaction between planned project activity and the receiving environment • Secondary – impacts that result from the primary interaction between the Project and its environment because of subsequent interactions within the environment. • Indirect – impacts that result from other activities that are encouraged to happen because of the Project.
3	**TEMPORAL SCALE OF IMPACT:** • Temporary - impacts are predicted to be of short duration, reversible and intermittent/occasional. The receptor will return to a previous state when the impact ceases or after a period of recovery. • Short-term - impacts that are predicted to last only for a limited period (i.e., during construction) but will cease on completion of the activity or because of mitigation measures and natural recovery (e.g., non-local construction workforce-local community interactions). • Long-term - Impacts that will continue for the project's life but cease when the project stops operating (i.e. 50years or when there is improvement in technology that requires replacement). These will include impacts that may be intermittent or repeated rather than continuous if they occur over an extended period.
4	SPATIAL SCALE OF IMPACT: • Onsite – impacts that are limited to the Project site. • Local - impacts that affect locally significant environmental resources or are restricted to a single (local) administrative area or a single community. For this ESIA, local impacts are limited to the Project site and its zone of influence. • Regional - impacts that affect regionally significant environmental resources or are experienced at a regional scale as determined by administrative boundaries. • National - impacts that affect nationally significant environmental resources; affect an area that is nationally important /protected, or have macro-economic

	consequences (i.e. Nigeria). • International - impacts that affect internationally essential resources such as areas protected by International Conventions. • Trans-boundary - impacts that are experienced in one country as a result of activities in another.

6.17 Magnitude of Impact

The term 'magnitude' covers all the dimensions of the predicted impact on the natural and social environment, including:

- The nature of the change (what resource or receptor is affected and how);
- The spatial extent of the area impacted, or proportion of the population or community affected;
- Its temporal extent (i.e. duration, frequency, reversibility); and where relevant (accidental or unplanned events), the probability of the impact occurring.

Table 6.2 provides the definitions for the spatial and temporal dimensions of the magnitude of impacts used in this assessment for biophysical impacts.

For social impacts, the magnitude considers the perspective of those affected by taking into account the likely perceived importance of the impact, the ability of people to manage and adapt to change and the extent to which a human receptor gains or losses access to or control over socio-economic resources (1) resulting in a positive or negative effect on their well-being (a concept combining an individual's health, prosperity, their quality of life, and their satisfaction).

6.18 Sensitivity of Resources and Receptors

Sensitivities are defined as aspects of the natural or social environment that support and sustain people and nature. Once affected, their disruption could lead to a disturbance of the stability or the integrity of that environment. For ecological impacts, sensitivity can be assigned as low, medium or high based on the conservation importance of habitats and species. For habitats, these are based on naturalness, extent, rarity, fragility, diversity and importance as a community resource.

For socio-economic impacts, the degree of sensitivity of a receptor is defined as a stakeholder's (or groups of stakeholders') resilience or capacity to cope with sudden changes or economic shocks'. The sensitivity of a resource is based on its quality and value/importance, for example, by its local, regional, national or international designation, its importance to the local or broader community, or its economic value.

6.19 Likelihood

Terms used to define the likelihood of occurrence of an impact are explained in Table 6.3.

Table 6.3: Explanation of Terms Used for the Likelihood of Occurrence

Definition of likelihood		
High probability	Refers to a very likely impact	Refers to very frequent impacts
Medium probability	Refers to a potential impact	Refers to occasional impacts
Low probability	Refers to an improbable impact	Refers to rare impacts

6.20 Impact Evaluation

The third stage in the assessment procedure involved the evaluation of the impacts identified to determine their significance. This was based on the methodological framework set by (ISO) 14001 – EMS and EMSP Aspects and Impacts – Determining Significance developed by the University of Bristol in 2015. The evaluation of impact significance was based on the following clearly defined criteria:

- Environmental Legislation and Policy
- Stakeholders' Concern and Interest
- The severity of Environmental and Social Impacts
- Magnitude/Scale of Impacts
- Frequency of Occurrence of Impacts

The above criteria and the rating adopted for the evaluation are described in Table 6.4.

Table 6.4: Indicative Project Activities and Environmental/social Receptors Assessed

Aspect	Phases	Activities
Indicative project activities	Pre-Construction Phase	Consultation with PAPs, Vegetation clearance, Transportation of men & materials
	Construction Phase	Transportation of men & construction materials, Establishment of a construction yard; Preparation of building foundations; Assembly of machinery and equipment for construction; Use of natural resources (water, energy sources); Disposal of waste materials from construction activities and wastewater; and Non-routine events (e.g. spills, traffic, accidents, occupational health & safety incidents).
	Operation Phase	Operation of the dam Routine maintenance of the facility
Environmental indicators, resources or receptors considered in the impact assessment	Construction and Operations	**Biophysical Environment:** • Air quality; • Noise, vibration; • Soils and geology; • Water resources; • Terrestrial and aquatic ecology. **Human Environment** • Visual amenities; • Community-level impacts; • Community health, safety and security; • Labour and working conditions; • Infrastructure; • Employment and economy; and • Cultural Heritage

For each of the above-mentioned environmental components, the associated potential impacts of Project activities are identified and the significance of the effects assessed. A summary table of all potential impacts with their significance is presented in Tables 6.5 to 6.6.

Table 6.5: Impact Evaluation Criteria and Ratings

	Consequence		
A	Environmental legislation and corporate Policy	Is there any legislation affecting the aspect?	Score
		The impact is covered by legislation & Policy	3
		The impact is covered by legislation	2
		The impact is covered by Policy	1
		The impact is not covered by legislation or Policy	0
B	Stakeholder concern/interest	What stakeholder concern or interest does the stakeholder raise?	Score
		The impact raises considerable global, national and local interest or would have a seriously detrimental effect on the reputation of the client	3
		The impact raises some interest and may have some detrimental effect on the reputation of the client	1
		The impact raises no interest and would have no effect on the reputation of the client	0
		The impact raises some interest and may have some positive effect on the reputation of the client.	-1
		The impact raises global, national, and local interest or would significantly positively affect the client's reputation.	-3
C	The severity of Environmental Impact	What is the severity of environmental impacts?	Score
		The impact has a moderate detrimental effect on the environment or a scarce, non-renewable resource. Long Term/ Irreversible Impact.	3
		The impact has a moderate detrimental effect on the environment or a scarce, non-renewable resource. Impact not reversible within a year.	2
		The impact has a minor detrimental effect on the environment and on scarce, non-renewable resources.	1

		Impact reversible within a month to a year.	
		The impact has no known effect on the environment	0
		The impact has a minor positive effect on the environment and on scarce, non-renewable resources.	-1
		The impact has a moderately positive effect on the environment and on scarce, non-renewable resources.	-2
		The impact has a significant positive effect on the environment or a scarce, non-renewable resource.	-3
D	Scale of Impacts	What is the scale of the impact?	Score
		The negative impact occurs in high or large quantities	3
		The negative impact occurs in medium quantities	2
		The negative impact occurs in low or small quantities	1
		The positive impact occurs in low or small quantities.	-1
		The positive impact occurs in medium quantities.	-2
		The positive impact occurs in high or large quantities.	-3
Z	LIKELIHOOD (Frequency of occurrence)	How frequently does the impact occur?	Score
		The impact occurs daily	5
		The impact occurs weekly	4
		The impact occurs monthly	3
		The impact occurs on an annual basis	2
		The impact is unlikely to occur	1

6.21 Overall Significance Ranking

Overall Significance Ranking

The identified environmental and social impacts are evaluated, categorized and scored according to the criteria defined in Tables 6.1; 6.4. Overall consequence of the project is finally determined using the consequence equation and the criteria in table 6.6.

Project Consequence (Overall Impact Significance) = [(A+ B + C + D)] **X** Likelihood (Z) = Significance evaluation score

Table 6.6: Significance Level Categories

Impact Significance	Score
Low Negative Significance	1 – 25
Medium Negative Significance	26 – 50
High Negative Significance	> 50
Positive Significance	< -1

ISO, 1996

6.9 Approach to mitigation measures

The approach adopted this report for identifying mitigation measures and their significance are based on the following considerations:

- Environmental laws and regulations in Nigeria, with emphasis on permissible limits for waste streams (FMEnv (formerly FEPA), 1991);
- AfDB's and other relevant international requirements;
- Best available Technology for Sustainable Development;
- Feasibility of application of the proposed mitigation measures in Nigeria;
- View and concerns of stakeholders as expressed during extensive consultations carried out during the study.

The essence of developing mitigation measures is to avoid, reduce, remedy or compensate for any adverse impacts identified, and to create or enhance positive impacts including environmental and social benefits. In this regard therefore, mitigation measures are understood to include operational controls as well as management actions. These measures may include:

- changes to the design of the project during the design process (e.g. changing the development approach);
- engineering controls and other physical measures applied (e.g. substation maintenance facilities);
- Operational plans and procedures (e.g. Occupational Health Safety Plans); and the provision of like-for-like replacement, restoration or compensation.

For any impact that is major significance, a change in design, layout or concept is usually required to avoid or minimize it. Impacts evaluated as moderate in importance, specific mitigation measures such as engineering controls or other alternatives may be needed to reduce the impacts to as low as reasonably possible levels.

In this case the approach also takes into consideration the technical and financial feasibility of the mitigation measures. Impacts assessed to be of Minor significance are usually managed through best engineering and technical practices and operational procedures. While negligible impacts may require no mitigation action, nonetheless they are usually included in the project design. Mitigation measures are proposed by focusing on such measures that can prevent or minimize undesirable impacts through the design and management of the project.

6.10 Residual Impact Assessment

Impact prediction considers any mitigation, control and operational management measures that are part of the project design and project plan. A residual impact is predicted to remain once mitigation measures have been designed into the intended activity. The residual effects that may remain after applying the impact mitigation measures have also been discussed for further reduction as possible.

6.11 Potential Impacts during Initial Preconstruction Phase

6.11.1 Impacts on Air Quality

The assessment of potential impacts on air quality, sources, rating criteria and mitigation measures are presented in Table 6.7.

Table 6.7 Impacts on Ambient Air Quality During Initial Preconstruction Phase

<table>
<tr><th>Impact Statement</th><th>Sources of Impact</th><th>Mitigation Measures Integrated into Project Design</th><th colspan="2">Impact on Ambient Air Quality</th></tr>
<tr><td rowspan="8">Reduction in ambient air quality

Contribution to global warming</td><td rowspan="8">The main potential sources of emission are fugitive dust produced by the movement of soils during site clearing, grading and filling, and emission from</td><td rowspan="8">Water shall be sprinkled on roads and other conveying routes and stockpiles to suppress dust. These emissions are short-termed and localized to the immediate site area. Regular maintenance of vehicle and construction equipment (regular emission control and</td><td>Impact criteria</td><td>Rating</td></tr>
<tr><td>Legislature</td><td>3</td></tr>
<tr><td>Stakeholder concern</td><td>1</td></tr>
<tr><td>Severity</td><td>1</td></tr>
<tr><td>Scale</td><td>1</td></tr>
<tr><td>Frequency</td><td>3</td></tr>
<tr><td>Overall rating</td><td>18</td></tr>
<tr><td>Impact Significance</td><td>Minimum</td></tr>
</table>

Impact Statement	Sources of Impact	Mitigation Measures Integrated into Project Design	Impact on Ambient Air Quality	
	internal combustion engines of construction equipment.	inspection) shall be ensured to greatly reduce mission from internal combustion engines.		
Mitigation measures				
Vehicles transporting men and materials will generate PM, SO2, CO, NO2, CO2 emissions. This Activity is expected to add to baseline concentrations. This impact is rated minor, and the implementation of the mitigation measures would drastically reduce the effect to barest minimum.				
Residual Impact				
Minor (Overall Rating = 18)				

Vehicles transporting men and materials will generate PM, SO_2, CO, NO_2, CO_2 emissions. This activity is expected to add to baseline concentrations. This impact is rated minor, and the implementation of the mitigation measures in Table 6.6 will reduce the effect to a minor level.

B: Vegetal removal during site clearance may contribute to global warming as a sink for carbon sequestration will be lost. However, this activity is in the short term as there will be vegetation replacement during construction in the form of economy of trees, vertiver grass and shrubs for soil and gully banks stabilization. It is therefore expected that the environmental quality will be restored over a long term. This impact is rated **minor** and the implementation of the mitigation measures will reduce the impact to normal level.

6.11.2 Impacts on Ambient Noise Level

The assessment of the potential impact on noise, sources, rating criteria and mitigation measures are presented in Table 6.8.

Table 6.8: Assessment of Impacts and Mitigation Measures on Ambient Noise Impact During Initial Preconstruction Phase

Impact Statement	Sources of Impact	Mitigation Measures Integrated into Project Design	Impact on Noise	
Noise pollution	Nuisance (noise and vibrations) due to movement from heavy duty equipment and vehicles affecting public and wildlife.	Machinery, vehicles and instruments that emit high levels of noise should be used on a phased basis to reduce the overall impact. Workers should be supplied with ear plugs and ear muffs to reduce the risk of hearing impairment.	Impact criteria	Rating
			Legislature	3
			Stakeholder concern	1
			Severity	1
			Scale	1
			Frequency	3
			Overall rating	18
			Impact Significance	**Minor**
Mitigation measures				
Plan work activities to avoid heavy duty movement during peak hours should be encouraged. Proper consultation with host communities to plan project activities accordingly while restricting movement and work activities to day-time only.				
Residual Impact				
Minor				

The baseline noise levels were normal within the regulatory limits for schools, residential areas and faith centres; the project may however add to the baseline noise level during this phase and the impact is rated Minor. However, implementing the mitigation measures shall reduce the impact to near normal level.

6.11.3 Impacts on Soil

The summary of the potential impact on soil sources, rating criteria and mitigation measures are presented in Table 6.9.

Table 6.9: Soil and Geology Impacts during Preconstruction Phase

Impact Statement	Sources of Impact	Mitigation Measures Integrated into Project Design	Impact on Soil and geology	
Change in Soil Quality	Slight soil erosion will be triggered during construction on the banks of the rivers and planting of trees and grasses on the degraded sites.	Minimize disturbances of the soil during planting and construction by employing techniques such as drilling for planting. Plant vetiver grass on all open spaces.	Impact criteria	Rating
			Legislature	1
			Stakeholder concern	1
			Severity	1
			Scale	1
			Frequency	5
			Overall rating	20
			Impact Significance	**Minor**
Mitigation measures				
Maintain and operate all vehicles and equipment engines under manufacturers recommendations; Regular cleaning of equipment, drains and roads to avoid excessive build-up of dirt; Use covered trucks for the transportation of materials that release dust emissions; and Provide and encourage the use of PPEs. Loading, unloading and handling of dusty materials will only be carried out in designated areas. Workers would be provided with dust protection PPE..				
Residual Impact				
Minor (Averall Impact Rating = 20)				

Impact Description

Land clearing, transportation of materials to the site shall likely cause a change in the soil structure, making it more compacted. Clearing of vegetation will also expose the soil to further water erosion. This impact is rated Minor, but the mitigation measures would significantly address the problem and the impact would restore to near normal.

6.11.4 Impacts on Surface and Groundwater

The potential impact on water resources, sources, rating criteria and mitigation measures are presented in Table 6.10.

Table 6.10: Impacts on Water Resources during Preconstruction Phase

Impact Statement	**Sources of Impact**	**Mitigation Measures Integrated into Project Design**	**Impact on surface and ground water resources**	
Surface Water contamination	The handling, storage and disposal of materials and wastes during construction shall be done in an environmentally safe manner with banded wall and concrete floor.	Measures should be taken to ensure that excavated materials are stacked properly to reduce additional turbidity effect on surface runoffs and cleared materials should stack properly to reduce turbidity effect on surface runoffs.	Impact criteria	Rating
			Legislature	3
			Stakeholder concern	1
			Severity	3
			Scale	1
			Frequency	4
			Overall rating	32
			Impact Significance	**Medium**
Underground Water	Accidental spills of fuel, lubricants and other agro-chemicals may affect ground water quality.			
Mitigation measures				
Measures should be taken to ensure that excavated materials are stacked properly to reduce additional turbidity effect on surface runoffs and cleared materials should stack properly to reduce turbidity effect on surface runoffs.				
Residual Impact				
Minor (Overall Impact Rating = 32)				

Impact Description

Baseline surface water and turbidity levels were within regulatory limits. The project activities will produce overburden which may be washed down by rain into nearby water bodies. This shall add to the baseline turbidity level, which is currently within WHO regulatory limits.

Depending on the spill's magnitude, a vast accidental spill may seep into the ground water and contaminate the water source. This shall lead to groundwater pollution; thus, rendering these waters unsafe for drinking. Vegetation clearing will increase the runoff rate into the river, adding to the present turbidity levels. Also, runoff may accidentally deposit spilt oil during machine/equipment repair and maintenance into the natural watercourses. This shall further influence the baseline surface water DO levels below the regulatory limits at project foot-prints, although the scale may be very low. The overall impact significance is Minor.

6.11.5 Impact on Vegetation

The potential impact on vegetation sources, rating criteria and mitigation measures are presented in Table 6.11.

Table 6.11: Impacts on Water Resources during Preconstruction Phase

<table>
<tr><th>Impact Statement</th><th>Sources of Impact</th><th>Mitigation Measures Integrated into Project Design</th><th colspan="2">Impact on vegetation resources</th></tr>
<tr><td rowspan="8">Destruction of Vegetation Resources</td><td rowspan="8">Vegetation clearing and loss of animal habitat due to initial removal of vegetation and playing new species.</td><td rowspan="8">Adequate measures should be taken to ensure minimal vegetation losses and re-planting of both exotic and economic vegetation species around the site Land clearing and site grading should be well planned to avoid excessive vegetation loss.</td><td></td><td></td></tr>
<tr><td>Legislature</td><td>3</td></tr>
<tr><td>Stakeholder concern</td><td>1</td></tr>
<tr><td>Severity</td><td>2</td></tr>
<tr><td>Scale</td><td>1</td></tr>
<tr><td>Frequency</td><td>4</td></tr>
<tr><td>Overall rating</td><td>28</td></tr>
<tr><td>Impact Significance</td><td>Medium</td></tr>
<tr><td colspan="5">Mitigation measures</td></tr>
<tr><td colspan="5">Adequate measures should be taken to ensure minimal vegetation losses and re-planting of both exotic and economic vegetation species around the site Land clearing and site grading should be well planned to avoid excessive vegetation loss.</td></tr>
<tr><td colspan="5">Residual Impact</td></tr>
<tr><td colspan="5">Minor)Overall Impact Rating = 28)</td></tr>
</table>

Almost all the vegetal resources in the study area were reviewed to offer Provisioning Services. However, considering the relative amount of vegetal quantity that would be cleared and the sensitivity of the habitats and the threatened plant species, implementing the mitigation measures listed shall reduce these impacts to a negligible significance

6.11.6 Impacts on Wildlife

The potential impact on wildlife sources, rating criteria and mitigation measures are presented in Table 6.12.

Table 6.12: Impacts on Wildlife during Preconstruction Phase

Impact Statement	Sources of Impact	Mitigation Measures Integrated into Project Design	Impact on wildlife	
Destruction/disturbance of Wildlife habitat.	The clearance of paths to assemble construction material, movement of construction materials to site, and increased noise level from these preconstruction activities would affect wildlife habitat.	Noise levels shall be minimized by restricting movement of materials and related preconstruction activities to daytime hours and the use of low-noise generating equipment/materials.	Impact criteria	Rating
			Legislature	2
			Stakeholder concern	1
			Severity	1
			Scale	1
			frequency	5
			Overall rating	25
			Impact Significance	**Minor**
Mitigation measures				
Noise levels shall be minimized by restricting pre-construction site activities to daytime hours and the use of low-noise generating equipment/materials. Project should also discourage or prohibit wildlife hunting.				
Residual Impact				
Minor (Overall Impact Rating = 25)				

Impact description

Vegetation shall be cleared during this project. This will lead to species migration, loss of habitat and loss of threatened flora species in the area. The mitigation measures proffered would reduce the impact to minor level.

6.11.7 **Impact on Fisheries and Aquatic Resources**

The potential impact on fish and other aquatic resources, rating criteria and mitigation measures are presented in Table 6.13.

Table: 6.13 Impacts on Fisheries and Aquatic Resources.

Impact Statement	Sources of Impact	Mitigation Measures Integrated into Project Design	Impact on fisheries and aquatic resources	
Poisoning of Fisheries and Aquatic Resources	Excessive application of agro-chemicals and fertilizer in plant nurseries around the dam can affect fish production.	Establishment of plants nursery for bio-remediation and buffer strip should be establish some distance away from the river systems. Proper application of required fertilizer to seedlings.	Impact criteria	Rating
			Legislature	2
			Stakeholder concern	1
			Severity	1
			Scale	2
			frequency	5
			Overall rating	25
			Impact Significance	**Moderate**
Mitigation measures				
Establishment of vertiver grass and other tree seedlings nursery for bio-remediation and buffer stripping should be located some distance away from the river banks and main and finger gully banks. Proper application of required fertilizer and other agrochemical on for raising grasses, shrubs and trees seedlings should be done in accordance with scientifically acceptable practices to minimize likelihood of surface runoff transporting unwanted chemical residues in to water bodies and contaminate the water.				
Residual Impact				
Minor (overall Impact Rating = 25)				

Impact Description

Excessive application of agro-chemicals and fertilizers on plant nurseries and subsequently on project footprints may lead to chemical pollution of both surface and ground water through run-off and seepage especially around the Dam. This has the potential to affect fish resource over time as quantity of chemicals in the water grows.

6.11.8 Impacts on Socio-cultural resources

The potential impact on socio-cultural resources, sources, rating criteria are presented in Table 6.14.

Table 6.14: Impacts on socio-cultural resources

<table>
<tr><th>Impact Statement</th><th>Sources of Impact</th><th>Mitigation Measures Integrated into Project Design</th><th colspan="2">Impact on Community Socio-cultural resources</th></tr>
<tr><td rowspan="7">Cultural Resources
A. Trespassing on Cultural sites like grave yards, prayer grounds etc.

B. Application of Agricultural measures to erosion control on disputed farm lands may heighten disputes and conflicts.</td><td rowspan="7">Although there are no known historical, cultural or archaeological sites within the project site, may infringe on lands in dispute of ownership and inheritance.

B. Implementation of on-farm agricultural techniques for erosion control may infringe on fields/farms that liable to inherence conflict among farm owners. Where this happens, it may have the potential to heightening tension and conflict among disputing family members on the use of the land.</td><td rowspan="7">A. If archaeological resources are found during construction, a qualified archaeologist shall be retained to evaluate the fund materials on site.

B. Proper consultations with PAPs and community heads should be maintained at all times to avoid any conflicts arising from land acquisition for project construction.</td><td>Impact criteria</td><td>Rating</td></tr>
<tr><td>Legislature</td><td>3</td></tr>
<tr><td>Stakeholder concern</td><td>1</td></tr>
<tr><td>Severity</td><td>1</td></tr>
<tr><td>Scale</td><td>1</td></tr>
<tr><td>frequency</td><td>4</td></tr>
<tr><td>Overall rating</td><td>24</td></tr>
<tr><td></td><td></td><td></td><td>Impact Significance</td><td>Minor</td></tr>
<tr><td colspan="5">Mitigation measures</td></tr>
<tr><td colspan="5">If archaeological resources are found during construction, a qualified archaeologist shall be retained to evaluate the fund materials on site.</td></tr>
<tr><td colspan="5">Residual Impact</td></tr>
<tr><td colspan="5">Minor (overall impact = 24)</td></tr>
</table>

Impact Description

Although there are no known historical, cultural or archaeological sites within the project site, land acquisition may infringe on lands in dispute of ownership and inheritance. Implementation of on-farm agricultural techniques for erosion control and acquisition of lands for other project activities may, if care is not taken, infringe on fields/farms that are liable to inherence disputes among families. Where this happens, it may have the potential to heightening tension and conflict among disputing family members on the use of the land.

6.12 ***Socio-economic Mitigation Measures***

6.12.1 ***Impacts on Demography/Population***

The potential impact of the project on population, demographic characteristics of the project area and the possible mitigation measure are presented in table 6.15.

Table: 6.15 Impacts on Demography/Population.

Impact Statement	Sources of Impact	Mitigation Measures Integrated into Project Design	Impact on Demography and Population	
Demography/Population	Identifiable negative impacts relate to increase in population of non-residents in the event that youths and local people are not recruited into the labour force during construction. There is also the likelihood of gender imbalance.	The contractor will mitigate this impact by localizing employment opportunities as much as possible. Contractor shall propose to provide employment to locals at all phases of development of the project and throughout its lifetime. Additionally, certain jobs will be subcontracted out to local businesses.	Impact criteria	Rating
			Legislature	3
			Stakeholder concern	2
			Severity	2
			Scale	2
			frequency	5
			Overall rating	45
			Impact Significance	**Medium**
Mitigation measures				

The contractor will however, mitigate this impact by localizing employment opportunities as much as possible and in consultation with community heads. Contractor shall propose to provide employment to locals at all phases of development of the project and throughout its lifetime. Additionally, certain jobs will be subcontracted out to local businesses.
Residual Impact
Minor (Overall rating = 45)

Description of the Project Impact

Identifiable negative impacts relate to increase in population of non-residents in the event that youths and local people are not recruited into the labour force during construction. There is also the likelihood of gender imbalance. It is expected that the proposed mitigation measures will ensure minimal impact and enhance the positive effects of the project.

6.12.2 Impacts on Income/Livelihood

The potential impact on income and livelihood sources, rating criteria and mitigation measures are presented in Tables 6.16.

Table: 6.16 Income/Livelihood

Impact Statement	Sources of Impact	Enhancement Measures Integrated into Project Design	Impacts on Income/Livelihood	
Income/Livelihood	Loss of farmlands and other livelihood structure	The potential impact on the incomes and livelihoods of potentially affected persons through loss of farmlands and loss of structures will be adequately mitigated with appropriate compensation plan and adjustment measures for affected persons.	Impact criteria	Rating
			Legislature	3
			Stakeholder concern	3
			Severity	3
			Scale	2
			Frequency	5
			Overall rating	55
			Impact Significance	**High negative**

Enhancement measures
The potential impact on the incomes and livelihoods of potentially affected persons (PAPs) through loss of farmlands and loss of structures will be adequately mitigated with appropriate compensation plan and adjustment measures for affected persons.
Residual Impact
High Negative (overall impact rating = 55)

Description of Impact

Loss of farmlands and other livelihood structures may ensure arising from land acquisition for Bio-remediation and related project activities. Although no direct residential area relocation is anticipated from the project, it is highly possible that farmlands will be affected especially near the footprints of the project i.e. around the reservoir, and around main and finger gullies. Measure recommended will therefore minimize to the minimum the undesirable effects of the project that may affect PAPs.

6.12.3 Impacts on Employment and Opportunities

The potential impact on livelihood activities, sources, rating criteria and mitigation measures are presented in Tables 6.17.

Table 6.17: Impacts on Employment and Opportunities

Impact Statement	Sources of Impact	Enhancement Measures Integrated into Project Design	Impact on the impact on employment and opportunities	
A. Employment opportunities	Material requirement and sales, Vegetal clearance, Transport of construction materials including seedlings, agro-	Prepare a local content plan to identify and select qualified local sources of machinery, stone boulders for gabions, gabion chains, improved tree and grass seedlings, such as vertiver grass etc. for the construction works from local and Nigerian sources. Make arrangement for advanced	Impact criteria	Rating
			Legislature	
			Stakeholder concern	
			Severity	
			Scale	
			Frequency	
			Overall rating	

	chemicals will result in Employment of workers	notice to local content providers, along with selection criteria including health and safety, to allow them to prepare for upcoming opportunities. Engage locals in contract farming to provide improved tree and grass seedlings locally and sale to the contractor.	Impact Significance	**Positive**
Enhancement measures				
Prepare a local content plan to identify and select qualified local sources of machinery, stone boulders for gabions, gabion chains, improved tree and grass seedlings, such as vertiver grass etc. for the construction works from local and Nigerian sources. Make arrangement for advanced notice to local content providers, along with selection criteria including health and safety, to allow them to prepare for upcoming opportunities. Engage locals in contract farming to provide improved tree and grass seedlings locally and sale to the contractor.				
Residual Impact (Positive Impact)				
Beneficial Positive				

Description of Impact

It is expected that casual un-skilled labour would be engaged on short-term occur for or throughout the preconstruction phase. The main jobs that will be available are the vegetal clearance, sales and requirement of materials. Supplies will include raw materials that meet standards as required for the construction of the facilities. This is a positive impact and, as such, does not require mitigation. The enhancement measures are stipulated in Table 6.18.

6.12.4 **Impact of Community Infrastructure**

The potential impact on community Infrastructure, sources, rating criteria and mitigation measures are presented in Tables 6.18.

Table: 6.18 Community Infrastructure

Impact Statement	Sources of Impact	Enhancement Measures Integrated into Project Design	Impact on Community Infrastructure	
community infrastructure	Interference with community infrastructure during construction activities including for example health infrastructure, water supply infrastructure, transport infrastructure etc.	Construction activities interference with community infrastructure will be minimized through proper planning. As part of corporate social responsibility, the contractor/company shall restore damaged infrastructure and provide additional amenities to support the communities.	Impact criteria	Rating
			Legislature	2
			Stakeholder concern	1
			Severity	1
			Scale	1
			Frequency	4
			Overall rating	20
			Impact Significance	**Minor**
Enhancement measures				
Construction activities interference with community infrastructure will be minimized through proper planning. As part of corporate social responsibility, the contractor/company shall restore damaged infrastructure and provide additional amenities to support the communities where necessary.				
Residual Impact				
Minor (overall impact rating = 20)				

Description of Impact

Interference with community infrastructure during construction activities are likely to happen. This will include interference with health infrastructure, water supply infrastructure, transport infrastructure etc. The mitigation measures suggested in Table 6.19 will minimize the impact which in any way is minor.

6.13 Impact and Mitigation Measures During Construction Phase

6.13.1 Impacts on Ambient Air Quality

The potential impact on Ambient Air Quality, sources, rating criteria and mitigation measures are presented in Table 6.20.

Table 6.19: Impacts on Ambient Air Quality

Impact Statement	Sources of Impact	Mitigation Measures Integrated into Project Design	Impact on Ambient air quality	
Air Quality	The main potential sources of emission are fugitive dust produced by the movement of soils during site clearing, grading and filling, and emission from internal combustion engines of construction equipment.	Water shall be sprinkled on roads and other conveying routes and stockpiles to suppress dust. These emissions are short-termed and localized to the immediate site area. Regular maintenance of vehicles and construction equipment (regular emission control and inspection) shall be ensured to greatly reduce mission from internal combustion engines.	Impact criteria	Rating
			Legislature	3
			Stakeholder concern	2
			Severity	2
			Scale	2
			Frequency	5
			Overall rating	45
			Impact Significance	**Medium**
Mitigation measures				
Water shall be sprinkled on roads and other conveying routes and stockpiles to suppress dust. These emissions are short-termed and localized to the immediate site area. Regular maintenance of vehicle and construction equipment (regular emission control and inspection) shall be ensured to greatly reduce mission from internal combustion engines.				
Residual Impact				

Impact Statement	Sources of Impact	Mitigation Measures Integrated into Project Design	Impact on Ambient air quality
Moderate (Impact Rating = 45)			

Impact Description

The main potential sources of emission are fugitive dust produced by the movement of soils during site clearing, grading and filling, and emission from internal combustion engines of construction equipment. The vehicle movement for the construction will result in PM, SO_2, CO, NOx_2CO_2 emissions. However, this may be minimal in view the fact that few vehicles are expected to be deployed at any time.

6.13.2 Impacts on Ambient Noise Level

The potential impact on Ambient Noise Level, sources, rating criteria and mitigation measures are presented in Table 6.20.

Table 6.20: Impacts on Ambient Noise Level

Impact Statement	Sources of Impact	Mitigation Measures Integrated into Project Design	Impact on Ambient noise level	
Noise pollution	Construction shall be restricted to daytime so as to avoid disturbance to nearby communities during night hour rest	All noise generating equipment shall be fitted with noise control as well as vibration devices, and properly maintained.	Impact criteria	Rating
			Legislature	3
			Stakeholder concern	2
			Severity	2
			Scale	2
			Frequency	5
			Overall rating	45
			Impact Significance	**Medium**
Mitigation measures				
All noise generating equipment shall be fitted with noise control as well as vibration devices, and properly maintained. Noise level shall be regularly monitored and accordingly adjusted. Construction activities shall take place in the day time.				
Residual Impact				
Moderate (Overall rating = 45)				

Description of Impact

During the construction phase, construction activities, traffic, and the use of construction equipment and machinery are likely to lead to a temporary increase in noise levels that may disturb adjoining areas and local fauna. Construction activities will be concentrated and done sequentially so that no area is prone to the long duration of noise impacts. There will be some noise generated from tractors and trucks transporting the materials and equipment, but traffic volumes are occasionally expected. Recommended mitigation measures shall lead to minimal noise pollution to an unnoticeable level.

6.13.3 Impacts on Soil

The potential impact on Soil, sources, rating criteria and mitigation measures are presented in Table 6.21

Table 6.21: Impacts on Soil

<table>
<tr><th>Impact Statement</th><th>Sources of Impact</th><th>Mitigation Measures Integrated into Project Design</th><th colspan="2">Impact on Soil</th></tr>
<tr><td rowspan="8">Soil degradation</td><td rowspan="8">To minimize soil erosion and soil quality degradation, construction personnel shall adhere to the recommended erosion and sedimentation control practices.</td><td rowspan="8">Using local species, a buffer zone shall be planted post-construction, around the Challawa Gorge Dam site and upstream of the dam as well to minimize erosion.</td><td>Impact criteria</td><td>Rating</td></tr>
<tr><td>Legislature</td><td>3</td></tr>
<tr><td>Stakeholder concern</td><td>3</td></tr>
<tr><td>Severity</td><td>1</td></tr>
<tr><td>Scale</td><td>1</td></tr>
<tr><td>Frequency</td><td>5</td></tr>
<tr><td>Overall rating</td><td>40</td></tr>
<tr><td>Impact Significance</td><td>Medium</td></tr>
<tr><td colspan="5">Mitigation measures</td></tr>
<tr><td colspan="5">Using local species, a buffer zone shall be planted post-construction, around the Challawa Gorge Dam site and upstream of the dam as well to minimize erosion.</td></tr>
<tr><td colspan="5">Residual Impact</td></tr>
<tr><td colspan="5">Moderate (overall rating = 40)</td></tr>
</table>

Impact Description

Soil can be contaminated during the construction phase by accidental oil/fuel spills from heavy machinery either at storage yards or work sites. In the event of an accidental spill, the proportion of soil contamination will depend on the magnitude of these unintentional events.

6.13.4 Impacts on Water Resources

The potential impact on Water Resources, sources, rating criteria and mitigation measures are presented in Table 6.22.

Table 6.22: Impacts on Water Resources at Construction Phase

Impact Statement	Sources of Impact	Mitigation Measures Integrated into Project Design	Impact on Water Resources during Construction	
A. Surface Water contamination; B. Ground Water	Surface water may get contaminated due to dust and other similar pollutants from bush clearing, preparation of vegetation nursery bed, excavation for planting, excavation for construction gabions and sediment traps along gully floors and gully banks during construction	Adequate environmental cleaning, coupled with good construction practices and site management shall be ensured. Contractor shall ensure that litters, fuels and solvents do not enter nearby streams and storm water drains. Gully floors and gully banks disturbance shall take place in the dry season to minimize sediment influx and to allow time for disturbed gully floors banks to settle adequately before the resumption of rains.	Impact criteria	Rating
			Legislature	3
			Stakeholder concern	1
			Severity	3
			Scale	2
			Frequency	5
			Overall rating	45
			Impact Significance	**Moderate**
Mitigation measures				

Impact Statement	Sources of Impact	Mitigation Measures Integrated into Project Design	Impact on Water Resources during Construction
Adequate environmental cleaning, coupled with good construction practices and site management shall be ensured. Contractor should ensure that litters, fuels and solvents do not enter nearby streams and storm water drains. Adequate environmental cleaning, coupled with good construction practices and site management shall be ensured. Contractor shall ensure that litters, fuels and solvents do not enter nearby streams and storm water drains. Gully floors and gully banks disturbance shall take place in the dry season to minimize sediment influx and to allow time for disturbed gully floors banks to settle adequately before the resumption of rains.			
Residual Impact			
Moderate (Overall rating = 45)			

Sources of impact on water resources include removing vegetation, vehicle movement, and contamination from potential spills. Vegetal clearance can increase soil erosion, causing sediment influx into water bodies, especially during rain events. This shall likely add to the baseline surface water with turbidity levels already above threshold limits. Poor waste management practices are likely to affect water quality (e.g. improper waste disposal in the stream). The risk of accidental oil spills from heavy machinery during the construction phase could result in water contamination.

6.13.5 Impacts on Vegetation

The potential impact on vegetation, sources, rating criteria and mitigation measures are presented in Table 6.23.

Table 6.23: Impacts on Vegetation

Impact Statement	**Sources of Impact**	**Recommendation Measures Integrated into Project Design**	**Impact on Vegetation during construction Phase**	
Degradation of Vegetation Resources	Movement of construction equipment and workers shall be restricted to the construction site.	During construction, a buffer of natural vegetation at the site boundary shall be maintained to serve as shelter belt and or wind break and further provide a milder microenvironment for	Impact criteria	Rating
			Legislature	3
			Stakeholder concern	2
			Severity	2
			Scale	2

		the project site. Strict control on site clearing activities shall be implemented to minimize loss of vegetation and clearance shall be strictly limited to target vegetation	Frequency	5
			Overall rating	45
			Impact Significance	**Moderate**
Mitigation measures				
During construction, a buffer of natural vegetation at the site boundary shall be maintained to serve as shelter belt and or wind break and further provide a milder microenvironment for the project site. Strict control on site clearing activities shall be implemented to minimize loss of vegetation and clearance shall be strictly limited to target vegetation.				
Residual Impact				
Moderate (Impact Rating = 45)				

Movement of construction equipment and workers shall be restricted to the construction site. During construction, a buffer of natural vegetation at the site boundary shall be maintained to serve as shelter belt and or wind break and further provide a milder microenvironment for the project site. Strict control on site clearing activities shall be implemented to minimize loss of vegetation and clearance shall be strictly limited to target vegetation. This impact is rated **moderate**. The application of Mitigation Measures will reduce the effects to a **minor** level.

6.13.6 Impact on Wildlife during Construction Phase

The potential impact on wildlife sources, rating criteria and mitigation measures are presented in Table 6.24.

Table 6.24: Impacts on Wildlife Resources during Construction Phase

Impact Statement	Sources of Impact	Mitigation Measures Integrated into Project Design	Impact on Wildlife during Construction Phase	
Destruction/Disturbance of Wildlife habitat and Resources.	Destruction of wild plants and animals during construction due noise, vegetation removals, movement of people and vehicles	During construction, workers shall be prohibited from hunting, killing, or collection of animals from the project area.		
			Legislature	3
			Stakeholder concern	1
			Severity	2
			Scale	1

	during construction buffers, gabions and sediment traps.		Frequency	4
			Overall rating	28
			Impact Significance	**Medium**
Mitigation measures				
Adequate measures should be taken to ensure minimal vegetation losses and re-planting of both exotic and economic vegetation species around the site Land clearing and site grading should be well planned to avoid excessive vegetation loss.				
Residual Impact				
Minor (Impact Rating = 28)				

Description of Impact

Almost all the vegetal resources in the study area were reviewed to offer Provisioning Services. However, considering the relative amount of vegetal quantity that would be cleared and the sensitivity of the habitats and the threatened plant species, implementing the mitigation measures listed shall reduce these impacts to a negligible significance

6.13.7 Impact on Fisheries and Aquatic Resources

The potential impact on Fisheries and Aquatic Resources sources, rating criteria and mitigation measures are presented in Table 6.25.

Table 6.25 Impact on Fisheries and Aquatic Resources

Impact Statement	**Sources of Impact**	**Mitigation Measures Integrated into Project Design**	**Impact on Fisheries Resources during Construction Phase**	
Fisheries and Aquatic Resources	High mortality of fish and other aquatic resources due to water contamination from increased turbidity, chemicals influx into surface water and likely migration of aquatic life to other locations that may endanger their lifes.	Situating plants nursery for seedlings development and subsequent propagation for bio-remediation and buffer stripping at some distance away from surface water, and away from the main and finger gullies. Proper application of		
			Legislature	3
			Stakeholder concern	1
			Severity	1
			Scale	1
			Frequency	5
			Overall rating	30
			Impact Significance	**Medium**

		required fertilizer to growing trees, grasses and shrubs to be in line with best agricultural practices and raising local stream bank buffers during construction until the planted trees and grasses reach maturity.		
Mitigation measures				
Situating plants nursery for seedlings development and subsequent propagation for bio-remediation and buffer stripping at some distance away from surface water, and away from the main and finger gullies. Also to ensure proper application of required fertilizers and other agricultural chemicals for the growing trees, grasses and shrubs in line with best agricultural practices and raising local stream bank buffers during construction until the planted trees, grasses and shrubs reach maturity stage.				
Residual Impact				
Moderate (Overall rating = 30)				

Impact Description

There is likelihood for high mortality of fish and other aquatic resources, due to water contamination and increased turbidity during construction. However, the measures recommended shall reduce the impact to a minimum level over short and long term.

6.13.8 Impacts on Community Health and Safety during Construction Phase

The potential impact on Community Health and Safety, sources, rating criteria and mitigation measures are presented in Tables 6.26.

Table 6.26: Impacts on Community Health and Safety

Impact Statement	Sources of Impact	Mitigation Measures Integrated into Project Design	Impact on Community Health and Safety

<table>
<tr><th>Impact Statement</th><th>Sources of Impact</th><th>Mitigation Measures Integrated into Project Design</th><th colspan="2">Impact on Community Health and Safety</th></tr>
<tr><td rowspan="8">Risking tensions between outsiders (especially non indigenes) workers on site;
Violation of community norm and cultural values by outsiders, workers food vendors etc.
Introduction of alien communicable & non-communicable diseases such as HIV/AIDS, Sexually Transmitted Diseases (STDs), Threat of spread of the dreaded Corona virus, etc. among workers and locals etc.</td><td rowspan="8">Employment of construction workers
The temporary influx of persons to the communities.
Community members providing goods (food vendors usually girls and adolescent females).</td><td rowspan="8">Develop a code of behavior for workers
Enhance ongoing consultations with community with good representation intelligently to create continuous dialogue, trust, and harmony and community involvement for confidence building and conflict resolution and management.
Contractor and PIU to sustain consultations with local community and their leaders, and critical Stakeholder Engagement, prepare and implement Stakeholder Engagement Plan.</td><td>Impact criteria</td><td>Rating</td></tr>
<tr><td>Legislature</td><td>3</td></tr>
<tr><td>Stakeholder concern</td><td>1</td></tr>
<tr><td>Severity</td><td>2</td></tr>
<tr><td>Scale</td><td>1</td></tr>
<tr><td>Frequency</td><td>5</td></tr>
<tr><td>Overall rating</td><td>35</td></tr>
<tr><td>Impact Significance</td><td>Moderate</td></tr>
<tr><td colspan="5">Mitigation measures</td></tr>
<tr><td colspan="5">
Develop a code of ethics for workers.
All workers to receive training on community relations and code of conduct.
Employ workers majorly from the host communities to do the unskilled jobs and where available
Engage skilled labour from the local communities.
Implement management practices aimed at eliminating disease vector breeding sites.
Conduct safety and health advocacy on communicable diseases.
Coordinate Stakeholder Engagement and implement Stakeholder Engagement Plan.
Develop a health plan to address potential health issues;
Initiate /enforce corporate health awareness programs for malaria, AIDS, etc.);
Provide site medical personnel to attend to emergencies;
</td></tr>
</table>

Impact Statement	Sources of Impact	Mitigation Measures Integrated into Project Design	Impact on Community Health and Safety
• Engage the services of retainer clinics to manage health issues; • Educate workforce on the prevention of malaria as well as encourage the use of mosquito nets Ensure personnel use appropriate PPE; • Prepare and implement an emergency response plan; • Ensure availability of first aid facilities onsite; • Provide information, education and communication about safe uses of water and occupational hygiene and safety; • Ensure Environmental Management for vector control and avoidance via settlement location and; • Develop and implement safe food storage and handling practices			
Residual Impact			
Moderate (Overall Impact Rating = 35)			

There are potential impacts envisaged to arise from difference in social and cultural norms and values between the construction workforce and locals due to differences in belief systems. This may also lead to the violation of the existing traditional norms in the project area. These impacts are rated medium as the application of the mitigation measures shall reduce the impact to a **minor** level.

New diseases may be generated from project activities or heighten the existing vectors such as mosquitos, typhoid fever, influx of workers with no or partial immunity to malaria parasite, contraction of HIV/AIDS due unregulated sex behaviour of workers, contraction of Corona viral disease due to unprotected contacts between workers from different environments (especially Kano State is among States with high to moderate incidences Corona Virus infection, etc. The influx of workers into the project area also increases the risks of Sexually Transmitted Diseases (STDs) and could adversely impact the spread of HIV/AIDS. If left unmanaged, this impact may result in long-term health issues that may eventually lead to fatality. The impact arising from this is ranked as a medium. Application of the recommended mitigation measures can potentially reduce the impact to a **Minor level.**

6.13.9 **Impacts on Social Infrastructure**

Table 6.27 is an assessment of Socio-economic impacts on the existing social infrastructure of the project that is expected to occur during the construction phase.

Table 6.27: Impacts on Socio-infrastructure

Impact Statement	Sources of Impact	Mitigation Measures Integrated into Project Design	Impact on Socio-infrastructure	
Exertion of pressure on existing social infrastructure.	An influx of workers, and demand for health care services in particular.	Provision of ad-hoc medical facilities for project workers and supporting community health facilities with free drugs and other heath equipment as part of cooperate social responsibility by the contractor.	Impact criteria	Rating
			Legislature	2
			Stakeholder concern	2
			Severity	1
			Scale	2
			frequency	5
			Overall rating	35
			Impact Significance	**Medium**
Mitigation measures				
The provision of ad-hoc health service facility including particularly first aid facilities for the workforce, e.g. medical services, firefighting equipment etc. Supporting local community health services to compensate for impacts as part of corporate social responsibility..				
Residual Impact				
Moderate (Overall Impact Rating = 35)				

Description Impact

The recruitment and subsequent influx of labour force in the project environment, and demand for health care services in particular is expected. This is likely to exert pressure on the already limited social and particularly health services facilities in the area.

6.13.10 Project Impact on Security

Table 6.28 is an assessment of project impacts on security of persons and material.

Table 6.28 Impacts on security of men and materials

Impact Statement	Sources of Impact	Mitigation Measures Integrated into Project Design	Impact on accidents, kidnappings banditry and traffic congestion	
Security/safety challenges for men and materials during construction such theft of project equipment and materials, and fear of Kidnapping of non-indigene staff.	Improper Storage of project equipment and material, exposer of staff to frequent high way travels etc.	Establish secured store for project implements, materials and equipment and recruit well-trained security men from within the local community and/or engage the services of uniformed security guards to oversee security of stores. Proper enlightenment of staff especially non-indigenes on security tips, travel time especially on high ways, vigilance around the project environment. Ensure all workers have official identification tags of cards and routinely check infiltration of unauthorized persons in to project site.	Impact criteria	Rating
			Legislature	3
			Stakeholder concern	3
			Severity	3
			Scale	3
			Frequency	5
			Overall rating	60
			Impact Significance	**High Negative impact**
Mitigation measures				
Establish secured store for project implements, materials and equipment and recruit well-trained security men from within the local community and/or engage the services of uniformed security guards to oversee security of stores. Proper enlightenment of staff especially non-indigenes on security tips, travel time especially on high ways, vigilance around the project environment. Ensure all workers have official identification tags of cards and routinely check infiltration of unauthorized persons in to project site.				
Residual Impact				
High Negative Impact (Overall Impact Rating = 60)				

Security/safety challenges for men and materials during construction such theft of project equipment and materials, and fear of Kidnapping of non-indigene staff. Improper Storage of project equipment and material, exposer of staff to frequent high way travels etc. This impact is rated **High Negative**, and implementing the mitigation measures listed shall reduce the potential impact to **minor** level.

6.13.11 Impacts on Employment and Opportunities

The potential on the impact on employment and opportunities, sources, rating criteria and mitigation measures are presented in Tables 6.29.

Table 6.29: Impacts on Employment and Opportunities

Impact Statement	**Sources of Impact**	**Enhancement Measures Integrated into Project Design**	**Impact on the impact on employment and opportunities**	
Creating market avenues for local sellers of Gabion Chains, Stone crashing machines, horticulturists, local sources agro-chemicals etc. to market their product and therefore boasting the economic value chain. Creating Opportunities for locals to get short term employment as workers especially the unskilled component; Creating opportunity	Material requirement, direct and indirect employment of workers	Prepare a local content plan to identify Nigerian suppliers of the needed materials and services.	Impact criteria	Rating
			Legislature	
			Stakeholder concern	
			Severity	
			Scale	
			Frequency	
			Overall rating	
			Impact Significance	**Positive**

for locals to engage in horticultural business of raising seedlings of fruits bearing trees, and to be engaged in contract farming of vertiver grass etc. for the project work and for the local communities; Creating opportunities for local food vendors to gain market opportunity for their local processed food.				
Enhancement measures				
Prepare a local content plan to identify Nigerian suppliers of the needed materials and services.				
Residual Impact				
Highly Beneficial Needs no scoring				

Based on the results of the socio-economic assessment, the unemployment rate in the area is high. The locals are, however, optimistic about the possibility of job availability with the project. Any available jobs opportunity will positively impact the employment and income situation at the study area. The effect is beneficial. Employment of casual un-skilled labour would occur for short-term contracts or the entire construction phase. This could result in a positive spin off during the construction phase as any level of employment in this region of moderate unemployment, and low wage levels will have a beneficial social spinoff. The impact is beneficial. During the construction phase, there will be provision for sub-contracting to local supplies. Supplies will include raw materials that meet standards as required for the construction of the facilities. Equal opportunities will be given to sub-contractors from the host communities. This is a positive impact and, as such, does not require mitigation.

6.13.12 Visual Impacts

The potential on Visual Impacts, sources, rating criteria and mitigation measures are presented in Table 6.30.

Table 6.30: Assessment of Visual Impacts

<table>
<tr><th>Impact Statement</th><th>Sources of Impact</th><th>Mitigation Measures Integrated into Project Design</th><th colspan="2">Impact on Visual Impacts</th></tr>
<tr><td rowspan="8">Visual impact</td><td rowspan="8">The presence of an active construction site</td><td rowspan="8">Maintain orderliness in the work area
Proper handling (treatment and disposal) of generated waste</td><td>Impact criteria</td><td>Rating</td></tr>
<tr><td>Legislature</td><td>2</td></tr>
<tr><td>Stakeholder concern</td><td>1</td></tr>
<tr><td>Severity</td><td>1</td></tr>
<tr><td>Scale</td><td>3</td></tr>
<tr><td>Frequency</td><td>5</td></tr>
<tr><td>Overall rating</td><td>35</td></tr>
<tr><td>Impact Significance</td><td>Medium</td></tr>
<tr><td colspan="5">Mitigation measures</td></tr>
<tr><td colspan="5">Restore temporal work zones after construction
Maintain orderliness in the work area
Proper handling (treatment and disposal) of generated waste</td></tr>
<tr><td colspan="5">Residual Impact</td></tr>
<tr><td colspan="5">Minor</td></tr>
</table>

Aesthetic impacts during the construction phase will be limited to work zones. The area already has many existing facilities; the changes in the landscape are not likely to produce significant impacts in most areas. These areas are not known to have unique landscape values. Setting up of these facilities may create visual intrusion by altering the typical landform pattern. Domestic waste might be disposed to the construction area, creating a visual nuisance. Construction waste will be disposed of at sites approved by relevant waste management. The duration of the construction activity is short term in nature, and the area's sensitivity is also medium. Thus the impact is rated **medium**.

6.13.13 Impact on Workplace Health Hazards and Safety

The summary of the potential impacts on workplace hazards and Safety, sources, rating criteria and mitigation measures are presented in Table 6.31.

Table 6.31: Assessment of Impacts on Workplace Health Hazards and Safety

<table>
<tr><th>Nature Impact</th><th>Sources of Impact</th><th>Mitigation Measures Integrated into Project Design</th><th colspan="2">Impact on Workplace Health Hazards and Safety</th></tr>
<tr><td rowspan="8">Hazards associated with the construction environment.</td><td rowspan="8">Workers stand the risks of work place hazards during construction due construction work, careless handling of construction machines and equipment, natural hazards from such as snake bit and other biologically induced work place hazards.</td><td rowspan="8">Develop project-specific health and safety procedures based on acceptable health and safety procedures, including provisions for training of all categories of workers.

Provide Personal Protective Devices (PPD) such as Rubber protective devices such as rubber-boot foot wares to all category of staff, head wares (helmets), nose and mouth pads. The contractor will be required to submit an OHS management plan to the PIU.
Workers will be provided with all the required PPE.
Toolbox talks shall be carried out daily on safe work practices and other OHS issues.</td><td>Impact criteria</td><td>Rating</td></tr>
<tr><td>Legislature</td><td>3</td></tr>
<tr><td>Stakeholder concern</td><td>3</td></tr>
<tr><td>Severity</td><td>3</td></tr>
<tr><td>Scale</td><td>3</td></tr>
<tr><td>Frequency</td><td>5</td></tr>
<tr><td>Overall rating</td><td>60</td></tr>
<tr><td>Impact Significance</td><td>High Negative</td></tr>
<tr><td colspan="5">Mitigation measures</td></tr>
<tr><td colspan="5">Develop project-specific health and safety procedures based international best engineering and safety practices including provisions for training to all categories of staff. Ensure periodic training of staff on workplace health and safety tips.
Provide and enforce the use of appropriate personal protective equipment (PPD), e.g. rubber hand gloves, hard hats, safety boots, etc. by all personnel at the project site</td></tr>
</table>

Nature Impact	Sources of Impact	Mitigation Measures Integrated into Project Design	Impact on Workplace Health Hazards and Safety
Limit work activities to daytime only and ensure availability of first aid facilities on all sites. Contract a retainer clinic to be engaged and ensure that site medical personnel are available at all work time. Provide an ambulance for conveyance of hazard affected staff for quick medical attention. Maintain a medical emergency response plan so that injured or ill persons can promptly access appropriate care including adequate fuel supply for emergency vehicles at all times. Ensure all fuel storage tanks are kept at safe distances from work areas. Ensure storage areas are identified with caution signs.			
Residual Impact			
High Negative (Overall Impact Rating = 60)			

Description Potential Work Hazard Impact

Hazards associated with the construction environment. Workers stand the risks of work place hazards during construction due construction work, careless handling of construction machines and equipment, natural hazards from such as snake bit and other biologically induced work place hazards.

6.14 Operation Phase Impacts and Mitigation Measures

The assessment of the potential impacts on air quality, sources, rating criteria and mitigation measures are presented in Table 6.25.

6.14.1 Impact on Ambient Air quality

The impact on ambient air quality is evaluated and presented in Table 6.32.

Table 6.32: Impacts on Ambient Air Quality

Impact Statement	Sources of Impact	Mitigation Measures Integrated into Project Design	Impact on Ambient Noise level	
Reduction in Ambient Air Quality	Fugitive dust produced by the movement of soils removed during construction	There will be no emission during operation. Fugitive dust produced by back-filling earth removed during site clearing, grading and	Impact criteria	Rating
			Legislature	3
			Stakeholder concern	2
			Severity	1
			Scale	1

Impact Statement	Sources of Impact	Mitigation Measures Integrated into Project Design	Impact on Ambient Noise level	
	phase, clearing, grading and back-filling, as well as emissions from internal combustion engines and other construction equipment can affect the ambient air quality. However this may be localized to specific construction sites in the two pilot sub watersheds.	filling, and emission from internal combustion engines of construction equipment will generate low degree of dust into the air. Movement of vehicles should monitored and restricted as much as possible.	Frequency	3
			Overall rating	21
			Impact Significance	**Minor**
Mitigation measures				
There will be no significant emission during operation. Movement of vehicles will be minimal while earth work that may raise fugitive dust would remain at the minimum level. Restrict movement of vehicles around the sites as much as possible				
Residual Impact				
Minor (Overall Impact rating = 21)				

Reduction in Ambient Air Quality may be low. Fugitive dust produced by the movement of soils removed during construction phase, clearing, grading and back-filling, as well as emissions from internal combustion engines and other construction equipment can affect the ambient air quality minimally. However this may be localized to specific construction sites in the two pilot sub watersheds.

6.14.2 Impact on Ambient Noise Level

The assessment of the potential impacts on Ambient Noise level, sources, rating criteria and mitigation measures are presented in Table 6.33.

Table 6.33: Impacts on Ambient Noise Level

<table>
<tr><th>Impact Statement</th><th>Sources of Impact</th><th>Mitigation Measures Integrated into Project Design</th><th colspan="2">Impact on Ambient Noise level</th></tr>
<tr><td rowspan="8">Increase in ambient Noise level</td><td rowspan="8">There will be no noise produced during the daily operation of gully bank treatment and bio-remediation measures, and provision of buffer zones. Therefore, no significant increase in noise levels is envisaged.</td><td rowspan="8">There will be no noise produced during the daily operation for gully bank treatment and bio-remediation measures, and provision of buffer zones. Therefore, no significant increase in noise levels is envisaged. However, workers may be provided with protective devices to mitigate any unexpected increase in noise due to running water across the gabions and sediment traps especially during rainy season.</td><td>Impact criteria</td><td>Rating</td></tr>
<tr><td>Legislature</td><td>3</td></tr>
<tr><td>Stakeholder concern</td><td>1</td></tr>
<tr><td>Severity</td><td>1</td></tr>
<tr><td>Scale</td><td>1</td></tr>
<tr><td>Frequency</td><td>2</td></tr>
<tr><td>Overall rating</td><td>12</td></tr>
<tr><td>Impact Significance</td><td>Minor</td></tr>
<tr><td colspan="5">Mitigation measures</td></tr>
<tr><td colspan="5">Personnel will be provided with noise protection PPE for use in noisy areas of the facility. Workers in noisy areas will not be allowed to work for more than 8hours at a time in the noisy environment. Ensure the use of PPE at all work hours.</td></tr>
<tr><td colspan="5">Residual Impact</td></tr>
<tr><td colspan="5">Minor (Overall Impact Rating = 12)</td></tr>
</table>

Description of Impact

There will be no noise produced during the daily operation of gully bank treatment and bio-remediation measures, and provision of buffer zones. Therefore, no significant increase in noise levels is envisaged.

6.14.3 Impact on Soil

The Assessment of the potential impacts on Soil, sources, rating criteria and mitigation measures are presented in Table 6.34.

Table 6.34: Impact on Soil

Impact Statement	Sources of Impact	Mitigation Measures Integrated into Project Design	Impact on Soil during Operation	
Soils contamination	Potential contamination of soil from accidental release of hazardous or contaminating material (liquid fuel, solvents, lubricants, Aluminium oxide paint, wastewater, etc. Negligence in the application of agro-chemical on planted	Adequate hazardous materials handling Programme shall be put in place to avoid poor handling and disposal of all forms of chemicals especially agro-chemicals, and to reduce incidence of surface run-off and soil contamination where chemicals are spilled.	Impact criteria	Rating
			Legislature	3
			Stakeholder concern	2
			Severity	2
			Scale	21
			frequency	3
			Overall rating	27
			Impact Significance	**Medium**

	trees, grasses, and shrubs.			
Mitigation measures				
Adequate hazardous materials handling Programme shall be put in place to avoid poor handling and disposal of all forms of chemicals especially agro-chemicals, and to reduce incidence of surface run-off and soil contamination where chemicals are spilled.				
Residual Impact				
Medium (Impact Rating = 27)				

Description of Impact

Potential contamination of soil from accidental releases of hazardous or contaminating materials such as liquid fuel, solvents, and careless handling of agro-chemicals in the application on planted trees, grasses, and shrubs.

6.15 Impact on Socio-economy

The Assessment of the potential impacts on Socio-economy, sources, rating criteria and mitigation measures are presented in Table 6.35.

Table 6.35: Impacts on Socio-economy

Impact Statement	**Sources of Impact**	**Mitigation Measures Integrated into Project Design**	**Impact on Socio-economy**	
Socio-economic development of communities around the dam and its watershed	New Development for improving the lives of communities living around the dam and its surrounding	The impact is beneficial and shall be enhanced by sustaining the project through adequate and effective maintenance activities and complying with the federal government's policies and laws on dam operation.	Impact criteria	Rating
			Legislature	
			Stakeholder concern	
			Severity	
			Scale	
			frequency	
			Overall rating	

	catchments		Impact Significance	**Positive**
Mitigation measures				
The impact is beneficial and shall be enhanced by sustaining the project through adequate and effective maintenance activities and complying with the federal government's policies and laws on dam operation.				
Residual Impact				
Beneficial (Positive Impact does not require scoring)				

The intended improvement in the reservoir water quality and reduced sedimentation will impact positively on water users downstream, water pumping for domestic use to Kano and its environs, improvement in fish population and dam's functionality will result in the improvement of social services infrastructure in the area and a reduced cost of providing these services. Therefore the overall impact on the watershed management during operation and maintenance is beneficial to government and the general public.

6.15.1 Impact on Occupational Hazard and Safety

The Assessment of the potential impacts on Health, Safety and security, sources, rating criteria and mitigation measures are presented in Tables 6.36

Table 6.36: Impacts on Health and Safety

Impact Statement	**Sources of Impact**	**Mitigation Measures Integrated into Project Design**	**Impact on Occupational Hazards and Safety**	
Occupational hazards and safety risks that may arise during the operation phase of the dam may arise from improper removal or incomplete evacuation of waste generated during the	Reservoir operations and management of Gabions, Sediment Traps and Vegetative Buffers.	Workers will be provided with all the required PPE. Worker enlightenment on operational safety issues shall be carried out regularly by Project Implementation and Monitoring Unit of HJKYB_TF throughout. Toolbox talks shall be	Impact criteria	Rating
			Legislature	3
			Stakeholder concern	3
			Severity	2
			Scale	1
			Frequency	5
			Overall rating	45
			Impact Significance	**Moderat e**

construction.		carried out regularly on safe work practices and other Operational Health Issues. First aid facilities shall be available in all work areas. Medical facilities shall be made available to all workers. Implementation of Emergency Response Plan and awareness-raising among workers shall be put in place. There will be regular monitoring of potential situations leading to disaster.		
Mitigation measures				
Workers will be provided with all the required PPE. Worker enlightenment on operational safety issues shall be carried out regularly by Project Implementation and Monitoring Unit of HJKYB_TF throughout. Toolbox talks shall be carried out regularly on safe work practices and other Operational Health Issues. First aid facilities shall be available in all work areas. Medical facilities shall be made available to all workers. Implementation of Emergency Response Plan and awareness-raising among workers shall be put in place. There will be regular monitoring of potential situations leading to disaster.				
Residual Impact				
Moderate (Impact Rating = 45)				

Occupational hazards and safety risks that may arise during the operation phase of the dam may arise from improper removal or incomplete evacuation of waste generated during the construction.

6.15.2 Impact on Security of installations and Buffer Vegetation

The Assessment of the potential impacts on project installation and Vegetative Buffers Management, sources, rating criteria and mitigation measures are presented in Tables 6.37.

Table 6.37: **Impact on Security of installations and Buffer Vegetation**

Impact Statement	**Sources of Impact**	**Mitigation Measures Integrated into Project Design**	**Impact on Surface water quality**	
Security of project installations including gabions, Sediment Traps and Vegetative Buffers	Local community foraging livestock, fishing, felling trees, destroying vertiver grass etc.	Implementation of Emergency Response Plan; Awareness-raising among workers and local community on the need to preserve and protect planted trees, grasses and shrubs from any form of destruction especially buy grazing animal, removal of premature trees or branches thereof for polls and fuel etc. Monitoring of potential situations leading to destruction of installations; constant awareness raising and consultations with local communities on benefits of protecting project installations and involving local vigilantes on monitoring and safety of installation from the beginning of operations.	Impact criteria	Rating
			Legislature	1
			Stakeholder concern	3
			Severity	3
			Scale	3
			Frequency	3
			Overall rating	30
			Impact Significance	**Medium**
Mitigation measures				
Implementation of Emergency Response Plan; Awareness-raising among workers and local community on the need to preserve and protect planted trees, grasses and shrubs from any form of destruction especially buy grazing animal, removal of premature trees or branches thereof for polls and fuel etc. Monitoring of potential situations leading to destruction of installations; constant awareness raising and consultations with local communities on benefits of protecting project installations and involving local				

Impact Statement	Sources of Impact	Mitigation Measures Integrated into Project Design	Impact on Surface water quality
vigilantes on monitoring and safety of installation from the beginning of operations.			
Residual Impact			
Minor (Overall Impact Rating = 30)			

Description of Impact

Impact on the security of installations at project sites; this includes Gabion Check Dams, Sediment Traps and Vegetative Buffers installations. Local community foraging livestock, fishing around gabions and sediment traps, felling trees, destroying vertiver grass etc.

6.15.3 Impact on economic trees and grasses used as Buffer

The Assessment of the potential impacts on economic trees and grasses planted as Vegetative Buffers Management, sources, rating criteria and mitigation measures are presented in Tables 6.38.

Table 6.38: **Impacts on economic trees and grasses planted as Vegetative Buffers**

Impact Statement	Sources of Impact	Mitigation Measures Integrated into Project Design	Impacts on economic trees and grasses planted as Vegetative Buffers	
Planted economic trees and grasses as vegetative buffer including Avocado pears, Improved mango species, improved oranges, as well as onions and vegetables mixed cropping around the reservoir.	Local Community demand and crave for edible fruits and vegetables, foraging livestock, fishing, felling trees, destroying, vertiver grass for transplanting and manging soil erosion and gully formation on their farm lands,	Project design includes reaping the economic benefits of exotic trees and other plant species to the communities. The HJKYB-TF managements raise income from the marketing of fruits etc. at local markets. HJKYRB-TF shall therefore put in place a management system to monitor, harvest and market the products from the trees to internally generate critically needed	Impact criteria	Rating
			Legislature	
			Stakeholder concern	
			Severity	
			Scale	
			Frequency	
			Overall rating	
			Impact Significance	**Positive Impact**

Impact Statement	Sources of Impact	Mitigation Measures Integrated into Project Design	Impacts on economic trees and grasses planted as Vegetative Buffers	
	vertiver grass for animal feed, etc..	revenue.		
Mitigation measures				
Project design includes reaping the economic benefits of exotic trees and other plant species to the communities. The HJKYB-TF managements raise income from the marketing of fruits etc. at local markets. HJKYRB-TF shall therefore put in place a management system to monitor, harvest and market the products from the trees to internally generate critically needed revenue.				
Residual Impact				
Positive Impact Does not require Scoring				

Description of Impact

Planted economic trees and grasses as vegetative buffer including Avocado pears, improved mango species, improved oranges, as well as onions and vegetables mixed cropping around the reservoir. Local Community demand and crave for edible fruits and vegetables, foraging livestock, fishing, felling trees, destroying, vertiver grass for transplanting and managing soil erosion and gully formation on their farm lands, vertiver grass for animal feed, etc.

6.16 Decommissioning Phase Impacts and Mitigation Measures

The decommissioning phase refers to all the activities related to the proposed watershed management project ends, i.e. when it terminates. During this phase, the demolition activities are likely to have similar impacts on the environment identified during the construction phase. These will include consequences such as rejuvenation of sedimentation, surface water pollution, visual impairment, air and noise pollution, risk of bush fires and safety and security of men, materials and project installations such as Gabions, Sediment traps, vegetative buffers etc. in this regard, impacts associated with the decommissioning exercise have been ranked on the bases of their significance index ranging from Low to Moderate.

Similarly, mitigation measures for impacts at the decommissioning stage will be implemented in accordance with subsisting practices at the time of decommissioning.

Consequently, the following mitigation measures have been suggested for issues arising from the decommissioning process:

- Contractor shall develop and implement a robust decommissioning plan in line with prevailing conditions and requirements at the time of decommissioning;
- Contractor shall ensure that excavated and stockpiled soil and vegetative material are removed and burned on the higher-lying areas and away from any runoff channels where it is likely to cause erosion or block the gullies to create any opportunity for flooding.
- Decommissioning activities should preferably occur during the dry season months to prevent soil erosion caused by heavy rains.
- All unprotected cleared areas and stockpiles shall be wetted with water to a reasonable degree of wetness to suppress any form of dust pollution. Institute noise control measures. All possible noise reduction protocols shall also be put in place during decommissioning activities.
- Take cognizance of peak traffic times and plan the transportation of decommissioned structures and personnel to avoid obstruction of local traffic by vehicles heavy machinery/trucks.
- It is necessary for the contractor to develop a decommissioning security plan and implement it to the latter.
- Ensure effective waste management from the start to the end of the decommissioning period.
- Enforce proper waste management policies in line with FMENV standards and requirements at the time of decommissioning.

Proper implementation of the above mitigation measures and those spelt out for construction impacts will reduce the impact to the **Barest Minimum** significance level.

6.17 Cumulative Impacts

Defining Cumulative Impacts

Development of this watershed management project may be happing simultaneously with other developmental activities within and around the Challawa Watershed (project area). When taken together these simultaneous (mutually related or unrelated) projects or programs may generate impacts that will affect the same receptors/resources. Such impacts from all potential outcomes will become cumulative.

These impacts are regarded as cumulatively induced from impacts, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted. In general, cumulative Impacts are impacts that act with influences from other projects such that:

- The totality of the impacts is greater than their parts; or
- The sum of the effects attains a threshold level such that the impact becomes significant.

The cumulative impacts that are considered to be relevant in the case of the CHallawa Gorge Dam Watershed Management include the following::

- **Accumulative**: the overall effect of different types of impacts at the same location. An example would be noise and water pollution effects of the Kano State government's proposed Hydro-electric power generating plant at the Challawa reservoir which has started, impacting the local communities as a nuisance/ disturbance and scaring wildlife from their natural harbitats.
- **Interactive**: where two different types of impacts (which may not singly be important) react with each other to create a new impact (that might be important) (e.g. water abstraction from a watercourse might exacerbate the consequences caused by increased sediment loading).
- **Additive** or **In-combination**: where impacts from the primary activity (i.e. the construction and operation of the Project) are added to impacts from third-party activities, e.g. An example would be noise and water pollution effects of the Kano State government's proposed Hydro-electric power generating plant at the Challawa reservoir which has started, impacting the local communities as a nuisance/ disturbance and scaring wildlife from their natural habitats in addition to the already identified effects of the Challawa Gorge Dam Watershed Mangement Project.

6.18 Identification of Relevant Development(s)

The cumulative impact assessment focuses on the combined effects of the Project with potential future development in the immediate area around the Project site. The cumulative assessment impacts the potential project in view, depending on the status of other projects and the level of data available to characterize the magnitude of the impacts.

Given the lack of available information regarding such future developments, this assessment follows a generic pattern. It focuses on critical issues and sensitivities for this project and how these might be influenced by cumulative impacts with a combination of other developments. Consultations with local and state authorities and identification of relevant and significant developments via searches of relevant documents provided invaluable assistant in this assessment. The main developments identified are cumulative impacts from other projects within 2km.

CHAPTER SEVEN

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

7.1 Introduction

An Environmental and Social Management Plan (ESMP) is an important component of an Environmental and Social Impact Assessment (ESIA) as it provides an important tool that can be used to measure and check, in a continuous manner, the efficacy of the mitigation measures and project commitments incorporated in the ESIA to minimize or eliminate identified negative impacts. In addition, the ESMP may also be used to ensure compliance with statutory requirements, and corporate safety & environmental and social management policies.

The key features of an ESMP, drawing from relevant existing guidelines as well as the Nigerian ESMP guidelines, is that it is applicable to a range of types and scales of projects or developments, from projects with a low level of environmental risk to those with high environmental risk; assumes a broad understanding of the term “environment”, that includes the biophysical, social and economic components; includes the enhancement of positive impacts (benefits) as well as the mitigation of negative impacts; and should not be viewed as a prescriptive and inflexible document.

An ESMP is therefore, a tool which ensures continuous assessment of the environmental and social impact of a project operation as well as proactive response to the impacts to reduce their overall effect on the identified environmental parameters. It makes an organization to do the right thing at the right time rather than responding to situations borne out of statutory or legal compulsion. This essential tool is contained in the International Standards Organization (ISO).

In this section, an ESMP is presented to be used throughout the life span of the proposed project in Challawa Gorge Dam, Kano State. This ESMP will facilitate environmental and social management of the proposed project and procedures that are provided to help prevent, avoid or minimize negative environmental impacts that may occur from the project planning phase through construction and operations.

Objectives of the ESMP

The ESMP is needed to successfully manage the project's environmental and social performance throughout its lifecycle. It integrates social and ecological management with overall project engineering, procurement, construction, and operations. The ESMP is prepared to achieve the following objectives:

7.2 Objectives of Environmental and Social Management Plan (ESMP)

The objectives of ESMP for the proposed project are to:

x. Monitor the project proponent’s compliance with all the mitigation measures and commitments in the ESIA report;
xi. Provide early warning signals on potential environmental changes, so that appropriate actions can be taken to prevent or minimize environmental and social impacts;
xii. Put in place a sound and cost-effective contingency plan that can be activated for prompt response to any unforeseen occurrence;
xiii. promote environmental and social control in the project implementation in all phases;
xiv. Ensure that all relevant stakeholders are well informed about their individual and collective responsibilities;
xv. Incorporate environmental and social management into the project design and implementation processes;
xvi. Serve as a proxy action plan for social and ecological management for the project;
xvii. Provide a framework for implementing environmental and social commitments (such as mitigation measures identified in the ESIA);
xviii. Prepare and maintain project ecological and social performance records for monitoring and evaluating performance monitoring, audits and non-compliance tracking.

The essence of the ESMP is to encourage and achieve the highest environmental and socio-economic performance standards, and routinely monitor project functions and activities.

7.3 Institutional Framework for Implementation of the ESMP

Responsibilities in implementing and monitoring the ESMP are shared between multiple stakeholders, including regulatory and concerned agencies, the AfDB-PIU, the proponent and the contractors.

The key roles and responsibilities for the implementation of the ESMP are presented.

Overall:

- The Kano State Ministry of Environment will have principal responsibility for all measures outlined in the ESMP for the construction phase.
- The Ministry is responsible for the implementation of the measures in the operation phase.
- Both may delegate responsibility to their contractors, where appropriate. In cases where other individuals or organisations have responsibility for mitigation or enhancement measures, this is indicated in Tables 7.2 and 7.3.
- Capacity building and training requirements are also described, where these relate to specific skills required to deliver the ESMP action in question.

The Project Implementation Unit (PIU) will manage the project.

The PIU shall hire and manage contractors; a witness NGO shall be accredited to monitor and evaluate the implementation of the ESMP to a certain extent. The contractors are responsible for the performance of the ESMP. Overall regulatory agencies at the National, State and Local Government levels are accountable for implementing ESMP.

7.3.1 *Project Proponent (HJKYB-TF)*

The project proponent is the Hadejia Jama'are Komadugu Yobe Basin Trust Fund. Six riparian States established the body in collaboration with Federal Government in Damaturu in 2006. The Trust Fund is an regional platform for a joint intervention with the support of the Federal Government of Nigeria for augmenting line agencies in addressing land and water resources issues in the KYB.

An Executive Secretary heads the HJKYB-TF. A PIU has been constituted with a Project Manager who reports to the Executive Secretary.

7.3.2 *Project Implementation Unit (PIU)*

The PIU set up by the HJKYB-TF-AfDB is saddled with the responsibility of project implementation. A Project Manager heads it. Members of the PIU consist of technical experts and environmental, social, and two liaison officers appointed from the Federal and Kano State Ministries of Water Resources.

PIU is responsible for the overall project planning and execution, including preparing bidding documents, hiring project management consultants, EPC contractors, and supervising the works. This approach includes ensuring proper implementation of the environmental and social management measures contained in the ESMP and monitoring. To provide additional oversight, the project PIU will retain the services of the ESIA Consultant to manage the ESMP implementation. The PIU will also invite relevant NGOs to monitor and ensure the adequate performance of the ESMP.

7.3.3 *The Ministry's HSE Department*

The HSE department shall be responsible for ensuring the implementation of management measures during the operation phase (post-commissioning), including audits, compliance monitoring, and preparation of periodic reports required by regulations to the operations.

7.3.4 *Regulatory Agencies and Other Concerned Authorities*

The Federal Ministry of Environment (FMEnv) is responsible for implementing the EIA Act 86 of 1992. Furthermore, the proponent and the affected LGA have specific oversight roles, which they perform under the coordination of the FMEnv. Responsibilities for the ESIA and its implementation are shared between multiple stakeholders, including Ministries of Water Resources (Federal and State) competent authorities, the project implementation unit (PIU), the proponent and the contractors as presented (Table 7.1).

Table 7.1: Project Implementation Unit (PIU), Proponent and Contractors

No	Steps/Activities	Responsible	Collaboration	Service Provider
1.	Identification and siting of the project	PIU	•Project proponent	Specialist Consultant
2.	Screening, categorisation and identification of the required instrument (national EIA procedure)	Env. safeguards specialist (ESS) on the PIU	•beneficiary; local authority; Social Safeguards Specialist (SSS) on the PIU, FMEnv and AfDB	Specialist Consultant
3.	Approval of the classification and the selected instrument by the Public EA Agency	PIE coordinator	•ESS-PIU; SSS-PIU	• Public EA Agency (PEA-FMEnv)

No	Steps/Activities	Responsible	Collaboration	Service Provider
				• The Bank
4.	Preparation of the safeguard document/instrument (ESIA, Env. Audit, simple ESMP, etc.) following the national legislation/procedure (considering the Bank policies' requirements)			
	Preparation and approval of the ToRs	ESS-PIU		• The Bank
	Preparation of the report		•Procurement specialist (PS-PIU); SSS-PIU; Local authority	• Consultant
	Report validation and issuance of the permit (when required)		•Procurement specialist (PS-PIU); SSS-PIU; Local authority	• Public EA Agency (PEA); The Bank
	Disclosure of the document		Project Coordinator	• Media; The Bank; Supervising engineer; PEA
4.	(i) Integrating the construction phase mitigation measures and E&S clauses in the bidding document before advertisement; (ii) ensuring that the constructor prepares his ESMP (C-ESMP), gets it approved and integrates the relevant measures in the works breakdown structure (WBS) or execution plan.	Technical staff in charge of the project (TS-PIU)	• ESS-PIU; PS-PIU	Procurement Specialist
5.	Implementation of the other safeguards measures, including environmental monitoring (when relevant) and sensitisation activities	ESS-PIU	• SSS-PIU, PS-PIU; TS-PIU; Financial Staff (FS-PIU); Local authority	• Consultant; National specialised laboratories; NGOs; State Ministries and Local Government Councils
6.	Oversight of safeguards implementation (internal)	SSES	• Monitoring and Evaluation Specialist (M&E-PIU); FS-PIU;	• Control Firm (Supervisor)

No	Steps/Activities	Responsible	Collaboration	Service Provider
			State and Local Governments	
	Reporting on project safeguards performance and disclosure	Coordinator	• M&E-PIU; ESS-PIU; SSS-PIU	M&E specialist and Technical officer
	External oversight of the project safeguards compliance/performance.	FMEnv	• M&E-PIU; ESS-PIU ; SSS-PIU; PS-PIU; Supervisor	Consultant
7.	Building stakeholders' capacity in safeguards management	ESS-PIU	• SSS-PIU; PS-PIU	• Consultant • NGOs • Other qualified public institutions • The Bank
8.	Independent evaluation of the safeguards performance (Audit)	ESS-PIU	• SSS-PIU; PS-PIU	• Consultant

*The Bank= AfDB

The responsibilities and roles for each of the institutions are discussed below.

The Federal Government of Nigeria

The Federal Ministry of Environment is responsible for the overall environmental policy of the Country. It has the responsibility for ESIA implementation and approval under the EIA Act. It has developed specific guidelines and regulations to protect the environment and promote sustainable development. It will monitor the implementation of mitigation measures when the project commences. And they can issue directives to the project on specific actions related to the environment in the project area. The Ministry involves the States typically and sometimes local governments in this responsibility depending on the particular activity.

Kano State Ministry of Water Resources and Environment

The Environment department of the ministry manages both human and industrial waste, protects and conserves the environment, and enforces laws on the environment in the State.

Project Proponent

HJKYB-TF has the overall management for implementing the Challawa Gorge Dam project. However, the body has delegated the daily implementation operations to the PIU**.**

Project Implementation Unit

It is a unit established by the proponent responsible for delivering the project, including planning, feasibility, ESIA, engineering, procurement and construction (EPC). Furthermore, the PIU shall ensure:

*****Proper implementation of the ESMP

*****Implementation of stakeholder's-approved projects financed through the EPC contractors.

*****Production of monitoring reports to appropriate government authorities, Ministry and the contractor in charge of the project.

Kano State Environmental Protection Agency

The agencies are responsible for preparing and updating periodic master plans for the development of environmental science and technology and advise the government of the financial and material required for the implementation of such programs; to establish a mechanism to predict ecological disasters; identify the problems of drainage and sewage systems and carry out measures to improve, protect and remedy their ecosystems, also protection and development of the environment and also ensuring a healthy environment.

Kano State Ministry of Transport (KnSMT)

The significant roles of the Ministry are;

*****To formulate and implement effective policies regarding road transportation to ensure that adequate road safety measures are implemented across the State.

*****To coordinate the creation of transportation parks, identification and development of railways and river transportation.

*****To ensure effective and efficient movement of goods and services that will enhance socio-economic growth throughout the States.

Kano State Ministry of Land Survey Housing and Urban Planning (KNSMLSHUP)

The Ministry is vested with the authority of land administration. They are also charged with the survey of state lands, determination of land use and control, compensations, housing policies and urban development. The Ministry is also responsible for the supervision of the PIU, mapping and surveying, registration of title to lands, development and maintenance of open spaces.

Local Government Areas (LGAs)

The affected LGAs are involved in the ESIA approval process. According to the national EIA requirement, the LGAs will have representatives in the panel that will review the report and advise the Minister to make decisions on the project.

The Customary District Councils

The traditional head of Karaye Emirate has an essential role in the project concerning mobilising the community members to support the project, grievance redress, peace and security of personnel, equipment, and facilities to be installed. Close contact and regular consultation shall be maintained with customary chiefs throughout the life of the project.

Witness NGO

To enhance transparency and trust from PACs, it is suggested that a witness NGO, recognised and credible in the project area, be retained, through a public proposal and selection process, to provide independent advice, and report on ESMP implementation and management, focusing on consultation activities, corporate social responsibilities/related activities and grievances management. This NGO could be a recognised and credible Human Rights advocacy group or an NGO active in rural, environmental, social or development.

This outside look will ensure that proper procedure and stated ESMP processes are followed, that PACs grievances are well taken care of, and that PACs are treated with fairness. This model of supervision is consistent with best practices nationally and internationally. It will ensure that the process is fair and equitable with net positive benefits for the PACs. It also minimises grievances.

Contractor Environmental Manager

Each contractor shall appoint a qualified environmental manager who, after approval by the PIU, will be responsible for daily management onsite and the respect of management measures from the ESMP. This manager will regularly report to the environment and social expert of the PIU during the entire construction period. Contractors must hold all necessary licenses and permits before the work begins. It will occur to provide to the PIU all of the required legal documents, among which the signed agreements with owners, authorisations for borrow pits and temporary storage sites, etc.

Communities (Community Liaison Officers)

Leaders and traditional institutions of the affected communities will assist in public sensitisation efforts to advance the implementation of ESMP.

7.4 Communication

After the transfer of operation, the state government will maintain a formal communication procedure with the regulatory authorities and communities. The E & S Manager in the PIU is responsible for transmitting HSE issues to and from regulatory authorities whenever required. Meetings will be held, as needed, between the state government and the appropriate regulatory agency and community representatives to review ESMP implementation, health and safety issues and community relationships during implementation performance, areas of concern and emerging issues. Dealings will be transparent, and stakeholders will have access to personnel and information to address concerns raised.

The Project will develop and implement a grievance mechanism whereby community members can raise any issues of concern. Grievances may be verbal or written and usually either specific claims for damages/injury or complaints or suggestions about how the Project is being implemented. When a grievance has been brought to the Project team's attention, it will be logged and evaluated. The person or group with the grievance must present grounds for making a complaint or claiming loss to make a proper and informed evaluation.

Where a complaint or claim is considered valid, steps are required to be undertaken to rectify the issue or agree on compensation for the loss. In all cases, the decision made and the reason for the decision will be communicated to the relevant stakeholders and recorded.

Where there remains disagreement on the outcome, an arbitration proceeding may be required to be overseen by a third party (e.g. government official). Local community stakeholders will be informed on how to implement the grievance procedures.

7.5 Documentation

The proponent for the operation phase will control HSE documentation, including management plans, associated procedures, checklists, forms, and reports. All records will be kept onsite and backed up at several off-site locations (including secure cloud storage facilities). Records will be held in both hard copy and soft copy formats. And all documents will be archived for the life of the project.

Furthermore, the document control procedure by the Ministry will describe the processes that the Project will employ for official communication of both hardcopy and electronic (through the internet) document deliverables. In addition, it will explain the requirement for electronic filing and posting and the assignment of document tracking and control numbers (including revision codes).

The E & S Manager of PIU is responsible for maintaining a master list of applicable HSE documents and ensuring that this list is communicated to the appropriate parties. The HSE Coordinator is responsible for providing notice to the affected parties of changes or revisions to documents, issuing revised copies, and checking that the information is communicated within that party's organisation appropriately.

The subcontractors will be required to develop a system for maintaining and controlling its HSE documentation and describe these systems in their respective HSE plans.

7.6 Operational Control Procedures

Each significant impact identified in the ESIA will have an operational control associated with it that specifies appropriate procedures, work instructions, best management practices, roles, responsibilities, authorities, monitoring, measurement, and record-keeping to avoid or reduce impacts. Operational controls are regularly monitored for compliance and effectiveness through a monitoring and auditing procedure described in the ESMP.

Operational control procedures will be reviewed and, where appropriate, amended to include instructions for planning and minimising impacts or reference relevant documents that address impact avoidance and mitigation.

7.6.1 *Managing Changes to Project Activities*

Changes in the Project may occur due to unanticipated situations. Adaptive changes may also occur during the final design, commissioning or even operations. The Challawa gorge dam management will implement a formal procedure to manage changes in the project that will apply to all project activities.

The procedure's objective is to ensure that the impact of changes on the health and safety of personnel, the environment, plant and shared equipment are identified and assessed before changes are being implemented. The management of change procedure will ensure that:

- proposed changes have a sound technical, safety, environmental, and commercial justification;
- Changes are reviewed by competent personnel, and the impact of changes is reflected in documentation, including operating procedures and drawings;
- hazards resulting from changes that alter the conditions assessed in the ESIA have been identified and evaluated, and the impact(s) of changes do not adversely affect the management of health, safety or the environment;
- changes are communicated to personnel who are provided with the necessary skills, via training, to implement changes effectively; and
- the appropriate proponent official (s) accepts the responsibility for the change.

As information regarding the uncertainties becomes available, the Project ESMP will be updated to include that information in subsequent revisions. Environmental and social, and engineering feasibility and cost considerations will be considered when choosing between possible alternatives.

7.6.2 *Emergency Preparedness and Response*

The proponent will prepare plans and procedures to identify the potential for and respond to environmental accidents and health and safety emergencies and prevent and mitigate potentially adverse ecological and social impacts that may be associated with them.

The Ministry will review emergency preparedness and response daily and after any accidents or emergencies to ensure that lessons learnt to inform continuous improvement. Emergency exercises will be undertaken regularly to confirm the adequacy of response strategies. Investigations of accidents or incidents will follow formal documented procedures.

7.6.3 *Checking and Corrective Actions*

Checking includes inspections and monitoring and audit activities to confirm the proper implementation of checking systems and the effectiveness of mitigations. Corrective actions include response to out-of-control situations, non-compliances, and non-conformances. Measures also include those intended to improve performance.

7.6.4 *Monitoring*

Monitoring will be conducted to ensure compliance with regulatory requirements and evaluate the effectiveness of operational controls and other measures intended to mitigate potential impacts. Monitoring parameters are included in the ESMP Tables 7.2 and 7.3.

Monitoring methodologies or processes must be put in place to ensure the efficacy of the mitigation measures identified in the ESIA. Monitoring methodologies should be established to address the following:

- Alteration to the biological, chemical, physical,social and health characteristics of the recipient environment;
- Alterations in the interactions between project activities and environmental and social sensitivities, and interactions among the various sensitivities;
- Monitor the effectiveness of the mitigation and enhancement measures;
- Determination of long term and residual effects;
- Identification of Project-specific cumulative environmental and social effects, if applicable;
- The quarterly FMEnv monitoring shall be performed with the involvement of the communities. This joint monitoring will support good community relations by creating trust and involvement;
- At the construction site, inspections should be performed on human resources procedures, occupational health, safety and security risks management, emergency planning and the open water on malaria larvae; and

- The recruitment, human resources procedures, HSE training and awareness of the labour force in the construction as well as the operation phase should be monitored to know their origin in line with the local content plan and the level of knowledge and awareness on the code of conduct, STD prevention and occupational H&S measures.

The FMEnv guidelines require an environmental monitoring plan as part of an ESIA. The monitoring program aims to ensure that the negative environmental and social impacts identified in this ESIA are effectively mitigated in the construction and operation stages of the Project.

7.6.5 *Auditing*

Beyond the regular inspection and monitoring activities conducted, audits will be carried out by the state ministry to ensure compliance with regulatory requirements as well as their HSE standards and policies. Audits to be conducted will also cover the subcontractor self-reported monitoring and inspection activities. The audit shall be performed by qualified staff, and the results shall be reported to the state ministry of environment to be addressed.

The audit will include a review of compliance with the requirements of the ESIA and ESMP and have, at a minimum, the following:

- completeness of HSE documentation, including planning documents and inspection records;
- conformance with monitoring requirements;
- efficacy of activities to address any non-conformance with monitoring requirements; and
- training activities and record keeping.

There will be a cycle of audits into specific areas of the Project. The frequency of audits will be risk-based and will vary with the Project stage and depend on previous audits' results. A regulatory compliance audit is a mandatory requirement to be carried out by an independent accredited consultant every three years during the operation phase and the reports submitted to the Federal Ministry of Environment.

7.6.6 *Corrective Action*

Investigating a 'near-miss or actual incident after it can be used to obtain valuable lessons and information that can be used to prevent similar or more severe occurrences in the future.

The proponent will implement a formal non-compliance and corrective action tracking procedure to investigate the causes and identify corrective actions to accidents or environmental or social non-compliances. This will ensure coordinated action from EPC Contractor and its subcontractors. The HSE coordinator will be responsible for keeping records of corrective actions and overseeing the modification of environmental or social protection procedures or training programs to avoid the repetition of non-conformances and non-compliances.

7.6.7 *Reporting*

Throughout the project, the proponent will keep the regulatory authorities informed of the Project performance concerning HSE matters by way of written status reports and face-to-face meetings. They will prepare a report on environmental and social performance and submit it to FMEnv. The frequency of this reporting will be determined by FMEnv, in a letter of approval of the project. These reports are prepared as part of the requirements for impact mitigation monitoring carried out by FMEnv.

If required, the proponent will provide appropriate HSE-related activities, including internal inspection records, training records, and reports to the relevant authorities. Subcontractors are also required to provide HSE performance reporting to the proponent regularly through weekly and monthly reports. These will be used as inputs to the above.

7.7 Grievance Mechanisms

During the implementation of the ESMP, disputes/disagreements between the project developer and the PACs may occur. There are significant challenges associated with grievance redress, especially in projects of this magnitude. A grievance procedure based on community grievance resolution channels and regulatory agencies shall be used.

7.7.1 *Customary Mediation*

All the communities affected by this project have internal mechanisms for resolving disputes through the customary chiefdoms. Such customary avenues should provide a first culturally appropriate grievance procedure to facilitate formal or informal grievance resolution.

The PIU shall set up a Customary Grievance Redress Committee in each community to address complaints. PAPs' complaints should first be lodged verbally or written in the grievance register through the customary chief, who in turn will invite the PIU. The PIU and the traditional leaders, and other Councils Chiefs will try to resolve the issue amicably. If the complaint cannot be resolved at this level or the plaintiff is not satisfied with the settlement proposed, the matter should be reported to the regulatory agencies.

7.7.2 *Regulatory Agencies*

FMEnv and the Kano State Ministry of Environment have the statutory responsibility for oversight and monitoring the implementation of the ESMP. The agencies shall pronounce judgment on any environmental complaint or dispute reported to them based on regulatory requirements. At this stage, if the plaintiff is still not satisfied with the settlement, they can then proceed to the official legal procedures.

7.7.3 *Courts of Law*

The judicial process under applicable laws will be followed, and the law courts will pass binding judgment on the matter.

7.7.4 *Grievance Resolution Procedures*

The first level is the Village Chief and the PIU: The aggrieved person shall first report the matter to the Village Chief for resolution. Issues that can be resolved at this level include community quota, boundary issues, etc. The type of issues to report to the PIU for possible adjudication have perceived damage to property or means of livelihood, incorrect PAP data, infidelity to ESMP and corporate social responsibilities, etc. If the issue is not resolved at this stage, it can then be escalated to customary mediation. If still no acceptable resolution is achieved, the parties may choose to go to the regulatory agencies and, after that, to the court under the laws of the Federal Republic of Nigeria. Figure 7.2 illustrates the procedure for grievance resolution.

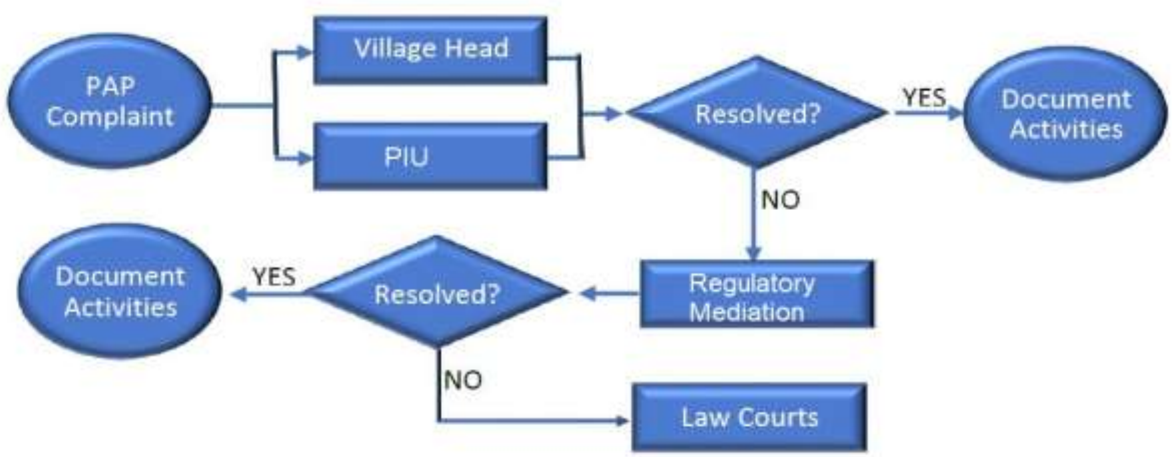


Figure 7.2: Grievance Resolution Procedures (Adopted from Jama'are River Regulation ESIA Report, 2021)

7.8 Proposed Management Plan

The Environmental and Social mitigation/enhancement measures and the responsibilities for implementation are in Tables 7.2&7.3. The EPC contractor has the responsibility for implementing the mitigation actions during the construction phase. The budget for implementation shall be included in the EPC contract as part of the overall construction cost.

The monitoring plan in Tables 7.4 and 7.5 contains details of responsibilities, parameters to be monitored, monitoring methods and standards/targets, and locations and monitoring frequency. The cost estimates cover costs of analyses of samples (where required), travelling expenses and regulatory costs. The budget for environmental and social monitoring during construction (Table 7.4) shall be added to the EPC contract budget. The EPC Contractor shall be required to disburse when needed, as may be directed by the Project Manager.

The budget for the monitoring during operations shall be provided by the Ministry's management in its annual budgeting process and administered directly by the appropriate authorities responsible for ensuring mitigation actions are implemented effectively. The Ministry shall adopt these measures and impose contractual conditions during the operation phase of the project. Additional detailed policies and specific plans have been developed to support the implementation.

Table 7.1 Responsibilities for Implementation and Monitoring of Mitigation Measure (Preconstruction/Construction Phase)

Indicator	Potential impact	Receptor	pre-mitigation Significance	Mitigation or enhancement measures	post-mitigation Significance	Responsibilities		
						Mitigation Action	Supervision	Monitoring
Air quality	Localised impairment of air quality by exhaust emissions from vehicles, equipment and construction engines (SO_2, CO, NOx, CO_2, PM) Elevated dusted levels in nearby communities' result from the dust raised by vehicle movements, wind, and handling of dusty material.	Project area	Medium	The proponent shall; Maintain and operate all vehicles and equipment engines under manufacturers recommendations - Restrict clearance to project footprint - Dust minimisation measures shall be implemented, including watering the construction areas, including the road surfaces before construction. - Soil stockpiles and stores of friable material will be covered to reduce the potential for fugitive emissions of dust where possible. - Loading, unloading and handling of dusty materials will only be carried out in designated areas. - Workers would be provided with dust protection PPE. The proponent shall; establish effective preventative maintenance to ensure all construction equipment is maintained in good working order not to produce an inordinate/excessive amount of exhaust emissions.	Minor	Contractor	AfDB-PIU	FMEnv, LGA Councils and KnMEnv

Indicator	Potential impact	Receptor	pre-mitigation Significance	Mitigation or enhancement measures	post-mitigation Significance	Responsibilities		
						Mitigation Action	Supervision	Monitoring
				Construction machinery will not be allowed to remain in idle mode over extended periods. Use ozone-depleting substances such as chlorofluorocarbons (CFCs), halons, carbon tetrachloride, trichloroethane, and halogenated hydro Bromo fluorocarbons (HBFCs) will not be permitted.				
Noise	Nuisance noise from construction activities and presence of construction workers	Project area and the construction workers	Medium	Develop a detailed plan that relates to noise control for relevant work practices and discuss this with construction staff during health & safety briefings Select 'low noise' equipment or methods of work Restrict construction activities to daytime Avoid dropping materials from height, where practicable. Near places of worship, construction producing nuisance level noise be minimised or rescheduled so as not to occur on a locally recognised religious day. This is particularly relevant along the access road alignment.	Minor	EPC Contractor	AfDB - PIU	FMEnv, LGA Councils and KnMEnv

Indicator	Potential impact	Receptor	pre-mitigation Significance	Mitigation or enhancement measures	post-mitigation Significance	Responsibilities		
						Mitigation Action	Supervision	Monitoring
				Work areas will be organised and operated to restrict noise levels not to exceed recommended thresholds at the nearest sensitive receptor during everyday activities. Advance notice will be given to communities if short-term noisy construction activities occur, which could cause these levels to be exceeded. Measures to minimise noise during construction will include: • locating and orientating equipment to maximise the distance and to direct noise emissions away from sensitive areas; • using buildings, earthworks and material stockpiles as noise barriers where possible, and turning off equipment when not in use. A preventative maintenance program for equipment and vehicles not to emit excessive noise or vibration due to inadequate maintenance or damage				

Indicator	Potential impact	Receptor	pre-mitigation Significance	Mitigation or enhancement measures	post-mitigation Significance	Responsibilities		
						Mitigation Action	Supervision	Monitoring
				Personnel will be made aware of the importance of minimising noise and the required measures in this regard.				
Soils	-Change to soil structure (erosion and compaction) as a result of excavation and backfilling and removal of vegetation, movement of machines and vehicles etc Also, contamination due to accidental spillage of fuels, chemicals and other lubricants. Improper disposal of wastes	Soil in and around the construction site	Medium	Construction of foundations to be undertaken in the dry season. Protect excavated soil materials from erosion. Ensure that the land shall be physically restored (include re-vegetation where possible) before the next rainy season. Accidental spills from machine maintenance shall be managed appropriately. Develop project-specific waste management plan and ensure proper implementation Provide adequate containers for waste collection Periodically audit contractor activities to check the level of compliance to regulatory waste management requirements.	Minor	EPC Contractor	AfDB - PIU	FMEnv, LGA Councils and KnMEnv

Indicator	Potential impact	Receptor	pre-mitigation Significance	Mitigation or enhancement measures	post-mitigation Significance	Responsibilities		
						Mitigation Action	Supervision	Monitoring
				Ensure engagement of government-approved waste management contractors Safe operating practices are enforced during construction The land area to be cleared will be kept to the minimum necessary to prevent soil disturbance outside the streams. Other surface water bodies will be protected where practicable to provide natural attenuation of flows. In areas of ground clearance, topsoil shall be stripped and salvaged as much as possible.				
				Implement adequate site drainage on the construction yard to allow for the directed flow of surface water off-site. This shall include cut-off drains to divert surface runoff from exposed soils or construction areas. Install oil/water separators and silt traps before effluent leaves the site. Minimise bare ground and stockpiles to				

Indicator	Potential impact	Receptor	pre-mitigation Significance	Mitigation or enhancement measures	post-mitigation Significance	Responsibilities		
						Mitigation Action	Supervision	Monitoring
				avoid silt runoff. Bunding of areas where hazardous substances are stored (e.g. fuel, waste areas). Remove all water accumulation within bunds using manually controlled positive lift pumps, not gravity drains. Regular checking and maintenance of all plant and equipment to minimise the risk of fuel or lubricant leakages. Training of relevant staff in safe storage and handling practices and rapid spill response and clean-up techniques. Set up and apply procedures regarding dealing with contaminated soils. Develop and implement a Waste Management Plan (as part of the ESMP) to ensure that waste is disposed of correctly.				
Water resources	Potential surface and groundwater contamination from accidental spills and	Local groundwater-well, borehole	Medium	Groundwater shall be used for construction in place of surface water. Accidental spills from machine	Minor	Contractor	AfDB - PIU	FMEnv, LGA Councils and

Indicator	Potential impact	Receptor	pre-mitigation Significance	Mitigation or enhancement measures	post-mitigation Significance	Responsibilities		
						Mitigation Action	Supervision	Monitoring
	improper disposal of waste and wastewater Surface water abstraction	and River		maintenance shall be managed appropriately. Continuous training of workers on HSE protocols Conducting daily safety briefings using existing roads instead of constructing new ones and limiting construction-related traffic (vehicles, machinery) to work areas as much as possible Refueling, maintenance and wash-down of construction vehicles and equipment will only occur in designated areas and away from surface water bodies and be provided with secondary containment measures. The construction contractor will be contractually required to take all reasonable precautions to prevent and clean up all spills/leaks and take necessary measures to prevent materials from falling into the river. Water for construction will be sourced from project boreholes.				KnMEnv

Indicator	Potential impact	Receptor	pre-mitigation Significance	Mitigation or enhancement measures	post-mitigation Significance	Responsibilities		
						Mitigation Action	Supervision	Monitoring
				Water use shall be monitored and recorded to maximise the efficiency of water use and minimise waste. Reuse of water shall be undertaken where practical and safe.				
Vegetation resources	Vegetation loss and disturbance to habitats, fauna and flora by construction activities Vegetation clearing will cause habitat disturbances that could create suitable conditions for invasive species to spread and loss of grazing fields for herds. Loss of species that offer Provisioning Services	Flora and fauna and habitat in the area of influence	Medium	Restrict construction activities, including vehicle movements and material storage in the project area Promote the use of existing access roads for machinery and vehicle movements Re-vegetation shall use species locally native to the site and not use any environmental weeds for erosion control. Workers shall be advised not to be killed in the unlikely event animals are encountered but instead caught and released into a similar environment. Vegetation clearing shall be confined to the immediate construction site.	Minor			
Community	Increased risks of traffic safety incidents	People living close	Medium	Develop a code of behaviours for workers	Minor	EPC Contract	AfDB - PIU	FMEnv, LGA

Indicator	Potential impact	Receptor	pre-mitigation Significance	Mitigation or enhancement measures	post-mitigation Significance	Responsibilities		
						Mitigation Action	Supervision	Monitoring
Health, Safety and Security	on public roads, air and noise pollutions	to project area, access roads and road users		All workers to receive training on community relations and code of behaviour. Employ workers majorly from host communities Management practices aimed at eliminating disease vector breeding sites. Awareness/health campaigns shall include other infectious diseases such as dysentery and cholera. Enhance ongoing consultations with local communities (with good representation) to create continuous dialogue, trust and planning of community development activities. Coordinate Stakeholder Engagement of all partners on the proposed site, prepare and implement Stakeholder Engagement Plan. Develop a health plan to address potential health issues		or		Councils and KnMEnv

Indicator	Potential impact	Receptor	pre-mitigation Significance	Mitigation or enhancement measures	post-mitigation Significance	Responsibilities		
						Mitigation Action	Supervision	Monitoring
				Initiate /enforce corporate health awareness programs for malaria, AIDS, etc.) Provide site medical personnel to attend to emergencies Engage the services of retainer clinics to manage health issues Educate workforce on the prevention of malaria as well as encourage the use of mosquito nets Ensure personnel use appropriate PPE Prepare and implement the emergency response plan. Ensure availability of first aid facilities onsite Provide information, education and communication about safe uses of water and occupational hygiene and safety Ensure Environmental Management for vector control and avoidance via settlement location				
Employ	Creation of temporary	Residents	Positive	Prepare a local content plan to identify	Positive	Contract	AfDB -	FMEnv,

Indicator	Potential impact	Receptor	pre-mitigation Significance	Mitigation or enhancement measures	post-mitigation Significance	Responsibilities		
						Mitigation Action	Supervision	Monitoring
ment and economy	jobs for residents and Nigerian nationals with skilled trades Supply chain opportunities for Nigerian companies that can provide goods and services needed by the company	of affected communities, Nigerian nationals, Nigerian companies and local SMEs		and select qualified local and Nigerian companies to provide needed supplies and services. Include provisions for advance notice to local companies, along with selection criteria including health and safety, to allow them to prepare for upcoming opportunities		or	PIU	LGA Councils and KnMEnv
Infrastructure	An influx of outside workers may pose additional pressure on social infrastructure, like medical costs, emergency services, water supply, solid waste management.	The project area of influence and nearby communities	Medium	Coordinate with medical posts and emergency services to prepare for water supply, waste management and incidents. Install proper and independent facilities at the construction site for water supply, sanitation, solid, liquid waste, medical services, fire-fighting equipment etc., so that pressure on community infrastructure is limited. Funding of local community projects to compensate for impacts.	Minor	Contractor	AfDB - PIU	FMEnv, LGA Councils and KnMEnv
Traffic congestion	Risk of road Accidents and Kidnapping	Workers and people in the affected	Medium	Implement a traffic safety plan including design of access point, signalization, speed limits, training of drivers, use of traffic guards,	Minor	EPC Contractor	AfDB - PIU	FMEnv, LGA Councils and

Indicator	Potential impact	Receptor	pre-mitigation Significance	Mitigation or enhancement measures	post-mitigation Significance	Responsibilities		
						Mitigation Action	Supervision	Monitoring
	Traffic Congestion	communities		procedures for the transport of oversized loads (e.g., engines), Maintain a log of traffic-related incidents, sensitisation of road users and people living close to the construction site. All vehicles are certified road/water worthy before being mobilised for work activities. Compliance with all roads safety transport rules, including speed limits Competency training and certification of drivers before mobilisation. Limit movement to daytime only. Setting and enforcing speed limits of 100km/hr (major roads) 40-60km/hr (built-up areas) and 10-30km/hr (construction sites); Consultation and good public relations with the stakeholder communities. Ensure government-approved security personnel is used on transport vehicles				KnMEnv

Indicator	Potential impact	Receptor	pre-mitigation Significance	Mitigation or enhancement measures	post-mitigation Significance	Responsibilities		
						Mitigation Action	Supervision	Monitoring
				and boats when warranted Coordinate work activities to avoid heavy traffic periods Use warning signs and traffic wardens/directors. Ensure activities causing blockages at road crossings are carried out within the shortest time practicable. Develop appropriate strategies to minimise the need for transportation of supplies Ensure compliance with all applicable laws, such as maximum load restriction and speed limits Community consultations and meetings on the ongoing road works and related hazards will be held. Active sites will be sealed off from the public using reflective tapes and cones; where necessary, road diversions will be created. Road safety initiatives will be developed and implemented, including:				

Indicator	Potential impact	Receptor	pre-mitigation Significance	Mitigation or enhancement measures	post-mitigation Significance	Responsibilities		
						Mitigation Action	Supervision	Monitoring
				Ensuring that only qualified (licensed) drivers operate machinery; Enforcing speed limits and traffic control measures in appropriate locations; Implementing road safety signage; Installing speed control devices such as governors on trucks.				
Visual amenities	Visual effects	Project area	Medium	Restore temporal work zones after construction Maintain orderliness in the work area Proper handling (treatment and disposal) of generated waste	Minor	EPC Contractor	AfDB - PIU	FMEnv, LGA Councils and KnMEnv
Workplace Health and Safety	Risk of workplace accidents and hazards	Workers at the construction site	High	Shall set up a local hiring office (or offices) to be set up for use by all contractors to advertise positions, receive applications, and provide guidance to applicants. Shall conduct periodic training of staff on workplace health and safety Shall ensure all personnel are qualified and certified for their relevant works. Shall ensure approved safe work procedures are provided and complied	Medium	Contractor	AfDB - PIU	FMEnv, LGA Councils and KnMEnv

Indicator	Potential impact	Receptor	pre-mitigation Significance	Mitigation or enhancement measures	post-mitigation Significance	Responsibilities		
						Mitigation Action	Supervision	Monitoring
				with at all times before commencement of work. Shall ensure SHE briefings, job hazards identification and controls, before the commencement of work activities Use of appropriate personal protective equipment (PPE), e.g. rubber hand gloves, hard hats, safety boots, life jackets etc. by all personnel at the project site Limit work activities to daytime only. Shall ensure availability of first aid facilities onsite Shall ensure retainer clinics are engaged and site medical personnel are available in case of accidents. Shall maintain a medical emergency response plan so that injured or ill persons can promptly access appropriate care. Shall ensure all fuel storage tanks are kept at safe distances from work areas Shall ensure storage areas are				

Indicator	Potential impact	Receptor	pre-mitigation Significance	Mitigation or enhancement measures	post-mitigation Significance	Responsibilities		
						Mitigation Action	Supervision	Monitoring
				identified with caution signs. Shall educate the workforce on risks associated with storage areas and prohibit activities (such as smoking) that can ignite storage tanks Shall designate no-smoking and smoke areas Shall hold SHE meetings and talks on fire hazard design work area to internationally acceptable standards Workers shall be provided with all the required PPE.				

Table 7.2 Responsibilities for Implementation and Monitoring of Mitigation Measure (Operations Phase)

Indicator	Potential impact	Receptor	Significance (pre-mitigation)	Mitigation or enhancement measures	Significance (post-mitigation)	Responsibilities		
						Mitigation Action	Supervision	Monitoring
Air quality	Exposure to emissions from vehicles (PM10, NO_2/NOx, SOx), Gaseous release from power generating sets	Workers onsite, communities within the area	Medium	Dust minimisation measures shall be implemented, including watering of the access road.	Minor	AfDB -PIU	KnMEnv	FMEnv

Indicator	Potential impact	Receptor	Significance (pre-mitigation)	Mitigation or enhancement measures	Significance (post-mitigation)	Responsibilities		
						Mitigation Action	Supervision	Monitoring
	The odour from wastewater effluents and onsite generated wastes Elevated dusted levels as a result of dust raised by vehicle movements, wind, and handling of dusty material			Speed limits will be implemented and enforced. Proper treatment of wastewater before releasing to the environment Effective preventative maintenance shall be established to ensure all vehicles and machinery are maintained in good working order and do not adversely impact air quality due to inadequate care or damage. There are long term plans in place to implement renewable energy generation options to reduce or eliminate dependence on fossil fuel generators; and Use ozone-depleting substances such as chlorofluorocarbons (CFCs), halons, carbon tetrachloride, trichloroethane, and halogenated hydro Bromo fluorocarbons (HBFCs) shall not be permitted.				

Indicator	Potential impact	Receptor	Significance (pre-mitigation)	Mitigation or enhancement measures	Significance (post-mitigation)	Responsibilities		
						Mitigation Action	Supervision	Monitoring
Noise and vibration	Noise from: operational activities, power generating sets, workers, etc.	Project area	Medium	Provision of noise protection PPE for use in noisy areas Noisy machinery (e.g. generators) will be housed/ screened where possible to contain the sound to a limited area. Workers in noisy areas will not be allowed to work for more than 8hours at a time in the noisy environment. The use of PPE shall be fully ensured	Minor	AfDB -PIU	KnMEnv	FMEnv
Soils and land-use	Potential contamination of soil from accidental release of hazardous or contaminating material, as well as from discharge of untreated wastewater effluents Compaction due to vehicular movement	Soils within and around the area	Medium	Appropriate flow diversion and erosion control structures, i.e. earth embankments, shall be put in place where soil may be exposed to high levels of erosion due to steep slopes, soil structure etc. Ensure safe operating practices are enforced during maintenance Implementation of the project-specific spill and Emergency Response Plan	Minor	AfDB -PIU	KnMEnv	FMEnv

Indicator	Potential impact	Receptor	Significance (pre-mitigation)	Mitigation or enhancement measures	Significance (post-mitigation)	Responsibilities		
						Mitigation Action	Supervision	Monitoring
				Ensure hydrocarbon/chemical spill containment and prevention measures and equipment are functional and effective for equipment and vehicles Double handling to be avoided where possible Educate personnel on hydrocarbon and chemical handling risks/hazards through SHE briefings/toolbox meetings				
Community/Occupational Health, Safety and Security	External safety risks of bush fires, building collapse, air/noise pollution, pest infestations, work-related injuries occurring, particularly as workers may not be familiar with the operational methods and machinery.	Project area and workers on site	Moderate	- Workers will be provided with all the required PPE. - Worker induction, followed by regular training on operational and safety issues, will be conducted throughout employment First aid facilities will be available in all work areas - Medical facilities will be available to all workers. Ensure environmental cleanliness of the project site	Minor	AfDB -PIU	KnMEnv	FMEnv
Impact on economy and livelihood	Challawa Dam operation	State/National level	Positive	beneficial impacts and shall be enhanced by sustaining the project through adequate and effective maintenance	Positive	AfDB -PIU	KnMEnv	FMEnv

Indicator	Potential impact	Receptor	Significance (pre-mitigation)	Mitigation or enhancement measures	Significance (post-mitigation)	Responsibilities		
						Mitigation Action	Supervision	Monitoring
				activities as well as complying with the federal government's policies and laws on project operation				
Waste generation f	Release of wastewater effluents Generation of solid wastes from operation activities Spent/used oils	Project area	Medium	Waste bins shall be provided in all facility areas to dispose of the various types of wastes generated by the project. These bins will be marked to facilitate waste segregation for collection, transportation and disposal. Separation of domestic and hazardous waste at the source shall be strictly enforced. Where possible, wastes will be reused or recycled. Burning of waste shall not be permitted. All personnel shall be trained in the appropriate management of waste according to the WMP. Wastewater effluents shall be appropriately treated before releasing them into the	Minor	AfDB -PIU	KnMEnv	FMEnv

Indicator	Potential impact	Receptor	Significance (pre-mitigation)	Mitigation or enhancement measures	Significance (post-mitigation)	Responsibilities		
						Mitigation Action	Supervision	Monitoring
				environment. Waste oils generated by the project (vehicles and machinery) will be collected and stored in sealed containers and arrangements made with companies who can use them in their operations or manage their disposal.				
Emergency Response and Disaster Management	Loss of life, injury, damage to equipment, fire outbreaks, building collapse	Project facility and workers	Medium	-Implementation of Emergency Response Plan - Awareness-raising among workers - Monitoring of potential situations leading to disaster.	Minor	AfDB -PIU	KnMEnv	FMEnv

Table 7.3: Environmental and Social Monitoring Plan during Pre-Construction Phase

Component	Parameters to be Monitored	Method	Standards/Targets	Location	Frequency	Responsibility	Unit Cost (NGN)	Cost Estimates/ year (NGN)
Air quality	SO_2, NOx, CO_2, CO, VOC, PM	Visual inspection of construction sites, access roads; verification of equipment and machinery Ambient air quality measurements	Avoid significant degradation of baseline conditions. WHO and national ambient air quality standards, FMEnv standards	Within and around the Project site	Bi-Annually	AfDB-PIU	2,000,000	4,000,000
Noise	Noise Levels	Noise level measurements	Avoid significant degradation of baseline conditions. WHO and FMEnv noise standards	Within and around the Project site	Quarterly	AfDB-PIU	20,000,000	80,000,000
Soils	Visual signs of contamination Status of drainages, bund walls, stockpiles, etc.	Visual inspection of the construction site	Avoid the use of erosive processes or control them Reduce soil compaction Avoid soil profile structure destruction Avoid any soil contaminations	Soils in and around the Project site	Quarterly	AfDB-PIU	30,000,000	120,000,000
	Soil biological, physical and chemical properties	Sampling and analyses of soils	Avoid significant degradation of baseline conditions. FMENV soil quality standards	Soils in and around the Project site	Yearly	AfDB-PIU		
Surface Water	Water Physico-chemical and microbiological -pH, temperatur	Analysis of surface and groundwater samples Visual detection of pollution signs (presence	Avoid significant degradation of baseline conditions WHO and FMEnv water quality standards	Waterbody within the project area	Bi-annually	AfDB-PIU	6,100,000	12,200,000

Component	Parameters to be Monitored	Method	Standards/Targets	Location	Frequency	Responsibility	Unit Cost (NGN)	Cost Estimates/ year (NGN)
	e, TSS, turbidity, phosphorus, metals, Sulphate, BOD, COD, coliform, fungi, etc.	of oil, waste, etc.)						
Aquatic ecology	Same as water quality Fish catch yield	Visual inspection of rivers and streams Interview with fishermen	Avoid equipment and vehicle movements in rivers and streams.					
Vegetation resources	Vegetation cover Pictorial comparison (before and after) Fauna species, age, number of individuals sighted	Visual inspection of construction sites and access roads	Avoid significant degradation outside the project footprint. Protection of flora species with conservation status Avoid habitat loss and disturbances for local fauna	Flora and Fauna community in Project site and the surrounding area	Once during vegetation removal in the project site	AfDB -PIU	6,000,000	6,000,000
Wildlife resources								
Stakeholder relations Management	No complaints/ concerns received Status of grievance resolutions	Interview neighbouring communities Stakeholder meetings Inspection of complaints/grievance logbook	Grievances are resolved effectively Complaints and issues are addressed timely	Neighbouring communities	Quarterly	AfDB -PIU	3,000,000	12,000,000

Compone nt	Parameter s to be Monitored	Method	Standards/Targets	Locatio n	Freq uenc y	Resp onsi bility	Unit Cost (NGN)	Cost Estimates/ year (NGN)
Grievance redress mechanis m	No complaints/ concerns received Status of grievance resolutions	Interview neighbouring communities Stakeholder meetings Inspection of complaints/griev ance logbook	Grievances are resolved effectively Complaints and issues are addressed timely	Neighbo uring commun ities	Quart erly	AfDB -PIU	2,250, 000	9,000,000
Health, Safety and Security	Incidences	Inspection and review of incidence log	ILO requirements and Factories Act minimum labour standards	Constru ction site	Quart erly	AfDB -PIU	1,000,00 0	4,000,000
Employme nt and economy	The proportion of employees from the host communitie s materials procured from community members made in Nigeria materials used	Inspect employee records Random interview with workers on site Inspection of procurement records Interview with suppliers and vendors	Semi-skilled and non-skilled labour employed from the PACs Materials available in the communities are used Made in Nigeria products are utilised, except where not available	Constru ction site	Quart erly	AfDB -PIU	2,500,00 0	10,000,000
Capacity Building	The proportion of employees from the PIU and State Officials for Traini ng, Workshops and Seminars on Global	Inspect PIU and State Officials records Qualitative interview with PIU and State Officials on Global warming, environmental harzards and innovative technologies	Skilled resource persons employed to train Training of PIU and State Officials in a foreign country to implement the knowledge in Nigeria.	PIU and offices of State Officials	Quart erly	AfDB -PIU	10,000,0 00	40,000,000

Component	Parameters to be Monitored	Method	Standards/Targets	Location	Frequency	Responsibility	Unit Cost (NGN)	Cost Estimates/ year (NGN)
	warming, environmental harzards and innovative technologies to provide solutions to environmental problems.							
TOTAL								**297,200,000**

Table 7.4: Environmental and Social Monitoring Plan during Construction Phase

Component	Parameters to be Monitored	Method	Standards/Targets	Location	Frequency	Responsibility	Unit Cost (NGN)	Cost Estimates/year (NGN)
Air quality	SO_2, NOx, CO_2, CO, VOC, PM	Visual inspection of construction sites, access roads; verification of equipment and machinery Ambient air quality measurements	Avoid significant degradation of baseline conditions. WHO and national ambient air quality standards, FMEnv standards	Within and around the Project site	Monthly	AfDB-PIU	2,000,000	24,000,000
Noise	Noise Levels	Noise level measurements	Avoid significant degradation of baseline conditions. WHO and FMEnv noise standards	Within and around the Project site	Monthly	AfDB-PIU	20,000,000	240,000,000
Soils	Visual signs of contamination Status of drainages, bund walls, stockpiles, etc	Visual inspection of the construction site	Avoid the use of erosive processes or control them Reduce soil compaction Avoid soil profile structure destruction Avoid any soil contaminations	Soils in and around the Project site	Quarterly	AfDB-PIU	20,000,000	80,000,000
	Soil biological, physical and chemical properties	Sampling and analyses of soils	Avoid significant degradation of baseline conditions. FMENV soil quality standards	Soils in and around the Project site	Quarterly	AfDB-PIU		
Surface Water	Water Physico-chemical and microbiological -pH, temperature, TSS, turbidity,	Analysis of surface and groundwater samples Visual detection of pollution signs (presence of oil, waste, etc.)	Avoid significant degradation of baseline conditions WHO and FMEnv water quality standards	Waterbody within the project area	Bi-annually	AfDB-PIU	7,500,000	15,000,000

Component	Parameters to be Monitored	Method	Standards/Targets	Location	Frequency	Responsibility	Unit Cost (NGN)	Cost Estimates/year (NGN)
	phosphorus, metals, Sulphate, BOD, COD, coliform, fungi, etc.							
Aquatic ecology	Same as water quality Fish catch yield	Visual inspection of rivers and streams Interview with fishermen	Avoid equipment and vehicle movements in rivers and streams.					
Vegetation resources	Vegetation cover Pictorial comparison (before and after) Fauna species, age, number of individuals sighted	Visual inspection of construction sites and access roads	Avoid significant degradation outside the project footprint. Protection of flora species with conservation status Avoid habitat loss and disturbances for local fauna	Flora and Fauna community in Project site and the surrounding area	Once during vegetation removal in the project site	AfDB-PIU	6,500,000	6,500,000
Wildlife resources								
Stakeholder relations Management	No complaints/ concerns received Status of grievance resolutions	Interview neighbouring communities Stakeholder meetings Inspection of complaints/grievance logbook	Grievances are resolved effectively Complaints and issues are addressed timely	Neighbouring communities	Quarterly	AfDB-PIU	2,500,000	10,000,000
Grievance redress mechanism	No complaints/ concerns received Status of grievance resolutions	Interview neighbouring communities Stakeholder meetings Inspection of complaints/grievance logbook	Grievances are resolved effectively Complaints and issues are addressed timely	Neighbouring communities	Quarterly	AfDB-PIU	3,000, 000	12,000,000

Componen t	Parameter s to be Monitored	Method	Standards/Targets	Location	Freq uenc y	Resp onsib ility	Unit Cost (NGN)	Cost Estimate s/year (NGN)
Health, Safety and Security	Incidences	Inspection and review of incidence log	ILO requirements and Factories Act minimum labour standards	Constru ction site	Quart erly	AfDB -PIU	1,000,00 0	4,000,00 0
Employme nt and economy	The proportion of employees from the host communitie s materials procured from community members made in Nigeria materials used	Inspect employee records Random interview with workers on site Inspection of procurement records Interview with suppliers and vendors	Semi-skilled and non-skilled labour employed from the PACs Materials available in the communities are used Made in Nigeria products are utilised, except where not available	Constru ction site	Quart erly	AfDB -PIU	2,000,00 0	8,000,00 0
Capacity Building	The proportion of employees from the PIU and State Officials for Traini ng, Workshops and Seminars on Global warming, environme ntal harzards and innovative technologie s to	Inspect PIU and State Officials records Qualitative interview with PIU and State Officials on Global warming, environmental harzards and innovative technologies	Skilled resource persons employed to train Training of PIU and State Officials in a foreign country to implement the knowledge in Nigeria.	PIU and offices of State Officials	Quart erly	AfDB -PIU	20,000,0 00	80,000,0 00

Component	Parameters to be Monitored	Method	Standards/Targets	Location	Frequency	Responsibility	Unit Cost (NGN)	Cost Estimates/year (NGN)
	provide solutions to environmental problems.							
TOTAL								**479,500,000**

Table 7.5: Environmental and Social Management Plan during Operations Phase

Component	Parameters to be Monitored	Method	Standards/Targets	Location	Frequency	Responsibility	Unit Cost (NGN)	Cost Estimates/ Year (NGN)
Air quality	SO_2, NOx, CO_2, CO, VOC, PM,	Visual inspection of substations and access roads; verification of equipment and machinery records Ambient air quality measurements	Avoid significant degradation of baseline conditions. WHO and national ambient air quality standards (FMEnv)	Project area	Bi-Annually	KnMEnv - HSE Dept.	2,750,000	5,500,000
Noise	Noise Levels	Noise level measurements	Avoid significant degradation of baseline conditions. WHO and FMEnv noise standards	Project area	Monthly	KnMEnv - HSE Dept.	4,400,000	55,280,000
Soils	Visual signs of contamination Status of drainages, bund walls, stockpiles, etc.	Visual inspection of substation sites and access roads	Avoid the use of erosive processes or control them Reduce soil compaction Avoid soil profile structure destruction Avoid any soil contaminations	Soils in and around the Project area	Bi-Annually	KnMEnv - HSE Dept..	20,000,000	40,000,000
	Soil biological, physical and chemical properties	Sampling and analyses of soils	Avoid significant degradation of baseline conditions. FMEnv soil quality standards	Soils in and around the project area	Bi-Annually	KnMEnv - HSE Dept		
Surface water								
Stakeholder relations Management	Number of complaints/ concerns received Status of grievance	Interview neighbouring communities Stakeholder meetings Inspection of complaints/grievance logbook	Grievances are resolved effectively Complaints and issues are addressed timely	Neighbouring communities	As need arises	KnMEnv - HSE Dept	10,500,000	10,500,000

Component	Parameters to be Monitored	Method	Standards/Targets	Location	Frequency	Responsibility	Unit Cost (NGN)	Cost Estimates/ Year (NGN)
	resolutions							
Grievance Redress Mechanism	Number of complaints/ concerns received Status of grievance resolutions	Interview neighbouring communities Stakeholder meetings Inspection of complaints/grievance logbook	Grievances are resolved effectively Complaints and issues are addressed timely	Neighbouring communities	As need arises	KnMEnv - HSE Dept	10, 200,000	10,200,000
Health, Safety and Security	Incidences	Inspection and review of incidence log		Project facility and workers	Bi-Annually	KnMEnv - HSE Dept	7,500,000	15,000,000
Employment and economy	The proportion of employees from the host communities materials procured from community members made in Nigeria materials used	Inspect employee records Random interview with workers Inspection of procurement records Interview with suppliers and vendors	Semi-skilled and non-skilled labour employed from the PACs Made in Nigeria products are utilised, except where not available ILO requirements and Factories Act minimum labour standards	Project facility	As need arises	KnMEnv - HSE Dept	1,000,000	1,000,000
Capacity Building	The proportion of employees from the PIU and State Officials for Traini ng, Workshops and Seminars on Global warming, environmental harzards	Inspect PIU and State Officials records Qualitative interview with PIU and State Officials on Global warming, environmental harzards and innovative technologies	Skilled resource persons employed to train Training of PIU and State Officials in a foreign country to implement the knowledge in Nigeria.	PIU and offices of State Officials	Quarterly	AfDB -PIU	15,000, 000	60,000,000

Component	Parameters to be Monitored	Method	Standards/Targets	Location	Frequency	Responsibility	Unit Cost (NGN)	Cost Estimates/ Year (NGN)
	and innovative echnologies to provide solutions to environmental problems.							
TOTAL								**197,480,000**

Chapter Eight
Conclusion and Recommendations

8.1 Summary and Conclusion

This Environmental and Social Impact Assessment (ESIA) Report was prepared in accordance with the requirements of the Federal Ministry of Environment and the African Development Bank (AfDB). Based on interactions between project activities and the recipient environment, the ESIP/ESMP is well documented in this report.

The proposed Challawa Gorge Dam Watershed Management Project by the HJKYB_TF is justifiable and will have a number of significant positive effects in the short and long term including:

- Reduce Environmental Pollution;
- Minimize global warming and climate change;
- Ensure minimum or no siltation of the Challawa Dam Reservoir which will boost agricultural, commercial, uninterrupted Kano Municipal water supply for domestic and industrial use in the area;
- Stabilize soils and control the menace of gully formation and farm lands destruction around the river banks in the area;
- Contribute to national water resources development and management; and
- Create employment opportunities for the people of the area.

The overall impacts associated with the activities of the proposed project can demonstrably be managed within reasonable and acceptable limits by applying all the recommended mitigation measures.

In addition to the identified mitigation measures, there are a number of other commitments to be followed. These include:

- Undertaking a Best Practicable Environmental Option (BPEO) for the watershed management;
- Define and undertake monitoring for atmospheric emissions, soil loss, sediment influx and social impacts;
- Regular auditing of environmental performance of the project operational elements;
- Carry out further studies to determine the best decommissioning strategy towards the end of the project lifecycle; and

An Environmental and Social Management Plan (ESMP) has also been drawn up to manage residual impacts, ensure compliance with regulatory requirements and the incorporation of environmental controls throughout the project life cycle.

8.2 Recommendation

In view of all that had been documented in this ESIA/ESMP report and the commitment by HJKYB-TF to ensure strict compliance with this EIA, the Hadeja-Jamaare-Komadugu-Yobe Basin Trust Fund hereby requests the endorsement of the AfDB and the National Regulatory body (FMEnv.) for Approval to enable timely commencement of the proposed project.

References

1. African Development Bank Group. Environmental & Social Assessment Procedures Basics For public Sector Operations: Compliance & Safeguards Division (Orqr.3). Retrieved 12th May, 2021 from safeguards@afdb.org
2. AfDB, Safeguards and Sustainability Series Volume 1 - Issue 4 (November 2015)
3. African Development Bank (AfDB). Environmental & Social Assessment Procedures Basics For public sector operations. Compliance & Safeguards Division (Orqr.3)
4. African Development Bank Group. Environmental & Social Assessment Procedures Basics For public Sector Operations: Compliance & Safeguards Division (Orqr.3). Retrieved 12th May, 2021 from safeguards@afdb.org
5. Federal Republic of Nigeria (1990): Land Use Act, Laws of the Federal Republic of Nigeria.
6. Federal Republic of Nigeria (March, 2019): Komadugu Yobe Basin Strategic Action Plan (SAP) - Main Report. KYB-TF.
7. UN-Water, 2020: UN-Water Policy Brief on the United Nations global water conventions: Fostering sustainable development and peace. Geneva, Switzerland.
8. African Development Bank (2013. AfDB Group's Integrated Safeguards System: Policy Statement and Operational Safeguards.
9. African Development Bank Group. Environmental & Social Assessment Procedures Basics for public Sector Operations: Compliance & Safeguards Division (Orqr.3). Retrieved 12th May, 2021 from safeguards@afdb.org
10. Federal Republic of Nigeria (March, 2019): Komadugu Yobe Basin Strategic Action Plan (SAP) - Main Report. KYB-TF.
11. World Commission on Dams (2000): Dams and Development: A New Framework. Earth Scan Publications Ltd, London and Sterling, VA.
12. SMEC Report, 2019: Priority Projects Preparation Report: Vol. 1A – Challawa Gorge Dam Catchment Management Project, March 2019.
13. Environmental and Social Impact Assessment (ESIA) For the Hadejia Jama'are Sub-Basin with Kano River Irrigation Scheme (KRIS) and Hadejia Valley Irrigation Scheme (HVIS) and the Associated Cumulative Impacts 2017. Prepared by Hospitalia Consultaire 2Masaka Close, off Olusegun Obasanjo Way, Zone 7, Abuja info@hospitaliaconsultaire.com www.hospitaliaconsultaire.com 2017

14. Federal Republic of Nigeria, Federal Ministry of Commerce and Industry (2010): Resettlement Policy Frame Work for Growth and Enterprises and Markets in States (GEMS) Project, Prepared by Earth Guard, March
15. AfDB, Safeguards and Sustainability Series Volume 1 - Issue 4 (November 2015).
16. African Development Bank (AfDB). Environmental & Social Assessment Procedures Basics For public sector operations. Compliance & Safeguards Division (Orqr.3).
17. Federal Republic of Nigeria (1992): Environmental Impact Assessment Decree No 86 of 1992 Laws of the Federation of Nigeria
18. Federal Republic of Nigeria (March, 2019): Komadugu Yobe Basin Strategic Action Plan (SAP) - Main Report. KYB-TF.
19. African Development Bank (2013. AfDB Group's Integrated Safeguards System: Policy Statement and Operational Safeguards.
20. Federal Republic of Nigeria Infrastructure Concession Regulatory Commission (ICRC) (2009): Resettlement Policy Framework (RPF) for Nigeria Public Private Partnership (PPP) Project, prepared by ERML, December.
21. Government of India, Ministry of Urban Development (2008): Environment and Social Management Framework for Global Environment Facility Sustainable Urban Transport Project, September
22. India Governments of India States of Tamil Nadu & Pondicherry (2005): Environmental and Social Management Framework for Emergency Tsunami Reconstruction Project, April .
23. ITUA, E.O. (2014). Resettlement Action Plan for the Ekehuan Flood intervention Erosion Site, Benin City as part of Nigeria Erosion and Watershed Management Project. Federal Ministry of Environment, Nigeria
24. SMEC (2019): Priority Projects Preparation Report: Vol. 1A-Challawa Gorge Dam Catchment Management Project, March 2019.
25. UN-Water, 2020: UN-Water Policy Brief on the United Nations global water conventions: Fostering sustainable development and peace. Geneva, Switzerland.
26. World Commission on Dams (2000): Dams and Development: A New Framework. Earth Scan Publications Ltd, London and Sterling, VA.
27. Jordan Drugge and Sharon L. Doty (2019): Functions of a Riparian Buffer: in Elizabeth Rogers (edt.) Working Party 5 Extension Bulletin March 2019.
28. World Commission on Dams (2000): Dams and Development: A New Framework. Earthscan Publications Ltd, London and Sterling, VA.

29. Olofin, E. A. 1984. Some effects of the Tiga Dam on valley side erosion in downstream reaches of the River Kano. Applied Geography 4 (4): 321–332.
30. Olofin, E. A. 1987. Some aspects of the physical geography of the Kano region and related human responses. Departmental Lecture Note Series: Geography Department, Bayero University. Debis Standard Printers, Kano, Nigeria.
31. Olofin, E. A., Nabegu, A. B. and Dambazau, A. M. 2008. Wudil within Kano region: a geographical synthesis. Published by Adamu Joji Publishers on behalf of The Department of Geography, Kano University of Science and Technology, Wudil.
32. Olofin, E. A. and Tanko A. I. (2003) Laboratory of Areal Differentiation –Metropolitan Kano in Geographic perspective, Department of Geography Field Studies Series 1. Bayero University Kano.
33. Chomchalow, Narong, 2005. Review and Update of the Vetiver System R&D in Thailand. Summary for the Regional Conference on vetiver 'Vetiver System: disaster mitigation and environmental protection in Viet Nam'.
34. Berg, van den, Johan, 2003. Can vetiver Grass be Used to Manage Insect Pests on Crops? Proc. Third International Vetiver Conf. China, October 2003.
35. Le Van Du and P. Truong (2006). Vetiver grass for Vietnam. Proc. Fourth International Vetiver Conference.
36. Maigari (2012
37. Bawden, et al. (1973)
38. Ayoade (1988)
39. Nazeef S; Ja'afar A. Abubakar K. A. and Kabiru M. (2021). Fish Species biodiversity of Dadin Kowa Reservoir: Current Status. World Journal of Advanced Research and Reviews, 2021, 11(02), 100-111.
40. Federal Ministry of Water Resources, Nigeria (2017): Environmental and Social Impact Assessment (ESIA) for the Hadejia Jama'are Sub-Basin with Kano River Irrigation Scheme (KRIS) and Hadejia Valley Irrigation Scheme (HVIS) and the Associated Cumulative Impacts. Hadeja-Jammare River Basin Development Authority, Nigeria.
41. ESIA For the Transmission Company of Nigeria Project Management Unit (TCN-PMU): Environmental and Social Impact Assessment (ESIA) for the Proposed 330/132/33kV Transmission Substation New Kano, Kano State. SMEC March, 2017.
42. Garba, I. (2009): Hydrogeological Map of Kabo Sheet 80 NW Topographical Sheet 1:50,000. Bajopas, Volume 2 Number 2 December, 2009).

43. Olofin, 1987
44. Taroyemani (1997) .
45. Ayoade, J.O. Tropical Hydrology and Water Resources; Macmillan Publishers Ltd.: London, UK, 1988; p. 189.
46. Tanko, A.I. Water Resource Development And Management. In Kano: Environment, Society And Development, 1st Ed.; Tanko, A.I., Momale, S.B., Eds.; Adonis And Abbey: London, UK; Abuja, Nigeria, 2014; Volume 1, P. 228, ISBN 978190911291 (Paper Back), 9781909112407 (Hard Cover).
47. Von Maydell, 1990; Danjuma, 2010).
48. Babatunde D, Raji A. (1982). Field Guide to Nigerian Fresh Water Fishes: Federal College of Fresh Water Fisheries Technology New Bussa, Nigeria.
49. Holden M, Reed W. West African Fresh Water Fish, 1972,
50. Nazeef Suleiman, Idris Ado Yola and Ibrahim Muhammad Ahmed (2018).Biodiversity and condition factor of fish species from Challawa Gorge Dam. International Journal of Fisheries and Aquatic 6(3): 112-117
51. (Powell, 1995; Swallow and Kamara, 2000)
52. Wolff, H. Ekkehard. "Hausa language": Encyclopedia Britannica. Retrieved 2021, 10-14)
53. Eberhard, David M., Gary F. Simons, and Charles D. Fennig (eds.). 2021. Ethnologue: Languages of the World. Twenty-fourth edition. Dallas, Texas: SIL International. Online version: http://www.ethnologue.com
54. The HERALD News Paper,
55. https://www.encyclopedia.com/social-sciences-and-law/anthropology-and-archaeology/people/hausa.
56. Smith, M. G. “The Hausa of Northern Nigeria.” In Paul Gibbs, ed., Peoples of Africa. New York: Holt, Rinehart, and Winston, 1965
57. Nigeria: Kano State Multiple Indicator Cluster Survey 2016-17 Final Report May, 2018
58. Babatunde, and Raji, (1998)
59. Holden and Reed (1972).
60. Iliyasu, Zubairu & Abubakar, Isa & Gajida, Auwal. (2010). Magnitude and leading causes of in-hospital mortality at Aminu Kano Teaching Hospital, Kano, Northern Nigeria: A 4-year prospective analysis. Nigerian journal of Medicine. Journal of the National Association of Resident Doctors of Nigeria. 19. 400-6. 10.4314/njm.v19i4.61964.\

61. Zubairu Iliyasu, Isa Sadeeq Abubakar, and Auwal Umar Gajida (2010): Nigerian Journal of Medicine. Oct-Dec 2010; 19(4):400-6. doi: 10.4314/njm.v19i4.61964.
62. Source: STATISTA. https://www.statista.com/statistics/1122916/main-causes-of-death-and-disability-in-nigeria/
63. ISO, 1996

APPENDIX 1

Letter of Authorisation to Disclose the ESIA by the Federal Ministry of Environment

FEDERAL MINISTRY OF ENVIRONMENT

Environment House
Independence Way South, Central Business District, Abuja - FCT.
Email: info@ead.gov.ng, eia@ead.gov.ng www.ead.gov.ng

ENVIRONMENTAL ASSESSMENT DEPARTMENT

Ref: FMEnv/EA/EIA/5991/Vol.1/X

Date: 30th May, 2023

The Director-General,
African Development Bank,
1521 Cadastral Zone AO,
Off Memorial Close,
Beside Silverbird Galleria,
CBD, Abuja

Attention: Dr. M. Bakia

AUTHORITY TO DISCLOSE

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF CHALLAWA GORGE WATERSHED MANAGEMENT PROJECT

I am directed to inform you that Hadejia Jama'are Komadugo Yobe Basin Trust Fund has registered the above-mentioned project with the Federal Ministry of Environment for an EIA permit.

2. The ESIA process is on-going, the draft ESIA Report has been submitted and shall soon be displayed for stakeholder's comments. You are kindly requested by this to proceed with your internal disclosure controls and to give the project all necessary assistance.

3. Please note that the Federal Ministry of Environment shall ensure that the Approval process leading to ESIA certification and monitoring is concluded.

4. Thank you for your cooperation.

Dr. Abbas .O. Suleiman, fnes
Director, Environmental Assessment Department
For: Honourable Minister.

LIST ORGANIZATIONS HAVING CONTRIBUTED TO THE PREPARATION OF THE ESIA REPORT

1. AFRICAN DEVELOPMENT BANK (AfDB)
2. FDERAL MINISTRY OF ENVIRONMENT
3. HADEJA JAMAMARE-KOMADUGU YOBE BASIN TRUSF FUND (JKYB-TF)
4. KANO STATE MINSTRY OF ENVIRONMENT.
5. HADEJA JAMARE RIVER BASIN DEVELOPMENT AUTHORITY
6. MANAGEMENT, CHALLAWA GORGHE DAM RESERVOIR

APPENDIX 2

LIST OF PROFESSIONALS HAVING CONTRIBUTED TO THE PREPARATION OF THE ESIA REPORT

A. PROFESSOR ABBAS BASHIR- CHIEF CONSULTANT

B. DR. BABAGANA BOSO - ENVIRONMENTAL SCIENTIST

C. DR. ELI JOEL – ENVIRONMENTAL SPECIALIST

D. DR. BUKAR NGAMDU – SOCIOECONOMIC SPECIALIST

E. ENGINEER AHMED SULAIMAN–ENVIRONMENTAL ENGINEER

F. MALAM MUHAMMED MODIBBO (GIS SPECIALIST)

G. AHMAD B. BASHIR – SECRETARIAT SERVICES

.

APPENDIX 3

LIST OF DOCUMENTS CONSULTED FOR THIS ESIA REPORT

1. African Development Bank Group: Environmental & Social Assessment Procedures Basics For public sector operations AFRICAN DEVELOPMENT BANK GROUP COMPLIANCE & SAFEGUARDS DIVISION (ORQR.3) safeguards@afdb.org.

2. African Development Bank Group: Environmental and Social Assessment Procedures (ESAP. SAFEGUARDS AND SUSTAINABILITY SERIES Volume 1 - Issue 4 (November 2015).

3. ENVIRONMENTAL IMPACT ASSESSMENT STUDY PROPOSAL For Dredging Operation (Marine Works) At Shoaiba Power Plant Extension, Stage III, 2009.

4. ENVIRONMENTAL IMPACT ASSESSMENT ACT: An Act to set out the general principles, procedure and methods to enable the prior consideration of Environmental Impact Assessment on certain public or private projects. [1992 No. 86.]   [10th December, 1992].

5. Guidance on EIA Scoping June 2000: Environmental Resources Management Norloch House, 36 King's Stables Road, Edinburgh EH1 2EU Telephone 0131 478 6000 Facsimile 0131 478 3636 Email post@ermuk.com http://www.ermuk.com

6. Environmental Impact Assessment Decree No 86 of 1992 Laws of the Federation of Nigeria 10th December1992

7. Guidance Note – ESMS Manual Environmental & Social Management System (ESMS) Version : 15 March 2020 Environmental and Social Impact Assessment (ESIA).

8. Environmental And Social Impact Assessment for Water Supply Alternatives for TMGO ESIA for Water Supply Alternatives

9. ENVIRONMENTAL IMPACT ASSESSMENT FOR MUNSHIWEMBA INTERMEDIATE DAM PROJECT

10. The Nigeria Land Use Act, 1978

11. The Notational Environmental Standards ans Regulations Enforcement Agency (NESREA) Law, 2007.

12. Dams and Development : A New Framework . Report Of The World Commission On Dams Earthscan Publications Ltd, London And Sterling, Va For Decision-M A Ki Ng.

13. Environmental Impact and Social Management Plan (ESMP: DIGINET ENGINEERING NIGERIA LTD. For the Proposed 100kw solar Plant at FARUN/DABAkazaure LGA, Jigawa State, Nigeria 2021. Federal Ministry of Environment

APPENDIX 4

LABORATORY RESULTS OF BASE LINE WET SEASON SOIL, WATER AND AIR CONDITION

CHALLAWA GORGE DAM ESIA STUDY

SOIL PHYSICOCHEMICAL PARAMETER

S/N	PARAMETER	SSL1		SSL2		SSL3		SSL4		SSL5		SSL6		SSL7		SSL8		SSL9		SSL10	
	DEPTH	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30
1.	Temperature (^oC)	30.5	30.4	30.3	31.5	30.0	30.1	31.5	32.5	33.4	33.3	30.5	30.4	30.3	31.5	30.0	30.1	31.5	32.5	33.4	33.3
2.	pH	7.13	8.01	8.23	7.20	7.23	7.15	7.15	7.41	7.43	7.31	8.14	8.61	8.25	8.21	8.21	7.16	8.14	7.44	8.43	8.31
3.	Potential difference (MV)	58.23	57.43	52.25	61.18	76.14	67.21	62.45	72.65	54.1	64.1	18.21	27.41	32.21	61.14	76.13	37.21	62.44	42.15	34.1	44.6
4.	TDS (mg/kg)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.	Conductivity	142	141	133	176	152	131	141	121	137	147	321	321	141	134	143	167	125	187	154	156
6.	Colour	Redish brown	Redish brown	Redish brown	Redish brown	Redish brown	Redish brown	Redish brown	Redish brown	brown	brown	Redish brown	Redish brown	Redish brown	Redish brown	0.54	0.31	0.21	0.31	0.15	0.31
7.	DO2 (mg/kg)	4.7	4.2	4.6	4.7	4.6	4.4	4.1	4.3	4.5	4.6	7.1	8.3	7.5	3.4	7.8	5.1	4.7	3.7	5.6	4.8
8.	BOD (mg/kg)	1.2	1.6	1.2	0.3	0.4	0.3	2.3	2.5	2.2	2.2	3.8	3.7	2.8	2.0	1.4	1.56	1.34	1.37	1.34	1.36
9.	COD (mg/kg)	16.78	19.0	19.78	32.18	32.5	41.50	43.12	32.10	11.3	19.10	14.8	18.9	16.9	14.6	0.32	0.41	0.17	0.23	0.18	0.18

10.	Turbidity (FAU)	-	-	-	-	5.4	8.5	9.3	7.4	8.3	7.9	-	-	-	-	-	-	-	-	-	-
11.	Alkalinity (mg/kg)	76.6	89.4	96.56	45.7	54.89	87.10	96.40	76.43	57.54	74.1	184	186	145.9	164.1	0.12	0.16	0.15	0.15	0.16	0.15
12	Phosphate (mg/kg)	32	34	54	46	53	58	56	48	38	58	54	87	76	34	0	0	0	0	0	0
13.	Hardness (mg/kg)	154	187	154	124	189	145	192	176	130	145	231	341	145	156	0.67	0.45	0.54	0.54	0.67	0.45
14	Carbonate (mg/kg)	0.05	0.61	0.53	0.35	0.23	0.23	0.45	0.65	0.80	0.83	1.89	1.67	1.76	1.45	0	0	0	0	0	0
15.	Salinity (mg/kg)	134.5	134.5	134.1	115.1	142.4	141.5	132.3	143.6	121.3	133.5	130.5	134.1	141.6	135.1	0	0	0	0	0	0
16.	TSS (mg/kg)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.54	0.31	0.21	0.31	0.15	0.31
17.	Total Organic Carbon (mg/kg)	0.23	0.23	0.43	0.34	0.45	0.16	0.34	0.57	0.43	0.31	0.23	0.43	0.51	0.34	7.8	5.1	4.7	3.7	5.6	4.8

SOIL EXCHANGEABLE CATIONS

S/N	PARAMETER	SSL1		SSL2		SSL3		SSL4		SSL5		SSL6		SSL7		SSL8		SSL9		SSL10	
	DEPTH	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30
1.	Na^+ (mg/kg)	143	29	36	36	41	43	34	53	51	43	32	43	31	34	52	56	32	43	32	31
2.	K^+ (mg/kg)	1.08	1.43	1.21	1.32	1.31	1.24	1.43	1.35	1.23	1.21	2.51	1.81	2.41	2.34	2.10	2.31	1.67	1.34	3.41	2.60
3.	Mg^{2+} (mg/kg)	0.24	0.31	0.34	0.16	0.18	0.15	0.35	0.17	0.24	0.14	13.8	17.8	15.4	14.6	16.8	18.4	21.5	15.7	13.1	13.34
4.	Ca^{2+} (mg/kg)	1.34	1.42	1.60	1.21	1.34	1.31	2.41	1.51	1.45	3.43	1.45	1.43	2.41	2.14	2.45	2.17	2.16	1.56	1.34	1.51

SOIL EXCHANGEABLE ANIONS

S/N	PARAMETER	SSL1		SSL2		SSL3		SSL4		SSL5		SSL6		SSL7		SSL8		SSL9		SSL10	
	DEPTH	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30
1	Sulphate as SO_4^{-2}(mg/kg)	54	34	54	43	34	65	23	45	45	45	45	38	37	45	35	56	57	34	41	41
2	Nitrate as NO_3^{-1} (mg/kg)	2.76	2.67	2.81	3.10	3.51	3.56	2.67	2.11	2.67	2.56	2.76	2.67	2.81	3.10	3.51	3.56	2.67	2.11	2.67	1.56
3	Nitrite NO_2^{-1} (mg/kg)	1.67	1.67	2.87	1.87	1.45	2.34	2.31	1.34	1.34	1.23	1.63	1.60	2.81	1.81	1.47	2.34	2.31	1.34	1.3	1.21
4	Ammonium as NH_4+ (mg/kg)	0.50	0.12	0.41	0.47	0.16	0.14	0.15	0.32	0.31	0.13	0.15	0.12	37	45	0.21	0.31	0.43	0.54	0.51	0.53
5	Nitrogen as N_2 (mg/kg)	1.67	1.54	2.54	2.54	2.12	2.30	3.67	3.18	1.51	1.4	1.78	1.56	0.14	0.31	1.56	1.45	1.89	1.45	1.34	1.45
6	Phosphate (mg/kg)	06	06	7.8	12	11	09	08	05	06	09	43	45	1.56	1.67	48	50	43	41	24	27
7	Chlorine as Cl_2 (mg/kg)	1.4	1.6	1.4	1.3	1.4	1.5	1.3	1.5	1.6	1.6	8.91	8.34	38	38	4.70	4.06	3.70	3.41	4.27	4.51

SOIL HEAVY METALS

S/N	PARAMETER	SSL1		SSL2		SSL3		SSL4		SSL5		SSL6		SSL7		SSL8		SSL9		SSL10	
	DEPTH	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30
1	Cadmium as Cd (mg/kg)	0.01	0.01	0.03	0.02	0.01	0.02	0.01	0.02	0.03	0.03	0.03	0.04	0.34	0.02	0.54	0.31	0.21	0.31	0.15	0.31
2	Zinc as Zn (mg/kg)	2.3	1.5	3.1	3.1	3.6	3.8	2.4	1.5	1.5	1.4	4.8	5.1	3.8	4.6	7.8	5.1	4.7	3.7	5.6	4.8
3	Iron as Fe (mg/kg)	3.1	4.5	3.5	3.1	2.4	2.6	3.6	3.4	3.5	3.4	1.87	1.64	1.34	1.45	1.40	1.56	1.34	1.37	1.34	1.36

4	Copper as Cu (mg/kg)	1.3	33.1	1.4	1.8	2.8	2.9	2.7	1.8	1.2	1.8	0.78	0.45	0.67	0.67	0.32	0.41	0.71	0.23	0.18	0.18
5	Nickel as Ni (mg/kg)	0	0	0	0	0	0	0	0	0	0	3.4	6.4	8.5	9.5	5.4	8.7	9.3	7.4	8.3	7.9
6	Lead as Pb (mg/kg)	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.02	0.01	0.16	0.16	0.13	0.17	0.12	0.16	0.15	0.15	0.18	0.15
7	Manganese Mn (mg/kg)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	Barium as Ba (mg/kg)	0	0	0	0	0	0	0	0	0	0	0.78	0.78	0.56	0.34	0.67	0.45	0.54	0.54	0.67	0.45
9	Arsenic as As (mg/kg)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	Mercury as Hg	0	0	0	0	0	0	0	0	0	0	0	0	00	0	0	0	0	0	0	0

SOIL CHARACTERISTICS

S/N	PARAMETER	SSL1		SSL2		SSL3		SSL4		SSL5		SSL6		SSL7		SSL8		SSL9		SSL10	
	DEPTH	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30
1	Texture	**Sandy**	**Sandy**	**Sandy**	**Sandy**	**Sandy**	**Sandy**	**Loamy**	**Loamy**	**Loamy**	**Loamy**	0.81	0.82	0.78	0.78	0.71	0.71	0.82	0.82	0.71	0.72
2	Grain size (mm)	0.71	0.72	0.80	0.80	0.71	0.71	0.82	0.82	0.71	0.72	32.0	32	31	31	31	31.2	31.2	31.1	31.2	31.1
3	Porosity (%)	32	32	31	31	31	32.2	31.2	31.1	31.2	31.1	15.2	15.6	16.6	13.5	12.2	16.3	15.2	15.3	16.2	15.1
4	Permeability (cm/hr)	15.2	15.6	16.6	13.5	12.2	16.3	15.2	15.3	16.2	15.1	-	-	-	-	-	-	-	-	-	-
5	Bulk density (g/cm^3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	Erosion potential	-	-	-	-	-	-	-	-	-	-	0.31	0.42	0.24	1.31	0.12	0.33	0.31	0.13	0.31	0.34
7	Moisture content (%)	0.31	0.42	0.24	1.31	0.12	0.33	0.31	0.13	0.31	0.34	0.81	0.82	0.78	0.78	0.71	0.71	0.82	0.82	0.71	0.72

WATER ANALYSIS

SAMPLE TYPE: **UNDERGROUND WATER**
VOLUME/QUANTITY: **1.5 LITRES**
PRESERVATION METHOD: **REFRIGERATION**

S/NO	PARAMETER	WS1 (MG/l)	WS2(MG/l)	WS3(MG/l)	WS4(MG/l)	WS5 (MG/l)	FMEnv/N SDW LIMIT (MG/l)	REMARKS
A	PHYSICAL TEST							
1	COLOUR	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	NS	Satisfactory
2	ODOUR	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Ns	Satisfactory
3	pH	8.31	6.5	8.23	7.89	8.91	6-9	Satisfactory
4	CONDUCTIVITY (µS/cm)	135	198	287	218	178	NS	Satisfactory
5	TDS	351	95	5.81	4.81	5.78	2000	Satisfactory
6	TSS	11	08	145	163	15.7	30	Satisfactory
7	DO	6.23	2.4	6.2	4.98	5.81	2-8	Satisfactory
8	TEMPERATURE	30.7	37.4	31.0	29.9	30.7	Ambient	Acceptable
B	CHEMICAL TEST							
9	TOTAL HARDNESS	2.3	80.0	6.9	15.8	10.6	150	Satisfactory
10	CALCIUM	0.23	26.0	3.65	6.81	9,67	200	Satisfactory
11	MAGNESIUM	0.45	47.0	1.89	8.10	5.67	200	Satisfactory
12	POTASSIUM	1.4	ND	2.90	5.89	7.5	NS	NS
13	SODIUM	45	124	54	67	68	NS	NS

14	TOTAL CHLORINE	0.06	ND	1.89	1.89	0.17	1	Satisfactory
15	AMMONIUM	2.00	2.50	5.81	6.8	21.9	600	Satisfactory
16	TOTAL PHOSPHATE	8.0	35	35	35	35	NS	Acceptable
17	NITRATE	6.0	13	11	14	10	20	Acceptable
18	SULPHATE	47	35	35	35	35	NS	
19	NITRITE	2.8	0.1	0.1	0.1	0.4	0.1	Satisfactory
20	BOD	14.0	1.3	1.3	1.5	1.3	40	Satisfactory
21	COD	0	0	0	0	0	50	Satisfactory
C	ORGANICS							
22	OIL AND GREASE	0	0	0	0	0	10	Satisfactory
23	PHENOL	0	0	0	0	0	NS	Acceptable
D	HEAVY METALS							
24	CHROMIUM	0	0.05	0.12	0.13	0.21	20	Satisfactory
25	IRON	11.4	0.41	0.28	0.28	0.22	<1	Unsatisfactory
26	LEAD	0	0.58	0.34	0.33	0.42	<1	Satisfactory
27	CADMIUM	0	0.04	0.06	0.06	0.016	3	Satisfactory
28	ZINC	0.1	0.004	0.001	0.0011	0.0013	0.01	Satisfactory
29	ARSENIC	0	0.0006	0.005	0.0016	0.0012	0.001	Satisfactory
30	MERCURY	0	0.87	0.72	0.74	0.84	NS	Satisfactory
31	COBALT	0.01	0.05	0.01	0.01	0.02	1	Satisfactory
32	COPPER	0.1	0.41	0.16	0.18	0.71	<1	Satisfactory
E	MICROBIOLOGICAL ANALYSIS							
33	TOTAL COLOFORM COUNT, MPN/100ml	45	12	15	17	18	400	Satisfactory
34	TOTAL AEROBIC MESOPHILIC BACTERIA PLATE COUNT, CFU/100ml	0	0	0	0	0	NS	Acceptable

SAMPLE TYPE: **SURFACE WATER**
VOLUME/QUANTITY: **1.5 LITRES**
PRESERVATION METHOD: **REFRIGERATION**

S/NO	PARAMETER	WS1 (MG/l)	WS2(MG/l)	WS3(MG/l)	WS4(MG/l)	WS5 (MG/l)	FMEnv/N SDW LIMIT (MG/l)	REMARKS
A	PHYSICAL TEST							
1	COLOUR	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	NS	Satisfactory
2	ODOUR	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Ns	Satisfactory
3	pH	8.13	7.16	8.23	7.89	8.91	6-9	Satisfactory
4	CONDUCTIVITY (µS/cm)	135	178	287	218	178	NS	Satisfactory
5	TDS	351	412	5.81	4.81	5.78	2000	Satisfactory
6	TSS	11.0	123	145	163	15.70	30	Satisfactory
7	DO	6.23	3.7	6.2	4.98	5.81	2-8	Satisfactory
8	TEMPERATURE	30.7	31.7	31.0	29.9	30.7	Ambient	Acceptable
B	CHEMICAL TEST							
9	TOTAL HARDNESS	2.3	6.45	6.9	15.8	10.6	150	Satisfactory
10	CALCIUM	0.23	4.67	3.65	6.81	9.67	200	Satisfactory
11	MAGNESIUM	0.45	1,89	1.82	8.13	5.66	200	Satisfactory
12	POTASSIUM	1.4	2.61	2.95	5.89	7.5	NS	NS
13	SODIUM	43	41	50	65	68	NS	NS
14	TOTAL CHLORINE	0.04	1.71	1.81	1.49	0.47	1	Satisfactory
15	AMMONIUM	2.00	34.89	5.81	6.8	21.9	600	Satisfactory
16	TOTAL PHOSPHATE	35	31	34	37	31	NS	Acceptable
17	NITRATE	10	10	10	10	10	20	Acceptable
18	SULPHATE	35	35	35	35	35	NS	
19	NITRITE	0.1	0.1	0.1	0.1	0.1	1.0	Satisfactory

20	BOD	1.3	1.3	1.3	1.3	1.3	40	Satisfactory
21	COD	0	0	0	0	0	50	Satisfactory
C	ORGANICS							
22	OIL AND GREASE	0	0	0	0	0	10	Satisfactory
23	PHENOL	0	0	0	0	0	NS	Acceptable
D	HEAVY METALS							
24	CHROMIUM	0.0	0.05	0.12	0.13	0.21	20	Satisfactory
25	IRON	11.4	0.41	0.28	0.28	0.22	<1	Unsatisfactory
26	LEAD	0	0.58	0.34	0.33	0.42	<1	Satisfactory
27	CADMIUM	0	0.04	0.06	0.06	0.16	3	Satisfactory
28	ZINC	0.1	0.004	0.0010	0.0011	0.0013	0.01	Satisfactory
29	ARSENIC	0	0.0006	0.005	0.0016	0.0012	0.001	Satisfactory
30	MERCURY	0	0.87	0.72	0.74	0.84	NS	Satisfactory
31	COBALT	0.01	0.05	0.01	0.01	0.01	1	Satisfactory
32	COPPER	0.1	0.41	0.1	0.1	0.1	<1	Satisfactory
E	MICROBIOLOGICAL ANALYSIS							
33	TOTAL COLOFORM COUNT, MPN/100ml	45	12	15	17	18	400	Satisfactory
34	TOTAL AEROBIC MESOPHILIC BACTERIA PLATE COUNT, CFU/100ml	0	0	0	0	0	NS	Acceptable

AIR QUALITY MEASUREMENT AT CHALLAWA GORGE DAM, KANO STATE

S/NO	PARAMETERS	ASP1	ASP2	ASP3	ASP4	ASP5	ASP6	ASP7	ASP8	ASP9	ASP10
1	Pm2.5 (UG/m^3)	98	65	15	50	10	18	54	58	0	165
2	Pm1.0 UG/m^3	31	23	19	33	73	63	13	33	71	43
3	Pm10 UG/m^3	15	18	189	10	18	13	18	48	31	48
4	HCHO UG/m^3	0.210	0.141	0.341	0.431	0.610	0.10	0.131	0.131	0	0.176
5	TVOC ppm)	0.167	0.176	0.544	0.176	0.176	0.176	0.176	0.176	0	0.176
6	Temp ^{0}C	36.8	35.6	35.7	35.6	35.6	35.6	35.6	35.6	35.8	35.6
7	HUMIDITY %	66	65	65	65	65	75	65	65	68	65
8	C2H4 ppm	5	3	5	1	0	2	2	2	0	3
9	CO ppm	0	0	0	0	0	0	0	0	0	0
10	NO2 ppm	0	0	0	0	0	0.1	0.1	0	0	0.3
11	NH3 ppm	13.0	18.1	14.0	12.4	17.4	15.4	17.4	17.4	0	17.4`
12	SO2 ppm	0	0	0	0	0.1	0.1	0	0	0.1	0.3
13	CO2 ppm	621	471	781	576	576	476	576	476	551	541
14	H2S ppm	0	0	0	0	1	1	0	0	1	0

SAMPLE ID	LOCATION/ NAMES	LATITUDE	LONGITUDE
AS1	ROGO (KARAYE ROGO ROAD)	11.548553	7.828996
AS2	TURAWA (TURAWA ROAD)	11.699634	8.036856
AS3	ROMON KUNNE (UNNAMED ROAD)	11.666501	7.912919
AS4	YOLA (UNNAMED	11.728852	7.985227

	ROAD)		
AS5	DAURA GARI	11.639298	8.087192
SSL6	SSL6 SAKARMA	11.639177	8.086922
SSL7	GUMSHI	11.648260	8.086711
SSL8	DAMP SITE (TURAWA ROAD)	11695463	8.042346
SSL9	CHALLAWA	11.698634	8.036857
SSL10	JERRY	11.697634	8.036853

APPENDIX 5

COMMUNIQUE ISSUED AT THE END OF A ONE DAY WORKSHOP FOR UPDATING HJKYB STAKEHOLDERS ORGANIZED BY THE HADEJIA JAMA'ARE KOMADUGU YOBE BASIN TRUST FUND HELD ON THURSDAY 1ST JULY 2021 AT BAUCHI STATE AGRICULTURAL DEVELOPMENT PROGRAMME, MTRM CONFERENCE HALL, BAUCHI, BAUCHI STATE.

1.0 PRESENTATIONS

After a brief on the project and the thrust of the workshop presented by the Executive Secretary of the HJKYB Trust Fund, Prof. Hassan Haruna Bdliya, the following discussions came up

DISCUSSIONS

The following issues that emanated from the presentations were discussed, elaborated and clarified:

- What can we do about the Fisheries priority project?
- What do we do after the appraisal?
- What can we do about the BoT?
- What can we do about the passage of the Water Resources Bill?
- How do we re-invigorate the IWRMC?

2.0 RESOLUTIONS

The Workshop Resolved as follows:

- The problems of KYB-WDI is the problem of all stakeholders
- Stakeholders and the TF should exploit political linkages to re-submit the fisheries project for possible funding
- The TF should follow AfDB standard procedure of engaging contractors/consultants and enquire about project implementation manual
- The TF should write to the Hon. Minister of Water Resources informing him of the expiration of BoT's tenure, subsequently the Minister in his capacity writes to the Governors of the riparian State
- The TF should support and encourage the Hon. Minister in sensitization campaign to enhance the passage of the Water Resources Bill
- SIWRMCs would be assisted by TF to reach out to their respective Commissioners of Water Resources and establish a define line of budget and desk officer
- **CONCLUSIONS**
- The workshop was adjudged to be successful, while stakeholders look forward to the implementation of the resolutions.

APPENDIX 6

RECORD OF CONSULTATION MEETINGS WITH PRIMARY AND SECONDARY STAKEHOLDERS

MINUTES OF ESIA STAKEHOLDERS' INTERACTIVE CONSULTATION WORKSHOP HELD AT THE CHALLAWA GORGE DAM MANAGEMENT OFFICE

The interaction started by 12:14 pm with an opening prayer by the Village head of Turawa, followed by self-introduction of all participants. The Consultant in Person of Prof. Abbas Bashir presented an Opening remark stating the purpose of the visit and what is expected of all participants in the event. The representative of the Federal Ministry of Environment Hajiya Sikirat further stressed the need for the project, she stressed the need for water shed management in order to sustain the Dam that supports the livelihood of the dependent community. She stressed the various techniques and methods that can be applied in addressing the issues identified. She further stressed that the purpose of the visit was to combine two very important activities that's scooping and site identification, they are important things been done in any ESIA or EIA activity. She raised some questions to the consultant for clarification. She further stressed the need for following all detailed aspects of the exercise to its logical conclusion.

The representatives of Kano State Ministries of Water Resources, Environment and Agriculture, gave their brief remarks on the purpose of the meeting. The Director of Environment in the Kano State Ministry of Environment further stressed on some of the important activities in relation to the eChallawa Gorge Dam and stressed the need for tree planting as a way of controlling erosion that affects the environment and the general livelihood of the inhabitants of the dam area. He emphasized on the need for community leaders to discourage their followers from cutting down trees through the process of deforestation which would negatively affect the environment. The director stressed the need for their response regarding the intending exercise.

The Project Manager, Challawa Gorge Dam, Mal. Ibrahim Zarewa once again welcome participants to the project office, the venue of the workshop. He then gave a brief background of the dam, he said Challawa Gorge Dam design and construction was started by Water Resources Engineering and Construction

Agency (WRECA). The contract was revoked and re-awarded to Julius Berger in 1989 and they completed in 20th July, 1992 and commissioned by former Nigerian Military Head of State, President Ibrahim Badamasi Babangida. The purpose of the dam is to store water under mandatory releases for irrigation to both Kano River Irrigation Project (KRIP) and Hadejia Valley Irrigation Project (HVIP). The water flows up to Lake Chad. The dam has a storage capacity of 930 million cubic meters. The dam has an area of about 100KM2 with a length of about 7.8Km long including the embankment.

Another purpose of the dam is to control flooding around the downstream communities. The dam attains its maximum storage capacity by the second week of August and start flowing to the downstream through the spillway. During the dam construction, some settlements were resettled and some disperse small villages were also brought together and resettled together and provided with all basic amenities like electricity, water supply, hospitals, schools, viewing centers among other basic needs of life. Many informal irrigation is ongoing within and around the dam site that has contributed to siltation of the dam.

The Community Leader of Turawa welcomed all participant to community and equally shows his delight with the crop of people participating in such exercise recalling that in those day, such activities were mostly carried out by expatriates (Turawa). He further advised the team to extend a letter formally to the district heads of Rogo, Karaye an Kiru being their superior traditional leaders within the area of the consultant's assignment. He stressed the need for proper management of the Challawa gorge dam as it boosts livelihood economic activities of the community.

The Community Leader of Sakarma also commended the effort of the Government for initiating such an important exercise that would address the problem of erosion that leads to the siltation of the Challawa dam, he further stated that most of the affected areas are within his domain assured the consultant that he's fully in support of the exercise.

Sarkin Noma also contributed his own by expressing his delight and satisfaction over the irrigation farming being practiced in the community as a result of construction of the dam. He stated that the dam was an integral aspect of their life, when the plan for construction of the dam was conceived, the community were against it entirely thinking that it would take away their source of livelihood completely. The representative of the herdsmen, Yakubu Musa Ardo and that of the fishermen also made their contributions by stating the need for the intended project in order to halt the deterioration of the dam that supports their main source of livelihood.

APPENDIX 7

RECORDS OF ATTENDANCE REGISTER FOR PUBLIC CONSULTATIONS AT Karaye, Rogo Kiru Communities of Challawa Gorge Dam, watershed Kano State

PUBLIC CONSULTATIONS AND STAKEHOLDERS ENGAGEMENT

(CHALLAWA GORGE DAM ESIA STUDY)

ATTENDANCE RECORD

PLACE NAME: Ayaga Gadan Dawaki DATE: 18th Aug. 2024

S/No.	Name	Telephone Number	Sex	Sign
1	[illegible]	[illegible]	F	
2	[illegible]	[illegible]	M	
3	USUMAN A WADA	[illegible]	M	
4	Hamza Abubakar	[illegible]	M	
5	Dauda Idris	[illegible]	M	
6	[illegible]	[illegible]	M	
7	[illegible]	[illegible]	M	
8	Abdulrashid Ali [illegible]	[illegible]	M	
9	Ali Dabou [illegible]	[illegible]	M	
10	Abdulkadir [illegible]	[illegible]	M	
11	Lawan Maishanu	[illegible]	M	
12	[illegible]	[illegible]	M	
13	Sanusi Ali Kabo	[illegible]	M	
14	Malam Ali	[illegible]	M	
15	Kabiru Abdu	[illegible]	M	
16	Alamu Kabo	[illegible]	M	
17	MALAM WASIU	[illegible]	M	
18	Abdulkadir Maigamawa	[illegible]	M	
19	Abdulkadir Amino	[illegible]	M	
20	HAMZA MUSA	07037881172	M	
21	Musa Shawai	[illegible]	M	
22	Yahaya Suleh Musa	[illegible]	M	
23	Hadiza Yahaya	[illegible]	F	
24	Alhaji Lale Audu	[illegible]	M	
25	Nazifi A. Mamman	[illegible]	M	
26	Yusha'u Hamma	[illegible]	M	
27				
28				
29				
30				

PUBLIC CONSULTATIONS AND STAKEHOLDERS ENGAGEMENT

(CHALLAWA GORGE DAM ESIA STUDY)

ATTENDANCE RECORD

PLACE NAME: Karaye DATE: 21 July 2021

S/No.	Name	Telephone Number	Sex	Sign
1	Rabo Abdurrahman		M	
2	Yusuf Sani	07068505258	M	
3	Mal. Bala Mai Alluro		M	
4	DAN MALLAM		M	
5	Audu Haladu	07026178688	M	
6	Dahfine Jakuru	07067335942		
7	Sale aaai kifi		M	
8	Ubale Amadu	07034447791	M	
9	magari Cade		M	
10	M nura Kafinia	07033413802	M	
11	Bala Mai tireda		M	
12	Rashiru Lawan		M	
13	Alh danasale mai gado	08065872354	M	
14	Bala caglgo		M	
15	Jume Jubo		F	
16	Alh zubairu		M	
17	HUDU MAI FATA		M	
18	Abdurrahman dan dauda		M	
19	Malam musa limanci		M	
20	malam Ahmadu limanci			
21	Alh Sadiku ganban	08069449556	M	
22	Nasiru irO	08037159804	M	
23	Alh yusuf audu	08143439958	M	
24	Alh Yunusa	09039970752	M	
25	Ashiru mustafa	09066603428	M	
26	magaji shehu	07037489492	M	
27	Idris muhammad	08060317584	M	
28	M audu tata Sau		M	
29	Sale Nahanre	08139506149	M	
30	Alh Barau	09031640105	M	
31	Alh Ibrahim jama'a	08143439948	M	

Scanned with CamScanner

PUBLIC CONSULTATIONS AND STAKEHOLDERS ENGAGEMENT

(CHALLAWA GORGE DAM ESIA STUDY)

ATTENDANCE RECORD

PLACE NAME: Tsoho Rogo DATE: 15th August 20[illegible]

S/No.	Name	Telephone Number	Sex	Sign
1	Auwalu dan Kala	09069035647	M	
2	Dantin dan Kaka	09079565548[illegible]	M	
3	Wada Alhasan	09136676747	M	
4	Jiitu Isah	08086199091	M	
5	Babandi muzi	08122474952	M	
6	Sule nakamo	08139506149	M	
7	Lawan [illegible]	09035676747	M	
8	Mamman Isa	08107771339	M	
9	[illegible] mazaki	07061 34292	M	
10	M. Yusuf Liman	07061 34292		
11	Rabi [illegible]	[illegible]	F	
12	Jinjiri Alssan	07069371286	M	
13	Seidi Gal[illegible]	07036402490	M	
14	Mustafa magaji	07049216118	M	
15	Yakubu [illegible]	07031249908	M	
16	Daulaki Yau	07011532197	M	
17	lalada Yau	07064294696	M	
18	Ja[illegible] Ya'u	07045332177	M	
19	Salisu Isa	08147679756	M	
20	Magaji Isa	07053107992	M	
21	Naziru md.	[illegible]	M	
22	Ali Isa dakaka	07636477873	M	
23	[illegible]	[illegible]	M	
24	Dandy Garba	[illegible]	M	
25	Dan Baba nasam	07014628727	M	
26	JUBO DAN AZUMI		M	
27	Mustafa Usman		M	
28	IBRAHIM DANJUMA	07085054708	M	
29	Malam Dan yaya		M	
30	Umaru Mai maganin [illegible]	08067362743	M	
31	Alhaji Mamman [illegible]		M	
32	HAMISU HALADU	07034377057	M	
33	Alhaji Magaji Kaphija		M	
34	MUHAMMADU DANTASHA		M	

PUBLIC CONSULTATIONS AND STAKEHOLDERS ENGAGEMENT

(CHALLAWA GORGE DAM ESIA STUDY)

ATTENDANCE RECORD

PLACE NAME: Ayaga Gadan Dam[illegible] DATE: 18th Aug. 2021

S/No.	Name	Telephone Number	Sex	Sign
1	[illegible]	[illegible]	F	
2	[illegible]	[illegible]	M	
3	USUMAN A WADA	[illegible]	M	
4	Hamza Abubakar	[illegible]	M	
5	Dauda Idris	[illegible]	M	
6	[illegible]	[illegible]	M	
7	[illegible]	[illegible]	M	
8	Abdullahi Ali [illegible]	[illegible]	M	
9	Ali Dabuu Samaila	[illegible]	M	
10	Abdullahi Sani	[illegible]	M	
11	Lawan Mai Shanu	[illegible]	M	
12	[illegible]	[illegible]	M	
13	Saadu Ali Kabu	[illegible]	M	
14	Malam Ali	[illegible]	M	
15	Kabiru Abdu	[illegible]	M	
16	Alamu Kabo	[illegible]	M	
17	MALAMI WASIU	[illegible]	M	
18	Abdulkadir Maigamawa	[illegible]	M	
19	Abdulkadir Amin	[illegible]	M	
20	HAMZA MUSA	[illegible]	M	
21	Musa Shamsu	[illegible]	M	
22	Yahaya Saleh Musa	[illegible]	M	
23	Hadiza [illegible]	[illegible]	F	
24	Alhaji Lale Audu	[illegible]	M	
25	Nazifa A. Mamman	[illegible]	M	
26	Yushau Haruna	[illegible]	M	
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				

Scanned with CamScanner