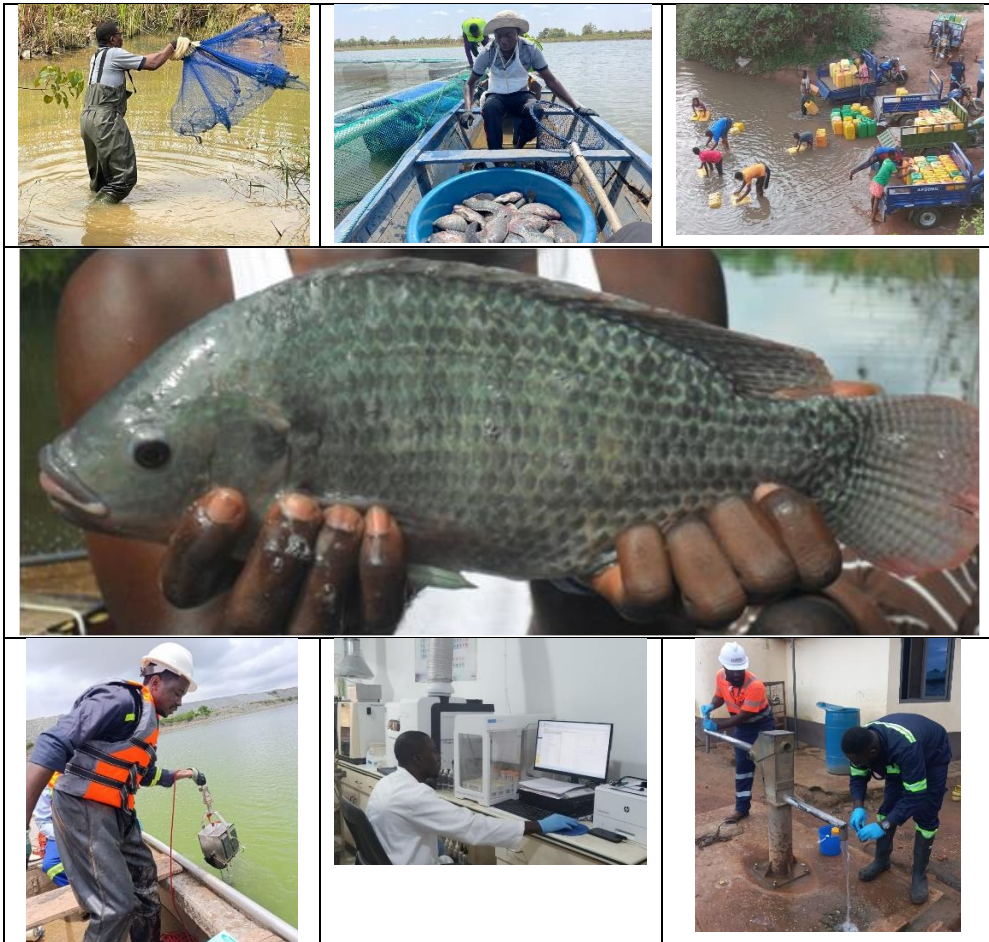


CSIR-WATER RESEARCH INSTITUTE



2025 Annual Report

CSIR-WATER RESEARCH INSTITUTE



2025 Annual Report

*CSIR-WATER RESEARCH INSTITUTE
(CSIR-WRI)*

*Annual Report
2025*

ACCRA, GHANA

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QUALITY WATER RESEARCH



FOR SUSTAINABLE NATIONAL DEVELOPMENT

**CSIR-WATER RESEARCH INSTITUTE
ACCRA, GHANA**

ACRONYMS

AI	-	Artificial Intelligence
AMR	-	Antimicrobial resistance
ARDEC	-	Aquaculture Research and Development Centre
ARO	-	Annualised Rate of Occurrence
AST	-	Antimicrobial Susceptibility Testing
AU	-	African Union
BPHRU	-	Biomedical and Public Health Research Unit
BOD	-	Biochemical Oxygen Demand
CC	-	Climate Change
CGIAR	-	Consultative Groups on International Agricultural Research
CSIR	-	Council for Scientific and Industrial Research
DO	-	Dissolved Oxygen
EBBHD	-	Environmental Biology, Biotechnology and Health Division
ECSED	-	Environmental Chemistry and Sanitation Engineering Division
EPA	-	Environmental Protection Authority
ESBL	-	Extended Spectrum Beta lactamase
ESIA	-	Environmental and Social Impact Assessment
EU	-	European Union
FAD	-	Fishery and Aquaculture Division
FAO	-	Food and Agriculture Organization
FDA	-	Food and Drugs Authority
FKs	-	Fish Kills
GDP	-	Gross Domestic Product
GFAASS	-	Ghana Forum for Agriculture Advisory Service and Support
GSA	-	Ghana Standards Authority
GWGD	-	Groundwater and Geoscience Division
IAB	-	Institute of Aquatic Biology
IASSIST	-	International Association for Social Science Information Services and Technology
IHNV	-	Infectious Hematopoietic Necrosis Virus
IMC	-	Internal Management Committee
MDR	-	Multidrug-resistant
NADMO	-	National Disaster Management Organization
RAS	-	Recirculatory Aquaculture Systems
RSA	-	Research Staff Association
SDGs	-	Sustainable Development Goals
SOPs	-	Standard Operating Procedures
SWCCD	-	Surface Water and Climate Change Division
TDS	-	Total Dissolved Solids
THB	-	Total Heterotrophic Bacteria
TSF	-	Tailings Storage Facility

TSS	-	Total Suspended Solids
UNESCO-IHP-		United Nations Educational, Scientific and Cultural Organization - Intergovernmental Hydrological Programme
VRA	-	Volta River Authority
WHO	-	World Health Organization
WQI	-	Water Quality Index
WRC	-	Water Resources Commission
WRI	-	Water Research Institute
WRM	-	Water Resources Management
WRRI	-	Water Resources Research Institute
WSD	-	Water Storage Dam
WSF	-	Water Storage Facility

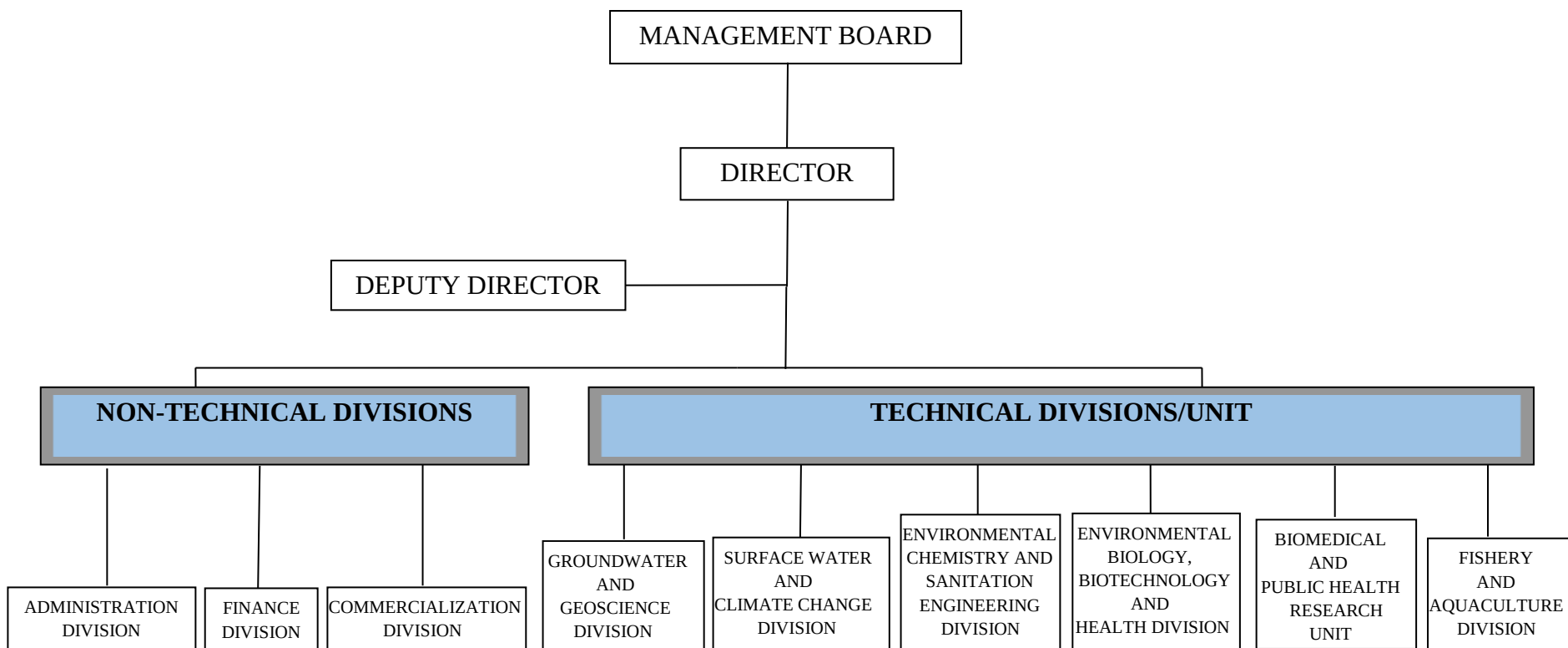
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ORGANOGRAM



FOREWORD BY THE DIRECTOR**Prof. Mike Yaw Osei-Atweneboana**

It is with immense pride and a deep sense of purpose that I present the 2025 Annual Report of the CSIR-Water Research Institute (CSIR-WRI). This report documents a year of sustained scientific rigour, meaningful collaboration, and tangible impact – reaffirming our standing as Ghana's foremost research institution for water and related resources.

The year 2025 underscored the urgency of our mandate. With water security, climate change, food systems, and public health converging as defining challenges of our era, the work of CSIR-WRI has never been more consequential. Working hand-in-hand with local and international partners, the Institute implemented 25 research projects spanning aquaculture and fisheries management, antimicrobial resistance surveillance, flood risk assessment, AI-driven evapotranspiration monitoring, and wetland ecosystem management, among others.

I am particularly proud of our researchers' engagement at both national and global levels. Staff participated in high-level scientific activities, presenting findings that place Ghana's water science and public health at the heart of international discourse. At the same time, our field teams were present in communities where the impact of our work is most directly felt by the people we serve.

Our commitment to nurturing the next generation of water resources and public health scientists remains steadfast. Through supervision of doctoral and masters' students, mentorship of national service personnel and interns, and the delivery of specialized training programmes, CSIR-WRI continues to invest in Ghana's scientific human capital. I warmly congratulate the several PhD students who successfully defended their theses this year under the supervision of our senior researchers.

The Institute's consultancy and advisory services portfolio also expanded significantly, serving clients ranging from major mining companies and hospitality groups to community water schemes and government agencies – ensuring our science is translated directly into practical solutions for industry and society.

The year was not without challenges. The Institute's Management Board, dissolved in December 2024, had not been reconstituted by the end of the year. I commend the Internal Management Committee for its diligence and sound governance during this transitional period, ensuring that operations continued seamlessly and targets were met.

I extend my heartfelt appreciation to all staff of CSIR-WRI for their dedication, creativity, and professionalism, and to our collaborators, development partners, donor agencies, and all stakeholders who continue to repose confidence in us. Together, we advance steadily toward our vision: a centre of excellence in the provision of scientific research into water and related resources for sustainable socio-economic growth of Ghana.

EXECUTIVE SUMMARY

The CSIR-Water Research Institute (CSIR-WRI), established in 1996 through the merger of the Institute of Aquatic Biology (founded 1965) and the Water Resources Research Institute (founded 1982), is mandated to conduct research into all aspects of water resources – both living and non-living – in support of Ghana's sustainable socio-economic development. This report summarises the Institute's research and development activities, scientific contributions, administrative performance, and service delivery for the year 2025.

Institutional Structure and Governance

CSIR-WRI operates from its main office in Accra, a branch office in Tamale, and an Aquaculture Research and Development Centre (ARDEC) in Akosombo. Research is delivered through five technical divisions – Environmental Biology, Biotechnology and Health; Environmental Chemistry and Sanitation Engineering; Fishery and Aquaculture; Groundwater and Geoscience; and Surface Water and Climate Change – alongside a Biomedical and Public Health Research Unit. The Institute's Management Board, dissolved in December 2024, remained unreconstituted throughout the reporting year; the Internal Management Committee (IMC) provided effective stewardship in the interim.

Human Resources and Capacity Development

The Institute's total staff complement stood at 215 at year-end, comprising 94 Senior Members, 86 Senior Staff, and 35 Junior Staff. Staff capacity was strengthened through participation in over 25 local and international training programmes covering climate risk analysis, machine learning, antimicrobial resistance surveillance, hydrological forecasting, geochemical modelling, and project management. Scientists represented the Institute at over 40 national and international conferences and workshops – including the World Water Week in Stockholm, the GMES & Africa Symposium in Dakar, and meetings in Cairo, Addis Ababa, and across Europe and West Africa. Six staff members were honoured for long service of between 20 and 42 years at the annual recognition ceremony.

Research and Development Activities

CSIR-WRI implemented 23 research projects in 2025, organised under three national development thematic areas:

- Theme 1 - Food Security and Poverty Reduction: 5 projects
- Theme 2 - Climate Change, Environmental Management and Green Technology: 16 projects
- Theme 3 - Biomedical and Public Health: 2 projects

Under Food Security, the CGIAR Aquatic Foods initiative – in partnership with the International Water Management Institute – demonstrated the viability of cage aquaculture in small reservoirs in the North-East Region, with pilot communities in Nalerigu, Langbinsi, Tombu, and Nansoni recording improved food security outcomes. The Fisheries Commission subsequently moved to scale up fish cage installations. Disease investigations were also conducted following fish mortality events in the Ellembelle District, Lake Volta, and the Keta Lagoon.

The Climate Change and Environment theme encompassed the most extensive portfolio. Highlights include: comprehensive water quality assessments of river systems across Ghana's southwestern, coastal, and Volta basins, as well as evaluation of bottled, jar, and sachet water brands in Accra. The CREAM project advanced climate resilience in the Pra and Densu river

basins management systems, with several linked PhD theses successfully defended. AI-driven evapotranspiration monitoring was piloted in agroclimatic zones across Ghana, Spain, and Egypt. Additional work addressed sustainable wetland management, flood risk assessments for Newmont Ahafo South Mine, wastewater treatment using fungal-assisted microalgal harvesting, and feasibility studies for converting water hyacinth into floating vegetable production systems.

In the Biomedical and Public Health theme, the Institute conducted a national-scale study on antibiotic-resistant bacteria in drinking water across twelve regions of Ghana. AMR surveillance in surface waters was also carried out using the WHO-endorsed ESBL-producing *E. coli* Tricycle Protocol under the Fleming Fund project, generating critical public health data consistent with a One Health approach to antimicrobial resistance management.

Scientific Output

Our scientists produced forty-one (41) peer-reviewed journal articles and eighteen (18) conference papers and abstracts during the year, alongside numerous technical reports, policy briefs, and consultancy outputs. Staff served as supervisors and external examiners for postgraduate students at the University of Ghana, Kwame Nkrumah University of Science and Technology, and the University for Development Studies, with several candidates graduating, following successful thesis defences in 2025.

Consultancy and Commercial Services

Consultancy services were provided for over 40 clients across the public and private sectors, including water and effluent quality testing for mining firms (AngloGold Ashanti, Newmont Ghana Gold, Zijin Akyem Ghana Gold), hospitality establishments (Mövenpick Ambassador Hotel, Four Points by Sheraton Accra Airport Hotel, Accra City Hotel), pharmaceutical companies, community water schemes, and government institutions. Groundwater investigations, ecological surveys, and borehole drilling services were also delivered.

Outlook

CSIR-WRI enters the year ahead with clear priorities: reconstituting the Management Board, mobilizing new research fundings, deepening collaborative networks, and continuing to build staff competencies. The Institute remains committed to its vision of quality water research for sustainable national development – generating innovative technologies that serve both the nation and the global community.

1.0 INTRODUCTION

1.1 Establishment

The Council for Scientific and Industrial Research-Water Research Institute (CSIR-WRI) is one of the thirteen (13) research institutes under the CSIR. It is a public institution established in 1996 from the merger of the former Institute of Aquatic Biology (IAB) and the Water Resources Research Institute (WRRI) which were established in 1965 and 1982, respectively.

1.2 Vision

To become a centre of excellence in the provision of scientific research into water and related resources for sustainable socio-economic growth of the country.

1.3 Mission

To conduct research into all aspects of water resources (both living and non-living) in order to provide scientific and technical information and services as well as strategies for the sustainable development, utilization and management of such resources for the socio-economic advancement of the country.

1.4 Values

Our core values include dedication to duty, commitment, loyalty to quality assurance and customer satisfaction

1.5 Key Objectives

The key objectives of the Institute are to:

- i. generate, develop, and transfer appropriate technologies, information, and services for sustainable development, utilization, and management of surface water resources;
- ii. generate, process and disseminate information on the availability of groundwater, rate and volumes to be abstracted for various uses as well as the reliability and sustainability of its recharge;
- iii. generate, process and disseminate water and wastewater quality information to end users;
- iv. enhance public health status through sound environmental management and water pollution control strategies;
- v. increase local fish production through participatory research and technology transfer in aquaculture and sustainable management strategies in inland and coastal waters of Ghana;
- vi. develop technologies and strategies that significantly increase knowledge towards the control and elimination of communicable and non-communicable diseases

1.6 Divisions

The mandate of the Institute is realized through the research and development activities of five (5) Technical Divisions, one (1) Technical Unit and three (3) Non-technical Divisions. The Technical Divisions and Unit are:

- Environmental Biology, Biotechnology and Health
- Environmental Chemistry and Sanitation Engineering
- Fishery and Aquaculture
- Groundwater and Geoscience
- Surface Water and Climate Change
- Biomedical and Public Health Research Unit

The Non-Technical Divisions are:

- Administration
- Commercialization and Information
- Finance

1.6.1 Objectives and Core Activities of the Technical Divisions/Unit

1.6.1.1 Environmental Biology, Biotechnology and Health Division (EBBHD)

The main objective of the Environmental Biology, Biotechnology and Health Division is to enhance public health status of Ghanaians through sound environmental management, water pollution control strategies, and preventive and control strategies for water-borne and other infectious diseases. The Division makes use of unicellular organisms and their products to control diseases and produce environmentally friendly by-products for socio-economic advancement of the country. The Division has expertise in the areas of Microbiology, Parasitology, Entomology, Biology of Aquatic Flora and Fauna, and Public Health.

Activities of the Division include:

- Water quality monitoring through microbial, algal, parasite and macro-invertebrate analyses;
- Microbiological analyses of drinking water, wastewater, air quality monitoring and other samples;
- Environmental surveillance for antimicrobial resistant bacteria;
- Identification and management of invasive plants in Ghana;
- Isolation and production of entomopathogenic bacteria used in biological control of disease vectors;
- Environmental impact assessment and watershed management;
- Research into water-related/borne parasitic diseases and other infectious diseases;
- Research into water-related vectors of diseases of public health importance to develop innovative strategies for control and prevention;
- Isolation, cultivation, and commercialization of Ghanaian microalgae species;
- Large-scale cultivation of microalgae cultures for industrial applications;
- Sale of microalgae growth media;
- Pilot-scale trial of seaweed cultivation for technology transfer;
- Public and environmental health education; and
- Training of scientists, technologists and technicians.

1.6.1.2 Environmental Chemistry and Sanitation Engineering Division (ECSSED)

The long-term objective of the Environmental Chemistry and Sanitation Engineering Division is to generate, process and disseminate water and wastewater quality information to end-users. Specific objectives are to:

- Perform quality and quantity assessments of industrial, agricultural and domestic discharges in both urban and rural areas and identify their environmental impact and health risks;
- Collect, process and disseminate high quality and reliable environmental data on surface and groundwater with regard to their physical/chemical constituents, and assess their human and ecological health risks;
- Monitor pollution in coastal waters and lagoons in Ghana;
- Undertake quality assessment of water meant for irrigation and aquaculture; and
- Assess the quality of water sources meant for the production of sachet and bottled water to acquire Food and Drugs Authority (FDA) permit as well as boreholes for individuals.

Currently, the major research programmes of the Division are:

- Monitoring of surface water quality and assessment of the associated health risks;
- Microplastics and fish dietary exposure assessment in the lower Volta Basin;
- Domestic and industrial wastewater studies;
- Environmental impact assessment studies;
- Development of strategies for water pollution control;
- Development of a technology for fluoride removal in drinking water; and
- Monitoring and risk assessment of toxic chemicals in the air.

1.6.1.3 Fishery and Aquaculture Division (FAD)

The mandate of the Fishery and Aquaculture Division is to generate scientific information to potentially enhance sustainable management and development of Ghana's fisheries and aquaculture resources. The Division's goal is to increase local fish production to support livelihoods through increasing yield from existing fisheries and the development of sustainable aquaculture and culture-based fisheries practices. The main objective is to ensure annual increase in domestic fish production through improved fish culture technologies and improved sustainable management strategies for inland and coastal fish, and fisheries resources in Ghana. The specific objectives are to:

- improve the quality and variety of fish seed;
- improve the quality and cost of fish nutrition;
- make fish production cost-effective and viable;
- make fish readily available and affordable;
- minimize the negative environmental impacts of fisheries and aquaculture activities;
- improve understanding of the state of fish and fisheries under natural conditions; and
- improve management interventions.

Currently, the Division's major Research and Development programmes are in the areas of aquaculture development, environmental impact assessment, fish stock assessments, and enhanced fish and culture-based fisheries.

1.6.1.4 Groundwater and Geoscience Division (GWGD)

The Groundwater and Geoscience Division (GWGD) generates, processes and disseminates information on groundwater availability, sustainability and its suitability to meet the demand for consumptive and non-consumptive daily uses; promotes integrated groundwater resources management; and undertakes geotechnical applications for socio-economic development.

The Division primarily conducts research on Ghana's and Sub-Saharan Africa's groundwater resources for government, non-governmental organizations and the general public, focusing on the following, among other things:

- Hydrogeological and geophysical investigations
- Groundwater monitoring and technical services
- Groundwater flow and contaminant transport modelling
- Hydrogeochemical modelling

1.6.1.5 Surface Water and Climate Change Division (SWCCD)

The mandate of the Surface Water and Climate Change Division is to generate, develop and transfer appropriate technologies, information and services for sustainable development, utilization and management of surface water resources for socio-economic development. The scope of work of the Division includes:

- Design, installation and monitoring of climate and river/stream discharges for research and decision support;
- Development of climate products, information and scenarios for assessment of surface water resources;
- Mapping and assessment of land-cover dynamics of the country;
- Assessment of surface water resources of the country, including impacts of climate and land-cover changes on the resources;
- Assessment of sediment transport by streams/rivers and discharges into reservoirs and other surface water bodies;
- Mapping and assessment of water-related ecosystem services;
- Development and adaptation of appropriate technologies and water conservation techniques for water supply to households, communities, farms and industries; and
- Assessment and development of climate change adaptation and mitigation strategies.

1.6.1.6 Biomedical and Public Health Research Unit (BPHRU)

The main objective of the Biomedical and Public Health Research Unit is to conduct biomedical research into communicable and non-communicable diseases and to develop technologies and strategies towards the control and elimination of various diseases. Core diseases of interest include:

- Onchocerciasis
- Schistosomiasis
- Soil Transmitted Helminths
- Elephantiasis
- Malaria
- Fish diseases
- COVID-19

Upcoming diseases of interest include:

- Cancer
- Buruli ulcer
- Diabetes
- Hypertension

1.7 Branches and Contacts

- Main office is in Accra, in the Greater Accra Region;
- Branch office in Tamale, in the Northern Region; and
- Aquaculture Research and Development Centre (ARDEC), at Akosombo in the Eastern Region.

We shall be grateful to receive comments, proposals and suggestions on any aspects of our activities or report. The contact details are:

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2.0 ADMINISTRATION

The Administration Division provided services and support to staff, Divisions and Outstations of the Institute to ensure effective and efficient work environment required for the achievement of the objectives of the Institute. The Division also implemented policies, regulations and rules of the Council and decisions taken at Management meetings to improve upon staff performance.

2.1 Management

The Institute's Management Board was not constituted during 2025 following the dissolution of the 53rd Board on 20th December 2024. Consequently, the Internal Management Committee (IMC) assumed oversight responsibility and worked assiduously to promote research activities while ensuring the achievements of the Institute's Key Performance Indicator (KPI) targets and advancing its strategic vision. Membership of the IMC is given in Appendix I.

2.2 Staff Strength

Staff strength at the end of the year 2025 stood at 215. This comprised 94 Senior Members, 86 Senior Staff and 35 Junior Staff. The list of Senior Members and Senior Staff distribution are presented in Appendix II.

2.3 Statistics on Human Resource Activities

A summary of staff promotions/upgrading, transfers, compulsory retirements, deaths, vacation of post, and resignations are presented in Appendix III.

2.4 Human Resources Development

Staff members were given the opportunity to acquire the necessary skills and knowledge through local and international training for the enhancement of their performance in the Institute and in conformity with the policy of CSIR to provide relevant training for staff. The statistics are presented in Appendix IV.

2.4.1 Short-Term Training Programmes Attended by Staff

Members of staff participated in the following short-term training programmes:

- 6th Edition of the African Scholar Mentorship Network (ASMN 6.0) Bootcamp. October – November 2025. DiaDeRC, Nigeria & University of Regina, Canada.
- Climate Risk Informed Decision Analysis (CRIDA); organised and funded by UNESCO Headquarters and Regional Training Centre for Water Resources and Irrigation (PACWA), Cairo, Egypt; 16 – 20 June 2025.
- Climate Information Services course, organised by African Group of Negotiators Expert Support (AGNES AFRICA), AICCRA, and the Alliance of Bioversity International & CIAT, 21st July - 22nd August 2025. (Online)
- Coastal Ocean Environment Summer School in Nigeria and Ghana (COESSING) 11th-15th August, 2025, University of Ghana, Legon, Accra, Ghana
- Development of high-Resolution Climate Dataset for impact assessment, CREAM Project training workshop organised by CSIR-Water Research Institute, at CSIR-WRI Conference room, Accra. On 20th March, 2025.
- Drought impact on agricultural yield in Ghana using Machine Learning approaches; organised and funded by UK Centre for Ecology and Hydrology, Wallingford; 24-28 June 2025.
- Ecosystem Services: a method for sustainable development, University of Geneva (MOOC-COURSERA), August 2024 - January 2025, online

- Flow cytometry workshop, Fiesta Royale Hotel, organised by Centre for Plant Medicine Research, 3rd November, 2025.
- GSMA-TEMBO Flood Early Warning System Project- Training Workshop, True Vine Hotel, Ahodwo-Kumasi, Organised by TAHMO, 28-30 January 2025.
- Hydrological Forecasting; organised by UK Centre for Ecology and Hydrology (online); 2nd September 2025.
- International Quality Management Training for Executives, organised by Ghana Institute of Engineering (GhIE; Online) for the period 1-3 December 2025
- Landslide Monitoring and Risk Assessment using NASA Earth system Data organised by NASA's Applied Remote Sensing Training (ARSET), on 11th, 13th & 18 March, 2025, Online
- Project Management Workshop. 14th November 2025. JOJE Project Training and Consulting (United Kingdom) in collaboration with Southern Sector RSA
- Project management, Presbyterian University, Abetifi-Kwahu, 20th January - 6th February 2025.
- Research Ethics Training Workshop, organised by the Management College of Southern Africa, 31st July 2025, virtual
- Systems modelling and optimization in the Pra and Densu river basins of Ghana - Testing WRM stakeholder engagement dashboard organised by CSIR-Water Research Institute, at CSIR-WRI conference room, Accra, 21st March, 2025.
- Spaceborne LiDAR for Monitoring vegetation structure and Biomass Using GEDI organised by NASA's Applied Remote Sensing Training (ARSET), on 23rd, 30th October & 6th November, 2025, Online
- Training on Gas Chromatography-Mass Spectrometry (GC-MS) methods, 18th and 27th March, 2025, online.
- Training on WHO Integrated Global Surveillance on ESBL-producing E. coli using a "One Health" approach: The Tricycle Protocol (29th -31st January 2025) at CSIR – Water Research Institute by Fleming Fund project
- Training Workshop on “Geochemical Modelling of Natural Waters with PHREEQC; Exploratory Data Analysis with Python Programming & Introduction to Machine Learning, organised by Smart Water Training Team, 12th November 2025, 27th November & 15th December 2025, online
- Training Course on Modelling Software for Transient Flows, organised by International Association for Hydro-Environment Engineering and Research (IAHR) for the period 24-28 March 2025
- Training on Machine Learning, organised by University of Pretoria, 16-17 October 2025, online
- Training Workshop on the Small Reservoirs Dashboard for Data-Driven Planning in Northern Ghana, organised by the International Water Management Institute (IWMI– West Africa), 14th August 2025, Modern City Hotel, Tamale, Ghana (Access the dashboard: <https://workflow.ourmarketplaceonline.com/formfilling/67e46100-e264-425b-9fb9-dac62211eaa4>)
- Workshop on the Future of Biodiversity Monitoring and Mapping in Ghana held on 29 - 30 April 2025. WASCAL, Accra. Organised by UK Centre for Ecology & Hydrology (UKCEH), Development Bank Ghana (DBG), and the Ghana Environmental Protection Agency (EPA).
- Workshop on “Strengthening Resilience to Water-Related Disasters under Climate Change for a Sustainable Society in Ghana” project. Best Western Premier Hotel,

Accra, on April 9, 2025. Organised by UNESCO Ghana, with the support of Government of Japan.

- Wetland and Agricultural Pathway Sustainability organised by Food and Agriculture Organisation of United Nations, on 26th March, 2025. online
- Women's Leadership and Negotiation Skills Course, as part of the African Women in Agricultural Research and Development (AWARD) – AWARD Climate Action (ACA) Fellowship, organised by AWARD, Mombasa, Kenya, 22nd – 26th September 2025

2.5 Participation in National and International Scientific Meetings

During the year, several research and technical staff participated in workshops, seminars and conferences held at regional, national and international levels. These offered staff opportunities to acquire the necessary skills and knowledge through local and international training to enhance their performance. The workshops, seminars and conferences included the following:

- World Water Day Policy Dialogue on “Sustainable Water Management in Ghana”, 25th March 2025, GIMPA, Accra.
- 1st National Coordinating Committee (NCC) on Drinking Water Quality Management Meeting, 7th May 2025, Ghana Standards Authority, Accra.
- 6th Meeting of the Technical Working Group (TWG) on Invasive Species (IS) Management in Ghana, 14th August 2025, EPA, Accra.
- Training: Continental AMR/C/U Surveillance Guidance, Ministry of Health/ African Society for Laboratory Medicine (ASLM), 20th-25th January, 2025, The Peninsula Resort, Akosombo.
- Tricycle Refresher Training, The Aurum Institute, Ghana, 27th-28th January 2025, Virtual.
- Training: Refresher training on bacterial identification and antimicrobial susceptibility testing, The Aurum Institute, Ghana, 26th -27th February 2025, CSIR-WRI, Accra.
- Training: Bug-Drug combination for antimicrobial susceptibility testing, The Aurum Institute, Ghana, 28th February 2025, Virtual.
- Workshop on Proposal and Scientific Writing for Scientists and Assistant Research Scientists, 28th January 2025, CSIR-WRI, Accra.
- Training: AMR advocacy at the government level, The Fleming Fund Fellowship Scheme, 5th March 2025, Virtual.
- Training: Integrated Surveillance of Antimicrobial Resistance under One Health approach, WHO Global and WHO Afro, 13th-15th May 2025, virtual.
- Training: Whole Genome Sequencing Data Analysis of Antimicrobial Resistance in Bacteria, Noguchi Memorial Institute for Medical Research, 30th May, 2025, Noguchi Memorial Institute for Medical Research, Accra.
- Training: Assessing the impact of research studies from the Structured Operational Research Training Initiative (SORT IT) on tackling antimicrobial resistance Module 3: Scientific Manuscript Writing, WHO, TDR and SORTIT, 21st –26th July, 2025, Sogakope Beach Resort.
- Training: Assessing the impact of research studies from the Structured Operational Research Training Initiative (SORT IT) on tackling antimicrobial resistance Module 4: Effective communication of research findings, WHO, TDR and SORTIT, 15th–19th September 2025, Hillview Guest Centre.
- Training: Capacity Building Engagement on Gender and Equity Analysis in Environmental Health AMR data in Ghana, Fleming Fund Country Grant and GEAR up (Gender and Equity within AMR), 26th September 2025, Mensvic Hotel.

- Training on WHONET Data Entry, The Aurum Institute, Ghana, 24th October, 2025, CSIR-WRI, Accra.
- Conference: 2025 Ghana AMR Conference, The Fleming Fund, 19th- 20th November 2025, Alisa Hotel, Ridge.
- Workshop: Research Dissemination of the HOTMATS project, ICARS, University of Ghana Medical School, 9th December 2025, AH Hotel
- World Aquaculture Day CSIR-RSA Celebrations, May 5, 2025, CSIR-WRI Conference Room, Accra.
- Waterweed to Value: Organic Compost Production from Invasive Waterweed in the Volta Region, 18th June, 2025, Alisa Hotel, Accra.
- Sixth Meeting of the Technical Working Group on Invasive Species Management in Ghana. 14th August, 2025, EPA Millennium Block Conference Room, Accra.
- Aquaculture Ghana Conference, Blue Food Innovation Hub Discussant Lead, October 30-31, 2025, World Trade Centre, Accra.
- Committee Meeting on National Technical Working Group on Water Quality, Ministry of Sanitation & Water Resources, 27th March, 2025, Airport View Hotel, Accra.
- Meeting on Driving Access and Equity in Water: The enabling environment for reaching last-mile communities in Ghana, National Level Learning Alliance Platform (NLLAP), RCN, 24th April 2025, Coconut Grove Hotel.
- National Antimicrobial Resistance Platform meeting, AURUM Institute, Ghana, 19th June 2025, Mensvic Hotel, East Legon.
- The Interreg MAC Project meeting ((SANIFISH PROJECT), Canary Islands, 24th June 2025, Labadi Beach Hotel.
- Committee Meeting on National Technical Working Group on Water Quality, Ministry of Sanitation & Water Resources, 1st October, 2025, GARID Conference Room, Ministries.
- Meeting on National Drinking Water Quality Management Coordinating Committee, Ministry of Sanitation & Water Resources, 12th November 2025, GSA Head Office, Accra.
- Dissemination workshop of the HOTMATS Project, University of Ghana Medical School, Department of Medical Microbiology, 9th December, 2025, AH Hotel, East Legon.
- Workshop on the Future of Biodiversity Monitoring and Mapping in Ghana held on 29 - 30 April 2025. WASCAL, Accra. Organised by UK Centre for Ecology & Hydrology (UKCEH), Development Bank Ghana (DBG), and the Ghana Environmental Protection Agency (EPA).
- Launch and inception workshop of the “Strengthening Resilience to Water-Related Disasters under Climate Change for a Sustainable Society in Ghana” project. Best Western Premier Hotel, Accra, on April 9, 2025. Organised by UNESCO Ghana, with the support of Government of Japan.
- EPIC Africa – Second Transition Space Volta River Basin Meeting, organised by UNER and VITO, March 12 to 13, 2025.
- DANIDA Forum on World Water Day, organised by the Denmark Embassy in Accra, March 20. 2025
- WaterTalk3 on “Rethinking Irrigation for Resilience in West Africa”, organised by IWMI Ghana, April 15, 2025.
- World Water Week 2025, Stockholm, Sweden, August 24-28, 2025. (online)
- SISTARS Project Workshop, organised by IESS, University of Ghana, Airport View Hotel, October 8-9, 2025.

- WaterTalk4 on “Circular Water Economy for Green Growth in West Africa”, organised by IWMI Ghana, April 15, 2025.
- Workshop on “Strengthening Ghana’s Circular Economy Innovation Ecosystem for Climate-Resilient Agriculture”, organised by IWMI-Ghana, Lancaster Hotel, Accra, 27 November 2025.
- GMES & Africa Continental Forum “GMES & Africa: Shaping the Africa EO Roadmap as a Pillar of a Sustainable Space Economy”, Cairo, Egypt, 1-3 December 2025.
- GMES & Africa and 9th AfriGEO Symposium 2025 under the theme “From Data to Impact”, Dakar, Senegal, 6-9 October 2025; presented a paper titled “Partnering NADMO to develop flood contingency plan for local level flood management in Ghana”
- Ninth Regional IHP national committees conference, Lusaka, Zambia, 25-26 May 2025; presented a paper titled “Ghana committee for UNESCO IHP: Overview and achievements.”
- Science Engagement with National and river basin (Pra and Densu) stakeholders; 19th August 2025 (Pra Basin - Kumasi); 21st August 2025 (Densu Basin - Koforidua) and 9th September 2025 (National -Accra); made presentations titled “Using Science Engagement to Capacitate Stakeholders for Climate-Resilient Water Management” and “Climate Data Innovation for Risk Analysis and Planning.”
- CSIR RSA Annual General Meeting, Nyankpala Agriculture Savanna Research Institute, Tamale, October 2025.
- Digital Solutions for Water Management: A Pan-African Symposium, Addis Ababa, Ethiopia 21-23 October 2025
- Multi-Stakeholder Validation Workshop on the Validation of Remote Sensing and Field Observation Inputs for Water Accounting of Sustainable Water Management in the Bontanga Irrigation Scheme. IWMI Ghana Office, 13 June 2025
- Use case workshop on the Coastal Erosion Intervention Monitoring Tool. IWMI Ghana office, 30 May 2025
- Drought impact on agricultural yield in Ghana using Machine Learning approaches. Visiting Scientist programme – a visit to UK Centre for Ecology and Hydrology, Wallingford, 1 – 28 June 2025
- Stakeholder engagement workshop to review and update the management plan for the Densu Delta Ramsar Site. – (CBCR - University of Ghana) – 4th December 2025
- UN Decade Workshop – Advancing Sustainable Solutions through Ecosystem Restoration, 10th December 2025 (online)
- Project Launch Meeting on the Integrated Land and Water Management of the Greater Amanzule Wetland systems (ILWGAWS), Tenack Beach Resort and Hotel, Beyin, Western Region, 17th to 19th February 2025
- A post-COP 29 Action Planning Event, Ange Hill Hotel, East Legon, Accra, 4th March 2025
- Ghana National Landscape Forum, Marriott Hotel, Accra, 2nd to 4th April 2025
- Stakeholder Engagement on the Climate Change Resilience Assessment (CCRA) for the Akosombo and Kpong Dams, organised by the Volta River Authority, Electro Volta Conference Room, Accra, 19th June 2025
- First 2025 Meeting for the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Ghana National Platform, Millennium Conference Room of the Environmental Protection Authority, 2nd July 2025

- Validation and Dissemination Workshop on the Sustainable Agriculture Technologies on Livelihoods of Small-Scale Farmers in Northern Ghana (SATLiS) project, CSIR-STEPRI Main Auditorium, 24th July 2025
- A Focus Group Discussion on AsKGovSRM-Ghana Project, CSIR-STEPRI, Accra, 30th October 2025
- Stakeholder Consultation Workshop on Cocoa Planetarius Metrics for Cocoa Production in Ghana, organised by the Nature and Development Foundation (NDF), and World Wildlife Fund (WWF), Ange Hill Hotel, Accra, 4th December 2025
- National Workshop to Update the National Biodiversity Strategy and Action Plan (NBSAP), organised by Ministry of Environment, Science and Technology, Sogakope Beach Resort, Volta Region, 7th to 9th December 2025
- Inaugural Workshop of the National Technical Working Group (NTWG) on Payment for Ecosystem Services (PES), organised by the World Resources Institute and EPA, Peduase Valley Resort, Aburi, 14th to 18th December 2025
- Ocean for Development Cooperation Programme, 3rd – 6th November, 2025, La Villa Boutique Hotel, Accra
- Validation Workshop – Blue Food Innovation Hub, 26th November 2025, Marriott Hotel, Accra

2.6 Employee Relations

2.6.1 Retirements and Service Recognition

The 2025 Retirements and Service Recognition Awards took place during the end-of-year party on 19th December, 2025. Staff honoured for their contributions to the Institute are listed in Table 2.1.

Table 2.1: List of Retirees in 2025.

No.	Name(s)	Years Served
1	Mr. Richard Kwayisi Kwapong	42 years
2	Mr. Joseph Danso	41 years
3	Mr. Patrick Amankwah Mainoo	24 years
4	Mr. Alex Siaw	23 years
5	Mr. Charles Smith Bonful	22 years
6	Mr. Bukari Banse	20 years

2.7 National Service and Industrial Attachment

As part of its social responsibility and commitment to national capacity building, the Institute supported tertiary institutions by providing practical training opportunities for students. The training programs lasted eleven (11) months for national service personnel and between four (4) to twelve (12) weeks for students on industrial attachment. The details are presented in Appendix V.

2.8 Visitors to the Institute

Some institutions/organizations visited the Institute during the year 2025. The details are shown in Table 2.2.

Table 2.2: Institutions that visited the Institute in 2025.

No.	Institution	Date of Visit
1	Ghana Health Service (National Taskforce on Containment of Polioviruses)	9 th June 2025
2	Ngleshie Amanfro Senior High School	27 th May 2025
3	Aburaman Senior High School	21 st March 2025

2.9 Membership of Committees and Boards

Staff continued to serve on various Committees and Boards such as:

- CSIR-Research Staff Association (CSIR-RSA)
- Ghana Forum for Agriculture Advisory Service and Support (GFAASS)
- Mt. Zion Credit Union
- Local Organising Committee (LOC) for 5th Africa Regional Workshop (2025), of International Association for Social Science Information Services and Technology (IASSIST)-Africa Chapter
- Immunology Society of Ghana
- Convention for Biomedical Research Ghana
- Fisheries Commission Board
- Ghana Science Association
- British Phycological Society
- British Ecological Association
- American Society for Microbiology
- African Scholars Network Mentorship
- Intellectual Property Right Committee of CSIR-WRI
- National Committee on Drinking Water Quality Management
- National Technical Committee for Drinking Water Quality.
- Technical Committee on Environmental Protection Standards on Effluent Quality.
- Board Member and Secretary, Global Farming and Technology Institute, Old Tafo, Eastern Region
- Board Secretary, Water Research Institute Cooperative Credit Union
- Organising Committee for AETFAT Congress 2025
- CSIR-WRI Editorial Committee
- Technical Working Group for the National Water Investment Program (NWIP)
- Ghana UNESCO-IHP Committee.
- Inter-Agency Committee on Dam Safety of the Water Resources Commission
- Facility Management Committee, CSIR-WRI
- GhIE-Research and Awards Committee, Ghana Institution of Engineering
- Welfare Committee, CSIR -WRI
- Ghana Natural Capital Accounting (NCA) Ecosystem Services Technical Sub-Working Group (The Ghana-World Bank Natural Capital Accounting Program)
- Ghana National Platform for the Intergovernmental Science Policy Platform on Biodiversity and Ecosystem Services (IPBES)
- Ghana National Technical Working Group (NTWG) on Payment for Ecosystem Services (PES)
- Technical Working Group (TWG), National Aquatic Animal Health Strategy (NAAHS) development
- Abstract and Poster Review Committee, Aquaculture Ghana
- Committee of Experts in Fish Feed Formulation, FC, Ghana

2.10 Staff Publications

Several members of staff produced journal papers, conference papers, technical and non-technical reports during the reporting year. Most of these reports/papers have been placed at the Institute's Library as reference materials. The details are provided in Appendix VI.

2.11 Consultancy and Advisory Services

The Institute carried out several consultancy and advisory services for various donor agencies, corporate bodies, governmental and non-governmental organizations, universities and technical universities, public and private sector organizations as well as individuals. The consultancy and advisory services included the following:

- Hydrogeology study of Pond 3 (Client: AngloGold Ashanti Ghana)
- Monthly assessment of effluent quality (Client: Meridian Port Services Limited)
- Quarterly assessment of effluent quality (Client: West Hills Mall Limited)
- Quarterly assessment of water and sludge quality (Client: West African Fish Ltd.)
- Monthly assessment of effluent quality (Client: Tema Lube Oil Co. Ltd.)
- Quarterly assessment of effluent and drinking water quality (Client: Movenpick Ambassador Hotel)
- Assessment of wastewater quality (Client: Cocoa Processing Company Limited)
- Assessment of product water and effluent quality (Client: Befesa *Desalination Developments Ghana* - ABENGOA).
- Assessment of water quality (Client: Environmental Services Limited)
- Assessment of water safety in the Ga West Municipal Assembly in Accra (Client: Water Resources Commission)
- Monitoring and maintenance of water treatment facility at the Regional Office of Bank of Ghana, Tamale (Client: SAHA Ghana)
- Yakura Dugout Water Quality Assessment for Saha Global (Client: SAHA Ghana)
- Water quality evaluation of water treatment centers of SAHA Global during the dry season (Client: SAHA Global, Ghana)
- Water Quality Assessment of Small- Scale mining on the Volta River (Client: TAMA Foundation Universal)
- Drilling and mechanization of boreholes at the premises of Bank of Ghana and the Regional Manager's residence (Client: Bank of Ghana)
- Quarterly assessment of effluent quality (Client: Movenpick Ambassador Hotel)
- Quarterly assessment of final effluent quality (Client: Phyto-Riker/GIHOC Pharmaceuticals)
- Monthly assessment of final effluent quality (Client: Accra Brewery Limited)
- Semi-annual water quality monitoring and assessment of the Coastal, Southwestern and Volta Rivers Systems of Ghana (Client: WRC)
- Monthly assessment of final effluent quality (Client: Standard Chartered)
- Assessment of final effluent (Client: TSL Logistics Ghana Limited)
- Water Quality Assessment and Evaluation of Shelf Life of Bottled and Jar Mineral Water Brands (Client: German Society for International Cooperation -Deutsche Gesellschaft für International Zusammenarbeit, GIZ)
- Physico-Chemical and Bacteriological Quality Assessment of Boreholes and Tap Water (Client: Appolonia City Water Limited)
- Physico-chemical and Bacteriological Quality Assessment of Boreholes and Tap Water (Client: Oyibi Area Water and Sanitation Scheme)
- Assessment of water quality of Borehole in the Amasaman District, Ga West Municipal Assembly (Client: Water Resource Commission)
- Assessment of product water and effluent quality (Client: Befesa *Desalination Developments Ghana* - Abengoa)
- Water Quality monitoring of Boreholes and Tap Water from Selected Communities at Oyibi (Client: Oyibi Area Water and Sanitation Scheme)

- Quality control of culture media used by Dannex Aryton Starwin PLC Pharmaceutical Company (Client: Dannex Aryton Starwin PLC.)
- Environmental monitoring of activity area at Kama Industries (Client: Kama Industries)
- Assessment of water quality and environmental monitoring (Client: GEO MDICORE Pharmaceutical limited)
- Assessment of water quality and drugs (Client: Golden Tower Limited)
- Streamflow measurements and Flood Risk Assessment at Newmont Ahafo South Mine (Client: Newmont Ghana Gold Limited)
- Survey, Capture and Relocation of Wildlife at the DTSF construction area at Obuasi Mine (Client: AngloGold Ashanti Ghana)
- Ecological Studies (Client: Zijin Akyem Ghana Gold Limited)
- Monitoring and maintenance of water treatment facility at the Regional Office of Bank of Ghana, Tamale (Client: Bank of Ghana)
- Yakura Dugout Water Quality Assessment (Client: Saha Global)
- Drilling of boreholes at the premises of Bank of Ghana and the Regional Manager's residence (Client: Bank of Ghana)
- Water quality evaluation of Water treatment centers (Client: SAHA Global)
- Drinking Water Quality Assessment of Water Treatment Systems (Client: Movenpick Ambassador Hotel)
- Quality Assessment of Drinking Water Treatment Systems, Food and Effluent Samples (Client: Accra City Hotel)
- Quality Assessment of Production Surfaces and Food Samples (Client: Airways Catering Ltd.)
- Quality Assessment of Production surfaces and Food Samples (Client: WAD African Food processing Ltd.)
- Drinking Water Quality Assessment of Water Treatment Systems at Four Points (Client: Sheraton Accra Airport Hotel)
- Quality Assessment of Drinking Water Treatment Systems, Food and Production Surface Samples (Client: Accra City Hotel)
- Quality Assessment of Production Water Treatment Systems Samples (Client: Little India Ltd.)
- Assessment of Effluent Quality (Client: Accra Shopping Mall)
- Water quality assessments (Client: A Rocha Ghana)
- Inventory of Commercial Water Suppliers & Users in Pra & Volta Basins (Client: World Bank)
- Spatial Predictive Mapping of Onchocerciasis Breeding Sites in Ghana (Client: NOGUCHI Memorial Institute)

2.12 Capacity Building/Human Resource Development

2.12.1 Training Offered by Staff to Individuals and Groups

The Institute offered several training programmes via various modules to individuals, groups, Non-governmental Organizations, and students of the Universities and Technical Universities. Amongst them were:

- Biosafety Training for National Service personnel and interns at the Biomedical and Public Health Research Unit
- Trained over 40 fish farmers in Nalerigu, Langbinsi, Nansoni and Tombu in post-harvesting handling and processing of fish.

- Supervised more than thirty (30) students from the tertiary institutions who came for attachment and National service personnel in the Environmental Biology, Biotechnology and Health Division.
- Training of staff from CSIR- Soil Research Institute on Antimicrobial Resistance in Environmental Samples under the Fleming Fund AMR project organised by the Microbiology laboratory (February, 2025)
- Training of Water Resources Commission staff on microbiological analysis in the Microbiology laboratory (August, 2025).
- Supervised six (6) internship students from the University of Ghana on their final year project works at the Hydrobotany laboratory.
- Training on “Downloading water level data from the hydrographic instrument was organised for the staff of Newmont Ghana Gold Limited (NGGL) at Kenyasi – Ahafo South from 7-11 July 2025
- Development of High-Resolution Climate Data. CSIR-Water Research Institute Conference room, 20 March 2025.
- Co-development of a Dashboard for Enhancing Stakeholder Participation in Water Resources Management: Academics. CSIR-Head Office conference room, 21 March 2025.
- Co-development of a Dashboard for Enhancing Stakeholder Participation in Water Resources Management: Stakeholders. CSIR-Head Office conference room, 29 May 2025.
- Training and supervision of 6 national service personnel and 8 interns in river discharge measurements, climate data reading and recording and report writing.

2.12.2 Contribution to Training Programmes (External Examiner, Supervision and Co-Supervision of Masters and PhD Thesis)

Postgraduate Thesis Examination

- External Examiner for Norberta Sitsofe Ofori, for her MPhil thesis “Building the Resilience of Smallholder Farmers to Climate Change: Using Indigenous Traditional Knowledge-Based Agricultural Practices in The Kumbungu District, Ghana”, by the Department of Environmental Science, Kwame Nkrumah University of Science and Technology, Kumasi in September, 2025.
- External Examiner for the PhD Oral Examination of Mr. Twumasi Ankrah Kwarteng on his thesis “Quality of Muni Lagoon and Its Tributaries in Effutu Municipality, Ghana”, at the Institute for Environment and Sanitation Studies, University of Ghana on 26th June, 2025.
- Examined a PhD thesis “Risk-Based Groundwater Development Investigation to Support IWRM and WASH Planning in the Pra and Ankobra River Basins, Ghana” by Emmanuel Arthur (student number: PG6991321), Department of Civil Engineering

Postgraduate Student Thesis Supervision

- Co- supervision of Master’s Thesis for Ms Ewura Abena Sarfowaa, UCC. Molecular Characterization of Giardia lamblia Isolates in Children at Cape Coast Metropolis
- Supervising a PhD student, Ibrahim Abdul-Gafaru; “Green Synthesis and Characterization of Iron Nanoparticles from Indigenous plant materials for heavy metal Remediation Contaminated water”. University of Development Studies
- Supervision of Esi Esuon Biney, a PhD student enrolled at the Civil Engineering of the Kwame Nkrumah University of Science and Technology; thesis topic – Integrated

Ecological Approach to Water Quality Assessment of the Barekese Reservoir for Efficient and Sustainable Management (2022 - 2025).

- Supervision of Bismark Akurugu; a PhD student on the CREAM project and enrolled at the Earth Science Department of the University of Ghana; thesis topic – Aquifer characterization and numerical modelling for groundwater resources assessment in the Densu Basin (Successfully defended his thesis and awaiting graduation).
- Supervision of Martin Addi; a PhD student on the CREAM project; enrolled at the Department of Meteorology and Climate Science, Kwame Nkrumah University of Science and Technology; thesis –Improving Multiple ENSEMBLES climate change projections over Pra and DENSU river basins for hydrological impact modeling (Successfully defended his thesis and graduated).
- Supervision of Mark Osei-Owusu; a PhD student on the CREAM project; enrolled at the Civil Engineering Department of Kwame Nkrumah University of Science and Technology; thesis – Impacts of changes in climate and land-use/-cover on hydrology of the Pra River Basin (Successfully defended his thesis and graduated).
- Supervision of Samuel Kyei-Manuh; a PhD student on the CREAM project; enrolled at the Department of Meteorology and Climate Science, Kwame Nkrumah University of Science and Technology; thesis – Water resource modelling in the Pra Basin from a multi-objective perspective (Successfully defended his thesis and graduated).
- Supervision of Felicia Dogbey, an MSc student on the GDZHIAO project; enrolled at the Department of Meteorology and Climate Science, Kwame Nkrumah University of Science and Technology; thesis – Mapping high-resolution actual evapotranspiration in the Veia wetland agroecosystem (Successfully defended her thesis and graduated)
- Supervision of Simeon Odametey; a PhD student on the CREAM project; enrolled at IESS, University of Ghana; thesis – Evaluating the dynamics of water-related ecosystem services in the Densu River Basin (Submitted his thesis for external review).
- Supervision of Franz Alex Gaisie-Essilfie; a PhD student on the CREAM project; enrolled at the Civil Engineering Department of Kwame Nkrumah University of Science and Technology; thesis – Machine learning-based model for prediction of land-use/land-cover changes in the Densu Basin, Ghana (Ongoing).

Lecturing

- Senior lecturer for the Water Quality Management course at the Department of Fisheries Science and Aquaculture, CCST.
- Part-time lecture at The Department of Meteorology and Climate Science, Kwame Nkrumah University of Science and Technology

2.13 Review of Manuscripts/Journals

- Urban sprawl and its effects on watershed hydrology in an ungauged basin- Kumasi, Ghana. A review for *Hydrological Sciences Journal*.
- Predictions of the effects of climate change on nutrient availability and primary production in the upper layers of Lake Tanganyika. A review for *Journal of Great Lakes Research*
- Projecting Climate-Induced Changes in Flood Hazard and Hydrological Extremes in the Brahmaputra Basin Using Machine Learning Framework. A review for *Journal of Water and Climate Change*
- Title: Urban sprawl and its effects on watershed hydrology in an ungauged basin, Kumasi, Hydrological Sciences Journal, Manuscript number: HSJ-2024-0381

- Title: Assessing Hydrologic and Policy Implications of Irrigation on the Canadian Prairies Under Climate Change, Sustainable Water Resources Management, Manuscript number: SWAM-D-25-00635

3.0 RESEARCH AND DEVELOPMENT ACTIVITIES

3.1 FOOD SECURITY AND POVERTY REDUCTION

3.1.1 FISHERY AND AQUACULTURE

3.1.1.1 CGIAR Initiative on Aquatic Foods

(Research Team: Dr Ruby Asmah - Principal investigator, Dr Emmanuel Mensah, Mr Acheampong Addo, Dr Miriam Ameworwor, Dr Pennante Naa Ayikailey Bruce-Vanderpuije)

Collaborating Agency: International Water Management Institute

Introduction

The CGIAR program on Sustainable Animal and Aquatic Foods aimed to strengthen aquatic food systems and unlock their full potential for people, nature, and climate through research and innovation. In Ghana, the project focused on enhancing food security and creating alternative livelihood opportunities through the promotion of cage fish production in reservoirs, particularly for youth and women in four (4) deprived communities (Nalerigu, Langbinsi, Tombu and Nansoni) in the North-East Region of Ghana. The project was coordinated by the International Water Management Institute while the Fisheries Commission of Ghana was the implementing partner. Within the project framework, CSIR-WRI was responsible for site selection and community entry, environmental impact assessment, capacity building in fish farming, routine fish sampling, water quality monitoring, and the development of a fish farm manual. The project began in 2022. It ended in 2025.

Objective

The overall objective of the project was to create alternative livelihoods jobs for youth and women and to enhance food security in the Northeast Region.

Activities Undertaken

Water samples were taken from the reservoirs for both physicochemical and microbial analyses. Physical parameters such as temperature, pH, and dissolved oxygen were measured *in situ* with the Aquaread AP-700 water quality meter. A handheld Echo Sounder was used to measure the depth of water at all sections of the reservoir. The caged fish were sampled biweekly to assess fish growth performance.

Key Results Achieved

Recorded pH values ranged from 6.1 – 7.9. Dissolved oxygen levels ranged from 5.3 – 8.2 mg/l. Temperature fell within 26 – 30 °C. There was a general decrease in water depth in the month of December as compared to the month of September in all communities. The rate of decrease could be due to evaporation and could have serious implications on cage depth during the peak dry season (February - April). Fish cultured in the four reservoirs showed steady growth but with some variations among the reservoirs (Table 3.1.1). Only one cage at Nansoni was sampled as the other cage had been harvested and sold. Fish size distribution within cages was generally uniform at Langbinsi and Nalerigu. However, slight size variation was observed in cages at Nansoni and Tombu.

Conclusion

Results from the study established the suitability and potential of small reservoirs in northern Ghana to contribute to caged fish production to improve livelihoods and food security in the country.

Table 3.1.1: Average weight of fish sampled at the four communities in September and December 2025.

Communities	September		December	
	Average weight (g) Cage 1	Average weight (g) Cage 2	Average weight (g) Cage 1	Average weight (g) Cage 2
Nalerigu	102.7	109.0	152.7	158.0
Langbinsi	60.3	55.7	130	107.3
Nansoni	266.7	307.1	-*	376.2
Tombu	173.7	192.2	300	203.1

* Fish harvested and sold out

Recommendation

The project should be replicated in other deprived regions in Ghana to enhance food security and nutrition.

Impact of the Study on the National Economy

- Men, women and youth acquired skills in fish farming for supplementary livelihood incomes.
- Increased local fish production.

3.1.1.2 Fish Disease Outbreak Investigation in the Ellembelle District, Western Region, Ghana

(Research Team: Regina Ama Banu - Principal Investigator, Rhoda Lims Diye, Humphery Darko, Mario Chrisk, Dorothy Lomo-Mainoo, Appiah Serapis, Mark Osa Akrong, Ayesha Algade Amadu, Acheampong Addo, Karyn Ewurama Quansah, Bright Idun, Nawal Moro Buri, Gideon Twieku, Selorm Borbor, Judith Wayo, Gabriel Appiah, Ruby Asmah)

Collaborating Agency: Fishery Commission

Introduction

On January 11, 2025, a fish disease outbreak was reported in the Ellembelle District of the Western Region, Ghana. Fishers observed red lesions (Figure 3.1.1), necrosis, tissue rot, and mass fish mortalities, particularly in the Ebi River, which serves as the primary fishing source for the Kamgbunli community. Fish disease occurrence posed a significant threat to livelihoods, food security, and public health. In response, the Fisheries Commission collaborated with the CSIR-WRI to investigate the cause of the outbreak. A multidisciplinary team from the CSIR-WRI conducted field investigations from 14th-16th January, 2025. The team held engagements with community leaders, the Ghana Health Service, Environmental Protection Authority, and local authorities on site. Initial information obtained from the community indicated that disease symptoms in fish caught from the river had been observed since November, 2024.

Objective

The main objective was to determine the cause of fish disease outbreak and mortality in the Ellembelle District. The specific objectives were to:

- assess physicochemical water quality in Ebi River;
- identify microbial, parasitic, and molecular pathogens associated with fish and environmental samples;
- evaluate ecological indicators of environmental stress;
- assess public health risks associated with identified pathogens; and
- provide recommendations to prevent future outbreaks.



Figure 3.1.1: Moribund fish with hemorrhagic lesions on skin of fish from River Ebi.

Activities Undertaken

Key activities conducted included:

Field Investigation and Stakeholder Engagement: Site visits were conducted at the affected communities and stakeholders including community leaders were engaged (Figures 3.1.2 and 3.1.3). Observed fish disease symptoms, environmental conditions, and fishing activities were documented.



Figure 3.1.2: Kamgbunli fishers (1st right, 1st & 2nd left) Assemblyman (3rd from left) with CSIR-WRI staff.



Figure 3.1.3: CSIR-WRI staff meeting with community elders for mission presentation.

Environmental and Biological Sampling: Environmental and biological samples, including water, sediment, and fish, were collected from the Ebi River (upstream, midstream and downstream), and nearby rivers (Fia and Amansuri) (Figure 3.1.4). Additionally, Borehole water samples, utilized by the community as their main source of drinking water, were collected for analysis. Fish samples exhibiting disease symptoms were also collected. Water samples were taken from a borehole that served as the primary drinking water source for the community. The collected samples were transported to CSIR-WRI laboratories for analyses.

Laboratory Analyses: The following comprehensive laboratory analyses were conducted:

- Physicochemical analysis to assess water quality;
- Microbiological analysis to identify bacterial pathogens;
- Parasitological analysis to detect protozoan and nematode parasites;
- Molecular analysis to identify pathogens and confirm fish species; and
- Ecological assessment of phytoplankton and macroinvertebrates as indicators of ecosystem health.

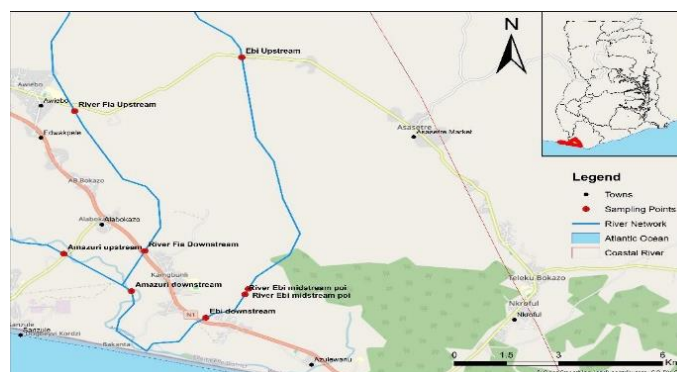


Figure 3.1.4: Map of Ebi river catchment area showing sampling points in the Ellembelle District in the Western Region of Ghana.

Key Results Achieved

Physicochemical Water Quality: Water quality in the rivers was generally suitable for fish survival and domestic use. However, the borehole water used by the community contained high iron concentrations, making it unsuitable for drinking without treatment.

Identification of Fish Pathogens: Multiple disease-causing organisms were identified, including bacterial pathogens such as *Aeromonas hydrophila*, *Pseudomonas putida*, *Enterococcus faecalis*, and *Staphylococcus sciuri*. These pathogens are known to cause skin lesions, hemorrhages, and fish mortalities. Parasitological analyses detected *Tetrahymena* species and *Eustrongylides* nematodes, which cause tissue damage and increase fish susceptibility to secondary infections. Molecular analyses confirmed co-infections involving viral, bacterial, fungal, and parasitic pathogens such as *Aeromonas hydrophila*, *Edwardsiella ictaluri*, *Flavobacterium columnare*, and Infectious Hematopoietic Necrosis Virus (IHNV).

Ecological and Environmental Findings: Low macroinvertebrate diversity and the presence of harmful algal species indicated environmental stress and possible organic pollution. These conditions weaken fish health and increase vulnerability to infections.

Public Health Risk: Some identified pathogens such as *Aeromonas* and *Klebsiella* species pose zoonotic risks and may affect humans through handling or consumption of infected fish.

Conclusion

The fish disease outbreak resulted from multiple bacterial, parasitic, viral, and fungal infections, aggravated by environmental stress and pollution. While general water quality was acceptable, ecological indicators showed ecosystem disturbance.

Recommendation

Continuous monitoring and improved environmental management are essential to prevent recurrence. Key measures include enhancing sanitation, controlling pollution, treating borehole water before domestic use, and preventing untreated waste discharge into rivers.

Impact of the Study on the National Economy

The investigation protects fisheries resources that support food security, employment, and income generation. Identifying the causes of fish disease outbreak helps safeguard fishers' livelihoods, promotes sustainable resource management, and reduces potential public health and economic burdens.

3.1.1.3 Assessment of Fish Kills in Lake Volta, Ghana

(Research Team: Dr. Etornyo Agbeko - Principal investigator, Mr. Eric Kretsi and Dr. Ebenezer K. Appiah)

Introduction

Fish kill (FK) which is the mass mortality of wild or cultured fish over a short period of time, occurs in most tropical lakes but it is under-reported or unreported. Life underwater and food fish security could be threatened by fish kills (FKs) phenomenon. These have affected capture and culture ecosystem services derived from most lakes, rivers, and streams in the tropics. Episodes of mass fish mortality often signal ecological stress or imbalance within aquatic ecosystems. Recent and repeated mass FKs in 2025 in Lake Volta raised serious concerns among fish farmers, researchers, and regulatory agencies, as they threatened both sub-regional food security and the livelihoods that depend on the fisheries and aquaculture within the lake. It was against this background that a study was initiated and completed in the reporting year.

Objective

The objectives were to identify the environmental stressors most strongly associated with mass fish mortality in Lake Volta and to provide evidence-based strategies to mitigate future events and safeguard aquaculture development in the lake.

Activities Undertaken

Water and fish samples were collected from selected hot spots associated with FKs in Lake Volta. Freshly dead or moribund fish were clinically examined to determine the fish health status. Historical records were collated, and the annualised rate of occurrence (ARO) of FKs was calculated, i. e., $ARO = \text{Total fish kill incidents} / \text{Total number of years}$.

Key Results Achieved

From the 2025 FK events and water quality analysis results, Lake Volta turned slightly acidic (pH 5.62-6.34), with nitrite (1.88 ± 0.02 mg/L) and DO (2.89 ± 0.16 mg/L). The FKs observed showed predominantly ectoparasite (*Argulus* spp.) and unconfirmed gill-associated diseases (Figure 3.1.5). The ARO of fish kill risk per year for Lake Volta, after its impoundment and enrichment phase, has been increasing over the last thirty (30) years. Fish kills (FKs) occurred once every five-year cycle return period (1990 to 1995), but by the year 2000, the event had doubled. From the year 2011, fish kills in Lake Volta became an annual event as the ARO was 1, and further increased after a decadal return to twice-per-year fish kill events within the years 2021 to 2025 with an ARO of 2 (Table 3.1.2).

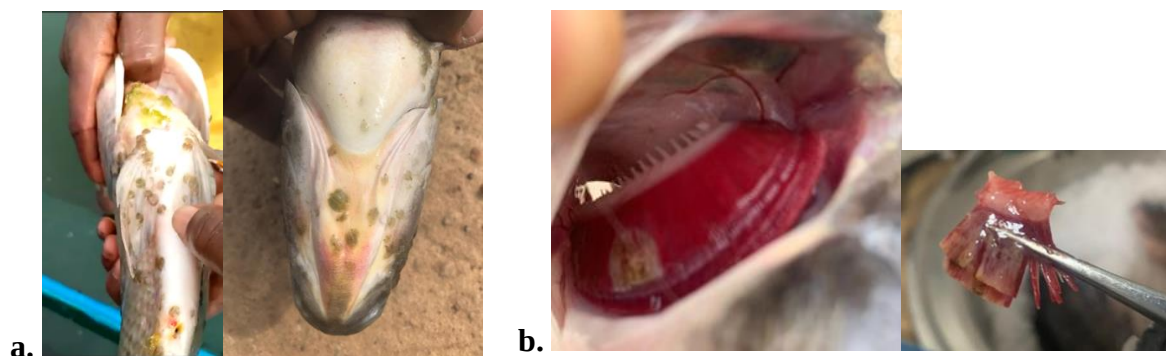


Figure 3.1.5: Clinical examination of fish kills in Lake Volta (a) Ectoparasite, *Argulus* spp. and (b) Gill infection in Nile tilapia, *Oreochromis niloticus*, from sections of the Lake.

Table 3.1.2: Historical perspective and annualised rate of occurrence (ARO) of fish kill for Lake Volta.

Year		Fish Kills Incidence	Duration (yrs)	ARO
1990	1995	1	5	0.2
1996	2000	2	5	0.4
2001	2005	2	5	0.4
2006	2010	4	5	0.8
2011	2015	5	5	1
2016	2020	5	5	1
2021	2025	10	5	2

Conclusion

Lake Volta is becoming increasingly vulnerable to recurrent fish kills and fish diseases as mass mortality of cultured and wild fish species are recorded annually.

Recommendation

An integrated lake management plan to protect fisheries biodiversity and resilient aquaculture production strategies are needed to sustain the Volta Lake for fish production.

Impact of the Study on the National Economy

Promotion of sustainable aquaculture in Lake Volta will augment local fish production to meet national fish production target of 160,414 metric tonnes for the year 2025 and beyond.

3.1.1.4 Eco-Innovative Technologies for Improved Nutrition, Sustainable Production and Marketing of Agroecological Food Products in Africa (INNOECOFOOD)

(Research Team: Dr. Etornyo Agbeko - Principal Investigator, Dr. Esther Wahaga, Dr. Lawrence Abbey, Dr. Benjamin Mintah, Dr. Mary Glover Amengo and Dr. Ebenezer Appiah)

Collaborating Agencies: FRI, CIIMAR, KMIFRI, TAFIRI, MAKERERE, UNAM, CLAR, UDSM, JKUAT, BMAEU, DENZLI, ICIPE, B2E, SPARKY, FSPN-Africa, INNOTECH, ISE, FMV, PECHE, NKSBB, JRC

Introduction

Aquatic foods are emerging as a healthy and more sustainable food production system globally. Freshwater aquaculture could contribute significantly to food security, job creation, livelihood empowerment, and economic transformation of a nation. These could be achieved through harnessing innovation and application of appropriate technologies in fish farming and other aquatic food production processes. The INNOECOFOOD project is expected to support AU - EU markets and trade through training of rural farmers, youth, and women to innovatively produce farmed tilapia and catfish, blue-green algae, *Cyanobacteria spirulina*, and insect value chains that will be processed into certified marketable human food products and feeds. The project began in 2024 and it is expected to end in 2026.

Objective

The objective was to establish innovative production/business Ecohubs and improve local aquaculture using AI and IoT in six Africa countries.

Activities Undertaken

Establishment of an Ecohub at the CSIR-WRI ARDEC in Akosombo continued under the reporting year. Construction works for a fish hatchery and a grow-out section, fish processing structure, *Spirulina* ponds, cricket/insect, and black soldier fly production sections were being completed. Screening and analysis of *Spirulina* samples were coordinated and done in Turkey

by project partners. Final versions of the project training manual (Project training modules) are under review for training of trainers.

Key Results Achieved

A fish hatchery and a grow-out structure are about 84% completed, with a 12-unit circular pond partially completed for tilapia and catfish production within the Ecohub (Figure 3.1.6). The fish processing structure is about 89% completed, with all units and partitions done. Classrooms for teaching project participants were about 80% completed. A total of two (2) unit *Spirulina* ponds were built, awaiting installation of inlets, outlets and bioreactors for production to begin (Figure 3.1.7). Cricket/insect structure with predator buffer created for sustainable production of insect meal. Black soldier fly structure is about 78% completed. The living lab cages were mounted with a walkway and external anchorage (Figure 3.1.8). Production net and other netting have been fabricated, awaiting installation to operationalise the system for table-sized fish production.



Figure 3.1.6: Innoecofood project Ecohub indicating the fish hatchery, fish processing structure, and mechanised borehole water systems under construction at CSIR-WRI, ARDEC, Ghana.



Figure 3.1.7: Inlet and outlet pipe installation works for *Spirulina* pond.



Figure 3.1.8: Living lab cages with anchorage and walkway pillars.

Conclusion

Various jobs and employment opportunities could be created from this Ecohub fish model. The installation of recirculatory aquaculture systems (RAS) and AI sensors for water quality monitoring and fish processing could showcase the use of modern technologies in advancing fish farming in Ghana.

Recommendation

Regional aquatic food production Ecohubs should be established based on lessons learnt from this prototype when completed at CSIR-WRI, ARDEC in Akosombo.

Impact of the Study on the National Economy

When the Ecohub is up scaled to other regions, it could contribute to meeting Ghana's fish production targets to minimise the Nation's fish deficit, create jobs for youth and women as well as contribute to better GDP.

3.1.1.5 Field Investigation of Fish Kill in the Keta Lagoon

(Project Team: Dr. Michael K. Dorleku and Mrs Regina Banu - Principal Investigators, Acheampong Addo, Martha Duku Agyemang, Selorm Borbor)

Collaborating Agencies: Keta Municipal Assembly, Fisheries Commission

Introduction

Coastal lagoons are highly productive ecosystems that support biodiversity, fisheries, livelihoods, and essential ecosystem services. The Keta Lagoon is one of Ghana's important coastal waterbodies, supporting fisheries, employment, income generation, and food security. However, on 26th August, 2025, residents of Aborlove-Nolopi in the Keta municipality reported a massive fish kill along the Keta Lagoon shoreline. This necessitated an investigation by a multidisciplinary team from the Institute. The investigation was initiated and completed in the year under review.

Objectives

The objectives were to:

- evaluate the water quality conditions of the Keta Lagoon following observed fish kills;
- determine the key environmental factors contributing to the mortalities; and
- assess the lagoon's suitability for sustaining healthy fisheries.

Activities Undertaken

Activities undertaken included sampling, field analyses, laboratory analyses, data analyses and report writing. In-situ water quality measurements were undertaken. Fish, sediment and water samples were collected for various analyses in the laboratory. The data collected across different tidal and spatial zones (shore, upstream, midstream, and downstream) (Figure 3.1.9) were compared to FAO, WHO, and USEPA guidelines to evaluate suitability for aquatic life.

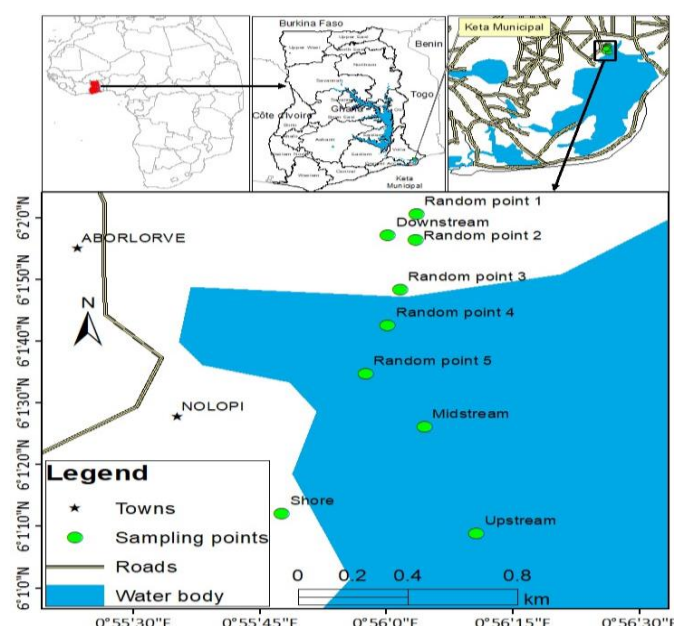


Figure 3.1.9: Map of sampling area with map of Ghana insert.

Key Results Achieved

- There was significant spatial and temporal variation in water quality. Midstream and upstream areas generally remain suitable for fisheries, while shoreline zones were impacted by organic and oil pollution, resulting in localized oxygen depletion (Figure 3.1.10).
- Sampled fish populations were generally in good physiological conditions.
- A diverse microbial community, including pathogenic and opportunistic bacteria and high total heterotrophic counts were recorded (Table 3.1.3).

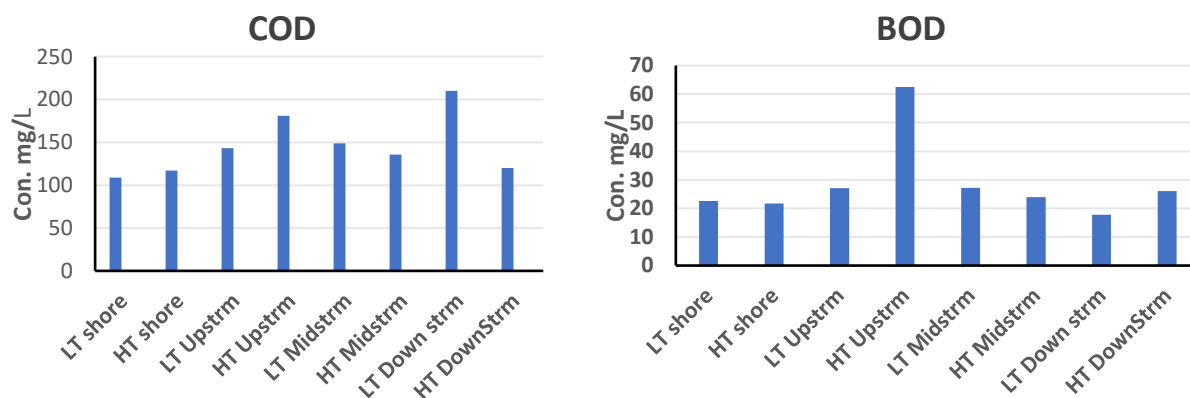


Figure 3.1.10xxx: Mean COD and BOD levels (organic pollution) of sampling points.

Conclusion

The mortalities were localized in nature and not widespread. Acute hypoxia, exacerbated by elevated ammonia concentrations, high temperatures, and reduced surface aeration could be responsible for the high tilapia species mortalities observed in the Keta lagoon.

Recommendations

The following recommendations were given at the end of the study:

- Regular monitoring of DO, ammonia, and BOD, particularly at shoreline locations;
- Reduction of organic runoffs and waste discharges into the lagoon from surrounding settlements;
- Control of oil and grease inputs from boats and local anthropogenic activities;
- Periodic testing of heavy metals in water and fish tissues;
- Promotion of mangrove restoration to improve oxygen balance, stabilize habitats, and enhance ecosystem resilience;
- Implement spatially targeted monitoring to identify localized stress points and guide timely management interventions;
- Routine monitoring of key indicator bacteria; and
- Public awareness should be raised to discourage consumption of untreated lagoon water and to highlight the importance of environmental management.

Impact of the Study on the National Economy

Survival and increased fish production in the Keta lagoon will augment national fish production which will contribute to improve GDP.

Table 3.1.3: Bacteriological Water Quality at different sampling points of the Aborlove-Nolopi catchment of the Keta Lagoon.

Sampling Days	Total Coliform	Faecal Coliform	<i>E. coli</i>	<i>Enterococcus</i> spp	<i>Vibro</i> spp	<i>Aeromonas</i> spp.	Total Heterotrophic Bacteria (THB)
	cfu/100ml						cfu/ml
Day 1							
Lowtide Upstream	7	0	0	2	5	8	1404
Lowtide Midstream	6	0	0	0	5	26	2340
Lowtide Downstream	13	0	0	20	4	15	1872
Lowtide shore	93	0	0	32	9	108	2808
Hightide Upstream	9	0	0	2	3	16	936
Hightide Midstream	13	0	0	4	3	0	1404
Hightide Downstream	21	0	0	25	4	8	3276
Hightide Shore	35	0	0	3	31	32	2340
Day2							
Lowtide Upstream	100	0	0	12	7	7	1300
Lowtide Midstream	279	0	0	22	15	15	3276
Hightide Downstream	27	0	0	4	7	25	1404
Hightide Shore	57	0	0	9	10	2	2808
Hightide Upstream	9	0	0	0	4	4	2808
Hightide Midstream	0	0	0	0	52	14	1404
Hightide Downstream	18	0	0	4	2	28	364
Hightide Shore	279	0	0	5	4	18	3276
WHO Guidelines Aquaculture ponds/lagoons	-	-	≤1000	-	-	-	-

3.1.1.6 Comparative Growth Performance of the Nile Tilapia, *Oreochromis niloticus*, Cultured in Floating Fish Cages, Hapa-in-Pond Systems and in Tarpaulin Tanks

(Project Team: Francis A. Anani - Principal Investigator, Lawrence A. Ahiah, Collins P. Duodu, Peter Kpordugbe, Luther J. Quarshie, Felix A. Ayarika, Kelvin K. Donkor and Ellen A. Diame)

Introduction

In Ghana, fish is cultured in different systems such as earthen ponds, floating fish cages and in tanks made of concrete, plastic or tarpaulin. The type of culture system used in rearing fish presents the fish with different environmental conditions that may directly or indirectly impact its growth performance. The study which began in 2024 ended in the reporting year.

Objective

The main objective was to compare the growth performance of Nile tilapia, *Oreochromis niloticus* in hapa-in-pond system (A), floating fish cage (B) and in tarpaulin tank (C).

Activities Undertaken

The following activities were undertaken in the year under review:

- Twelve (12) fine mesh net hapas and tarpaulin tanks measured 5.0 m x 2.0 m x 1.2 m (i. e. length, width and height, respectively) each whilst 12 cages measured 2.0 m x 2.0 m x 1.4 m each were constructed;
- Initial weight range, mean weights of *O. niloticus* fingerlings were determined using digital weighing balance (0.1 g) whilst lengths were measured using fish measuring board (0.1 cm);

- The fingerlings were stocked at 5 fish m⁻³ in hapa-in-pond system and in tarpaulin tanks whilst 15 fish m⁻³ in cages based on recommended stocking density range for the respective systems;
- Fish were fed with the same extruded pelleted commercial feed of size 4.5 mm and 30.0% crude protein content; three (3) times a day at a reducing rate of 4.0 to 2.5% of their biomass;
- Water quality parameters such as temperature, DO and pH in the experimental systems were determined biweekly;
- The standard lengths, total lengths and weights of fish samples from each system were measured fortnightly;
- Fish in all systems were harvested after 18 weeks (126 days) and they were sorted, counted and weighed;
- Various growth performance indicator indices such as SR, WG, SGR, FCR and FE were computed; and
- All data were statistically analysed.

Key results achieved

- There were significant differences (Duncan MRT, $P < 0.05$) in all growth performance indicator indices among all culture systems with those of tarpaulin tanks being the least (Duncan MRT, $P > 0.05$);
- The largest fish weights (> 400.0 g) were realized in cages only; and
- The best performed system in terms of fish growth was cage whilst the worst was tarpaulin tank in which the least survival rate ($51.33 \pm 3.06\%$) was also recorded.

Conclusion

The use of cages to culture Nile tilapia is recommended over hapa-in-pond systems or tarpaulin tanks. However, alternative to cages should be hapa-in-pond systems.

Impact of the Study on the National Economy

Adoption of cage culture of Nile tilapia in appropriate water bodies will increase the overall national fish production and subsequently appreciation in the GDP.

3.1.1.7 Evaluation of Three Locally Formulated Tilapia Feeds for Nile Tilapia (*Oreochromis niloticus*) Production in Floating Fish Cages

(Project Team: Francis A. Anani - Principal Investigator, Lawrence A. Ahiah, Collins P. Duodu, Peter Kpordugbe and Luther J. Quarshie)

Introduction

The high cost of formulated fish feeds is due to the over reliance on imported feed ingredients by local commercial fish feed producers. Further, the unstable exchange rate of the local currency to the US dollar and the high import taxes had resulted in price instability which is negatively affecting fish feed costs. The study, which ended in the year under review, started in 2024.

Objective

The objective was to assess the growth performance and profitability of feeding three (3) different tilapia feeds (A, B and C) to the Nile tilapia, *Oreochromis niloticus* cultured in floating fish cages.

Activities Undertaken

Activities carried out included:

- Fish were separately fed with feeds A, B and C 3 times daily at a reducing rate of 4.0 to 2.5%;
- Water quality parameters [temperature, dissolved oxygen (DO) and pH] were determined biweekly;
- The standard lengths (SLs), total lengths (TLs) and weights (Ws) of fish samples were measured fortnightly; and
- Final data were analyzed statistically at the end of 18 weeks (126 days) culture period.

Key results achieved

- The recorded final mean weights (FMWs) were 274.93 ± 11.94 , 261.40 ± 15.15 and 309.07 ± 16.29 g for feeds A, B and C, respectively;
- Feed C was significantly higher (Duncan MRT, $P < 0.05$) than A and B;
- Nutritional value of flesh of the harvested fish fed with the various feeds were similar; and
- Although the use of all the feeds was profitable, that of A was the most.

Conclusion

Any of the 3 feeds is recommended for tilapia grow-out production based on regional or seasonal availability and costs of the ingredients used and the formulation that will give the least cost.

Recommendation

The following recommendations were given:

- To guarantee that the cost of producing any selected feed/formulation is not affected by regional or seasonal variations, alternative and sustainable ingredient sources such as duckweeds, *Spirulina* and other freshwater weeds which can easily be cultured by fish farmers in tanks or in earthen ponds should be used to replace some of the ingredients in the various feed formulations; and
- Additionally, production and use of insect larvae meal through breeding of insects such as black soldier fly to replace protein-based ingredients such as fish meal and/or soybean meal should be considered.

Impact of the Study on the National Economy

On-farm fish feed production using locally available ingredients will reduce the cost of farmed fish production, increase fish production and subsequently appreciation in the GDP.

3.2 CLIMATE CHANGE, ENVIRONMENTAL MANAGEMENT AND GREEN TECHNOLOGY

3.2.1 POLLUTION AND WASTE MANAGEMENT

3.2.1.1 Integrating Fungal-Assisted Microalgal Harvesting for Sustainable Treatment and Resource Recovery from Wastewater

(Research Team: Ayesha Algade Amadu - Principal Investigator, Oduro-Mensah, Daniel; Qiu, Shuang; Abbew, Abdul-Wahab; Li, Mengting; Lu, Xiyang.; Ameka, Gabriel Komla; Osei-Atweneboana, Mike Yaw; Akrong, Mark Osa; Donkor, Jacob; Ge Shijian)

Collaborating Agencies: Nanjing University of Science and Technology, University of Ghana

Introduction

Industrial and food-processing effluents, such as cocoa pulp wastewater, pose environmental challenges when discharged untreated. Microalgae-based wastewater treatment has gained attention because microalgae efficiently remove nutrients such as nitrogen and phosphorus and produce biomass that can be converted into valuable products. However, a major limitation of this technology is the high cost and difficulty of harvesting microalgae due to their small size and low density. Traditional harvesting methods such as centrifugation and chemical flocculation are energy-intensive and costly. Biological approaches, particularly fungal-assisted microalgal harvesting, offer a sustainable alternative, by allowing fungi to aggregate microalgae into larger flocs that can be easily separated from wastewater. This study started in 2024 and ended in the reporting year.

Objective

The study aimed to investigate fungal-assisted microalgal harvesting as a cost-effective and sustainable method for wastewater treatment and resource recovery. The specific objectives were to:

- screen fungal isolates capable of forming pellets suitable for harvesting microalgae;
- optimize cultivation conditions to enhance pellet formation and harvesting efficiency; and
- evaluate the ability of microalgae–fungi consortia to remove nutrients and pollutants from real wastewater.

Activities Undertaken

The following activities were carried out during the year under review:

- Isolation and screening of eleven fungal isolates for pellet-forming ability.
- Optimization of cultivation conditions such as agitation speed, carbon sources, inoculum size, and carbon–nitrogen ratios.
- Co-cultivation of fungi with wastewater-derived microalgae to evaluate harvesting efficiency.
- Microscopic and scanning electron microscopy analyses to observe interactions between fungal hyphae and microalgal cells.
- Testing the selected fungal isolates in real wastewater (food-processing effluent) to evaluate nutrient removal and treatment performance.

Key Results Achieved

Key results obtained included the following:

- Two fungal isolates (FP and T10) demonstrated very high microalgal harvesting efficiencies of 97.5% and 96.5%, respectively.

- The microalgae–fungi consortium significantly improved wastewater treatment compared with monocultures.
- Nutrient and pollutant removal efficiencies included:
 - 82.5% ammonium ($\text{NH}_4^+\text{-N}$) removal
 - 66.4% COD reduction
 - 92.4% phosphate ($\text{PO}_4^{3-}\text{-P}$) removal
- The fungal hyphae aggregated microalgae cells through charge interactions, entrapment in hyphae, and extracellular polymeric substances, forming pellets that simplified harvesting.
- The fungal isolate FP was identified as the most effective candidate for further wastewater treatment applications.

Conclusion

The study successfully demonstrated that fungal-assisted microalgal harvesting is an efficient and sustainable approach for wastewater treatment and biomass recovery. Screening and optimization of fungal isolates identified highly effective strains capable of forming pellets that significantly enhance microalgae harvesting efficiency. The microalgae–fungi consortium also showed improved nutrient and pollutant removal from wastewater compared to monocultures, highlighting its potential for integrated wastewater treatment and resource recovery systems.

Recommendation

Some recommendations provided were:

- Further research should focus on scaling up the fungal-assisted microalgal harvesting system for industrial wastewater treatment.
- Long-term pilot-scale studies should be conducted to evaluate operational stability and economic feasibility.
- Exploration of additional wastewater sources and fungal strains could improve treatment efficiency and biomass productivity.
- The harvested biomass should be investigated for value-added applications such as biofuels, animal feed, or bioproducts.

Impact of the Study on the National Economy

The technology offers significant potential benefits to the national economy by:

- providing cost-effective and environmentally friendly wastewater treatment solutions for food industries;
- supporting circular bioeconomy initiatives through the conversion of harvested biomass into biofuels, feed, and other valuable products; and
- reducing environmental pollution through wastewater reuse.

3.2.1.2 Water Quality Index Assessment of River Bodies in the Southwestern, Coastal and Volta River Systems in Ghana in 2025 – Findings and Recommendations

(Project Team: Humphrey F. Darko - Principal Investigator, Dr. K.A. Asante, Victor Mante, Michael Afram, Jude Quansah)

Collaborating Agency: Water Resources Commission (WRC)

Introduction

Water quality is critical for public health, ecosystem protection, agriculture, fisheries, hydropower generation, and industrial development. In 2025, a national water quality monitoring exercise was conducted across major rivers and lakes within the Southwestern,

Coastal, and Volta River Systems, covering 41 stations across the 16 Regions of Ghana. The Water Quality Index (WQI), with values ranging from 0 (poorest quality) to 100 (best quality), was used to assess pollution status of the rivers and lakes. The WQI classifies water into 4 categories as:

- Class I (Good quality): >80
- Class II (Fairly good quality): >50–80
- Class III (Poor quality): 25–50
- Class IV (Grossly Polluted): <25

The index reflects the degree to which water quality is affected by human activities. The study was initiated in 2023 and is expected to end in 2030.

Objectives

The objectives of the 2025 monitoring programme were to:

- assess the pollution status of selected river monitoring stations using WQI;
- identify rivers and lakes requiring priority management actions; and
- provide evidence-based information to guide policy and decision-making.

Activities Undertaken

The following activities were undertaken during the year under review:

- Two national sampling campaigns were conducted in February 2025 (dry season) and July 2025 (wet season).
- Water samples were collected from 41 monitoring stations in February and 40 stations in July because one station, Ampansie, was not accessible in July.
- Laboratory analysis was performed on each sample to determine various water quality parameters.
- WQI values were computed for each station using 10 key water quality parameters.
- Comparative seasonal analysis was conducted.

Key Results Achieved

Dry Season (February 2025)

Out of 41 monitoring stations:

- Class I (Good quality): 5 stations (all in the Volta Rivers System)
- Class II (Fairly good quality): 29 stations
- Class III (Poor quality): 7 stations
- Class IV (Grossly Polluted): 0 stations

Most rivers (71%) fell within Class II, indicating that most uses of the water were protected but some were threatened or impaired.

Seven stations (17%) were in Class III, showing that several uses of the water were threatened, likely due to anthropogenic activities such as illegal mining, agricultural runoff, and domestic waste discharge.

No station recorded Class IV status.

Wet Season (July 2025)

Out of 40 stations assessed (one station, Ampansie, was inaccessible):

- Class I (Good quality): 2 stations (again, all in the Volta Rivers System)
- Class II (Fair good quality): 30 stations
- Class III (Poor quality): 8 stations

- Class IV (Grossly Polluted): 0 stations

Comparing with the Dry Season (February):

- The number of Class I stations decreased (5 to 2).
- Class III stations increased slightly (7 to 8).
- Majority (75%) remained in Class II.

The reduction in Class I and slight increase in Class III during July (Figure 3.2.1) may be linked to surface runoff during the rainy season, which transports sediments, nutrients, and pollutants into rivers, and to illegal gold mining activities.

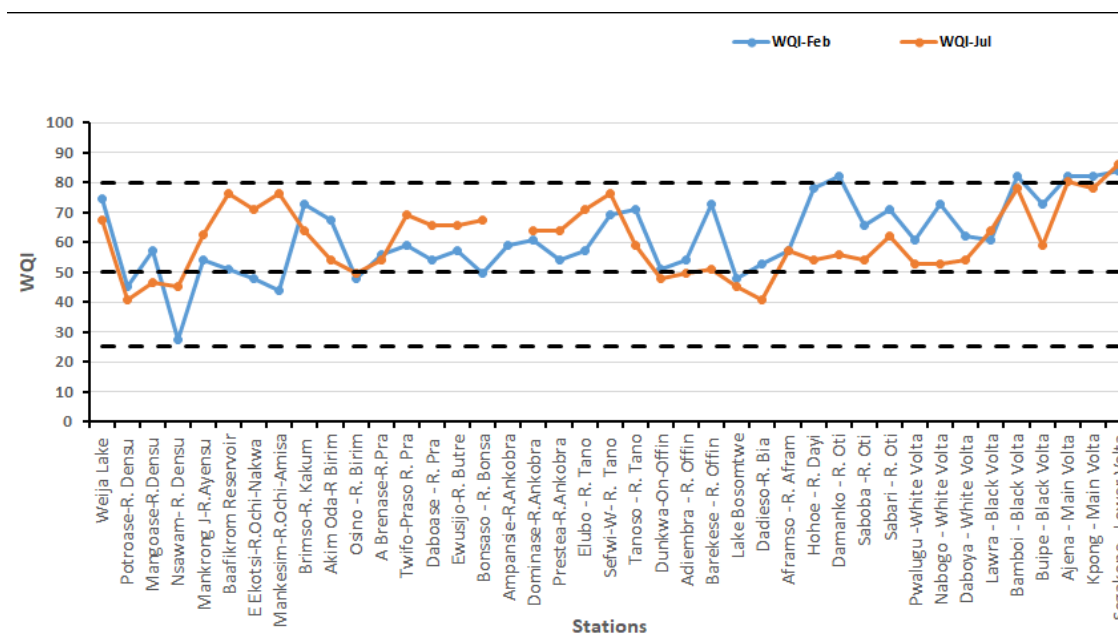


Figure 3.2.1: Seasonal Variations of WQI at the Monitoring Stations.

Overall Water Quality Status for 2025

- No river station was classified as Class IV (Grossly Polluted) in 2025.
- The river systems are generally in a fairly good quality (Class II) state.
- However, persistent Class III stations indicate localized pollution hotspots.
- Seasonal variation shows increased vulnerability during the rainy season.

Overall, water quality across the monitored basins can be described as moderately impacted by human activities, with specific areas requiring targeted intervention.

Conclusion

The 2025 national monitoring exercise successfully assessed the pollution status of major river systems using the Water Quality Index.

The results show that:

- Most rivers are in Class II, meaning water uses are generally protected but under pressure.
- A number of stations remain in Class III, requiring management attention.
- No river was classified as grossly polluted.

The objective of identifying pollution levels and priority areas has been achieved.

Recommendation

The following recommendations were given:

- **Enforcement:** Regulation and enforcement should be strengthened in Class III stations, especially in areas affected by illegal mining and untreated waste discharge.
- **Pollution Source Control:** Promote best agricultural practices to reduce nutrient and sediment runoff.
- **Community Engagement:** Implement education programmes in riparian communities to reduce indiscriminate waste disposal and illegal mining activities.

Impact of the Study on the National Economy

The monitoring programme contributes to the national economy by:

- Protecting drinking water sources.
- Supporting fisheries and aquaculture sustainability.
- Safeguarding hydropower infrastructure.
- Reducing public health risks and water treatment costs.
- Providing data for government and stakeholders to make informed decisions regarding water resource management, leading to sustainable economic development.

3.2.1.3 Water Quality Assessment and Shelf-Life Evaluation of Popular Bottled, Jar and Sachet Water Brands in Accra Market and Stored Under Two Conditions

(Research Team: Dr. Mark Osa Akrong - Principal Investigator, Dr. K. A. Asante, Regina Ama Banu, Prof. Mike Osei-Atweneboana, Humphrey Darko, Karyn Quansah, Nawal Moro, Frank Oppong, Daniel Amoah, Ayesha Amadu, Dorothy Lomo-Mainoo, Gertrude Nortey)

Collaborating Agency: GIZ

Introduction

Access to safe drinking water is essential for public health, and in Ghana, there has been a growing reliance on packaged drinking water such as bottled water and large reusable jars. This trend is driven by the perception that packaged water is cleaner, safer, and more reliable than municipal water supplies, and it is often regarded as an improved water source. Packaged water typically undergoes advanced treatment processes, including microfiltration, reverse osmosis, ultraviolet radiation, and ozonation, making it especially attractive to vulnerable populations such as the elderly, young children, pregnant women, and immunocompromised individuals. Despite these rigorous treatment processes, packaged water remains susceptible to microbiological contamination at various stages, including production, packaging, transportation, distribution, and storage. Storage conditions such as temperature, humidity, and exposure to light can affect microbial growth, taste, odour, overall quality, and shelf life, thereby influencing consumer safety and confidence. This study aims to assess the quality and shelf life of popular packaged drinking water in Accra under different storage conditions simulating what pertains in real-world conditions, with findings expected to guide regulatory agencies and stakeholders on the importance of proper storage practices to ensure safe and acceptable drinking water for the public. The study began in 2025 and is expected to end in 2026.

Objectives

The objectives were to:

- i. select six popular packaged water brands (Jar, bottled) in Accra market and determine the baseline physico-chemical and bacteriological quality of the packaged water brands.
- ii. evaluate monthly, the physico-chemical and bacteriological quality of the packaged water brands subjected to two storage conditions over a three-month period.

Activities Undertaken

Popular packaged water brands comprising jar and bottled water were procured from production sites and wholesalers in the Accra market. The selected brands were designated A, B, C, D, E and F. Prior to storing the packaged water under the two conditions to simulate real-world storage conditions, a baseline water quality assessment of the various brands and types was conducted. Mineral water jars and bottled water samples were immediately analysed for the baseline study. The jar contains both refilled and disposable types. The packaged water was then divided equally into two sets and subjected to two storage conditions: one set kept in a clean, spacious, and well-ventilated (room temperature) condition, and the other set in a more constrained (harsh) condition under a protected shed. Samples were assessed for physicochemical and biological (bacteriological, parasitological and presence of microalgae) parameters following the Standard Methods for the Examination of Water and Wastewater. The temperature and humidity levels under the two storage conditions were monitored and recorded.

Key Results Achieved

The baseline results showed that the physico-chemical quality of the 6 brands and types of the water samples satisfied the WHO Guideline/GSA Standard for drinking water. The bacteriological analysis showed that all bottled water brands, as well as the corresponding jar water samples from brands B, C and D satisfied the WHO Guidelines and Ghana Standards for drinking water (Table 3.2.1). Furthermore, all the samples were devoid of parasites, and microalgae contamination.

Table 3.2.1: Bacteriological baseline results of popular packaged water in Accra market.

BRAND	Total coliform (log cfu/100ml)	E. coli (log cfu/100ml)	Pseudomonas spp (log cfu/100ml)	Enterococcus spp (log cfu/100ml)	Clostridium spp (log cfu/100ml)	THB' 22°C (log cfu/ml)	THB' 37°C (log cfu/ml)
Jar							
(A)	0	0	0	0	0	2.46	2.50
(B)	0	0	0	0	0	0.95	1.04
(C)	0	0	0	0	0	0.00	0.00
(D)	0	0	0	0	0	0.00	0.00
(E)	0	0	0	0	0	2.30	2.32
(F)	0	0	0	0	0	3.51	3.52
Bottled							
(A)	0	0	0	0	0	<1	<1
(B)	0	0	0	0	0	1	2
(C)	0	0	0	0	0	<1	<1
(D)	0	0	0	0	0	<1	<1
(E)	0	0	0	0	0	<1	<1
(F)	0	0	0	0	0	<1	<1
Ghana Standards GS 175:2024	0	0	0	0	0	1.71	2.70
WHO Guideline	0	0	0	0	0	-	-

For the shelf-life results, variations in the physicochemical parameters between baseline (March) and subsequent months (April–May) were generally minor and not statistically significant at $\alpha = 0.05$. This was consistent for the different water brands, types and storage conditions. The bacteriological quality assessment of bottled and mineral jar water stored under

room temperature and harsh conditions for the three months revealed that 81.3% (117 out of 144 samples; 36.9% jar and 44.4% bottled) of the samples had bacterial counts that satisfy the WHO Guidelines/Ghana Standards GS 175:2024 limits. All the samples were devoid of most of the bacteriological parameters (Total coliform, *E. coli*, *Pseudomonas* spp., *Enterococcus* spp. and *Clostridium* spp.) except total heterotrophic bacteria (THB). Comparatively, the mean Total Heterotrophic Bacteria counts in the samples were higher in the jar water than the bottled water samples. Similarly, the bacterial counts were marginally higher in water samples stored under room condition than the harsh condition for both THB incubation temperatures of 22 °C and 37 °C. Moreover, the disposable jar mineral water showed lower bacterial counts than refilled jars, this was likely due to better hygiene and the absence of biofilm formation. Furthermore, none of the samples had the presence of parasite and microalgae throughout the study.

Conclusion

The baseline results showed that the physico-chemical quality of the 6 brands and types (jar and bottled) of the water samples satisfied the WHO Guidelines/Ghana Standards for drinking water. Also, the bacteriological water quality indicated that all the bottled water brands, as well as the corresponding jar water samples from brands B, C and D conformed to the WHO Guidelines and Ghana Standards and thus safe for drinking. Conversely, the jar water from A, E and F recorded high total heterotrophic bacteria counts, rendering them unsafe for consumption. The shelf-life study revealed minimal variation in the concentrations of the physicochemical parameters of the samples from the different water brands, types and storage conditions. Bacteriologically, majority (81.3%) of the packaged water stored under the two conditions for three months had bacterial counts that satisfy the WHO/Ghana Standards GS 175:2024 limits. All the samples across the baseline and shelf-life assessment were devoid of parasites and microalgae.

Recommendation

It was recommended that the shelf-life study be extended to a full year in order to generate comprehensive data on quality variations over time. Similar studies should be carried out in other cities to generate nationally representative data on water quality patterns and associated storage risks.

Impact of the Study on the National Economy

The outcomes of this project will provide critical evidence to support regulatory agencies such as the Food and Drugs Authority (FDA) and the Ghana Standards Authority (GSA) to strengthen the regulation and monitoring of packaged water quality. Improved regulatory oversight will contribute to safer drinking water, a reduction in waterborne diseases, and lower public health expenditures. Consequently, national resources that would otherwise be diverted to disease treatment can be redirected toward productive development initiatives, thereby supporting sustainable economic growth.

3.2.1.4 Feasibility Studies for Converting Water Hyacinth to Floating Vegetable Farm

(Research Team: Dr. Michael Kumi and Dr. Etoroyo Agbeko (PhD) - Principal Investigators, Victor Mante, Eric Kretsi)

Collaborating Agency: Orange Sparks BV, Ghana Office

Introduction

Water hyacinth (*Eichhornia crassipes*) is one of the world's most prolific invasive aquatic species, posing severe ecological and socioeconomic challenges across sub-Saharan Africa. In

Ghana's Volta Basin, the uncontrolled proliferation of water hyacinth (Figure 3.2.2) has degraded water quality, disrupted fishing livelihoods, obstructed navigation, and reduced biodiversity in affected communities.



Figure 3.2.2: Water hyacinth infestation on the Volta Basin.

Despite these adverse effects, water hyacinth possesses remarkable biomass properties that, if properly harnessed, can be repurposed into productive agricultural infrastructure. The AquaFarm project, funded by Orange Sparks BV (Netherlands), was conceived to explore the technical and economic feasibility of transforming harvested water hyacinth into floating vegetable farming platforms. Implemented across the communities of Kua, Adotorkor, and Avegoeme in the Sogakope District of the Volta Region, the project represents an innovative intersection of environmental remediation, climate adaptation, and food security. This Phase I feasibility study commenced in July 2025 and was designed to generate the evidence base necessary to guide a full-scale pilot in Phase II.

Objectives

The objectives of the study were to:

- i. establish baseline water quality across potential sites;
- ii. evaluate the biomass characteristics of water hyacinth for floating farm construction; and
- iii. identify the most viable pilot site based on technical and economic considerations.

Activities Undertaken

The project was implemented through five interlinked phases during the reporting period. The first phase involved inception and planning activities, including refinement of the work plan, clarification of research questions, and collection of baseline information on water hyacinth spread, and community dynamics across target sites in the Volta Basin. The second phase focused on stakeholder engagement and site selection. Consultations were conducted with community leaders, cooperatives, the Volta River Authority (VRA), and the Environmental Protection Authority (EPA). These engagements helped validate site selection criteria and identify communities willing to participate as early adopters (Figure 3.2.3).



Figure 3.2.3: Stakeholder engagement session with community members and leaders at Kua.

The third phase involved technical feasibility and baseline studies, during which field assessments were conducted to measure biomass coverage, water quality parameters, dissolved oxygen, biochemical oxygen demand (BOD), nutrient levels, and parasitic contamination across the three communities. Early structural prototypes of floating farm platforms were also developed and tested. The fourth phase encompassed economic feasibility and market exploration. This included cost-structure analysis for floating platforms, assessment of local vegetable market demand, and exploration of community-based production models and potential market linkages with supermarkets and distributors. The fifth and final phase involved synthesis and strategic planning for Phase II, consolidating findings from the technical, economic, and stakeholder engagement activities into a coherent strategy for the next phase of the project.

Key Results Achieved

Field assessments revealed significant variation in biomass availability and water chemistry across the three communities, necessitating site-specific design considerations. Kua recorded the most extensive water hyacinth biomass coverage, exceeding 90% of assessed water surface area at a density of 15-20 tonnes per hectare, though it also presented poor dissolved oxygen levels. Avegoeme, by contrast, exhibited optimal oxygen levels but had comparatively limited biomass. Adotorkor presented intermediate conditions between the two. These variations confirmed that while water hyacinth can be technically transformed into viable floating platforms across all sites, anchoring systems, material processing methods, and health safeguards must be tailored to each location's specific conditions. Early structural prototypes developed during the assessment phase demonstrated encouraging levels of stability and adaptability to local water conditions (Figure 3.2.4).



Figure 3.2.4: Early prototype of the water hyacinth-based floating vegetable farm platform.

On the economic side, analysis identified Kua as the most cost-effective pilot site. It was estimated that harvesting over 10,000 kg of water hyacinth annually in Kua alone could enable the construction of approximately 300 floating farm units, each capable of generating between GHC900 and GHC1,200 in revenue per three-month production cycle. Market analysis confirmed strong local demand for vegetables, and community-based production models were identified as the most promising vehicle for scale-up. One technology has been developed through the project and is pending intellectual property protection.

Conclusion

The Phase I feasibility study has confirmed that converting water hyacinth into floating vegetable farming platforms is both technically and economically viable in the Volta Basin. With respect to the first objective, baseline water quality data established clear differences across the three sites, providing a reliable foundation for site-specific interventions. Regarding the second objective, biomass evaluations confirmed that water hyacinth in the study area possesses the structural properties needed for floating farm construction, with Kua presenting the most abundant and accessible resource. On the third objective, Kua emerged as the most viable pilot site, offering the optimal combination of biomass abundance, construction cost savings, and environmental remediation potential. Together, these findings validate the AquaFarm concept as a practical and scalable solution to simultaneously address invasive species management, food production, and livelihood development in riparian communities.

Recommendation

Based on the findings of Phase I, it is recommended that Phase II proceed with Kua as the primary pilot site for full-scale prototype development and validation. The project team should prioritize resolving the poor dissolved oxygen conditions at Kua through appropriate platform design and hyacinth harvesting strategies that promote water circulation. Community-based enterprise models should be formalized with clear governance structures, training programmes, and defined market linkages before full deployment. Regulatory alignment with the VRA and EPA should be completed early in Phase II to avoid delays. Additionally, the technology developed during Phase I should be submitted promptly for intellectual property protection to safeguard the innovation ahead of scale-up and potential commercialisation. Engagement with supermarkets and distributors identified during the market exploration phase should be advanced to secure off-take agreements that underpin the business model's financial viability.

Impact of the Study on the National Economy

The AquaFarm project holds significant implications for Ghana's national economy across multiple dimensions. By converting an environmental liability into a productive agricultural resource, the project directly supports Ghana's food security agenda and reduces dependence on vegetable imports and long supply chains from distant growing regions. Year-round floating vegetable production in the Volta Basin can increase local food availability, stabilize prices, and improve nutrition outcomes in riparian communities.

From a livelihood perspective, the community-based production model creates direct employment opportunities in biomass harvesting, platform construction, vegetable cultivation, and market distribution, particularly for women and youth who are often the most vulnerable in these communities. The projected revenue of GHC 900–1,200 per farm unit per three-month cycle represents a meaningful supplementary income stream for smallholder farmers currently marginalized by the hyacinth infestation.

At a broader macroeconomic level, the project contributes to Ghana's climate resilience agenda by demonstrating a replicable green enterprise model that transforms ecological degradation into economic opportunity. Restoring navigable waterways and improving water quality further reduces costs associated with water treatment, healthcare burdens from waterborne diseases, and disruptions to the fishing industry. If scaled across the Volta Basin and other affected water bodies in Ghana, the AquaFarm model has the potential to contribute meaningfully to agricultural GDP, rural income growth, and the country's commitments under its Nationally Determined Contributions (NDCs) to the Paris Agreement.

3.2.1.5 Monitoring and Maintenance of Water Treatment Facility at the Regional Office of Bank of Ghana, Tamale

(Research Team: Gerard Quarcoo (PhD) – Principal Investigator, Zita Naangmenyele Abuntori, Emmanuel T. Mensah (PhD), Emmanuel M. Obeng Bekoe, Abdul Latif Salifu, Eugene Sintim and Ewurama Adu-Boakye)

Collaborating Agency: Bank of Ghana, Tamale

Introduction

The intake of water containing pathogenic organisms or toxic chemicals could result from poor environmental conditions, thereby posing serious risks to human health. It is therefore critical that continuous monitoring of water quality be carried out on water supply systems, since the quality can change with time and by other environmental factors. In line with this, following the installation of water treatment devices at its Tamale office, the Bank of Ghana engaged the CSIR-Water Research Institute, Tamale, to continuously monitor the treatment system to ensure effective operation of the installed devices. The project started 2023 and it is renewable yearly.

Objectives

The objectives were to:

- i. monitor the water treatment devices and assess its efficiency by examining the treated water suitability for potable use;
- ii. assess the bacteriological quality of the treated water and compare results with WHO guidelines and Ghana Standards for its potability; and
- iii. provide technical advice and recommendations.

Activities Undertaken

During the reporting year, water filters were changed monthly, quarterly bacteriological water quality analysis were conducted, and bacteriological parameters such as total coliforms, *Escherichia coli* (*E. coli*), *Faecal enterococci*, *Pseudomonas aeruginosa*, *Clostridium perfringens*, and Total Heterotrophic bacteria (THB) were determined.

Key Results Achieved

The results of the bacteria levels in the borehole water used in the premises of Bank of Ghana, Tamale, is shown in Table 3.2.2. The results indicated that there was presence of total coliforms and pathogenic organisms such as *E. coli* in the source water. Total heterotrophic bacteria in the source water ranged from 120 to 410 cfu/1ml for the source water and from 95 to 470 cfu/ml during the project period. However, all the parameters in the treated water conformed to the Ghana Standards GS 175-1(2024) and WHO guidelines (2022) for potable use.

Table 3.2.2: Bacteriological analysis of water samples from the Bank of Ghana, Tamale.

Microbial analysis						
First Quarter (January, 2025)						
ID/Parameter	Total coliforms	<i>E. coli</i>	Faecal enterococci	<i>Pseudomonas aeruginosa</i>	<i>Clostridium perfringes</i>	THB/1ml
Kitchen (Treated)	<1	<1	<1	<1	<1	95
Main Premises (Source)	<1	<1	<1	<1	<1	120
WHO Guidelines	<1	<1	<1	<1	<1	-
Ghana Standards	<1	<1	<1	<1	<1	≤500
Second Quarter (May, 2025)						
ID/Parameter	Total coliforms	<i>E. coli</i>	Faecal enterococci	<i>Pseudomonas aeruginosa</i>	<i>Clostridium perfringes</i>	THB/1ml
Kitchen (Treated)	<1	<1	<1	<1	<1	370
Main Premises (Source)	<1	<1	<1	<1	<1	410
WHO Guidelines	<1	<1	<1	<1	<1	-
Ghana Standards	<1	<1	<1	<1	<1	≤500
Third Quarter (July, 2025)						
ID/Parameter	Total coliforms	<i>E. coli</i>	Faecal enterococci	<i>Pseudomonas aeruginosa</i>	<i>Clostridium perfringes</i>	THB/1ml
Kitchen (Treated)	<1	<1	<1	<1	<1	105
Main Premises (Source)	5	<1	<1	<1	<1	130
Who Guidelines	<1	<1	<1	<1	<1	-
Ghana Standards	<1	<1	<1	<1	<1	≤500
Fourth/Final Quarter (October, 2025)						
ID/Parameter	Total coliforms	<i>E. coli</i>	Faecal enterococci	<i>Pseudomonas aeruginosa</i>	<i>Clostridium perfringes</i>	THB/1ml
Kitchen (Treated)	<1	<1	<1	<1	<1	380
Main Premises (Source)	50	40	<1	<1	<1	400
WHO Guidelines	<1	<1	<1	<1	<1	-
Ghana Standards	<1	<1	<1	<1	<1	≤500

ID - Identity, CFU - colony forming units Except for THB (cfu/ml), all parameter results are expressed as cfu /100 ml

Conclusion

It was concluded that, with the exception of the source water samples, the bacteriological parameters of the treated water were completely satisfactory for use as a drinking source. This implies that the water treatment machine is running efficiently and produces safe drinking water.

Recommendation

Monitoring of the water treatment facilities involving monthly changing of the water filters and water quality testing must continue to ensure effective operation of the installed water treatment devices.

3.2.1.6 Assessment of Effluent Quality for Accra Shopping Mall Wastewater Treatment Facility

(Research Team: Dr. Michael Kumi - Principal Investigator, Mr. Emmanuel Adu-Ofori, Ms. Murjanatu Abdul-Hamid)

Collaborating Agency: Accra Shopping Mall Management

Introduction

The Accra Shopping Mall is a major commercial establishment located in Accra, Ghana. The facility generates significant volumes of wastewater from food courts, retail sanitary facilities, commercial kitchens, and general maintenance operations. To ensure environmental protection

and regulatory compliance, the mall operates an on-site wastewater treatment facility designed to reduce pollutant concentrations prior to discharge.

Wastewater discharge in Ghana is regulated under Ghana Standards GS 1212:2019, which specifies maximum permissible limits for physical, chemical, microbiological, and heavy metal parameters in treated effluent. Compliance with this standard is essential to safeguard public health, surface water bodies, groundwater resources, and aquatic ecosystems.

This annual assessment evaluated treatment performance from January to November 2025 through systematic sampling and laboratory analysis of influent and treated effluent. Twenty-three physicochemical and microbiological parameters were analysed to determine compliance status, removal efficiencies, and operational stability. The report focuses primarily on treated effluent quality in comparison with Ghana Standards GS 1212:2019.

Objectives

The objectives of the project were to:

- i. monitor wastewater treatment performance through systematic monthly sampling;
- ii. assess compliance of treated effluent with Ghana Standards GS 1212:2019;
- iii. quantify pollutant removal efficiencies;
- iv. identify seasonal variations and operational trends; and
- v. provide evidence-based recommendations for sustained excellence.

Activities Undertaken

Sample Collection

Monthly paired influent and effluent samples were collected from January through November 2025. Standard wastewater sampling protocols were followed. Microbiological samples were preserved and analyzed within prescribed holding times.

Laboratory Analysis

The following parameter categories were analyzed:

- Physical: Temperature, pH, Electrical Conductivity, Turbidity, Colour
- Solids: Total Dissolved Solids (TDS), Total Suspended Solids (TSS)
- Organic: BOD₅, COD
- Nutrients: Ammonia-N, Nitrate-N, Total Phosphorus
- Heavy Metals: Arsenic, Cadmium, Chromium, Copper, Lead
- Microbiological: Total Coliform, E. coli

Standard Methods for the Examination of Water and Wastewater were used for analysis.

Data Analysis

Results were compared with Ghana Standards GS 1212:2019 limits. Removal efficiencies were calculated, and trend analysis was performed to evaluate seasonal and operational variations.

Key Results Achieved

Overall compliance

The treatment facility achieved 100% compliance across all monitored parameters during the eleven-month assessment period. Treated effluent quality was assessed against the discharge limits specified in Ghana Standards GS 1212:2019. All monitored physico-chemical and microbiological parameters met the regulatory requirements, achieving 100% compliance

during the assessment period. The ranges and average values obtained for each parameter are presented in Table 3.2.3.

Table 3.2.3: Summary of Treated Effluent Quality Compared with Ghana Standards GS 1212:2019 Limits.

Parameter*	GS 1212:2019 Limit	Treated Effluent Range	Average	Compliance (%)
BOD ₅	50	11.9 – 38.2	26.2	100
COD	250	64.0 – 210	129.1	100
TSS	50	13.6 – 33.0	22.6	100
Ammonia-N	1.0	0.540 – 0.895	0.688	100
Total Phosphorus	2.0	0.160 – 1.88	0.874	100
Turbidity (NTU)	75	17.3 – 44.0	—	100
Total Coliform (CFU/100mL)	400	0	0	100
<i>E. coli</i> (CFU/100mL)	10	0	0	100

* All units are in mg/L unless otherwise stated

Pollutant removal efficiencies

The efficiency of the treatment system was evaluated by determining the percentage reduction of key pollutants between influent and treated effluent. The results indicate high removal performance across organic matter, suspended solids, nutrients, turbidity, and microbiological indicators. Average removal efficiencies and observed removal ranges are presented in Table 3.2.4.

Table 3.2.4: Summary of Pollutant Removal Efficiencies of the Wastewater Treatment System.

Parameter	Average Removal (%)	Removal Range (%)
BOD	73.8	66.5 – 94.2
COD	70.2	54.7 – 90.8
TSS	89.7	78.1 – 96.3
Turbidity	87.4	51.7 – 95.7
Ammonia-N	91.1	84.5 – 94.3
Total Phosphorus	62.8	46.6 – 91.8
Total Coliform	>99.9	Complete elimination
<i>E. coli</i>	>99.9	Complete elimination

Key observations

- Organic load spikes (BOD up to 415 mg/L; COD up to 2,281 mg/L) were effectively managed.
- TSS removal remained consistently high despite influent peaks of 675 mg/L.
- Complete elimination of pathogens was achieved in all months.
- Heavy metals remained below detection limits throughout the study period.

These results demonstrate strong operational resilience and robust process control.

Conclusion

The 2025 assessment confirms that the Accra Shopping Mall wastewater treatment facility achieved all stated objectives. The system demonstrated:

- 100% regulatory compliance across all 23 parameters.
- Exceptional microbiological performance with complete pathogen elimination.
- Effective organic matter and nutrient removal.
- Operational stability under variable loading conditions.

The facility represents a benchmark model for commercial wastewater management in Ghana, demonstrating that environmental protection and operational efficiency can be simultaneously achieved.

Recommendation

To sustain and enhance current performance, the following were recommended:

- i. Maintain systematic monthly monitoring.
- ii. Document and institutionalize Standard Operating Procedures (SOPs).
- iii. Strengthen preventive maintenance scheduling.
- iv. Conduct periodic capacity assessment for future expansion.

Impact of the Study on the National Economy

This project demonstrates how a private commercial entity, through strict adherence to national environmental regulations, can make meaningful contributions to Ghana's economy and sustainable development. By fully complying with wastewater discharge standards, the facility prevents water pollution and protects aquatic ecosystems that support fisheries, agriculture, tourism, and other water-dependent economic sectors. The complete elimination of pathogenic microorganisms reduces the risk of waterborne diseases, thereby lowering healthcare costs and minimizing productivity losses within the workforce.

The company's consistent regulatory compliance strengthens Ghana's image as a responsible and well-regulated investment destination, encouraging private sector growth, attracting investors, and supporting employment creation. In addition, the project enhances national technical capacity in wastewater monitoring, treatment performance assessment, and environmental compliance management, providing a practical model that other commercial and industrial facilities can replicate. By aligning its operations with national standards and contributing to the achievement of Sustainable Development Goals (SDGs) 6 and 12, the company demonstrates that private sector regulatory compliance and environmental stewardship directly support sustainable economic growth, public health protection, and long-term national development.

3.2.1.7 Energising Landscapes: lands, livelihoods, and energy infrastructures in Ghana (EnergyScapes)

(Research Team: Ing. Dr. Deborah Darko - Principal Investigator, Alex Franz Gaisie-Essilfie)

Collaborating Agencies: Newcastle University, King's College London, University of Ghana, University for Development Studies

Introduction

Energy availability and affordability are considered crucial in Africa and have been used to justify large scale appropriation and acquisition of lands. Despite Ghana's varied energy sources, a history of inconsistent electricity provision continues to drive policies on new energy infrastructure constructions. This has resulted in extensive land acquisition, displacements, and resettlement of communities close to such infrastructures, with broader livelihood challenges. This project focuses on three geographically diverse communities in Ghana situated near distinct energy infrastructures (gas, hydroelectric, and solar). Investigating how different energy infrastructures affect everyday livelihoods, prospects for land tenure, use and accessibility will integrate local knowledge and values in addressing the multidimensional challenges communities face and in enhancing inclusive energy governance. The project started in 2024 and is expected to end in 2026.

Objectives

The overarching objective of the project was to explore the influence of oil, hydroelectric, and solar energy infrastructures on livelihoods, environmental injustices, and socioeconomic impacts on neighbouring communities. The specific objectives were to:

- i. explore how different energy infrastructures impact forms of tenure, use and accessibility of lands, highlighting diverse impacts on people of various backgrounds and land statuses in the selected communities;
- ii. investigate the territorial development visions and transformations driven by the different energy infrastructure agencies and companies;
- iii. collectively map communities' everyday experiences of energy landscapes including interactions with the natural and built environment, forms of access restrictions, impacts on common resources as well as local concerns, demands, and aspirations;
- iv. consolidate knowledge and research capabilities of both Ghanaian and UK researchers by engaging in collaborative research and co-producing knowledge with communities, local authorities (local assemblies), energy infrastructure companies, and policy think-tanks; and
- v. establish an international interdisciplinary network between project partnership and a wider network of multidisciplinary researchers and relevant stakeholders to contribute to future research and policy on energy infrastructures in Ghana and comparable African countries.

Activities undertaken

In 2025, substantial progress was achieved across work packages. Primary data collection activities were completed, including household surveys across all three study sites and key informant interviews and focus group discussions with opinion leaders and community members in the Bui, Kaleo, Atuabo enclaves. Key informant interviews with energy-sector institutions were initiated and are ongoing. In parallel, the recruitment of a Postdoctoral Fellow was successfully concluded, with the Fellow appointed by Newcastle University to support project implementation.

A comprehensive review and synthesis of energy masterplans, Environmental and Social Impact Assessment (ESIA) documents, and related reports was completed for the Atuabo Gas Project, the Bui Hydropower Project and Kaleo Solar Power Project, strengthening the project's analytical foundation. In preparation for participatory research, mapping approaches and storytelling tools were finalized, and basemaps and supporting spatial materials were developed.

As part of the project's participatory research component, seven participatory mapping workshops were conducted across the three case study sites; Bui (resettlement and host communities), Kaleo, and Atuabo/Sanzule. Approximately 200 community members participated, supported by 15 trained local facilitators. The workshops generated rich spatial and qualitative insights into how energy infrastructure shapes local environments, livelihoods, access to resources, and social relations, reinforcing the importance of community-centered knowledge in promoting equitable and inclusive energy transitions in Ghana.

Knowledge synthesis and dissemination activities are ongoing, with multiple peer-reviewed manuscripts under development.

Key results achieved so far

Results achieved included:

- i. Socio-economic, institutional, and spatial datasets have been generated across all study sites.
- ii. Community experiences of energy infrastructure impacts have been systematically documented.
- iii. Participatory mapping strengthened the integration of local knowledge into energy governance debates.
- iv. Synthesized documentary review of energy infrastructure governance and safeguards.
- v. Reviews of energy masterplans and ESIA documents identified key planning and governance gaps.
- vi. Collaborative analyses are underway, supporting the development of multiple research manuscripts.

3.2.1.8 AI-Driven Evapotranspiration Monitoring for Improving Water Resource Management in Data-Scarce Regions: Evidence from Agroclimatic Zones in Spain, Egypt, and Ghana

(Research Team: Ing. Dr. Deborah Darko - Principal Investigator, Alex Franz Gaisie-Essilfie, Patricia Granaham)

Collaborating Agencies: Insto. Pirenaico De Ecologia (Spain), Zagazig University (Egypt), Central Laboratory for Agriculture Climate, Arc (Egypt), Kwame Nkrumah University of Science and Technology (KNUST), University of Energy and Natural Resources (UENR) (Ghana)

Introduction

This project employs Artificial Intelligence (AI) techniques to assess evapotranspiration patterns across a diverse range of agricultural practices and hydroclimatic characteristics. The Ebro Valley (Spain), the Nile Delta (Egypt), and the Volta basin (Ghana) were selected due to their varied hydroclimatic conditions and their significant contributions to regional water resource management and food production. These selected regions are crucial for regional food security and the preservation of local communities. However, they face increasing challenges from climate change, which threatens their agricultural productivity and livelihoods. The project's primary goal is to bridge the gap between scientific understanding and practical applications by using AI to analyze evapotranspiration patterns and their influencing factors. This analysis aims to improve the efficiency of water management and irrigation practices, thereby enhancing both the sustainability of agriculture in water-limited environments and agriculture's resilience to climate variability. Ultimately, the project intends to generate novel insights into the spatiotemporal dynamics of evapotranspiration and to examine the implications of these insights for the future of sustainable water management. The project was initiated in the reporting year and is expected to end in 2026.

Objectives

The objective of this project is to incorporate scientific knowledge with practical applications by analysing evapotranspiration patterns and creating decision-support tools that utilize AI techniques. The specific objectives were:

- i. Characterizing the existing evapotranspiration patterns using AI techniques, incorporating data from various sources such as satellite imagery, climate models, and ground-based observations.
- ii. Evaluating the influence of climate change on evapotranspiration, examining how changes in
- iii. different meteorological variables may affect water loss through evapotranspiration.

- iv. Determining the main non-climatic factors driving evapotranspiration patterns, including land use changes, vegetation cover, soil moisture, and other relevant variables.
- v. Utilizing AI techniques to develop models that can improve projections of evapotranspiration
- vi. patterns under different climate change scenarios and future water resource management scenarios.

Activities Undertaken

In 2025, project activities focused on strengthening the scientific and data foundations for AI-driven evapotranspiration (ET) estimation in data-scarce regions across selected agroclimatic zones in Spain, Egypt, and Ghana. A comprehensive review journal article examining the application of artificial intelligence and machine learning techniques for estimating ET in data-limited contexts was developed. This involved an extensive literature review, critical appraisal of existing AI-based ET models, and synthesis of methodological strengths, limitations, and emerging research gaps. The manuscript is currently under preparation for submission to a peer-reviewed journal.

In parallel, meteorological datasets for the study basins were acquired, quality-checked, and pre-processed to support subsequent modeling and comparative analyses. This included the collation of long-term climate records spanning 1960–2025, incorporating key parameters such as temperature, relative humidity, wind speed, and solar radiation. The expanded dataset enables the testing and comparison of multiple reference evapotranspiration (ET_o) estimation approaches, including both data-light empirical equations and more data-intensive formulations.

Additionally, an initial appraisal of suitable machine learning algorithms for ET estimation was undertaken to inform model selection and experimental design in subsequent project phases. Collectively, these activities have positioned the project to advance robust AI-based ET modelling and to support improved water resources management in data-scarce environments.

Key Results Achieved

Results achieved included:

- Review manuscript on AI-based evapotranspiration estimation in data-scarce regions is under development.
- Long-term meteorological datasets (1960–2025) compiled and pre-processed for the study sites.
- Initial appraisal of suitable machine learning algorithms for evapotranspiration estimation completed.
- Harmonized datasets prepared to support testing of multiple ET_o equations and AI-driven models.

3.2.1.9 Building Climate Resilience into River Basin Management (CREAM)

(Research Team: Dr. Emmanuel Obuobie - Principal Investigator, Dr. Emmanuel Obeng Bekoe, Dr. Francis Amevenku, Dr. Sylvester Afram Boadi, Dr. Prosper Bazaanah, Dr. Barnabas Amisigo, Ing. Gabriel Appiah, Ing. Frank Oblim, Ing. Patricia Granaham, Sylvia Amponsah, Mark Osei-Owusu, Franz Alex Gaisie-Esilfie, Bismark Akurugu and Simeon Odametey)

Collaborating Agencies: CSIR-Food Research Institute, Kwame Nkrumah University of Science and Technology, Hydrological Services Department, Ghana Meteorological Agency, SIRCOOL Bottled Water Company Ltd, Geological Survey of Denmark and Greenland, Aarhus University, and Central Queensland University

Introduction

CREAM is a six-year project funded by the Ministry of Foreign Affairs of Denmark. It aims at creating a knowledge base and capacity for integrating climate change, shared socioeconomic pathways, land-use/-cover change and other future development scenarios into river basin management to enhance climate resilience, livelihood, water-food-energy security, and environmental conservation. It began in 2019 and ended in the reporting year.

Objectives

The scientific objectives were to:

- i. Improve the data basis for high-resolution, bias-corrected CC projections for use in impact studies and to analyse trends in extreme climate events in the two study basins.
- ii. Further develop and test methodologies for integrating climate change scenarios (RCPs), shared socio-economy pathways (SSPs) and land-use/-cover change in an ensemble of water resource modelling tools, to assess impacts on basin water resources.
- iii. Improve the evidence and tools for assessing, valuing and integrating water-related ecosystem services directly into river basin management.
- iv. Develop an interdisciplinary framework for supporting stakeholder dialogue and negotiations in WRM.
- v. Analyse stakeholder constraints to effective water governance and develop strategies to introduce innovative, effective policies and measures and enhance resilience.
- vi. Enhance the capacity of researchers, PhD students and stakeholders of how to incorporate climate resilience into water management.

Activities Undertaken

- (a) **Project Co-ordination/leadership:** Led the CREAM team by coordinating all project partners and work package leaders in the implementation of project activities planned for the 2025 year. Additionally, I led the preparation of the project's 2024 technical report and supported the finance team to prepare the project's 2024 financial report. Both reports were submitted to the DANIDA Fellowship Centre.
- (b) **Capacity Enhancement of Stakeholders:** Led the organisation of 3 technical training events were organised in the reporting year. The first training titled "Development of High Resolution Climate Dataset for Impact Assessment" was held on 20th March 2025 at the CSIR-Water Research Institute for 20 participants drawn from 6 institutions (Ghana Meteorological Agency, Climate Change Centre - University of Ghana, Physics Department- University of Ghana, Meteorology and Climate Department- KNUST, Ghana Space Science and Technology Institute - GAEC, and CSIR-WRI). Participants were trained in the use of analytical and statistical techniques implemented in R, coupled with conditional merging approach to develop high resolution (e.g. 1km x1km) rainfall and temperature data from 14 satellite and re-analysis products. The second training, which

was a mock training on a newly developed water resources decision support dashboard, was held on 21st March at CSIR-WRI. The aim was to administer the training to 20 scientists from CSIR-WRI, KNUST and Ghana Space Science and Technology Institute from different scientific backgrounds to obtain feedback for improving the dashboard and for informing preparations for a multi-stakeholder training planned for May 2025. The participants provided critical feedback that was used to improve the dashboard. The third training event was held on 29 May 2025 at the main conference room of the CSIR Head Office. The participants were drawn from the Water Resources Commission, Environmental Protection Agency, Ghana Water Limited, Community Water and Sanitation Agency, Ghana Irrigation Development Authority, and KNUST. The training was mostly hands-on and participants provided extremely useful feedback which has been used to improve the functionality of the dashboard.

- (c) **Field Data Collection and Equipment maintenance:** Led a team to conduct 4 rounds of field data collection from climate, riverflow and groundwater level equipments installed in both Pra and Densu River Basins were conducted in February, May, August and December of 2025. The data collected have been pre-processed, quality controlled and archived. Routine maintenance was conducted on the installed equipments. This included changing of batteries of data loggers and sensors, clearing of weeds within and around the fenced perimeters, cleaning of dusts and soil particles on sensors and replacing of padlocks.
- (d) **Supervision of PhD Students:** In the reporting year, I co-supervised 6 PhD students who were funded by the CREAM Project. Four of the students (Martin Addi and Mark Osei-Owusu, Samuel Kyei-Manuh and Bismark Awinbire Akurugu) successfully defended their PhD theses in 2025; the first 3 also graduated in the same year. The last of the 4 (Bismark) is scheduled to graduate in February 2026. Of the remaining 2 students, one (Simeon Odametey) submitted his thesis to the graduate school at the University of Ghana in the reporting year while the other (Franze Alex Gaisie-Essilfie) made further advancement with the writing of his thesis and plans to submit by end of the first quarter of 2026.
- (e) **Final Meeting by project partners:** The CREAM project organised final meetings for partners and PhD students to present full results of their work and to discuss the wayforward for completing outstanding journal manuscripts. The meeting was held from 22nd to 24th September 2025 at the main auditorium of the CSIR-STEPRI and was attended by all the partners and PhD students. The meetings were also used to develop outlines for merging policy briefs of the different work packages into 2 main policy briefs for the project. The policy briefs will be finalized and published in the next quarter.
- (f) **Final Project Reporting:** Preparation of final project reports, both technical and financial, commenced in November of the reporting year and is expected to be completed by end of first quarter of 2026.
- (g) **Publications:** Three journal articles were published in the reporting year. In addition, 4 manuscripts were drafted and 2 of that have already been submitted to journals for consideration while the remaining 2 are undergoing internal review.

Published Articles

- 1 Obuobie, E., Osei, M.A., Agyekum, J., Addi, M., Gyasi-Agyei, Y., Boadi, S.A. and Oblim, F.T. (2025). Spatiotemporal analysis of past and future precipitation

- and temperature extremes over Pra River Basin, Ghana. *Modeling Earth Systems and Environment* 11 (293). <https://doi.org/10.1007/s40808-025-02474-0>.
2. Obuobie, E., Akurugu, B.A. and Granaham, P. (2025). A review of the Groundwater characteristics of the crystalline basement rocks in the Pra River Basin, Ghana. *Environmental Earth Sciences* (2025) 84:427. <https://doi.org/10.1007/s12665-025-12426-7>
 3. Kyei-Manuh, S., Osei, M.A., Aryee, J.N.A., Quansah, E., Obuobie, E., Amekudzi, L.K. (2025). Lightning and thunderstorms, the source of severe weather over Ghana, West Africa. *PLoS Clim* 4(9): e0000703. <https://doi.org/10.1371/journal.pclm.0000703>

Manuscripts submitted and under review

1. Osei-Owusu et al. (2025). Evaluating the effectiveness of three imputation techniques to reconstruct gaps in daily streamflow time series. *Submitted to Hydrological Sciences journal*
2. Kyei-Manuh, S., Amisigo, B., Obuobie, E., Osei-Owusu, M., Addi, M. and Amekudzi, L. (2025). Assessing Climate Change Impacts on Surface Water Resource Allocation in the Pra River Basin of Ghana. *Submitted to Hydrological Sciences journal*
3. Osei-Owusu et al. (2025). Assessing the effectiveness of single and multi-site calibration for simulating streamflow and estimating the water balance of the Pra Basin. *Undergoing internal review.*
4. Kyei-Manuh, S., Amisigo, B., Obuobie, E. and Amekudzi, L. Navigating Water Trade-Offs: An Interactive Dashboard for Participatory Decision-Making in the Pra River Basin, Ghana. *Undergoing internal revision.*

Key Results Achieved

Key results achieved included:

- i. Archived data on climate, hydrology, and groundwater for the Pra and Densu Basins.
- ii. Functional and well-maintained hydro-meteorological monitoring networks.
- iii. Three workshops organised - for enhancing capacity of stakeholders.
- iv. Three journal articles published and 4 manuscripts drafted.
- v. Three PhD graduates; one PhD student successfully defended thesis; another PhD student submitted thesis and another PhD student working to finalise thesis.

Impact of the Study on the National Economy

The project will develop innovative tools that can be used to support water management at national and regional scale. The output will also contribute to Ghana's achievement of the sustainable development goals, particularly goals 1 (no poverty), 6 (clean water and sanitation) and 13 (climate action).

3.2.1.10 Sustainable Wetland and Flood Management for Strengthening Food Security and Ecosystem Resilience in West Africa (GDZHIAO)

(Research Team: Dr. Emmanuel Obuobie - Principal Investigator, Dr. Sylvester Aframe Boadi, Dr. Prosper Bazaanah & Franz Alex Essilfie-Gaisie)

Collaborating Agencies: Centre de Suivi Ecologique (Senegal), Centre for Space Science and Technology Education (CSSTE, Nigeria), Institut Supérieur d'Etudes Spatiales et Télécommunications (Burkina Faso); Volta Basin Authority (Burkina Faso), Centre Universitaire de Recherche et Application en Teledetection (Cote D'Ivoire), Institut Géographique du Burkina (Burkina Faso), Department of Parks and Wildlife Management (The Gambia), Center for Remote Sensing and Geographic Information Services (Ghana), Direction nationale des eaux et forêts (Mali), Centre National de Surveillance et d'Observation Environnementales (Guinée), Direction de la Faune, Chasse et des Aires Protégées (Niger), Direction des Parcs Nationaux (Senegal), Space For Humanity Foundation (Nigeria), (INE, Benin)

Introduction

The GDZHIAO project aims at assisting decision-makers and stakeholders manage wetlands and floods in West Africa by providing tools, innovative approaches and earth observational data for effectively monitoring and managing wetlands and floods at several scales. This including supporting disaster management organizations to harmonize and develop legislative and regulatory framework for managing wetlands and floods. The CSIR-WRI team on the project works specifically on flooding issues. The project was initiated in 2022 and is expected to end in 2026.

Objectives

The specific objectives of the CSIR-WRI component were:

- i. Identify and map past and on-going initiatives and programmes related to floods in Ghana.
- ii. Appraise existing policies on flood management to identify areas of weaknesses that should be strengthened.
- iii. Develop and simulate flood contingency plans for 2 districts in Ghana, jointly with the National Disaster Management Organization (NADMO) and in collaboration with relevant stakeholders.
- iv. Strengthen capacity of NADMO and other disaster management organizations to enhance community participation in the planning and management of floods.
- v. Consolidate and operationalize the flood services for the Black Volta Basin in Ghana based on flood forecast systems from other project partners (INE/CSSTE).

Activities Undertaken

Activities undertaken in the reporting year included:

- (a) **Supervision of student:** In the reporting year, I co-supervised the project's master degree student (Felicia Dogbey – KNUST) and supported her to successfully finalize, submit and defend her MPhil thesis. She has since graduated and obtained a full scholarship to do a PhD study in the USA.
- (b) **Setup and operationalization of flood alert system:** I led the modification and testing of a flood alert system, for disseminating flood warnings in the Black Volta Basin in Ghana. The system, which was originally developed by CSIR-WRI in the MiFMAS project, also funded by GMESS and African under Phase 1, was modified to pair with the newly developed flood forecasting Application led by partners in Benin. The alert system has been finalized for operational use and disseminated via github.

- (c) **Publication:** the project prepared and published 2 blogs based on stakeholder engagement conducted in 2024/2025 and prepared a technical report on the flood alert system that was setup and operationalised in the last quarter of 2025.

Blogs

- (i) *Prosper Bazaanah, Sylvester Afram Boadi, Charlotte Norman, Frank Aggrey, Jacob Agyekum and Emmanuel Obuobie. 2025. Using Participatory System Mapping Approach to Strengthen Community Adaptation to Flood Risk in the Black Volta River Basin in Ghana. A blog of the GDZHIAO project. Can be accessed from <https://csir-water.com/using-participatory-system-mapping-approach-to-strengthen-community-adaptation-to-flood-risk-in-the-black-volta-river-basin-in-ghana/>.*
- (ii) *Sylvester Afram Boadi, Prosper Bazaanah, Charlotte Norman, Frank Aggrey, Jacob Agyekum and Emmanuel Obuobie. 2025. Empowering Stakeholders to Develop and Test a Flood Contingency Plan for Effective Flood Management in the Black Volta River Basin of Ghana. A blog of the GDZHIAO project. Can be accessed from <https://csir-water.com/empowering-stakeholders-to-develop-and-test-a-flood-contingency-plan-for-effective-flood-management-in-the-black-volta-river-basin-of-ghana/>*

Technical report

- i. *Obuobie, E. and Gaisie-Essilfie, F.A. (2025). A semi-automated application for disseminating flood alert in the Black Volta Basin of Ghana. Technical Report submitted to GDZHIAO project, CSE, Dakar. 10pp*

Key Results Achieved

Results achieved in the reporting year included:

- i. Finalised flood alert system for flood warnings in the Black Volta Basin of Ghana.
- ii. Technical report on the flood alert system
- iii. Two published scientific blogs based on stakeholder engagement for flood contingency planning and identification of flood threats to communities.

Impact of the Study on the National Economy

The project will develop innovative tools and approaches and couple that with earth observation data for effective monitoring of wetland and flood at multiple scales. These will be co-developed with disaster management organizations (e.g., NADMO, GMET and HSD) and will be integrated into existing national systems to enhance flood and wetland management in the country.

3.2.1.11 Using Science Engagement to Capacitate Stakeholders for Climate-Resilient Water Management

(Research Team: Ing. Dr Emmanuel Obuobie - Principal Investigator, Dr Prosper Bazaanah - Project Coordinator, Dr Sylvester Boadi, Dr Bismark Awimbire Akurugu and Dr Jacob Agyekum)

Collaborating Agencies: Senior Secondary Schools within the basins, Water Resource Commission (Pra and Densu Basin Secretariat), Small Scale Miners Association, Environmental Protection Agency, Forestry Commission, Community Water and Sanitation Agency, National Commission for Civic Education, Water Producers Association, Poultry Farmers, Minerals Commission, Department of Gender, Regional Coordinating Councils and Municipal, Metropolitan and District Assemblies

Introduction

This project is informed by the “*Building Climate-Resilience into Basin Water Management (CREAM)*” project, which was funded by DANIDA and implemented in the Pra and Densu River Basins of Ghana. The aim of the CREAM project was to build climate resilience into basin water management in Ghana by integrating climate change scenarios, land use/land cover changes, and shared socio-economic pathways into water management decisions and practices. Over the period of implementation (2019-2025), the CREAM project worked closely with key stakeholders in the water, environment and agriculture sectors and co-developed significant outputs (results, data, tools, methodologies and publications) that can be used by key government agencies (e.g., WRC, EPA, GIDA), River Basin Boards etc, to inform and improve current basin water management. However, uptake of the project results and outputs is potentially threatened by the recent change in government in Ghana, which has led to the restructuring of government ministries and agencies at national and local administrative levels. The restructuring has led to changes to heads of some government agencies, replacement of some technical staff and reconstitution of River Basin Boards, among others. Some of the affected heads of agencies and technical staff have participated in past training events of the project and worked closely with the project team since inception, to co-create results. Their departure has the potential to impact negatively on the uptake of the project outputs. Therefore, the science engagement activity was designed to implement new and additional science engagement in the form of familiarization and training workshops to introduce the CREAM project, share results and build the capacity of particularly new heads and technical staff of affected agencies at national and local levels, to ensure uptake of the CREAM project results and thereby improve climate-resilient water management in the project basins. Three such workshops will be held; one each for stakeholders at the national level, Pra and Densu River Basins and senior secondary schools within the Pra and Densu basins. Finally, the activity will make use of radio programmes in the most common languages in the Pra and Densu Basins to create awareness and educate the basin inhabitants on the need to preserve water bodies and ecosystems within the basins. The project began and ended in 2025.

Objectives

The objectives were to:

- i. create awareness of the CREAM project among new stakeholders and key staff of relevant government ministries and agencies, to enhance uptake of project outputs.
- ii. build capacity of new staff of project stakeholders from the water, environment and agriculture sectors with skills and knowledge to support efforts of protecting water resources and implementing climate resilience strategies, using results, data and tools developed by the CREAM project.
- iii. conduct outreach in selected secondary schools to educate students and teachers, particularly female students and teachers, on climate monitoring, climate change adaptation and water management.

- iv. conduct public engagement activity via radio programmes in local languages to create awareness and educate local people and businesses in the Pra and Densu Basins on how to preserve water bodies and ecosystems in the two basins for their benefits.

Activities Undertaken

The following activities were undertaken during the reporting year:

- (a) **National and basin-level stakeholder engagements:** The workshops enabled the CREAM project research team to share a range of datasets, research findings, and tools developed by the project. These included high-resolution climate data that offer detailed insights into extreme events like prolonged dry spells and heatwaves. They also presented simulations of surface and groundwater availability using the SWAT and MODFLOW models to show how climate change and land-use changes affect water resources in the basins. In addition, the team showcased work on ecosystem services and valuation, as well as a decision-support dashboard for water allocation and trade-off analyses. Participants also learned about ecosystem services and basin-level governance, helping them identify gaps, understand stakeholder roles, and explore new ways to improve collaboration for more effective and inclusive water management. Participants came to understand that effective basin management requires the involvement of all key stakeholders in decision-making and enforcement processes.
- (b) **Engagement with school management, teachers and students:** The engagements created awareness among students and teachers, particularly female students, on climate monitoring, climate change adaptation, and water management issues in the Pra and Densu River Basins. Both students and staff showed strong interest in water governance and management, including practical ways to reduce pollution, protect water resources, and explore current and future opportunities in the water and environmental sector. It is anticipated that these engagements will stimulate sustained discussions and concrete actions at the individual, school, and community levels, thereby strengthening environmental stewardship and protection. It is also hoped that these engagements will lead to an increased number of females in climate and water science careers in the coming years.

Key Results Achieved

The project enhanced capacity of multiple stakeholders including government agencies, private sector organizations and CBOs in the use of data and tools developed by the CREAM project for supporting the execution of their mandates. It also built capacity and created awareness on climate change and water management among students, teachers and managements of 5 selected senior high schools.

Conclusion

The project demonstrated the value and need for ecosystem conservation, the need for integrating high-resolution climate data, advanced hydrological modelling, and decision-support tools developed for water resources management in the Pra and Densu River Basins. At the national and basin levels, the engagements strengthened stakeholders' understanding of climate risks, surface and groundwater dynamics, and trade-offs in water allocation, while reinforcing the importance of inclusive, collaborative basin governance. At the SHS level, the engagements successfully raised awareness and built interest in climate monitoring, adaptation, and water governance, particularly among female students. In linking basin-level challenges to

everyday actions and future career opportunities, the project helped foster a culture of environmental stewardship and inspired the next generation of water and climate professionals.

Recommendation

It was recommended that national and basin-level institutions formally integrate the CREAM project's high-resolution climate datasets, hydrological models, ecosystem services assessments, and decision-support dashboard into routine planning, water allocation, and enforcement processes to strengthen evidence-based and climate-resilient basin management. Capacity-building programmes should be expanded to ensure continuous use and interpretation of the tools for proactive adaptation and integrated water resources management. At the school level, partnerships between water agencies and senior high schools should be strengthened through curriculum, clubs, and mentorship activities to translate awareness into sustained action. Emphasis should be placed on supporting and mentoring female students to pursue careers in climate, water, and environmental sciences.

Impact of the Study on the National Economy

The project is expected to positively impact the national economy by enhancing water resources management, climate resilience, and sustainable development. In equipping stakeholders with high-resolution climate data, hydrological modelling tools, ecosystem services valuation, and decision-support dashboards, the project enables more informed and strategic planning for water allocation, agricultural production, and disaster preparedness, reducing economic losses from extreme events such as droughts, floods, and heatwaves. Improved basin governance and stakeholder collaboration also help mitigate environmental degradation, including pollution and illegal mining, which threaten water quality and socio-economic productivity. Additionally, raising awareness among students and teachers, particularly female students, fosters a pipeline of future professionals in climate and water science, supporting long-term human capital development and innovation in water-dependent sectors, thereby contributing to sustainable economic growth and resilience.

3.2.1.12 Integrated Land and Water Management of the Greater Amanzule Wetland System (ILWGAWS)

(Research Team: Ing. Dr. Emmanuel Obuobie - Principal Investigator, Dr. Sylvester Afram Boadi - Coordinator, Dr. Jacob Agyekum, Ing. Gabriel Appiah, Ing. Frank Teye Oblim, Mark Osei-Owusu, Simeon Odametey, Franz Alex Gaisie-Essilfie)

Collaborating Agency: University of Education, Winneba; and Hen Mpoano

Introduction

The Greater Amanzule Wetland System (GAWS) is threatened by artisanal mining, climate change, rubber plantations, and subsistence farming despite its ecological support for fauna and flora. Major interventions have focused less on the hydrological systems of the GAWS. This project seeks to bridge this knowledge gap through work packages: hydrological systems and ecosystem service analysis; climate-smart farming for households; and development of decision tools and policy briefs to enhance conservation efforts. The project started in the reporting year and is expected to end in 2027.

Objectives

The overarching objective was to improve livelihoods of households and the ecosystem services of GAWS under increasing pressures of man and climate change. Also, to help Ghana conserve its wetland and maintain its National Determined Contributions with respect to carbon. The specific objectives were to:

- i. Examine the main hydrological characteristics of the Greater Amanzule Wetland Systems.
- ii. Analyze the major land cover and ecosystems services changes within the GAWS over the last 30 years.
- iii. Assess the effects of climate, socio-economic and political factors on the hydrological systems and ecosystem services of the GAWS.
- iv. Develop climate-smart alternative livelihood strategies for the communities within the GAWS.
- v. Develop decision support tools and train conservation personnel for the management of the GAWS.

Activities Undertaken

The activities undertaken under the project are broadly grouped under four activities, corresponding to the three (3) activities led by CSIR-WRI under WP3 (which is led by UEW).

Data collection and reporting on hydrological profiling: Both secondary hydro-meteorological and in-situ on-field data were collected and analysed to characterise and profile the surface water resources in the GAWS area. The in-situ field measurements were carried out from the 14th to 21st July 2025. Based on the data collected, IDF curves and hydrographs for the different river basins of interest were generated, and peak discharge computations were finalized. The main deliverables (data, maps and reports) under this activity were compiled and submitted to UEW on 30th September 2025.

Hydrological Modelling (SWAT Modelling) and Climate Change Evaluation: Under this activity, data was collected to set up the Long-Short Term Memory (LSTM) model. The initial plan/methodology was to model using SWAT. However, due to data challenges, the team had to switch from setting up SWAT models to LSTM for the hydrodynamics activity. The LSTM models were therefore set up and calibrated for 5 of the 6 sub-basins in the GAWS area. Streamflow was generated for these sub-basins and the report on the hydrodynamics modelling activity was drafted.

Climate data collection and analysis: Under the climate change evaluation activity, temperature (European Centre for Medium-Range Weather Forecasts Reanalysis Five [ERA5]) and rainfall (Multi-Sourced Weighted-Ensemble Precipitation [MSWEP]) data were sourced from global datasets, bias-corrected and used to generate the spatio-temporal analysis of the historical and future mean climate trends and extreme indices of the GAWS. The technical report on the climate change evaluation and associated data and maps were compiled and submitted to UEW for onward submission to the GCBC.

Water and Soil Quality Analysis: The protocols for water and soil sampling were first established. After this, the first round of sampling in the GAWS area was conducted from the 17th to 23rd September 2025. The results received from the laboratories were shared with the WP3 team lead at UEW.

Key Results Achieved

The key results from the different activities included:

- Seven basins were delineated with their sub-catchments contributing all or a significant proportion of their flows through the GAWS area.
- The drainage densities of the sub-catchments are very coarse to coarse, ranging from 0.96 km/km² to 2.02 km/km², at an average of about 1.60 km/km².

- The average stream discharge ranges from 1.58 m³/s to 97.13 m³/s. The highest rainfall and stream discharges were observed during June.
- The average maximum depth of the rivers/streams in the GAWS area as estimated from the one-time in-situ measurement was 2.45 m, while the average width was 32.2 m.
- Present-day data indicate rising mean temperatures, more frequent warm nights and days, and a narrowing diurnal temperature range, particularly within the wetland system, suggesting a moderating influence of coastal and wetland microclimates. Precipitation analysis shows spatial gradients, with higher rainfall along the western coast and increasing intensity of extreme rainfall events such as very wet days (R95P) and maximum 5-day totals (Rx5day), although total annual rainfall trends are modest.

Conclusion

Key conclusions from the activities undertaken during the year include the following:

- The highest rainfall and stream discharges were observed during June. Both the rainfall and temperature exhibited an upward trend in the period studied, with potential negative implications for flood, agriculture and human health.
- Rainfall and Temperature patterns in the GAWS underscore the dual challenge of rising heat stress and increasing precipitation variability. Future projections under both RCP4.5 and RCP8.5 scenarios indicate an amplification of these trends, with more pronounced warming, increased frequency of warm extremes, and intensified precipitation extremes. These observed and projected climate trends imply heightened risks to public health, urban infrastructure, and water management in the GAWS, necessitating integrated climate adaptation strategies that address both escalating heat stress and increasing precipitation extremes under future climate scenarios.

Recommendation

The future climate projections emphasize the need for proactive, adaptive management strategies, including wetland conservation, sustainable water use, and flood mitigation, to safeguard ecosystem integrity and community resilience under both moderate- and high-emission futures.

Impact of the Study on the National Economy

ILWGAWS is generating knowledge on the surface and sub-surface hydrological resources. This includes knowledge on the characteristics of the hydrological resources (via the hydrological profiling activities), climate and land use/land cover changes in the GAWS and how these changes interact with wetland resources. The project outputs should also provide data and maps on areas of significant degradation to inform restoration activities. The scientific and policy-based data from ILWGAWS would help key national institutions and stakeholders update existing knowledge on the hydrological profiles of surface and sub-surface water resources in the area, including data on streamflow, ground water systems, aquifers and recharge zones. In terms of livelihood and conservation outcomes, the research knowledge from the project will be utilized to train households in beekeeping, agroforestry and native species nursery, and create decision support tools for government officials and stakeholders to enhance ecological planning and conservation decisions.

3.2.1.13 Streamflow Measurement and Flood Risk Assessment

(Research Team: Ing. Dr. Frederick Yaw Logah - Principal Investigator, Dr. Ruby Asmah, Ing. Dr. Deborah Darko, Ing. Gabriel Appiah, Mr. Mark Osei-Owusu, Ing. Surv. Patricia Granaham)

Introduction

Newmont Ahafo Mine is planning to expand the Apensu Open Pit in the southern section of the mine while also developing the Apensu underground resource. To support these developments, studies are being conducted to assess the technical and environmental requirements for the proposed expansion. Consequently, there is a need to expand the existing Tailings Storage Facility (TSF) Cell 1 and construct a new TSF to provide adequate tailings storage capacity for the remaining life of the mine and future expansion plans. As part of these studies, the Awonsu pit is being evaluated as a potential option for future in-pit tailings storage. However, before in-pit deposition at Awonsu, the existing Cell 1 TSF raise is also being assessed for optimization to provide additional storage capacity. As part of the mine's water management strategy, the capacity of the existing fixed 50 litre per second mine water treatment plant has been increased through the addition of a mobile treatment plant with a capacity of 60 litres per second. To support the studies, streamflow measurements were required on the Awonsu, Subika, Subri, Samansua, and Amoma streams to assess flood risk, identify flood-prone areas, and recommend appropriate flood mitigation measures within the study area. Hence, Newmont Ahafo Gold Mine (Ghana) Limited requested the CSIR-Water Research Institute (CSIR-WRI) to undertake streamflow measurements and conduct a flood risk assessment within the mine lease. The study commenced during the reporting year and is expected to be completed in 2026.

Objective

The objective was to measure and analyze streamflow patterns, assess flood risk in the main surface water bodies within the NGGL lease area and to estimate the current capacity of the WSF reservoir.

Activities Undertaken

Activities undertaken during the year included streamflow measurement, data collection and analysis, hydrological simulation, flood risk assessment, and report writing and recommendation.

Key Results Achieved

Rainfall in the area is bimodal, with peaks in May/June and September/October, with an annual range of 1,068.1-1,286.2 mm and a long-term average of 1,213.6 mm. The mean annual potential evapotranspiration (972.21 mm) is more than the rainfall amount from January-March (3 months) and November-December (2 months). There are variations in the width and depth of the Awonsu and Subri River channels, with most of the sections exhibiting a U- and V-shaped profiles, respectively. Siltation was observed downstream of the Awonsu stream, especially at the Awonsu–Tano confluence. The Subri had an average width of about 5 meters from NSW 6, and widens from Achirensua to the Tano River. Rating curves were developed for six (6) of the monitoring stations within the NGGL lease area. With $R^2 \approx 1.0$, the discharges and their corresponding water levels within the study are said to have a very good correlation. However, no rating curves were developed at ECD 4, NSW 9, due to insufficient flows (zero flows).

The longitudinal profile and the maximum depth of the WSF were about 5.0 km long and 11.2 m deep, respectively. The effective surface area and volume of water in the WSF were

estimated to be approximately $1.12 \times 10^6 \text{ m}^2$ and $3.62 \times 10^6 \text{ m}^3$, respectively. The result indicates that the WSF has the potential to store about three times this volume during the wet season. This finding is crucial for planning and managing reservoir operations.

The entire length of the Tano River and streams within the NGGL lease area were observed to experience some extent of inundation at least once every year. All the streams and the Tano River can be a threat to lives and properties during high flows. The shallow nature of sections of the streams could be the cause of flooding along the streams. The most vulnerable areas are within the main river channel and the immediate banks with flood depth greater than 1.0 m. Inundation of farmlands, which are mainly for the cultivation of cocoa and maize, is the immediate effect of flooding that the study uncovered.

Conclusion

The study measured and analysed streamflow and flood risk in the surface water bodies within the NGGL lease area. The cross-sections of the Awonsu stream are generally uniform with a U-shaped channel profile, while sections of the Subri River exhibited trapezoidal and V-shaped channels with an average width and depth of about 5 m and 40 m, respectively. The estimated low ($0.06 \text{ m}^3/\text{s}$) and high ($256.46 \text{ m}^3/\text{s}$) streamflows are vital to effectively manage flood and drought periods efficiently, as well as guiding the dam's regulation within the NGGL lease area. Inundation of farmlands, which are mainly for the cultivation of cocoa and maize, is the immediate effect of flooding that the study uncovered. Crop destruction could occur if farmlands or croplands are flooded.

Recommendation

Presented below is a summary of recommendations for management considerations:

- i. Gauge readers and water level sensors (transducers) should be installed at the remaining monitoring stations and on the WSF to keep monitoring water levels as an early warning and to have a better understanding of the characteristics of stream flow within the lease area.
- ii. The established rating curves should be updated with additional data, including high stream flows, obtained from field measurements.
- iii. Development of a detailed Stage-Area-Volume relation for the WSF is crucial and recommended for reservoir operation, planning, and management.
- iv. The streams should be dredged to improve the carrying capacity of the river channels.
- v. Enhancement of vegetation within the floodplain and stabilization of riverbanks to retain water and reduce sediment transport.

3.2.1.14 Harnessing Community Resilience and Machine Learning for Adaptive Malaria Control amid Climate Change in the Upper West Region of Ghana

(Research Team: Dr. Jacob Agyekum - Principal Investigator, Dr. Prosper Bazaanah, Dr. Sylvester Afram Boadi, Ing Frank Obim, Mario K. Danban)

Collaborating Agencies: Ghana Health Service, Ghana Meteorological Assembly, Wa Municipal Assembly

Introduction

Malaria remains a major public health challenge in sub-Saharan Africa, particularly in northern Ghana, especially the Upper West, where seasonal outbreaks persist and are increasingly shaped by climate variability. Rising temperatures, altered rainfall patterns, drought, and extreme weather events are modifying mosquito breeding habitats, shifting transmission seasons, and expanding vector ranges into previously less-affected areas, making outbreaks

more difficult to predict and control. These climatic pressures, combined with inadequate sanitation infrastructure and limited access to healthcare services, heighten community vulnerability. Although Ghana's National Malaria Control Programme (NMCP) has reduced malaria cases nationally through core interventions such as insecticide-treated nets, indoor residual spraying, and antimalarial treatment, it does not sufficiently integrate climate and environmental data, community adaptation strategies, or a fully functional climate-informed early warning system (EWS) into its framework. As climate patterns continue to shift, malaria control in northern Ghana requires a more adaptive and anticipatory approach that combines climate-informed predictive modelling with community resilience and local knowledge systems. Integrating environmental data, machine learning-based early warning tools, and participatory community engagement will strengthen outbreak prediction, improve targeted responses, and ensure culturally appropriate, sustainable malaria control aligned with climate-resilient development objectives. The study was initiated in the year under review and is expected to end in 2027.

Objectives

The objectives were to:

- i. Assess the impact of climate change on malaria transmission patterns in Wa Municipality, using historical climate data and malaria incidence records to identify emerging trends.
- ii. Test and adapt ensemble of machine learning models to predict malaria outbreaks based on climate variables (e.g., temperature, rainfall, relative humidity) and epidemiology (including environmental factors), integrating community health data for improved accuracy.
- iii. Strengthen community resilience by engaging local populations in malaria prevention and adaptation strategies, including the use of climate-informed health interventions and educational programmes.
- iv. Evaluate the effectiveness of adaptive malaria control measures implemented in collaboration with local communities, considering both climate variability and seasonal malaria dynamics.
- v. Facilitate capacity-building within local health systems and communities to better manage and respond to malaria risks, using data-driven insights to guide decision-making and resource allocation.

Activities Undertaken

The following activities were carried out in the reporting year:

Ethical Clearance Application

The ethical clearance application process was started and successfully completed. All required documentation, including the approved survey questionnaire and focus group discussion guides, were finalized and submitted through the online application platform. Approval was granted, enabling the study to proceed fully with data analysis and subsequently community engagement phases in compliance with ethical standards.

Initial Stakeholder Engagements

Initial stakeholder engagements have been done to discuss project objectives and expectations. These include phone calls to the office of the Deputy Director of Ghana Health Service and a follow-up in-person meeting. Phone calls and follow-up meetings with Ghana Meteorological Agency, and phone call discussions with the Regional Director of Health for Upper East region of Ghana. The needed data, Malaria and Climate data were also discussed. From these initial

engagements, The Malaria Data (OPD cases), and climate data sources were acquired from Ghana Health Services (GHS) and the Ghana Meteorological Agency (GMet). Other source of climate data (e.g., CHIRPS, ERA5) to cover areas of no station data were also discussed and agreed upon.

Data Collection and Processing: Malaria data has been collected from the GHS during the initial engagement. The data was cleaned, ensuring quality control. The data was processed into Machine Learning Models structure for easy model runs. Similarly, climate data were acquired from GMet and other open data sources (to augment GMet data) and prepared for machine learning model runs. Each dataset requires careful cleaning, formatting, and alignment to ensure consistency across different sources. Since the study integrates multiple domains, (climate, environment, and health) substantial effort has gone into harmonizing these data layers to make them suitable for computational modeling. Another area of progress is the systematic review, which is currently underway. This review focuses on synthesizing existing literature on the intersection of malaria, climate change, and the use of artificial intelligence approaches in Africa.

Data Analysis on climate-malaria relationship: Preliminary statistical and exploratory analyses were conducted to examine the relationship between malaria incidence and key climate variables such as rainfall, temperature, and humidity. Climate and malaria datasets were temporally and spatially aligned to ensure consistency across sources. Initial trend analysis and correlation assessments were performed to identify seasonal patterns and potential lag effects between climate drivers and malaria outcomes.

Initial Machine Learning (ML) Model Runs: Initial machine learning model runs were conducted using the processed malaria and climate datasets. Data were structured into training and testing sets, and baseline models were implemented to assess predictive performance and identify influential variables. These initial runs provided valuable insights into model behavior, data suitability, and areas requiring further refinement, forming the foundation for more advanced model optimization in subsequent phases.

Planning for Community Engagement: Plans for community engagement activities were developed in preparation for implementation in late February. The Health Director of Upper West Region in Ghana has been formally contacted and has expressed readiness to support and facilitate the community engagement process. This collaboration will support effective community participation and ensure that planned engagement activities align with local health priorities and implementation structures.

Key Results Achieved

Key results included the following:

- **Ethical Clearance was approved**
- **Initial Data analysis on Malaria Dynamics in the districts in the Upper West**
The initial dynamics of Malaria cases in the Upper West region was done to assess the inter-annual variability (Figure 3.2.5), the seasonal variation (Figure 3.2.6) and the annual cycle (Figure 3.2.7). The inter-annual variability shows a decreasing trend in the annual Malaria cases, the third quarter with the highest number of cases, with OPD cases peaking in October for all districts

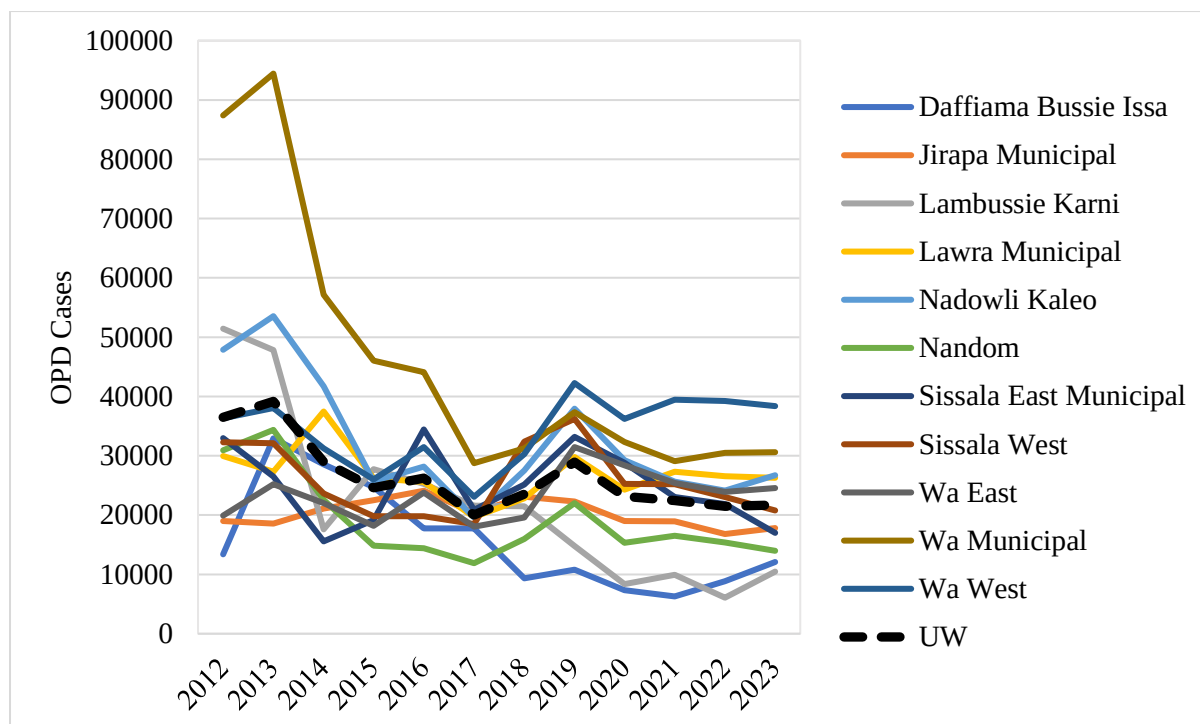


Figure 3.2.5: Inter-annual variation of Malaria OPD cases in the districts in Upper West.

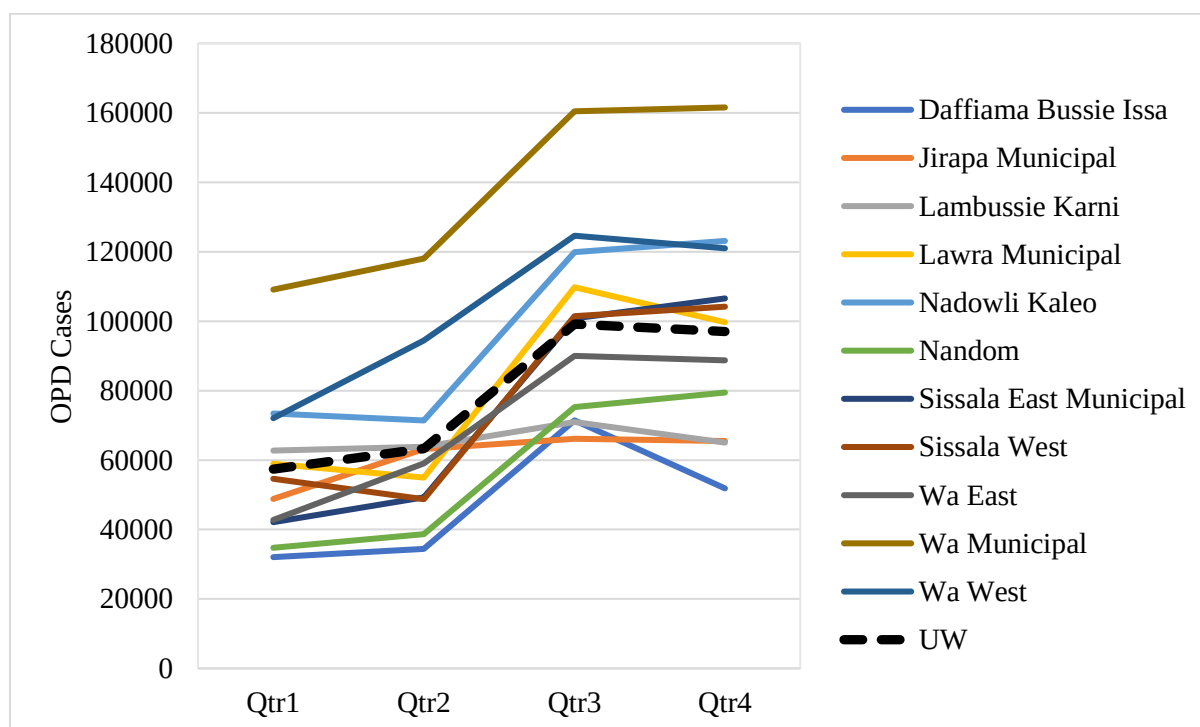


Figure 3.2.6: Seasonal Variation of Malaria OPD cases in the districts in Upper West.

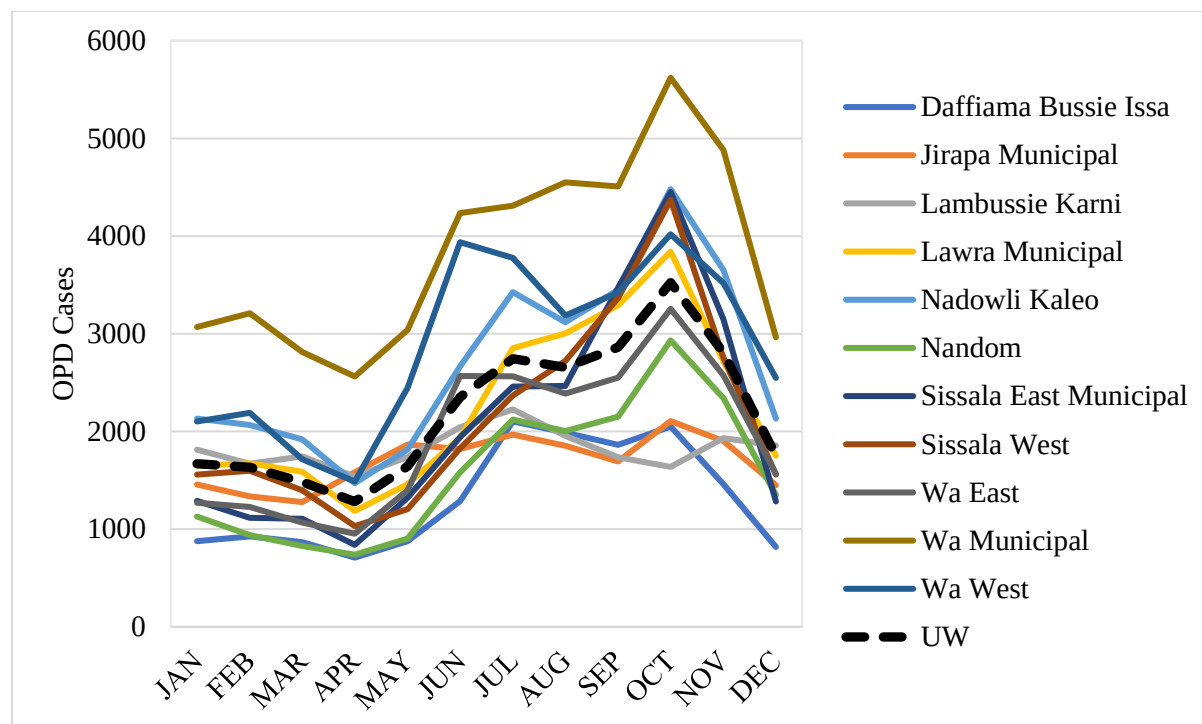


Figure 3.2.7: Annual cycle of Malaria OPD cases in the districts in Upper West.

Conclusion

The project establishes a strong technical and institutional foundation for climate-informed malaria control in the Upper West Region. Through ethical clearance, stakeholder collaboration with the Ghana Health Service and Ghana Meteorological Agency, data harmonization, and initial modeling, it has progressed from concept to operational readiness. By institutionalizing a climate-informed Early Warning System and strengthening community-based adaptive strategies, the initiative is positioned to enhance outbreak prediction, optimize resource allocation, and contribute to sustainable, climate-resilient health and economic development in Ghana.

Recommendation

The following recommendations were given:

- Institutionalize a climate-informed malaria Early Warning System (EWS) within Ghana's health sector by integrating meteorological data, predictive analytics, and district-level surveillance into routine planning and budgeting frameworks.
- Strengthen community-based adaptive malaria control by formally embedding local knowledge, participatory surveillance, and resilience-building strategies into national malaria policy and implementation guidelines.

Impact of the Study on the National Economy

The project will strengthen Ghana's national economy by reducing malaria-related morbidity and mortality, particularly in high-burden northern regions, thereby lowering healthcare expenditures and minimizing productivity losses from illness and absenteeism. By integrating climate-informed early warning systems and community-based adaptive strategies, it will enable more efficient allocation of public health resources, reduce the economic shocks associated with seasonal outbreaks, and enhance workforce resilience in climate-vulnerable areas. Improved health outcomes will support agricultural productivity, local enterprise

continuity, and human capital development, contributing to long-term economic stability and climate-resilient growth in Ghana.

3.2.1.15 Review of the Health Impact Assessment Report for Communities around the Water Storage Facility (WSF) for Newmont Ghana Gold Limited (Ahafo South Mine)

(Research Team: Dr. Kwadwo Ansong Asante - Principal Investigator, Dr. Samuel Armoo, Dr. Ruby Asmah, Dr. Lawrence Osa-Nyarko, Dr. Ayesha Agalde Amadu, Prof. Mike Yaw Osei-Atweneboana and Dr. Isaac Kofi Yankson - CSIR-BRRI)

Collaborating Agency: CSIR-Building and Road Research Institute

Introduction

Newmont Ghana Gold Limited (NGGL) engaged the Council for Scientific and Industrial Research - Water Research Institute (CSIR-WRI) to conduct an independent technical review of a Health Impact Assessment (HIA) report submitted by a consultant. The review assessed whether the study objectives were achieved, evaluated the adequacy and quality of the sampling procedures, analytical methods, data analysis, and quality assurance processes, and evaluated the validity of the results, interpretations, and conclusions presented. The review began and ended in the reporting year.

Objectives

The objectives of the review were to:

- i. assess the objectives of the study and determine if achieved;
- ii. review sampling procedures, methods used in analyzing samples, data analysis, procedures, etc.;
- iii. conduct quality assurance of the methodology adopted for the study;
- iv. study the results and interpretation of results and determine if the outcomes are correct;
- v. answer the question “Are conclusions from the study valid?”; and
- vi. highlight any gaps in the report and provide recommendations.

Activities Undertaken

During the reporting year, the review was completed. Hence, a draft report was written and sent to Newmont Ghana Gold Limited awaiting their comments.

Key Results Achieved

The study presented a comprehensive HIA of the Ahafo South Mine, clearly outlining its objectives, scope, and methodology, with a focus on evaluating environmental contamination and associated human health risks. It integrated multiple components, including groundwater, soil, air quality, noise, and food pathways such as crops and poultry, in an effort to provide an understanding of exposure risks within the Damso community. Findings indicated that while some environmental parameters remain within acceptable limits, there were localized concerns, particularly elevated heavy metals e.g., arsenic and lead, turbidity, particulate matter, and SO₂, mainly in areas influenced by mining activities. The assessment of food sources (cassava, cocoyam, and poultry) further highlights potential bioaccumulation and dietary exposure risks for both adults and children. Overall, the report gives valuable insights for environmental management and public health decision-making, although some sections would benefit from deeper critical analysis and interpretation.

Conclusion

Although the report provided a comprehensive assessment, it was constrained by several recurring methodological and reporting weaknesses that reduce its scientific robustness and clarity. Across sections, there was a consistent need for improved methodological transparency, including clearer descriptions of sampling design (sites, timelines, coordinates, and seasonal coverage), laboratory procedures, quality assurance/quality control measures, and use of certified reference materials. The control site was insufficiently characterized, and in some cases sampling conditions (e.g., animal rearing systems) were unclear. There were also issues with scope definition and consistency, particularly regarding inclusion of food crops and animals, as well as incomplete or uneven consideration of commonly consumed plant and animal parts. Several sections lacked historical baseline data, limiting the ability to interpret changes over time, while risk assessments relied on generalized assumptions than community-specific exposure data.

Data handling and interpretation presented additional concerns, including inconsistencies in seasonal reporting, incorrect or unclear guideline values, and incomplete or inconsistent referencing of standards and prior studies. Statistical methods and pollution classification thresholds were also not always clearly defined. Presentation issues such as misaligned tables and text, equation inconsistencies, and unclear sample identification further affected readability and coherence.

Recommendation

The results and discussion would benefit from stronger integration, including clearer linkage to emission sources, improved comparison with control conditions, and better quantification of exceedances, alongside a deeper One Health perspective connecting environmental, animal, and human health impacts. While the conclusions are generally consistent with the results, they lack sufficient depth and integration to fully support decision-making, particularly in relating environmental exposures to health outcomes and comparing risk levels across environmental and animal sources, locations, and contaminants. Enhancing the presentation of risk magnitude and exceedances would improve the study's clarity, scientific rigor, reproducibility, and policy relevance.

Impact of the Study on National Economy

The findings will go a long way to resolve any perceived confrontation between the Damso community and NGGL.

3.2.1.16 Surface Water Ecological Studies Monitoring at the Akyem Mine

(Research Team: Dr. Ruby Asmah - Principal Investigator, Dr. Kwadwo Ansong Asante, Mr. Theodore Quarcoopome, Dr. Samuel Armoo, Mrs. Regina Ama Banu and Dr. Ayesha Amadu)

Introduction

Zijin Golden Ridge Limited (ZGRL), Akyem Gold Mine is a Greenfield open pit operation located in the Birim North District of the Eastern Region of Ghana. The site is located approximately 3 km west of the district capital, New Abirem. The company has a Water Storage Dam (WSD) located within the Alotusu stream drainage and intercepts runoff water from a catchment area of approximately 309 hectares. Two major rivers; the Pra and the Mamang Rivers surround the Akyem Mine area. Water contained in the Akyem WSD is used in the processing of ore and for other mining operations. The water quality assessment of the facility was undertaken as part of information gathering intended to assess the ecological status

of the WSD and to enhance its management and economic uses. The study was initiated in the year under review and is expected to be finalized in 2028.

Objectives

The main objective of the study was to assess the ecological status of the water storage dam (WSD) and to reduce the density of fish stock in the facility.

For water quality assessment, the specific objectives were to:

- i. determine and establish the quality of water in the WSD and a source of water to the WSD; the Maman River and how these vary seasonally; and
- ii. determine the quality of sediment in the WSD and the Maman River and how these vary seasonally.

Activities Undertaken

Field sampling was undertaken from 16th to 18th June, 2025 to capture the minor rainy (wet) season. Water samples were collected with a 2.0 L Van-Dorn water sampler from 0.5 m below the surface and 0.5 m above the sediment at the downstream section, directly into pre-cleaned 1000 mL plastic sample bottles. Surface and bottom water samples were taken at each of the three (3) selected monitoring locations of the WSD. In addition, three samples from the upstream, Pra confluence and Nkwateng were taken along the Mamang river. Temperature, pH and conductivity were measured in situ with a multi-parameter probe. Sediment samples from the WSD and the two rivers were also collected using an Ekman grab into polyethylene bags. All the collected samples were stored in insulated boxes with ice and transported to the CSIR-WRI laboratories in Accra for analyses. Prior to transporting the samples to Accra, they were kept in cold boxes

The physico-chemical parameters were determined according to the methods described in the Standard Methods for the Examination of Water and Wastewater (APHA-AWWA-WEF, 2017). Water samples for heavy metals analysis were digested with concentrated nitric acid, while sediment samples were digested with nitric acid and hydrogen fluoride combination in an Ethos Microwave Digester prior to analysis by the Microwave – Plasma Atomic Emission Spectrometer.

Percentage organic matter in sediment was determined by loss of ignition. A sample measuring ~0.5 g of ground dried sediment was placed in a muffle furnace at 550°C for 5 hrs. The organic matter (%) was calculated as the difference between the initial and final sample weights, divided by the initial sample weight and multiplied by 100%.

Key Results Achieved

The pH values of the WSD ranged between 7.58 pH units and 7.97 pH units. The measured pH values in the WSD fell within the Ghana Standards (GS 1212:2019) acceptable range of 6 – 9 for effluent discharge into natural water bodies. Turbidity values varied between 5.53 and 8.20 NTU. The measured turbidity values were far below the GS1212:2019 value of 75 mg/L and therefore satisfactory. Total hardness, calcium, magnesium, sodium, potassium and chloride concentrations could not be compared as no GS1212:2019 values exist. Regardless, the values obtained are not alarming. Fluoride was detected at some sections in the WSD but no GS1212:2019 value exists to compare the results with albeit they appear low.

Dissolved oxygen concentrations varied between 6.29 and 9.54 mg/L. Therefore, the WSD seems well oxygenated. In this assessment, BOD values ranged between 3.30 and 5.50 mg/L

while COD varied from 27.6 to 35.6 mg/L. Both BOD and COD concentrations were far below the GS1212:2019 thresholds of 50 and 250 mg/L, respectively.

Predominantly, the nutrients levels have been low in the WSD. The low nutrient content could probably be due to minimal influence from land run-offs or its utilization as nutrient by the algal community. As observed in the past, free and total cyanide were not detected at any of the three sites in the WSD, thereby satisfying the Ghana Standards (GS1212:2019). Concentrations of all the analyzed heavy metals were either low or below the detection limits as previously reported and therefore below the available Ghana Standards (GS1212:2019).

Concentrations of only copper from 2 of the 3 WSD sites exceeded the Threshold Effect Concentration and the percentage organic matter measured in the WSD sediments ranged from 1.51% to 1.58% signifying moderate organic matter.

For the Mamang river, the pH values varied between 7.13 and 7.96 pH units, with all values falling within the range of 6.0 to 8.5 characteristic of natural freshwater bodies. The pH values were also within the range of 6.5 to 8.5 stipulated for drinking and domestic uses. Turbidity values (515 – 616 NTU) measured from the Mamany river grossly exceeded the water quality Guideline/Standard of 5 NTU (GSA, 2014; WHO, 2011). Illegal small-scale mining activities could explain the high turbidity values encountered.

To assess the nutrient status of the river, nitrate, sulphate and total phosphorus were measured and the concentrations were low in the Mamang river when juxtaposed with the available water quality Guidelines/Standards. Concentrations of calcium, magnesium, sodium, chloride, fluoride and potassium in the river were all low in relation to the water quality Guidelines/Standards as reported previously. The dominance of sodium over magnesium may suggest the influence of domestic wastes and other activities in the area.

The minimum required dissolved oxygen (DO) for proper growth and development of aquatic life is 5 mg/L. In this monitoring, the DO values for the Mamang river were 3.70 mg/L (Confluence), 4.32 mg/L (Nkwateng) and 7.02 mg/L (Upstream). BOD levels determined for the Mamang river varied between 6.50 and 9.20 mg/L. High BOD levels indicate the extent of biodegradable organic pollutants in a water body. COD levels of 36.2 – 55.6 mg/L were encountered.

Iron concentrations measured at the 3 selected sites of River Mamang (5.21 – 9.94 mg/L) significantly exceeded the Guideline/Standard of 0.30 mg/L, in addition to lead (Pb) concentrations exceeding at all the sampling sites of River Mamang. The other measured heavy metals were either below the detection limits or below the water quality Guidelines/Standards. Neither free nor total cyanide was measured in the Mamang river.

Chromium and lead levels in sediment samples from all the 3 sites of the Mamang river exceeded the TEC limit. The percentage organic matter measured in the Mamang river measured between 0.258% and 1.03% indicating moderate organic matter.

The pH values of the WSD were quite stable between 2016 and 2020 but have increased marginally since 2021. Nevertheless, the values have been within the WHO Guidelines/Ghana Standards. On the other hand, the pH values of the Mamang river have been fairly stable over the years. The conductivity values in the WSD have increased steadily over the years. For Mamang river, except 2017, conductivity values have been very stable. However, the

conductivity values at the Mamang-Pra confluence and Mamang Nkwateng have been erratic. The DO values in the WSD appear increasing over the years while for Mamang river the DO values have not been stable. Turbidity values in the WSD have been stably low till date, while Mamang river recorded the highest turbidity value in 2025 since the monitoring began. The nitrate concentrations have been low in the WSD except in 2020 which showed relatively high nitrate value. However, the nitrate concentrations have been significantly high in the Mamang river particularly in years 2020, 2021 and 2025. Arsenic has been negligible in the WSD and very low levels measured in the Mamang river over the years.

Conclusion

A report outlying the finding of the study has been submitted to ZiJin Golden Ridge Limited awaiting the next sampling campaign in 2026.

Recommendation

It is important to regularly monitor the water quality since communities along the rivers depend on the river water for potable use.

Impact of the Study on National Economy

Having and maintaining the quality of the rivers will serve the communities well in terms of good water for their potable use and also improve their livelihoods through farming and fishing. This will reduce sickness/diseases and reduce the impact on the already stressed health facilities.

3.3 BIOMEDICAL AND PUBLIC HEALTH

3.3.1 BIOMEDICAL, BIOSAFETY AND ETHICS

3.3.1.1 Antibiotic-Resistant Bacteria in Drinking Water Across Twelve Regions of Ghana: Strengthening Evidence for National Surveillance

(Research Team: Karyn Ewurama Quansah - **Principal Investigator**, Ms. Hawa Ahmed, Mrs. Lady Boamah Adomako, Mrs. Regina Ama Banu, Dr. Mark O. Akrong, Mr. Selorm Borbor, Mr. Mohammed Bello, Ms. Nawal Moro Buri, Mr. Emmanuel Obeng Bekoe and Dr. Gerard Quarcoo)

Collaborating Agencies: WHO - Ghana Office, TDR, SORTIT

Introduction

Antimicrobial resistance (AMR) is an emerging public health threat that extends beyond clinical settings into environmental reservoirs, including drinking water systems. In Ghana, gaps in routine environmental AMR surveillance limit understanding of the potential contribution of drinking water to the spread of resistant bacteria. This study investigates bacterial contamination and antimicrobial resistance patterns in drinking water to support evidence-based water safety and public health interventions. It started in 2024 and ended in the reporting year.

Objective

The objective of the study was to assess the bacterial contamination and resistance profiles of *Escherichia coli* and *Pseudomonas aeruginosa* in 1886 drinking water samples from 12 regions of Ghana between April 2024 and April 2025.

Activities Undertaken

Activities undertaken during the reporting year included laboratory analysis of drinking water samples, isolation and confirmation of *Escherichia coli* and *Pseudomonas aeruginosa*, testing of isolates for antibiotic susceptibility using the Kirby-Bauer disk diffusion method, data analysis and drafting of a manuscript for publication in a peer-reviewed journal.

Key Results Achieved

Majority of the treated and packaged water samples were free from bacterial contamination. Multidrug-resistant (MDR) *E. coli* isolates were found in samples from eight regions, and MDR *P. aeruginosa* isolates were found in three regions, mostly from borehole water. *E. coli* isolates from untreated water samples exhibited high resistance to cefuroxime (74%) and amoxicillin-clavulanate (50%). Resistance to gentamicin increased from 3% in the Greater Accra region (2022) to 35% in 2025, while ertapenem resistance also rose from 6% to 18%.

Conclusion

The continued presence of *E. coli* in untreated water sources, along with newly identified MDR hotspots of *E. coli* and *P. aeruginosa* across the country, and the rising resistance to WHO 'Watch' category antibiotics such as gentamicin and ertapenem, underscores that antimicrobial resistance (AMR) remains a significant public health threat linked to environmental reservoirs. The findings from this study provide strong evidence for incorporating Antibiotic Susceptibility Testing (AST) into routine water quality monitoring.

Recommendation

The study's findings highlight the urgency of integrating AMR surveillance into national water quality initiatives. Coordinated public health interventions to educate communities on household water treatment practices and the health risks posed by AMR is needed.

Additionally, targeted active surveillance supported by whole-genome sequencing is necessary to better track and understand the spread of antimicrobial resistance.

Impact of the Study on National Economy

This project contributes to current knowledge on AMR in drinking water in Ghana. It also enhances Ghana's economic resilience by identifying hidden risks in water supplies that can lead to costly health burdens. By providing evidence of resistant bacteria in community water sources, the study informs targeted public health interventions that reduce disease incidence, lower healthcare expenditures, and minimise productivity losses associated with waterborne and resistant infections. Strengthening AMR surveillance in environmental reservoirs supports safer water infrastructure investments, enhances workforce health, and contributes to sustainable economic development by protecting human capital and reducing long-term treatment costs for resistant infections

3.3.1.2 Antimicrobial Resistance Monitoring in Ghanaian Surface Waters: Evidence for Public Health Action Using the WHO Extended-Spectrum β -Lactamase-Producing *E. coli* Tricycle Approach

(Research Team: Regina Ama Banu - Principal Investigator, Patrick Ofori, Selorm Borbor, Mark Osa Akrong, Ophelia Osei Ulzen, Karyn Ewurama Quansah, Jesse Ansong Sefa, Lady Asantewah Boamah Adomako, Ben Amoah, Margaret Ofosua, Nawal Moro Buri, Mohammed Bello, Tesha Owusu, Gideon Asamaoh, Albert Kobina Mensah, Frederick Yaw Logah, Andrews Elikem Tetteh, Nana Eghele Adade, George Amoo Adjei, Ethel Atanley, Hilda Ohene Asa, Kwame Essah, Michael Adu, Collins Korbla Tay, Mike Yaw Osei-Atweneboana)

Collaborating Agencies: UK AID Soil Research Institute, Aurum Institute Ghana, Fleming Fund, Mot Macdonald

Introduction

The Extended Spectrum Beta lactamase producing *Escherichia coli* (ESBL Ec) Tricycle Surveillance in Ghana has recently been upscaled to include Kumasi, a fast-growing metropolitan area and Asokore Mampong in the Ashanti Region of Ghana. This expansion sought to capture data reflecting regional heterogeneity for effective One Health policy formulation and by extension to support global surveillance efforts. This study is guided by a simplified but well-structured protocol; The WHO ESBL Ec Tricycle Protocol. It guides surveillance in a One Health Approach, using ESBL-Ec as a key indicator organism as resistance caused by this pathogen signifies a breakdown in first-line therapies (ECDC & CDC, 2012). Adopting the One Health paradigm recognizes that human infection patterns are closely linked to environmental reservoirs. Thus, integrating environmental data into One Health studies is critical for strengthening clinical decision-making. Further, understanding multi-drug resistance (MDR) profiles alongside regional susceptibility patterns – guided by environmental evidence – provides a more complete picture of resistance dynamics and supports informed antimicrobial use. This integrated approach is essential for preserving the efficacy of last-resort antimicrobials. The project started in the reporting year and is expected to end in 2026.

Objectives

The objectives were to:

- i. evaluate surface waters from four Ghanaian cities – Accra, Kasoa, Kumasi, and Asokore Mampong – by sampling the Odaw, Okurudu, Susan, and Subin rivers respectively, using the environmental work package of the WHO ESBL-Ec Tricycle Protocol; and

- ii. characterize ESBL-Ec resistance profiles against key antimicrobials, define multi-drug resistance (MDR) status, and assess associated clinical risks within a One Health framework.

Activities Undertaken

Environmental surveillance was conducted for five months across four urban river systems (Odaw, Okurudu, Susan, Subin) (Figure 3.3.1). A total of 240 isolates were generated across the four surveillance locations. Antimicrobial Susceptibility Testing (AST) was performed using the Kirby-Bauer disk diffusion method, following CLSI guidelines. Raw susceptibility data were managed and analyzed using WHONET 2025.

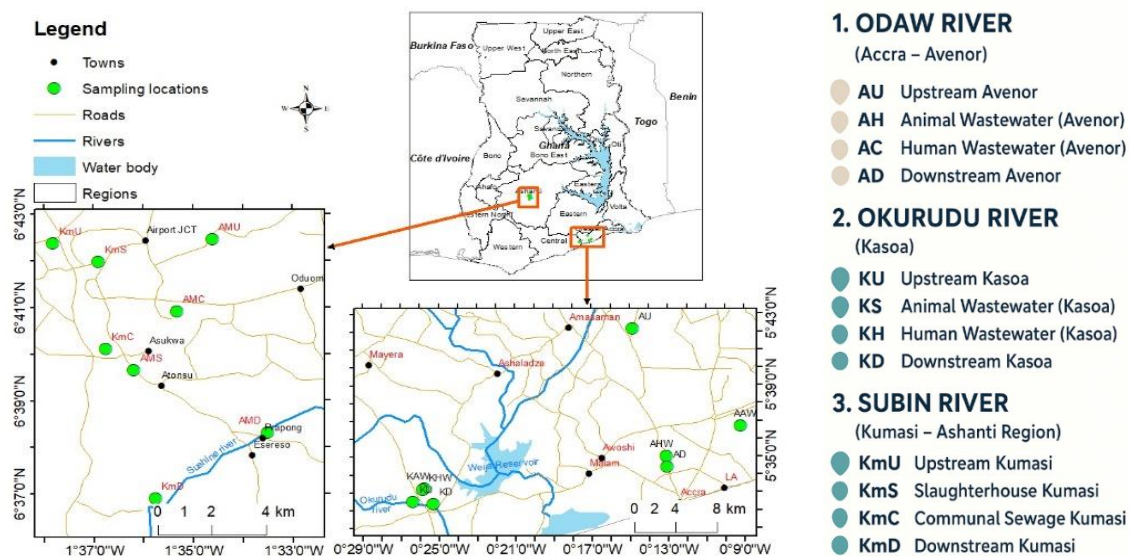


Figure 3.3.1: Map of study area.

Key Results Achieved

There was regional variation in resistance to five key antibiotic classes. Both Greater Accra and Ashanti (Figure 3.3.2) showed extremely high resistance to 3rd-generation cephalosporins and tetracyclines, highlighting these antibiotic classes as major contributors to the multidrug-resistant profiles observed. Ashanti exhibits slightly higher resistance to fluoroquinolones and aminoglycosides, suggesting more intense antibiotic pressure or differing wastewater dynamics. Though carbapenem resistance remains low, its detection in both regions signals emerging vulnerability in last-resort treatment options (Table 3.3.1).

To highlight the dominance of multi-drug resistance collectively across all regions and sampling sites, resistance to 3rd-generation cephalosporins (95.20%) and tetracyclines exceeded 90%, undermining their effectiveness as first-line treatment options (Table 3.3.1). High fluoroquinolone resistance further reinforces the risk of treatment failure, narrowing therapeutic choices. Although carbapenem resistance remains low, its detection in surface waters is alarming given its critical role as a last-resort drug, signalling emerging threats to clinical care and One Health security.

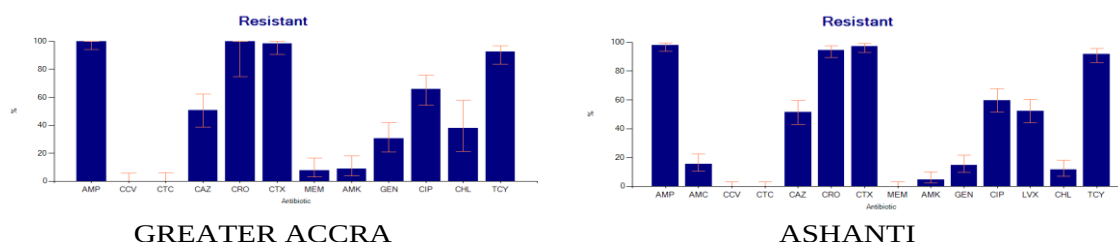


Figure 3.3.2: Regional Comparison of AMR from surface waters of Greater Accra and Ashanti Region.

Table 3.3.1: Multi-Drug Resistance (MDR) Across All Sites (Greater Accra Region & Kumasi).

Antibiotic Class	Average % Resistance	MDR Status
3rd-Gen Cephalosporins	95.20%	MDR Driver
Tetracyclines (T)	90.80%	MDR Driver
Fluoroquinolones (F)	61.60%	MDR Driver
Aminoglycosides (A)	23.00%	Reserve Option
Carbapenems (C)	3.80%	Last Resort

Conclusion

High resistance to cephalosporins, tetracyclines, and fluoroquinolones confirms their role as dominant MDR drivers in Ghanaian surface waters. Regional differences, especially elevated aminoglycoside and fluoroquinolone resistance in Ashanti Region, suggest localized antibiotic pressure or wastewater dynamics. The detection of carbapenem resistance, though low, signals emerging threats to last-resort treatment options and underscores the urgency of One Health surveillance.

Recommendation

Strengthening One Health AMR surveillance, regulating the use of key MDR-driving antibiotics, implementing region-specific interventions, improving wastewater treatment and antimicrobial stewardship, and closely monitoring emerging carbapenem resistance are essential to control resistance.

Impact of the Study on National Economy

Failure to act will increase healthcare costs, reduce workforce productivity, threaten food security and water safety, and place additional strain on national infrastructure and trade.

APPENDICES**APPENDIX I: Membership of the Internal Management Committee (IMC)**

1.	Prof. Mike Y. Osei-Atweneboana	Director (Chairman)
2.	Dr. Ruby Asmah	Deputy Director
3.	Dr. Emmanuel Obuobie	Head, Surface Water & Climate Change Division (SWCCD)
4.	Dr. Mark Osa Akrong	Head, Environmental Biology, Biotechnology & Health Division (EBB&HD)
5.	Dr. Samuel Armoo	Head, Biomedical and Public Health Research Unit (BPHRU)
6.	Dr. Kwadwo Ansong Asante	Head, Environmental Chemistry and Sanitation Engineering Division (ECSED)
7.	Mr. Theodore Quarcoopome	Head, Fishery and Aquaculture Division (FAD)
8.	Dr. Collins Okrah	Head, Groundwater & Geoscience Division (GWGD)
9.	Mr. Emmanuel Asiedu-Darko	Head, Administration Division (ADMIN.)
10.	Mr. Frederick Yeboah	Head, Finance Division (FD)
11.	Mr. Ebenezer Ofosu-Nkrumah	Head, Commercialization Division (CD)
12.	Dr. Francis Assogba Anani	Officer-In-Charge, ARDEC – Akosombo
13.	Dr. Emmanuel Tetteh-Doku Mensah	Officer-In-Charge, Tamale Office
14.	Dr. Michael Dorleku	President, Research Staff Association (RSA) – Local
15.	Mr. Samuel Kanati	Rep. CSIR Administrators Association Ghana (CAAG)
16.	Mr. Evans Osei	Local President, Senior Staff Association (SSA)
17.	Mr. Francis A. Boakye	Local Chairman, Trade Union Congress (TUC)
18.	Mrs. Regina Ama Banu	Local President, Ladies Club
19.	Mrs. Rebecca Tekpertey	Administrative Officer (Secretary)

APPENDIX II: List of Senior Members and Senior Staff**List of Senior Members**

No.	Name	Designation
1.	Prof. Mike Y. Osei-Atweneboana	Director - Principal Research Scientist
2.	Dr. (Mrs.) Ruby Asmah	Deputy Director - Principal Research Scientist
3.	Dr. Kwadwo Ansong Asante	Principal Research Scientist
4.	Dr. Mark Osa Akrong	Principal Research Scientist
5.	Mr. Emmanuel Asiedu-Darko	Principal Administrative Officer
6.	Mr. Frederick Yeboah	Principal Accountant
7.	Ing. (Dr.) Emmanuel Obuobie	Principal Research Scientist
8.	Ing. (Dr.) Frederick Y. Logah	Senior Research Scientist
9.	Dr. Collins Okrah	Senior Research Scientist
10.	Mr. Humphrey F. Darko	Senior Research Scientist
11.	Mr. Theodore Quarcoopome	Senior Research Scientist
12.	Mrs. Regina Ama Banu	Senior Research Scientist
13.	Dr. Michael Kumi	Senior Research Scientist
14.	Dr. Samuel Armoo	Senior Research Scientist
15.	Dr. Francis A. Anani	Senior Research Scientist
16.	Ing. Dr. (Mrs.) Deborah Darko	Senior Research Scientist
17.	Dr. Emmanuel Tetteh-Doku Mensah	Senior Research Scientist
18.	Dr. Agbeko Etornyo	Senior Research Scientist
19.	Dr. (Mrs.) Rhoda Lims Diyie	Senior Research Scientist
20.	Dr. Pennante N. A. Bruce-Vanderpuije	Senior Research Scientist
21.	Dr. Seth K. Agyakwah	Research Scientist
22.	Dr. Elias Asuming-Brempong	Research Scientist
23.	Dr. Franklin Obiri-Nyarko	Research Scientist
24.	Dr. Gerard Quarcoo	Research Scientist
25.	Dr. Solomon A. Owiredu	Research Scientist
26.	Ms. Saada Mohammed	Research Scientist
27.	Dr. Evans Manu	Research Scientist
28.	Dr. Michael Dorleku	Research Scientist
29.	Dr. William E. Arko	Research Scientist
30.	Mrs. Zita Naangmenyele Abuntori	Research Scientist
31.	Mr. Edward J. Tettevi	Research Scientist
32.	Dr. Mariam Y. Ameveworwor	Research Scientist
33.	Dr. Frank Adu-Nti	Research Scientist
34.	Dr. Raymond Kojo Agbadi	Research Scientist
35.	Dr. Prosper Bazaanah	Research Scientist
36.	Dr. Patrick S. K. Fatsi	Research Scientist
37.	Dr. (Mrs.) Lawrence Osae-Nyarko	Research Scientist
38.	Dr. (Mrs.) Betty Oppong Bandoh	Research Scientist
39.	Dr. (Mrs.) Akua Kyerewa Botwe	Research Scientist
40.	Dr. Appiah Ebenezer Koranteng	Research Scientist
41.	Dr. Sylvester A. Boadi	Research Scientist
42.	Dr. Jacob Agyekum	Research Scientist
43.	Dr. Sumabe Kasim Balagra	Research Scientist
44.	Dr. Ayesha A. Amadu	Research Scientist
45.	Dr. Joseph Harold Osei Nyarko	Research Scientist
46.	Mr. Kwabena O. Benson	Scientific Secretary
47.	Dr. Bismark A. Akurugu	Research Scientist

No.	Name	Designation
48.	Dr. Mark Osei-Owusu	Research Scientist
49.	Mr. Emmanuel O. Armah	Assistant Research Scientist
50.	Ing. Ralph Tagoe	Assistant Research Scientist
51.	Mrs. Martha D. Agyemang	Assistant Research Scientist
52.	Mrs. Sandra V. Asare	Assistant Research Scientist
53.	Mrs. Mercy Johnson-Ashun	Assistant Research Scientist
54.	Ms. Hawa Ahmed	Assistant Research Scientist
55.	Ing. Gabriel Appiah	Assistant Research Scientist
56.	Mr. Franz A. Gaisie-Essilfie	Assistant Research Scientist
57.	Mr. Faisal A. Nuru-Ahmed	Assistant Research Scientist
58.	Mr. Jude O. Quansah	Assistant Research Scientist
59.	Mr. Martin A. Adakpeya	Assistant Research Scientist
60.	Mrs. Lady B. A. Adomako	Assistant Research Scientist
61.	Mrs. Theodora L. E. Agbotui	Assistant Research Scientist
62.	Mr. Haruna Zaid	Assistant Research Scientist
63.	Mr. Divine W. Hotor	Assistant Research Scientist
64.	Mr. Emmanuel Adu-Ofori	Assistant Research Scientist
65.	Dr. Nyamadi Akpene Aku	Assistant Research Scientist
66.	Mr. Imoro Nfayem	Assistant Research Scientist
67.	Mrs. Abigail Nunoo Akuetteh	Assistant Research Scientist
68.	Mr. Eugene Sintim Gyabaah	Assistant Research Scientist
69.	Ms. Adelina Akuamoah Boateng	Assistant Research Scientist
70.	Ing. Patricia Granaham	Assistant Research Scientist
71.	Ing. Frank T. Oblim	Assistant Research Scientist
72.	Mrs. Karyn Ewurama Quansah	Assistant Research Scientist
73.	Nana Aso Amonoo	Assistant Research Scientist
74.	Mr. Acheampong Addo	Assistant Research Scientist
75.	Mrs. Dora D. Ocran	Assistant Research Scientist
76.	Mr. Daniel K. Amoah	Assistant Research Scientist
77.	Ms. Millicent Adu-Boakye	Assistant Research Scientist
78.	Ms. Yaa Asabea Agadzi	Assistant Research Scientist
79.	Mr. Simeon Nii Laryea Odametey	Assistant Research Scientist
80.	Mr. Ebenezer Ofosu-Nkrumah	Marketing Officer
81.	Mr. Samuel Kanati	Administrative Officer
82.	Mrs. Rebecca Tekpertey	Administrative Officer
83.	Mrs. Lydia Kusi	Administrative Officer
84.	Ms. Sylvia Amponsah	Public Relations Officer
85.	Mrs. Doris Damoah	Senior Accountant
86.	Mrs. Regina A. Atsu	Accountant
87.	Ms. Sem Shelipstics	Accountant
88.	Engr. Simon K. Anane	Senior Estate Officer
89.	Mrs. Esther Mate-Ahmed	Accountant
90.	Ms. Matilda A. Tagoe	Accountant
91.	Ms. Salima Abdulai	Administrative Officer
92.	Ms. Clarissa Y. Nutsugah	Marketing Officer
93.	Mr. Benjamin Ashaley Quaye	Internal Auditor

List of Senior Staff

No.	Name	Designation
1.	Mr. Mohammed M. Bello	Chief Technical Officer
2.	Mr. Salifu Abdul-Latif	Chief Technical Officer
3.	Mr. Christopher Y. Nfojoh	Chief Technical Officer
4.	Mrs. Benedicta Osei-Tutu	Chief Administrative Assistant
5.	Mr. Francis A. Boakye	Chief Technical Officer (Systems Administrator)
6.	Mr. Ebenezer N. D. Koranteng	Chief Marketing Assistant
7.	Mrs. Priscilla Ampofo-Yeboah	Chief Administrative Assistant
8.	Mr. Serapis A. Asiedu	Chief Technical Officer
9.	Mr. Victor Nii Mante	Chief Technical Officer
10.	Mr. Michael D. Afram	Chief Technical Officer
11.	Mr. Alex Yeboah	Chief Accounting Assistant
12.	Ms. Genevieve G. Kwogana	Chief Administrative Assistant
13.	Mr. Emmanuel M. Obeng Bekoe	Chief Technical Officer
14.	Mr. Serlom Borbor	Chief Technical Officer
15.	Ms. Murjanatu Abdul-Hamid	Chief Technical Officer
16.	Mr. Eric Y. Darko	Chief Technical Officer
17.	Ms. Esther A. Sowah	Chief Technical Officer
18.	Mrs. Dorothy Krodua	Chief Administrative Assistant
19.	Mr. Evans V. Osei	Chief Technical Officer
20.	Mrs. Cecilia Dwamena-Yeboah	Chief Administrative Assistant
21.	Ms. Joyceline Asare-Bediako	Chief Administrative Assistant
22.	Mr. Enoch Karbo	Chief Accounting Assistant
23.	Mr. Lawson Maxi-Millian Abaah	Chief Technical Officer
24.	Mr. Fredrick Sakyi	Chief Stores Superintendent
25.	Mr. Ebenezer D. Mensah	Principal Works Superintendent
26.	Mrs. Doris Derpog Neequaye	Principal Administrative Assistant
27.	Mr. Bright K. Idun	Principal Technical Officer
28.	Mr. Isaac Kwarteng	Senior Works Superintendent
29.	Mr. Lawrence Yawson	Senior Technical Officer
30.	Ms. Naa Adjeley Kuma	Senior Technical Officer
31.	Mr. Emmanuel Boadu Kwakye	Senior Technical Officer
32.	Mr. Bright Selorm Amedorme	Senior Technical Officer
33.	Mr. Manfred Dakorah Asiedu	Senior Technical Officer
34.	Ms. Abena Konadu Owusu-Senya	Senior Technical Officer
35.	Ms. Lucy Adu	Senior Administrative Assistant
36.	Mrs. Doris Obeng Bekoe	Senior Administrative Assistant
37.	Ms. Freda Kwarteng	Technical Officer
38.	Mr. Felix J. Ofosu	Technical Officer
39.	Mr. Abdul-Rahaman Mohammed-Sadat	Technical Officer
40.	Ms. Dorothy Lomo-Mainoo	Technical Officer
41.	Ms. Getrude Nortey	Technical Officer
42.	Ms. Nawal Moro Buri	Technical Officer
43.	Mr. Mario Chrisk	Technical Officer
44.	Mr. Samuel Birikorang	Technical Officer
45.	Mr. Evans Tarko Dankwa	Technical Officer
46.	Mr. Thompson G. Nyamesah	Technical Officer
47.	Mr. Issahaku Tofic	Technical Officer
48.	Mr. Samuel Kwadwo Debrah	Technical Officer
49.	Mr. Kelvin Kweku Donkor	Technical Officer
50.	Ms. Grace Kwaku-Anim	Technical Officer

No.	Name	Designation
51.	Ms. Joyce Kplorla Kusorgbor	Technical Officer
52.	Mr. Joel John Otchere-Baffour	Technical Officer
53.	Mr. Gideon Twieku	Technical Officer
54.	Mr. Frank Twumasi Oppong	Technical Officer
55.	Ms. Cindy Xolali Anane	Technical Officer
56.	Mr. Mario Danban Kugre	Technical Officer
57.	Ms. Millicent Mansa Amegazo	Technical Officer
58.	Mr. David Britton N. A. Ammah-Tagoe	Technical Officer
59.	Ms. Linda Hine	Technical Officer
60.	Ms. Judith Wayo	Technical Officer
61.	Mr. Frank Twum Aboagye	Technical Officer
62.	Mr. Benjamin Boaky Tenkorang	Purchasing Assistant
63.	Mr. Joshua Ferguson	Accounting Assistant
64.	Mr. Innocent Kwakugah	Accounting Assistant
65.	Paa Kobina Sagoe Gyapong	Accounting Assistant
66.	Ms. Eunice Nyarko Darko	Accounting Assistant
67.	Ms. Rita Atiemo	Accounting Assistant
68.	Mr. Michael Arthur	Assistant Transport Officer
69.	Ms. Felicity Hope Mortey	Auditing Assistant
70.	Ms. Abigail Sefah	Marketing Assistant
71.	Ms. Rejoice Darkey	Marketing Assistant
72.	Mr. Louis Akon Akon-Yamga	Marketing Assistant
73.	Mr. Ebenezer Okantey	Marketing Assistant
74.	Ms. Ayishetu Wortey	Front Desk Officer
75.	Nana Afua O. Boateng	Administrative Assistant
76.	Ms. Amanda Maasoyuor Karbo	Administrative Assistant
77.	Ms. Victoria Lilian Sackey	Administrative Assistant
78.	Ms. Abigail Dede Ometse Quaynor	Administrative Assistant
79.	Ms. Linda Brako	Administrative Assistant
80.	Mr. Emmanuel Ayim	Administrative Assistant
81.	Mr. Frank Goka	Security Officer
82.	Mr. Issah Hamidu	Security Officer
83.	Mr. Kassim B. Seidu	Security Officer
84.	Mr. Jones Ofori	Security Officer
85.	Mr. Mike Ben Niekye	Security Officer

Staff Distribution among the Divisions and Sections

Division/Section	Senior Members	Senior Staff	Junior Staff	Total
Directorate	3	1	-	4
Commercialization	4	10	-	14
Surface Water and Climate Change	12	1	-	13
Ground Water and Geoscience	7	5	-	12
Environmental Chemistry and Sanitation Engineering	14	10	-	24
Environmental Biology, Biotechnology & Health	8	7	-	15
Biomedical and Public Health Research Unit	17	11	-	28
Fishery and Aquaculture	16	6	8	30
Finance	6	10	-	16
Audit Unit	1	1	-	2
Administration	5	16	-	21
• Transport	-	2	5	7
• Estate Section	1	1	9	11
• Security Section	-	5	13	18
Total	94	86	35	215
Contract Appointment				
• Directorate	-	1	-	1
• CSIR College of Science and Technology (CCST)	1	-	-	1
• Fishery and Aquaculture Division	-	1	4	5
• Research Support Office	1	-	-	1
• Estate	-	-	3	3
Total	2	2	7	11
Overall Total	96	88	42	226

APPENDIX III: Human Resource Activities

Post Retirement Contract Appointment /Contract Appointment

No.	Name	Designation	Staff Category	Division	Effective Date
1.	Dr. Barnabas Amisigo	Principal Research Scientist	Senior Member	RSO	01-Jan.- 2025 to 31 Dec.-2025
2	Dr. Henderick R. Dankwa	Principal Research Scientist	Senior Member	CCST	01-Jan.- 2025 to 31 Dec.-2025
3	Ms. Grace Narh	Labourer	Junior Staff	FAD	01-Aug.-2025 to 31-Jan.-2026
4	Mr. Enoch Ahadzi	Labourer	Junior Staff	FAD	01-Aug.-2025 to 31-Jan.-2026
5	Mr. Owiredi Darkwah	Labourer	Junior Staff	FAD	01-Aug.-2025 to 31-Jan.-2026
6	Mr. Stephen Amanor Tetteh	Farm Hand	Junior Staff	FAD	01-Aug.-2025 to 31-Jan.-2026
7	Ms. Phillipa Akuamoah Boateng	Assistant Farm Manager	Senior Staff	FAD	01-Aug.-2025 to 31-Jan.-2026
8	Mr. Samuel Annang	Driver	Senior Staff	Directorate	01-Oct.-2025 to 31-Mar.-2026
9	Ms. Sogloba Disayikom	Cleaner	Junior Staff	Estate	01-Jul.-2025 to 31-Dec.-2026
10	Mr. Joseph Daani	Gardener	Junior Staff	Estate	01-Nov.-2025 to 30-Apr.-2026
11	Ms. Abigail Adobea	Cleaner	Junior Staff	Estate	01-Nov.-2025 to 30-Apr.-2026

Promotion/Upgrading

Senior Members

No.	Name	Division	Previous Designation	Current Designation	Effective Date
1.	Dr. Ayesha Amadu Algade	EBBHD	Assistant Research Scientist	Research Scientist (PhD)	12-Jun-2024
2.	Dr. Evans Manu	GWGD	Research Scientist (Non-PhD)	Research Scientist (PhD)	18-Dec.-2023
3.	Dr. William Ekow Arko	ECSED	Research Scientist (Non-PhD)	Research Scientist (PhD)	15-Jul.-2025
4.	Dr. Solomon Amoah Owiredi	FAD	Research Scientist (Non-PhD)	Research Scientist (PhD)	22-Aug.-2025
5.	Mr. Emmanuel Obeng Bekoe	EBBHD	Chief Technical Officer	Assistant Research Scientist	20-Dec.-2023

Senior Staff

No.	Name	Division	Previous Designation	Current Designation	Effective Date
1.	Mr. Isaac Kwarteng	ADMIN.	Senior Works Superintendent	Principal Works Superintendent	1-Jan.-2025
2.	Mrs. Doris Obeng Bekoe	ADMIN.	Front Desk Officer	Senior Front Desk Officer	1-Jan.-2025

3.	Mrs. Abena Konadu Owusu-Senyah Enninful	BPHRU	Technical Officer	Senior Technical Officer	1-Jan.-2025
4.	Mr. Manfred Dakorah Asiedu	BPHRU	Technical Officer	Senior Technical Officer	1-Jan.-2025
5.	Mr. Bright Selorm Amedorme	ECSED	Technical Officer	Senior Technical Officer	1-Jan.-2025
6.	Mr. Joseph Danso	ADMIN. (Transport)	Assistant Transport Officer	Senior Assistant Transport Officer	1-Jul.-2025
7.	Mr. Alexander Siaw	ADMIN. (Transport)	Works Superintendent	Senior Works Superintendent	1-Jul.-2025
8.	Mr. Ebenezer Dickson Mensah	ADMIN. (Estate)	Principal Works Superintendent	Chief Works Superintendent	1-Jul.-2025
9.	Mr. Charles Smith Bonful	ADMIN. (Security)	Security Officer	Senior Security Officer	1-Jul.-2025
10.	Mr. Louis Akon Akon-Yamga	CD	Senior Marketing Clerk	Marketing Assistant	4-Dec.-2023
11.	Mr. Felix Awalikake Ayarika	FAD	Technical Assistant Gd. I	Technical Officer	1-Nov.-2024
12.	Ms. Ayishetu Wortey	ADMIN.	Senior Telephonist	Front Desk Officer	10-May-2024

Transfer

No.	Name	Designation	Category of Staff	Division/ Section	From	To	Effective Date
1.	Ms. Afua Twumasiwaa Adjei	Accounting Assistant	Senior Staff	Finance	CSIR-FORIG	CSIR-WRI	01-Jan.-2025
2.	Ms. Sarah Pentsil	Senior Research Scientist	Senior Member	FAD	CSIR-WRI	CSIR-FORIG	01-Sept -2025
3	Dr. Yaw Anane Adjei	Research Scientist	Senior Member	BPHRU	CSIR-WRI	CSIR-CRI	01-Nov.-2025
4	Ms. Salima Abdulai	Administrative Officer	Senior Member	ADMIN	CSIR-WRI Tamale	CSIR-WRI Accra	01-Oct.-2025

Compulsory Retirement

No.	Name	Designation	Category of Staff	Division/ Section	Effective Date of Retirement
1.	Mr. Patrick Amankwah Mainoo	Research Scientist	Senior Member	GWGD	07-Oct.-2025
2.	Mr. Richard Kwayisi Kwabong	Principal Printing Assistant	Senior Staff	CD (Printing)	03-Jul.-2025
3.	Mr. Charles Smith Bonful	Senior Security Officer	Senior Staff	ADMIN. (Security)	02-Sept.-2025
4.	Mr. Joseph Danso	Senior Assistant Transport Officer	Senior Staff	ADMIN. (Transport)	20-Nov.-2025
5.	Mr. Alex Siaw	Senior Works Superintendent	Senior Staff	ADMIN. (Transport)	18-Nov.-2025
6.	Mr. Bukari Banse	Security Assistant Gd. II	Junior Staff	ADMIN. (Security)	28-Dec.-2025

Resignation

No.	Name	Designation	Category of Staff	Division/Section	Effective Date
1.	Dr. Emmanuel Kaboja Magna	Research Scientist	Senior Member	FAD	31-Mar.-2025
2.	Mr. Deryl Nii Okantey Kuevi	Assistant Research Scientist	Senior Member	BPHRU	03-Feb.-2025
3.	Mr. Isaac Agyapong	Technical Officer	Senior Staff	BPHRU	17-Feb.-2025
4.	Ms. Queenstar Naa Dedei Quarshie	Assistant Research Scientist	Senior Member	BPHRU	29-Dec.-2025

Vacation of Post

No.	Name	Designation	Category of Staff	Division/Section	Effective Date of Vacation
1.	Mr. Anthony Morkeh	Security Officer	Senior Staff	ADMIN. (Security)	7-May-2025

APPENDIX IV: Human Resource Development - Staff Pursuing Various Courses – 2025

No.	Name of Officer	Designation	Training Required	Division/ Section	Date Started	Programme Duration	Expected Date for Completion	Full Time/ Weekend	Status
1.	Mario Chrisk	Technical Officer	MPhil. Environmental Health (UDS)	EBB&HD	Sept. 2025	2 years	Sept, 2027	Local (Sandwich)	Ongoing
2.	Cecilia Dwamena-Yeboah	Chief Administrative Assistant	MBA Human Resource Management (University of Ghana)	ADMIN.	Oct. 2025	2years	Sept, 2027	Local (Weekend)	Ongoing
3.	Evans Victor Osei	Chief Technical Officer	MPhil. Computer Science (Ghana Communication Technology Univ.)	CD	Sept. 2025	2 years	Sept, 2027	Local (Weekend)	Ongoing
4.	Rita Amanor	Accounting Assistant	MBA Accounting, (Methodist Univ.)	FINANCE	Aug. 2025	2 years	Sept, 2027	Local (Weekend)	Ongoing
5.	Eunice Nyarko Darko	Accounting Assistant	MBA Accounting and Finance (UPSA)	FINANCE	Sept. 2025	2 years	Aug, 2027	Local (Weekend)	Ongoing
6.	Mario Danban Kugre	Technical Officer	MSc. Water Resource Eng. And Mgt.	SWCCD	Jan. 2025	2 years	Jan, 2027	Local (Full-Time)	Ongoing
7.	Abigail Nunoo Akuetteh	Assistant Research Scientist	PhD Geography & Resource Development	GWGD	Jan. 2026	4 years	Jan, 2030	Local (Full-Time)	Ongoing
8.	Ms. Regina Akusika Atsu	Accountant	MBA Accounting	FINANCE	Sept. 2025	2 years	Sept, 2027	Local (Weekend)	Ongoing
9.	Ms. Joyceline Asare Bediako	Chief Administrative Assistant	MBA. Human Resource Management (Pentecost University)	ADMIN	Sept. 2025	2 years	Oct, 2027	Local (Weekend)	Ongoing

APPENDIX V: National Service Personnel and Interns Posted to the Institute in 2025

Interns 2025

No.	Name of Student	Institution	Programme	Division
1.	Phillis Esi Macklin	KNUST	MPhil Water Supply and Environmental Sanitation	ESCED
2.	Rhoda Ansomah Debrah	University of Ghana	Bachelor of Arts (Geography)	SWCCD
3.	Leslie Kwaku Osei Adomako	University of Ghana	Physical Science (Geophysics)	GWGD
4.	Mercilyn Naa T. Tetteh	University of Cape Coast	BSc. Biomedical Science	BPHRU
5.	Asubonteng Geoffrey	University of Ghana	BSc. Biomedical Science	ESCED
6.	Afordofe Bright Jerome	University of Ghana	Ba. Geography and Chinese	GWGD
7.	Essel Christabel Efua Atta	University of Ghana	BSc. Biological Science	EBB&H
8.	Amoah Raymond Odei	University of Cape Coast	BSc. Biomedical Science	BPHRU
9.	Samuel Larbi	University of Ghana	BSc. Plant and Environmental Biology	EBB&H
10.	Botchway Lamptey Daniella	University of Ghana	BSc. Biological Science	EBB&H
11.	Botchwey Bless Joeclyn	University of Ghana	BSc. Plant and Environmental Biology (Biological Science)	EBB&H
12.	Jezhi Judith Paul	University of Ghana	BSc. Plant and Environmental Biology	EBB&H
13.	Ahmed Hamdiya	University of Ghana	BSc. Biological Science	EBB&H
14.	Okae-Lartey Prince	University of Ghana	BSc. Biochemistry, Cell and Molecular Biology	BPHRU
15.	Amoah Raymond Odei	University of Cape Coast	BSc. Biomedical Science	BPHRU
16.	Coffie Vanessa	University of Ghana	BSc. Biological Science	EBB&H
17.	Kafuma Abba Droefenu	University of Ghana	BSc. Biological Science	EBB&H
18.	Debrah Kelvin Darkwah	Regent University	Ba Information	CD
19.	Onyame Alberta	Accra Technical University	BSc Water and Sanitation Engineering	SWCCD

20.	Nukporte Lord Selase	Accra Technical University	BSc Meteorology and Climate Science	SWCCD
21.	Adamu Ayishatu Kunate	University of Ghana	BSc Marine Science	FAD
22.	Arthur Joseph Boahene	University of Ghana	BSc Biological Science	EBB&H
23.	Anku Ellen	University of Ghana	BSc Biological Science	EBB&H
24.	Adwoa Sedem Effah Omari	University of Ghana	BSc Public Health	BPHRU
25.	Saah Mark	Accra Technical University	Btech Accounting	FINANCE
26.	Christabel Adjetei Tetteh	University of Development Studies	BSc. Biochemistry	BPHRU
27.	Kombat Yirdem Kenedy	University of Development Studies	BSc Biotechnology and Molecular Biology	BPHRU
28.	Abigail Bonzo	University of Development Studies	BSc. Biochemistry	BPHRU
29.	Gideon Yachim Nwati	University of Development Studies	BSc Biotechnology and Molecular Biology	BPHRU
30.	Mustapha Ahmed Ibrahim	University of Development Studies	BSc Biotechnology and Molecular Biology	BPHRU
31.	Seidu Mohammed-Mudasiru	University of Development Studies	BSc Chemical Science and Technology	ESCED
32.	Ngaikedi Chidimma Favour	Central university	BSc Public health	BPHRU
33.	Asiamah Marcelina Ama Oye	Central university	BSc Public health	BPHRU
34.	Amoo-Gyasi Salma	Central university	BSc Public health	BPHRU
35.	Boniface Goodness Ugonna	Central university	BSc Public health	BPHRU
36.	Odoko Samuella Onyeidienyefa	Central university	BSc Public health	BPHRU
37.	Essel Christabel Efua Atta	University of Ghana	BSc Biological Science	EBB&H
38.	Okyere Anne Yaa	Accra Technical University	Btech. Science Laboratory Technology	ECSED
39.	Anku Ellen	University of Ghana	BSc. Biological Science	EBB&H

40.	Salifu Mariam	Accra Technical University	Btech. Science Laboratory Technology	EBB&H / ECSED
41.	Armah Mary	Accra Technical University	Btech. Science Laboratory Technology	EBB&H/ ECSED
42.	Kemenyo Prince	Accra Technical University	Btech. Science Laboratory Technology	EBB&H/ ECSED
43.	Ninso Michael Jojo	Mangel Klicks Company Ltd	BSc Biomedical Engineering	BPHRU
44.	Antwi Bethel	Mangel Klicks Company Ltd	BSc Biomedical Engineering	BPHRU
45.	Hussain Mariam	Accra Technical University	Btech. Science Laboratory Technology	ECSED
46.	Armah Mary Okyere	Accra Technical University	Btech. Science Laboratory Technology	EBB&H/ ECSED
47.	Salifu Mariam	Accra Technical University	Btech. Science Laboratory Technology	EBB&H/ ECSED
48.	Arkoh Kofi Asare	Accra Technical University	Btech. Science Laboratory Technology	ECSED
50.	Eshong Selma	Accra Technical University	Btech. Science Laboratory Technology	ECSED
51.	Debey Felicity Mawunyo	Accra Technical University	Btech. Science Laboratory Technology	EBBH
52.	Defor Sesie	University of Cape coast	BSc. Environmental Science	EBBH
53.	Osborne Bagumaodey Asempah	University of Cape coast	BSc. Environmental Science	EBBH
54.	Adu Caleb Kwame	University of Cape Coast	BSc Molecular Biology & Biotechnology	BPHRU
55.	Asamoah Emmanuella	University of Ghana	BSc Nutrition and Food Science	EBBH
56.	Abdallah Samira Iiyasu	KNUST	BSc Biological Sciences	BPHRU
57.	Elsie Tawiah Danso	Accra Technical University	Btech. Science Laboratory Technology	ECSED
58.	Emmanuella Yaa Konadu Larbi	University of Cape coast	BSc. Environmental Science	ECSED
59.	Cornelius Adjabeng	University of Cape coast	BSc. Environmental Science	ECSED

60.	Charles Edem Dzitse	KNUST	BSc. Environmental Science	ECSED
61.	Appiah Caleb Amoyaw	University of Cape Coast	BSc. Environmental Science	ECSED
62.	Mabel Akos Siame	Accra Technical University	Btech. Science Laboratory Technology	ECSED
63.	El-Esam Dzramdo Ahiribi	University of Cape Coast	BSc. Water and Public Health Engineering	ECSED
64.	Monica Mensah	Pan African University of Water and Energy Sciences	MSc. Water Engineering	ECSED
65.	Peasah Nana Adwoa Semaah	KNUST	BSc Biological Sciences	BPHRU
66.	Ansah-Arthur Charlene Naa Lamiokor	KNUST	BSc Biological Sciences	BPHRU
67.	Nyamedor Nana Aba Yanney	KNUST	BSc Biological Sciences	BPHRU
68.	Dzradosi Phoebe Seli	KNUST	BSc Biological Sciences	BPHRU
69.	Aryee Herbert Robinson	KNUST	BSc. Biochemistry	ECSED
70.	Gavor Charity Sesinam	KNUST	BSc. Chemical Engineering	ECSED
71.	Dogbey Christopher Yaw	Ghana Communication Technology University	BSc. Information Technology	CD
72.	Rockson Emmanuella	KNUST	BSc. Biochemistry	ECSED
73.	Phoebe Narkie Odei	KNUST	BSc Biological Sciences	BPHRU
74.	Kingsley Nketia Ansu	KNUST	BSc. Biochemistry	ECSED
75.	Agyekum Ohene Samuel	KNUST	BSc. Biochemistry	BPHRU
76.	Elizabeth Nyarko Ampong	Accra Technical University	Btech. Science Laboratory Technology	ECSED
77.	Patience Gordon Ansah	Accra Technical University	Btech. Science Laboratory Technology	ECSED
78.	Nana Yaw Darko	University of Ghana	BSc Agricultural Engineering	FAD
79.	Aisha Ahmed Quarshie	KNUST	BSc Natural Resources Management	FAD

80.	Princess Dakogri	Accra Technical University	Btech. Science Laboratory Technology	ECSED
81.	Okae-Lartey Prince	University of Ghana	BSc Biochemistry, Cell & Molecular Biology	BPHRU
82.	Addo Brako Adom Dansoa	KNUST	BSc. Petrochemical Engineering	ECSED
83.	Warihanatu Yakubu	Univ. of Energy and Natural Resources	BSc Biological Sciences	EBBH
84.	Oduro-Sarkodee Kohath	UMAT	BSc Chemical Engineering	ECSED
85.	Kwasi Christopher Amuzu	Accra Technical University	Btech. Science Laboratory Technology	ECSED
86.	Alhassan Hanif	Accra Technical University	Btech. Science Laboratory Technology	ECSED
87.	Tetteh Daniella Akos	University of Ghana	BSc Biological Sciences	EBBH
88.	Nana Ayisha Suglo Mohammed	KNUST	BSc Biological Sciences	EBBH
89.	Ethan O. Nii Torgbor Provencal	KNUST	BSc Biological Sciences	EBBH
90.	Josephine Gyamfua Adu-Twum	University of Ghana	BSc Biological Sciences	EBBH
91.	Frederica Ackon	University of Ghana	BSc Biochemistry, Cell & Molecular Biology	EBBH
92.	Owusu Dankwa Attaa Phillipa	KNUST	BSc Geological Engineering	GWGD
93.	Esther Mathias	KNUST	BSc Biochemistry	ECSED
94.	Amanfu-Arthur Michael Kobina	KNUST	BSc Biological Sciences	EBBH
95.	Gilda Eyrar Amengor	KNUST	BSc Biological Sciences	EBBH
96.	Osei-Appaw Kimani Akua Agyemang	University of Ghana	BSc Biochemistry, Cell & Molecular Biology	EBBH
97.	Forkuoh Obaayaa Rosabell	KNUST	BSc Biochemistry	ECSED
98.	Osei-Bonsu Felicia	KNUST	BSc Biochemistry	ECSED
99.	Clifton Nii Lantey Lamptey	University of Ghana	BSc Earth Science	GWGD
100.	Anthony Abaya Tetteh	University of Ghana	BSc Biochemistry, Cell & Molecular Biology	EBBH
101.	Obeng Kwadwo Ababio	KNUST	Biochemistry	ECSED

102.	Samuel Owusu Ofori	Accra Technical University	Btech. Science Laboratory Technology	ECSED
103.	Anum Blessing Naa Ayorkor	University of Ghana	BSc Biological Sciences	ECSED
104.	Carlos Nartey Asare	University of Ghana	BSc Animal Biology and Biochemistry	EBBH
105.	Kuffuor Cindy	University of Ghana	BSc Biological Sciences	ECSED
106.	David L. Aboagye	KNUST	BSc Meteorology and Climate Science	SWCCD
107.	Emmanuel Owusu	UMAT	Geological Engineering	GWGD
108.	Vivian Afia Konadu Tontoh	KNUST	BSc Biological Sciences	ECSED
109.	Jeffery Nii Teiko Kloutse	KNUST	BSc Biological Sciences	ECSED
110.	Elorm Deborah Nyadornu	KNUST	BSc Biochemistry	BPHRU
111.	Gambrah Charles Amankwa	UMAT	BSc Chemical Engineering	ECSED
112.	Mary Yitaa	KNUST	BSc Biological Sciences	EBBH
113.	Maison Andy Kwabena Ofose	KNUST	BSc. Agricultural Engineering	FAD
114.	Michael Nartey Nubuor	UMAT	BSc Chemical Engineering	ECSED
115.	Claudia Abigail Tabiwaa Newton	KNUST	BSc Biological Sciences	EBBH
116.	Acquaye Shanice Shenell	KNUST	BSc Biological Sciences	EBBH
117.	Sampson Okoh	UMAT	BSc Chemical Engineering	ECSED
118.	Nurudeen Bello	UMAT	BSc Chemical Engineering	ECSED
119.	Amartefio Kendrick	KNUST	BSc Biochemistry	ECSED
120.	Desewu Elizabeth Enyonam	KNUST	BSc Biochemistry	ECSED
121.	Fiagbenya Anthony Mawuto	KNUST	BSc Geological Engineering	GWGD
122.	Gbodji Sheena Sedinam Akosua	KNUST	BSc Chemical Engineering	ECSED
123.	Franklina Asiedu-Boadi	KNUST	BSc Biological Sciences	EBBH
124.	Asare Boateng Akuamoah	KNUST	BSc Telecommunication Engineering	CD
125.	Bruce Mildred	KNUST	BSc Biochemistry	EBBH

126.	Grace Akosua Ayo-Alaka	University of Ghana	BSc Biological Sciences	EBBH
127.	Biam Dugbatey Doku	KNUST	BSc Biochemistry	ECSED
128.	Eugene Jamil Asante	KNUST	BSc Meteorology and Climate Change	SWCCD
129.	Obeng Kwadwo Ababio	KNUST	BSc Biochemistry	ECSED
130.	Najid-Abdul Razak	KNUST	BSc Chemical Engineering	ECSED
131.	Collins Daitey-Acquie	University of Ghana	BSc Earth Science	GWGD
132.	Sandra Frimpomaa Asare	KNUST	BSc Biochemistry	ECSED
133.	Rhoda Wiafe	KNUST	BSc Chemistry	ECSED
134.	Alex Amanfu	KNUST	BSc Biological Sciences	EBBH
135.	Jessica Sedjoah Wepare	University of Ghana	BSc Earth Science	GWGD
136.	Amponsah Morrison	Sunyani Technical University	BSc Procurement and Supply Chain Management	Finance
137.	Tetteh Zabadiah Ogbordjor	University of Ghana	BSc Earth Science	GWGD
138.	Success Owusu	Accra Technical University	BSc Analytical Chemistry	ECSED
139.	Frimpong Chrisca Ntiriwaa	University of Ghana	BSc Animal Biology and Conservation Science	BPHRU
140.	Emmanuel Sylvester Assam	Accra Technical Univ.	BSc Analytical Chemistry	ECSED
141.	Michael Percy Donkor	University of Ghana	BSc Earth Science	GWGD

National Service Personnel 2025

No.	Name	Institution	Programme	Division
1.	Joyce Owusu	Accra Technical University	Btech Science Laboratory Technology	ECSED
2.	Christiana Larkai	Accra Technical University	Btech Science Laboratory Technology	ECSED
3.	Bright Tetteh	KNUST	BSc Chemistry	ECSED
4.	Salomey Maabena Emeffa Acheampong	KNUST	BSc Environmental Science	ECSED
5.	Esaaba Nana Efua Ampah	KNUST	BSc Chemistry	ECSED
6.	Alberta Mamle Onyame	Accra Technical University	BSc Water and Sanitation Engineering	ECSED
7.	Cecil Kwabena Wiredu	KNUST	BSc Chemical Engineering	ECSED
8.	Denkyira Jason Ofori	KNUST	BSc Petrochemical Engineering	ECSED
9.	Dorcas Sefakor Hotor	KNUST	BSc Aquaculture and Water Resources Mgt.	FAD
10.	George Kwesi Boateng	KNUST	BSc Aquaculture and Water Resources Mgt.	FAD
11.	Clifford Kwabena Birikorang	KNUST	BSc Agricultural Biotechnology	FAD
12.	Joel Siaw	KNUST	BSc Physics	GWGD
13.	Felix Owusu Amponsah	KNUST	BSc Geological Engineering	GWGD
14.	Jessica Boakye	KNUST	BSc Geological Engineering	GWGD
15.	Christiana Aganamah Aganah	KNUST	BSc Geological Engineering	GWGD
16.	Abdul Gafar Iddrisu	University of Environment and Sustainable Development	BSc. Geography & Earth Science	GWGD
17.	Enoch Tettey Wealthy Teye	KNUST	BSc Geological Engineering	GWGD
18.	Emmanuel Offei Ayeh	University of Ghana	BSc Earth Sciences	GWGD
19.	Leslie Kwaku Osei Adomako	University of Ghana	BSc Physical Sciences	GWGD
20.	Frederick Afful	University of Ghana	BSc Earth Sciences	GWGD
21.	Regina Abroso-Affum	KNUST	BSc Meteorology and Climate Science	SWCCD
22.	Erica Owusu-Banahene	KNUST	BSc Meteorology and Climate Science	SWCCD

No.	Name	Institution	Programme	Division
23.	Emmanuella Sam	University of Ghana	BSc Biological Science (Plant & Environmental Biology)	EBB&HD
24.	Nigel-Ben Narh	KNUST	BSc Biological Science	EBB&HD
25.	Julian Nii Amartey Amamoo	University of Ghana	BSc Biological Science	EBB&HD
26.	Samuel Larbi	University of Ghana	BSc Biological Science (Plant & Environmental Biology)	EBB&HD
27.	Layla Abubakar	University of Ghana	BSc Biological Science	EBB&HD
28.	Laila Inusah	University of Ghana	BSc Biological Science	EBB&HD
29.	Martha Medina Adamu	Accra Technical University	Btech Science Laboratory Technology	EBB&HD
30.	John Yirenkyi Simmons	University of Ghana	BSc Biological Sciences (Plant & Environmental Biology)	EBB&HD
31.	Mariama Mahama	University for Development Student	BPH Disease Control	BPHRU
32.	Abena Nketia Ofori	University of Cape Coast	BSc Molecular Biology and Biotechnology	BPHRU
33.	Mabel Johnson Amoah	University of Cape Coast	BSc Biochemistry	BPHRU
34.	Dennis Edzebubu Kordzo Deh	University of Cape Coast	BSc Molecular Biology and Biotechnology	BPHRU
35.	Edward Banfro	University of Health and Allied Science	Bachelor of Public Health (Disease Control)	BPHRU
36.	Joycelyn Yayra Glory	University of Ghana	Biological Sciences (Biochemistry, Cell and Molecular Biology)	BPHRU
37.	George Kakraba Owu	Accra Technical University	Btech Medical Laboratory Technology	BPHRU
38.	Caroline Akweley Tetteh	University of Health and Allied Science	Bachelor of Public Health (Disease Control)	BPHRU
39.	Joseph Antwi	University for Development Studies	BSc Biotechnology and Molecular Biology	BPHRU
40.	Clifford Opare	Ghana Communication Tech. University	BSc. Computer Engineering	CD
41.	John Kofi Asante Okrah	Accra Technical University	BSc Information Technology	CD

No.	Name	Institution	Programme	Division
42.	Kwame Mawusene Dafeamekpor	Methodist University College	BSc Information Technology	CD
43.	Shulamite Asamoah	Accra Technical University	HND Accountancy	Finance
44.	Frederick Quarcoo	University of Professional Studies	BBA Accounting	FINANCE
45.	Travis Nii Adotey Quaye	University of Ghana	BSc Accounting	FINANCE
46.	Jennifer Anim	University of Professional Studies	BSc Banking and Finance	FINANCE
47.	Ellis Chin Nyarko	Accra Technical University	HND Purchasing & Supply	FINANCE
48.	Felix Owusu Amponsah	KNUST	BSc Geological Engineering	FINANCE
49.	Ebenezer Mensah	Accra Technical University	HND Secretaryship & Management	ADMIN
50.	Eugenia Atiboly	Accra Technical University	HND Secretaryship & Management	ADMIN
51.	Francisca Pecku	University of Professional Studies	BSc Business Administration	ADMIN

Summary of National Service Personnel/Interns in 2025

Institution of National Service Personnel	Number of Students	Institution of Industrial Attachment Intern	Number of Students
Kwame Nkrumah University of Science and Technology	17	Kwame Nkrumah University of Science and Technology	47
University of Ghana	11	University of Ghana	37
University of Cape Coast	3	University of Cape Coast	10
University for Development Studies	2	Pan African University of Water and Energy Science	1
Accra Technical University	10	Accra Technical University	23
University of Environment & Sustainable Development	1	Central University	5
University for Professional Studies	3	University of Energy and Natural Resources	1
Ghana Communication Technical University	1	University of Mines and Technology	6
University of Health & Allied Sciences	2	Reagent University	1
Methodist University College	1	University of Development Studies	6
		Ghana Telecom University College	1
		Sunyani Technical University	1
		Mangel Klicks Company Limited	2
Total	51	Total	141

APPENDIX VI: LIST OF STAFF PUBLICATIONS

Journal Papers

1. Abdul-Gafaru, I., Cobbina, S. J., & Kumi, M. (2025). Green-synthesized magnetic iron oxide nanoparticles for the adsorptive removal of CD^{2+} and PB^{2+} from aqueous solution. *Discover Water*, 5 (1), 92. <https://doi.org/10.1007/s43832-025-00285-z>
2. Abdulai, K., Adam, A. R., Bawah, A. M., Aleboko, S. O., Daudi, A., Ahmed, M. D., & Haruna, Z. (2025). Efficacy of anthropometric measures in predicting hypertension among adult Ghanaians: A community based cross-sectional study. *Health Sciences Investigations Journal*, Vol 7 No 1
3. Aboagye, F. T., Annison, L., Aidoo, E. K., Acquah, M. E., Ashong, Y. A., Oppong, B. B., Osae-Nyarko, L., Owusu-Frimpong, I., Hackman, H. K., Annison, S., Quarshie, Q. D., Owusu-Senyah Enninful, A. K., Kuma, N. A., Egyam, B. C., & Osei-Atweneboana, M. Y. (2025). Cycle threshold values and SARS-CoV-2 variant associations with breakthrough infections: a retrospective study in Accra, Ghana. *BMC Infectious Diseases*, 25(1), 1269. <https://doi.org/10.1186/s12879-025-11732-6>
4. Adjei, F. O., Adjei, K. A. & Obuobie, E. (2025). Calibration of the Hargreaves and Priestley-Taylor equations for estimating reference evapotranspiration in the Densu River Basin in Ghana. *African Journal of Environmental Science and Technology*, 19(3), 131-142. <https://academicjournals.org/journal/AJEST/article-full-text-pdf/02463D273092>
5. Agyekum, J., Annor, T. & Obuobie, E. (2025) Future changes in extreme precipitation events over the Volta Basin under medium and high emission scenarios. *Climate Dynamics* (2026) 64:6. <https://doi.org/10.1007/s00382-025-07957-5>.
6. Akurugu, B. A., Yidana, S. M., Obuobie, E., Seidenfaden, I. K., Stisen, S. & Chegbele, L. P. (2025). Groundwater Recharge estimation from multiple independent methods in the fractured hard rock aquifers in the Densu River. *Sustainable Water Resources Management* 11(10), <https://doi.org/10.1007/s40899-024-01178-0>.
7. Amadu, A. A., Oduro-Mensah, D., Qiu, S., Abbew, A. W., Li, M., Lu, X., Ameka, G. K., Osei-Atweneboana, M. Y., Akrong, M. O., Donko, J. K., & Ge, S. (2025). Integrating fungal-assisted microalgal harvesting for sustainable treatment and resource recovery from wastewater. *Water*, 17(19), 2832. <https://doi.org/10.3390/w17192832>
8. Anani, F. A., Fatsi, P. S. K., Appiah, E. K., Diame, E. A., & Maxwell, O. (2025). Comparative single- and co-nursing of Nile tilapia,

- Oreochromis niloticus* and African catfish, *Clarias gariepinus* fingerlings in hapa-in-pond system. *International Journal of Fisheries and Aquatic Research*, 10(2), 62-68.
9. Anani, F. A., Fatsi, P. S. K., Appiah, E. K., Donkor, K. K., Ayarika, F. A., & Dankwa, E. T. (2025). Comparative length-weight relationship, condition factor and nutritional value of cultured African catfish, *Clarias gariepinus* fed with two feed types and their mixture. *Aquatic Food Studies*, 5(1), AFS294. <https://doi.org/10.4194/AFS294>
 10. Anani, F. A., Donkor, K. K., Ayarika, F. A., Johnson-Ashun, M., & Birikorang, S. (2025). Profitability of small-scale grow-out production of caged Nile tilapia, *Oreochromis niloticus* in the Volta Lake of Ghana. *Asian Journal of Fisheries and Aquatic Research*, 27(8), 20-31. <https://doi.org/10.9734/ajfar/2025/v27i8974>
 11. Anani, F. A., Appiah, E. K., Fatsi, P. S. K., Ayarika, F. A., Dankwa, E. T., Donkor, K. K., Diame, E. A., & Opoku, M. (2025). Growth performance and cost-effectiveness of feeding composite nursing of Nile tilapia, *Oreochromis niloticus* and African catfish, *Clarias gariepinus* fingerlings with two feed types and their mixture. *Asian Journal of Fisheries and Aquatic Research*, 27(12), 102-112. <https://doi.org/10.9734/ajfar/2025/v27i121041>
 12. Andoh, C. N., Ackerson, N. O. B., Antwi, M., Agbeko, E., *et al.* (2025) Charting pollution: Spatial modeling of microplastics distribution in sediments and surface water from Lake Volta, Ghana, using ArcGIS. *International Journal of Energy and Water Research*, 9, 2727–2741 <https://doi.org/10.1007/s42108-025-00417-0>
 13. Ashraf, A., Basheer, M., Gonzalez, J. M., Ceseña, E. A. M., Etichia, M., Obuobie, E., Bottacin-Busolin, A., Adamowski, J., Panteli, M. & Harou, J. J. (2025). Delivering equity in low-carbon multisector infrastructure planning. *Nature Communication*, 16, 5320. <https://doi.org/10.1038/s41467-025-59738-7>.
 14. Asmah, R., BruceVanderpuije, P., Quarcoopome, T., Addo, A., Appiah, S. A., Emahi, I., & ObiriNyarko, F. (2025). The state of the Bui reservoir: Evaluation of water quality using physicochemical parameters – A decade after impoundment. *Water Environment Research*, 97(11), e70196.
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16. Bekoe, E. M. O. B, Hayford, D., Quarcoo, G., & Yar, D. D. (2025) Groundwater microbial quality and risk evaluation in a rapidly transforming urbanized area of Northern Ghana. *BMC Environmental Science*, 2, 9. <https://doi.org/10.1186/s44329-025-00022-w>
17. Biney, E. E., Gyamfi, C., Karikari, A. Y., & Darko, D. (2025). Reservoir ecological health assessment methods: A systematic review. *Ecological Indicators*, 171, 113130
18. Boadi, S. A., Owusu, K. & Obour, P. B. (2025). Impact of cashew cultivation on food security, sovereignty, and income diversification in Jaman North District, Ghana. *GeoJournal*, 90, 36. <https://doi.org/10.1007/s10708-025-11283-y.s>
19. Bruce-Vanderpuije, P., Asmah, R., Ameworwor, M., Hotor, D. W., Hildebrandt, L., Präfroch, D., Ebinghaus, R., Zaid, H., Norvimagbe, I. C., Asante, K. A., Nunoo, A. A., & Osei-Atweneboana, M. Y., (2025) Quantitative assessment of microplastics in fish from the Gulf of Guinea, Ghana, using LDIR spectroscopy: Implications for marine food safety and health risk evaluation. *Environmental Pollution*, 379, 126518. <https://doi.org/10.1016/j.envpol.2025.126518>
20. Bruce-Vanderpuije, P., Agadzi, Y. A., Norvimagbe, I. C., Asmah, R., Hildebrandt, L., Proefrock, D., Ebinghaus, R. & Asante, K. A. (2025) Microplastics in the lower Volta Basin, Ghana: Quantitation and fish dietary exposure assessment using advanced spectroscopic techniques. *Chemosphere*, 375, 144236. ISSN 0045-6535, <https://doi.org/10.1016/j.chemosphere.2025.144236>.
21. Donkor, D. M., Marfo, E., Bockarie, A., Tettevi, E. J., Antwi, M. H., Dogah, J., Osei, G. N. & Simpong, D. L., (2025) Genetic and environmental risk factors for dementia in African adults: A systematic review. *Alzheimer's & Dementia*, 21(4), p.e70220.
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24. Kyei-Manuh, S., Osei, M. A., Aryee, J. N. A., Quansah, E., Obuobie, E., & Amekudzi, L. K. (2025) Lightning and thunderstorms, the source

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 27. Makhanya, N. P., Kumi, M., Mbohwa, C., & Oboirien, B. (2025) Application of machine learning in adsorption energy storage using metal organic frameworks: A review. *Journal of Energy Storage*, 111, 115363. doi:<https://doi.org/10.1016/j.est.2025.115363>
 28. Obuobie, E., Agyekum, J., Osei, M. A. & Addi, M. (2025) Changes in extreme precipitation events in the Volta River Basin under 1.5°C, 2°C and 3°C global warming levels. *Journal of Theoretical and Applied Climatology*, 156 (411). <https://doi.org/10.1007/s00704-025-05639-0>.
 29. Obuobie, E., Osei, M. A., Agyekum, J., Addi, M., Gyasi-Agyei, Y., Boadi, S. A. & Oblim, F. T. (2025) Spatiotemporal analysis of past and future precipitation and temperature extremes over Pra River Basin, Ghana. *Modeling Earth Systems and Environment*, 11 (293). <https://doi.org/10.1007/s40808-025-02474-0>.
 30. Obuobie, E., Osei, M. A., Addi, M., Agyekum, J., Akurugu, B. A., Bazaanah, P., Gaisie-Essilfie, F. A. & Appiah, G. (2025) Analysis of spatio-temporal trends in climate extremes in the lower Volta Basin, Ghana. *Journal of Theoretical and Applied Climatology*, 156 (120), <https://doi.org/10.1007/s00704-024-05316-8>.
 31. Obuobie, E., Akurugu, B. A. & Granaham, P. (2025) A review of the groundwater characteristics of the crystalline basement rocks in the Pra River Basin, Ghana. *Environmental Earth Sciences*, 84, 427. <https://doi.org/10.1007/s12665-025-12426-7>
 32. Opoku, F., Agorku, E. S., Kumi, M., & Govender, P. P. (2025) Exploring the anodic performance of InSnPS/GaGeAsSe heterostructure as an ultra-high-rate rechargeable Li ion battery via first-principles study. *Physical Review Materials*, 9 (10), 105401.
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- regions of Ghana: Strengthening evidence for national surveillance. *Tropical Medicine and Infectious Disease*, 10(10), 291. <https://doi.org/10.3390/tropicalmed10100291>
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40. Quarcoo, G., Naangmenyele, Z., Mensah, E.T-D., Bekoe, E.M.O., Salifu, A-L., Adu-Boakye, M., Sintim, E. (2025). Water treatment centers of SAHA Global during the dry season. A consultancy report submitted to SAHA Global, Ghana.
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2. Akita, L.G., Biney, C., Akrong, M., Laudien, J. 2025. Bacteria as an indicator of the Ecological Health of Coastal waters, Gulf of Guinea, Ghana. The Biennial Science and Development Conference, University of Ghana. 18-20th June, 2025.
3. Amadu, A.A., Oduro-Mensah, D., Abbew, A., Ameka, G.K., deGraft Johnson, K.A.A., Osei-Atweneboana, M.Y., Akrong, M.O., Li, M., ¹, Lu, X., Qiu, S & Ge, S. (2025) A Taxonomic Study of a Microalgal-Fungal Consortia in Bioremediation: Investigating Nutrient Recovery, Pelleting, and Harvesting Efficiency from Food Processing Effluents. 53rd AETFAT Congress at the University of Ghana on the 3rd to 8th August, 2025.
4. Anani, F. A., Fatsi, P. S. K., Appiah, E. K., Ayarika, F. A., Donkor, K. K., Diame, E. A. and Dankwa, E. T. (2025). Comparative condition factor and nutritional value of cultured African catfish *Clarias gariepinus* fed with commercial catfish feed, tilapia feed and their equal mixture. Aquaculture Ghana 2025 Event, 29th & 30th Oct., 2025. World Trade Centre, Accra, Ghana. Book of Abstracts.
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 8. Banu, R.A., Ofori P., Borbor, S., Akrong, M.O., Ulzen., O.O., Quansah., K.E., Adomako Boamah, L.A., Quansah, Amoah B., Ofori M., Buri, N.M., Bello, M., Owusu, T, Asamoah, G., Mensah, A.M., Logah F.Y., Tetteh, A.E., Adade, N. E., Adjei, G. A., Atanley., E., Asa, H.O., Adu, M., Tay K. C., Osei Atweneboana, M, Y., (2025). Antimicrobial Resistance Monitoring in Ghanaian Surface Waters: Evidence for Public Health Action Through the WHO Tricycle Approach. 2025 Ghana AMR Conference. Alisa Hotel, Accra Ghana. 19th - 20th November, 2025.
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 11. Bazaanah, P. Obuobie, S.A. Boadi, F.T. Oblim, P. Granaham & M.K. Danban (2025). *Citizens' perceptions of water and sanitation*

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 14. Logah F.Y. (2025). Sustainable Water Resource Management in Ghana. Theme: Leveraging Innovative Science to Strengthen Public-Private Partnerships for Sustainable Development in Ghana. 34th Ghana Science Association Biennial Conference at the Dr. Andani Andam Academic Board Chamber, UDS, Tamale, from 23rd to 25th September 2025.
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 17. Quansah, K.E., Ahmed, H., Thekkur, P., Hedidor, G.K., Adomako Boamah, L.A., Banu, R.A., Akrong, M.O., Borbor, S., Buri, N.M., Bello, M., Ebenezer Worlanyo Wallace-Dickson, E.W., Quarcoo, G., Obeng Bekoe, E.M., Zolfo, M. (2025) Antibiotic-Resistant Bacteria in Drinking Water Across Twelve Regions of Ghana: Strengthening Evidence for National Surveillance. Ghana Antimicrobial Resistance Conference 2025, 19th -20th November 2025 at Alisa Hotel, Accra.

18. Quarcoo, G., Emmanuel M. O. Bekoe, Samuel Armoo (2025) Assessment of Environmental Health Laboratories to propose a sentinel site for AMR surveillance in the Northern region of Ghana. Paper presented at the 8th Ghana Field Epidemiology and Laboratory Training Program (GFELTP), Scientific Conference and Competency Graduation. Labadi beach Hotel, Greater Accra, 10th -11th December, 2025

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1. Amadu, A. A. (2025) Revised Hydrobotany Laboratory Standard Operating Procedures (SOP), CSIR-WRI, Accra.
2. Amadu, A. A. (2025) Revised Microalgae Identification Manual, CSIR-WRI, Accra.
3. Appiah G., Logah F.Y., and Osei-Owusu M. (2025). Manual for downloading water level using the IJINUS Data Logger (Ultrasonic water level monitor). CSIR-Water Research Institute, Accra, Ghana.
4. Kyei-Manuh, S., Amisigo, B. and Obuobie, E. (2025). CREAM stakeholder Engagement Dashboard Manual, 18pp.
5. Logah F.Y., Appiah G., and Osei-Owusu M. (2025). Manual for downloading water level using the HOBO Water Level Logger (Transducer). CSIR-Water Research Institute, Accra, Ghana.

Mass Media Publications/Media Features

1. Galamsey Menace: Water pollution deepens as illegal miners block Ankobrah River, Environmentalist Call for state of Emergency. Interview conducted live at ABC Television on Tuesday, March 4, 2025.
2. Tariff Hikes: Water Treatment Cost Could Skyrocket even further if Galamsey Continues Eco-Citizen Warn. Interview conducted live at ABC Television on Tuesday, September 16, 2025.
3. Interviewed on TV3 regarding the use of wastewater in irrigating vegetables that is likely to be eaten raw. <https://www.facebook.com/share/r/15g32LjSCk/?mibextid=wwXIfr>
4. Interviewed by TV3 regarding the water quality test results of water used by the people in Totopey, Ada East. https://youtu.be/ycV-dsg6nks?si=mbFTMcxIhz_MzpCS
5. 11th November 2025 Supported the 2025 World Antimicrobial Awareness Week (WAAW) media campaign by the AMR Fellows, delivering critical AMR messaging in the local language to maximize

- community reach in Ghana.
<https://www.facebook.com/share/v/1A2cwEWV7y/>
6. 19th Nov. 2025. Gave an exclusive interview on Antimicrobial Resistance (AMR), with excerpts published in the *Ghanaian Times* newspaper for the WAAW 2025 campaign.
<https://ghanaiantimes.com.gh/over-5000-annual-deaths-in-ghana-linked-to-antimicrobial-resistance-health-experts/>
 7. Public presentation delivered on progress and achievements of Ghana's committee of the UNESCO Intergovernmental Hydrological Programme (IHP) at the climax of Ghana's celebration of the 50th anniversary of the UNESCO IHP, Academy of Arts and Sciences, 23rd July 2025. Can be accessed from https://youtu.be/JHiPD7wid_4?si=kHJFSrDvpWjrhmgA (from 32-56 minutes).
 8. Radio panel discussant on the topic "Our Water, Our Future" under the DFC-funded project titled "*Using Science Engagement to Capacitate Stakeholders for Climate-Resilient Water Management.*" held on Oyerapa FM (100.7FM), on 21st December 2025: Link : <https://www.facebook.com/share/v/1BaFm9F5uN/>
 9. Radio panel discussant on the topic "*Rethinking the Value of Water*", held on Asaase FM in Tamale during the 2025 World Water Day, held on 22nd March 2025
 10. Organization of World Water Day 2025 in Tamale
<https://www.facebook.com/share/p/1V7p5VZAA7/>;
<https://zaaghana.com/health/water-quality-concerns-raised-as-ghana-marks-world-water-day/>;
<https://drive.google.com/drive/folders/1CFXrwHGuutUPYJDYusQWw01qcxydsyb?usp=sharing>
 11. <https://www.afro.who.int/countries/ghana/news/who-supports-researchers-turn-amr-evidence-action-ghana>
 12. <https://gna.org.gh/2025/05/research-scientists-call-for-investments-in-malaria-research-and-elimination/>
 13. <https://gna.org.gh/2025/04/malaria-can-abort-pregnancies-and-cause-infant-deaths-researchers>

Blogs

1. Boadi, S.A., Bazaanah, P., Norman, C., Aggrey, F., Agyekum, J., and Obuobie, E. (2025). Empowering Stakeholders to Develop and Test a Flood Contingency Plan for Effective Flood Management. *A GDZHIAO Project Activity Blog*. Available online at: <https://csir-water.com/empowering-stakeholders-to-develop-and-test-a-flood->

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Posters

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