CSIR-WATER RESEARCH INSTITUTE

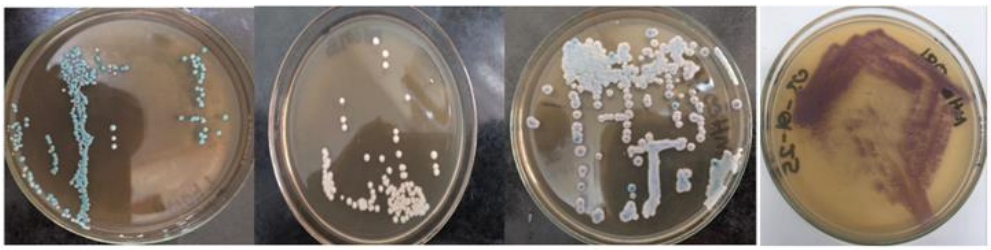




2024 Annual Report







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CSIR-WATER RESEARCH INSTITUTE

2024 Annual Report

CSIR-WATER RESEARCH INSTITUTE (CSIR-WRI)

Annual Report 2024

ACCRA, GHANA

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QUALITY WATER RESEARCH

FOR SUSTAINABLE NATIONAL DEVELOPMENT

CSIR-WATER RESEARCH INSTITUTE
ACCRA, GHANA

ACRONYMS

ADGR	-	Average Daily Growth Rate
ATPS	=	African Technology Policy Studies Network
ARDEC	-	Aquaculture Research and Development Centre
AU	-	African Union
BE	-	Blue Economy
BPHRU	-	Biomedical and Public Health Research Unit
CC	-	Climate Change
CCST	-	CSIR-College of Science and Technology
COMM	-	Community Ownership and Management Model
CSIR	-	Council for Scientific and Industrial Research
CT	-	Control Tanks
CWSA	-	Community Water and Sanitation Agency
DO	-	Dissolved Oxygen
DTSF	-	Dokyiwa Tailings Storage Facility
EBBHD	-	Environmental Biology, Biotechnology and Health Division
ECSED	-	Environmental Chemistry and Sanitation Engineering Division
EPA	-	Environmental Protection Agency
EU	-	European Union
FAD	-	Fishery and Aquaculture Division
FC	-	Fisheries Commission
FCR	-	Feed Conversion Ratio
FDA	-	Food and Drugs Authority
FGD	-	Focus Group Discussion
GAWU	-	Ghana Agriculture Workers Union
GMET	-	Ghana Meteorological Agency
GMW	-	Global Mangrove Watch
GSA	-	Ghana Science Association
GSA	-	Ghana Standards Authority
GWL	-	Ghana Water Limited
GWGD	-	Groundwater and Geoscience Division
HSD	-	Hydrological Services Department
IMC	-	Internal Management Committee
IAB	-	Institute of Aquatic Biology
IBCSWG	-	International Blue Carbon Scientific Working Group
IRB	-	Institutional Review Board
IWMI	-	International Water Management Institute
KNUST	-	Kwame Nkrumah University of Science and Technology
LBW	-	Life Below Water
MESTI	-	Environment, Science, Technology, and Innovation
MMDAs	-	Metropolitan, Municipal and District Assemblies
MoFA	-	Ministry of Food and Agriculture

MPAs	-	Marine Protected Areas
MSP	-	Marine Spatial Planning
MWHWR	-	Ministry of Works, Housing and Water Resources
NADMO	-	National Disaster Management Organization
NTDs	-	Neglected Tropical Diseases
OD	-	Ocean Decade
POPs	-	Persistent Organic Pollutants
PURC	-	Public Utilities Regulatory Commission
RAM	-	Rapid Assessment Methodology
RAS	-	Recirculatory Aquaculture System
RSA	-	Research Staff Association
SDGs	-	Sustainable Development Goals
SOP	-	Sustainable Ocean Plan
SOPs	-	Standard Operating Procedures
STHs	-	Soil Transmitted Helminthiases
SWCCD	-	Surface Water and Climate Change Division
TDS	-	Total Dissolved Solids
THB	-	Total Heterotrophic bacteria
TSS	-	Total Suspended Solids
TT	-	Treatment Tanks
TWG	-	Technical Working Group
UN-OD	-	United Nation Ocean Decade
UNEP	-	United Nation Environment Programme
UNESCO-IHP	-	United Nations Educational, Scientific and Cultural Organization - Intergovernmental Hydrological Programme
UDS	-	University for Development Studies
UCC	-	University of Cape Coast
UG	-	University of Ghana
UTI	-	Urinary Tract Infection
WHO	-	World Health Organization
WRC	-	Water Resources Commission
WRI	-	Water Research Institute
WRM	-	Water Resources Management
WRRI	-	Water Resources Research Institute
WSD	-	Water Storage Dam

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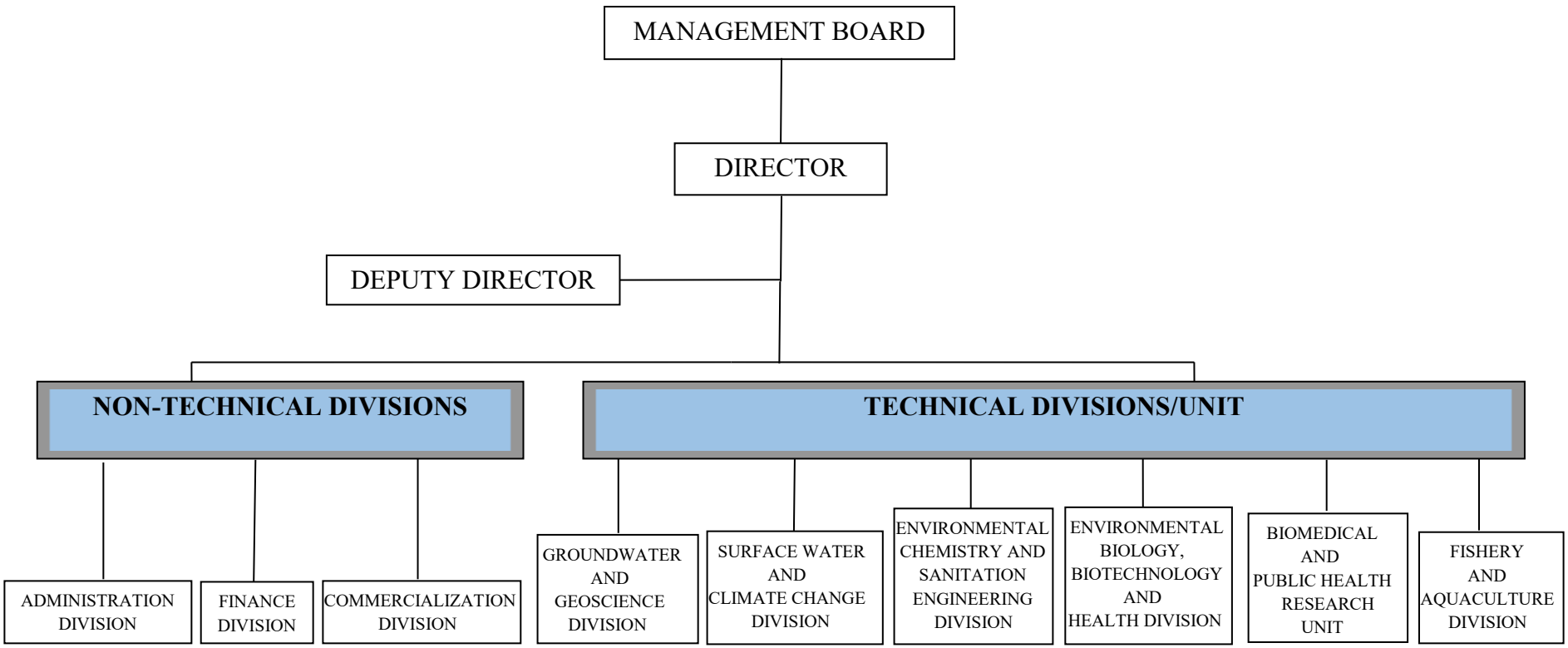
ORGANOGRAM


MANAGEMENT BOARD
DIRECTOR
DEPUTY DIRECTOR
NON-TECHNICAL DIVISIONS
TECHNICAL DIVISIONS/UNIT
ADMINISTRATION DIVISION
FINANCE DIVISION
COMMERCIALIZATION DIVISION
GROUNDWATER AND GEOSCIENCE DIVISION
SURFACE WATER AND CLIMATE CHANGE DIVISION
ENVIRONMENTAL CHEMISTRY AND SANITATION ENGINEERING DIVISION
ENVIRONMENTAL BIOLOGY, BIOTECHNOLOGY AND HEALTH DIVISION
BIOMEDICAL AND PUBLIC HEALTH RESEARCH UNIT
FISHERY AND AQUACULTURE DIVISION

FOREWORD BY THE DIRECTOR

Prof. Mike Yaw Osei-Atweneboana

Since its inception in 1996, the CSIR-Water Research Institute, which is one of the 13 research institutes of the Council for Scientific and Industrial Research (CSIR), has been undertaking scientific research into water and its related resources. The aim is to provide technological information and services as well as strategies for the sustainable development, utilization, and management of water resources for the socio-economic advancement of the country.

In 2024, research activities by the staff of WRI focused on enhancing food security, poverty reduction, public health, and water quality, all geared towards the socio-economic development of the country. Several consultancy and advisory services for donor agencies, corporate bodies, governmental and non-governmental organizations, public and private sector organizations as well as individuals were also carried out.

Again in 2024, members of staff participated in several national and international scientific meetings and served on technical committees and boards. The annual report highlights summaries of key research findings and achievements of staff.

The Institute wish to acknowledge our development partners, donors, sponsors, collaborators and all those who contributed to our success in diverse ways.

EXECUTIVE SUMMARY

As one of the 13 research institutes of the Council for Scientific and Industrial Research (CSIR), the CSIR-Water Research Institute (CSIR-WRI) during the year 2024, took steps toward the realization of its vision of becoming a centre of excellence in the provision of scientific research into water and related resources as well as public health.

Mandated to conduct research into all aspects of water resources (both living and non-living), the Institute, in partnership with local and international collaborators, implemented over twenty (20) research projects. The focus was to provide scientific and technological information and services as well as strategies for the sustainable development, utilization, and management of water resources for the socio-economic advancement of the country.

The 2024 Annual Report highlights the Institute's research and development (R&D) activities which focus on sustainable water resource management for socio-economic advancement. The report comprises three (3) sections: Introduction, Administration, and Research and Development activities. The Introduction covers an overview of the establishment, vision statement, mission statement, objectives and core activities of the Research Divisions. The administrative report comprises staff strength, appointments, promotion/upgrading, new recruitment, bereavements as well as national service recruitment. The R&D section is a compilation of research projects undertaken by the research staff, and commercialization of activities through consultancy and advisory services.

The Institute, in partnership with local and international collaborators, implemented a total of twenty-one (21) research projects during the year. These have been reported under three thematic areas:

i. Food Security and Poverty Reduction (9 projects)
ii. Climate Change, Environmental Management and Green Technology (9 projects)
iii. Biomedical and Public Health (3 projects)

A total of forty-three (43) journal papers, two (2) book chapters, ten (10) conference papers, seven (7) conference paper abstracts, and several technical reports, consultancy reports, newsletter articles, posters, manuals and mass media publications were authored by scientists in collaboration with scholars worldwide. A number of media features were also undertaken during the year.

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 of 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 resistance 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 (ECSED)

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
- Improve understanding of the state of fish and fisheries under natural conditions
- improve management interventions

Currently, the Division's major Research and Development programmes are in the areas of aquaculture development, environmental impact assessment and fish stock assessments, 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 modeling
- 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 bio-medical 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 information are:

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or

The Director,
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P. O. Box M 32,
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2.0 ADMINISTRATION

The Administration Division provided services and support to staff, the Divisions and Outstations of the Institute to ensure effective and efficient work environment 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 staff performance.

2.1 Management

Management Board worked assiduously with the Internal Management Committee (IMC) to promote research activities of the Institute and ensured that the Institute worked within set targets in its Key Performance Indicators while keeping to its vision. Membership of the Management Board and the IMC are indicated in Appendices I and II, respectively.

2.2 Staff Strength

Staff strength at the end of the year 2024 stood at 225. This was made up of 98 Senior Members, 88 Senior Staff and 39 Junior Staff. The list of Senior Members and Senior Staff distribution are presented in Appendix III.

2.3 Statistics on Human Resource Activities

The number of appointments, promotions/upgrading, transfers, compulsory retirements, deaths and resignations are shown in Appendix IV.

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 V.

2.4.1 Short-Term Training Programmes Attended by Staff

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

- A one-day FLO-2D webinar on Tailings Dam Modelling training, organised by FLOW-2D Software, Inc. on 28th August 2024.
- A day's training of research assistants on fish feed trials, June 5, 2024, Aquaculture Demonstration Centre, Fisheries Commission, Ashaiman, Accra.
- Aquaculture training workshop for trainer of trainees on agribusiness and fish feed preparation, April 12 to 15, 2024, Flossel and Cycle Farms, Sogakope and Tema.
- AMR training workshop by RECABAW, 22nd - 26th April, 2024.
- Capacity Building Workshop for the Technical Working Group (TWG) responsible for the development of a National Aquatic Animal Health Strategy, October 10, 2024, Mac-Dic Royal Plaza Hotel, Koforidua.
- Carbonising Soil: Revolutionising Agriculture. Organized by EOS Data Analytics & AgriProve, 18th July 2024, (Participated online via Click Meeting).
- Consultative Workshop on Existing Situation for the Coastal and Marine Environment (Fishery and Aquaculture sector presenter). Aburi, 19th – 20th December, 2024.
- Coastal Geomorphology Training (Online), as part of the Global Monitoring for Environment and Security and Africa (GMES & Africa) Support Programme, organized by European Commission and the African Union Commission, 7th - 9th February 2024.
- Ecosystem Services: a method for sustainable development, University of Geneva (MOOC-COURSERA) (online) August 2024 - January 2025.

- EOSDA Crop Monitoring: New Features and Plans for 2024, Organized by EOS Data Analytics, 30th January 2024, (Participated online via Click Meeting).
- Introduction to Cell Culture, 20th August, 2024 (Online).
- NDC data collection training for focal persons and Climate Change Champions, online, 6th June 2024, African Technology Policy Studies Network (ATPS).
- Pathway to Aquaculture Biosecurity: Managing Disease Risks in the Value Chain (Online), November 20th – 22nd 2024, at the Mac-Dic Royal Plaza Hotel, Koforidua.
- Policy and Measures for Aquaculture Environmental Health Training. JICA, Japan. January 14th February 3, 2024.
- Sustainable Lake Management for 20 hours, organised by CAP-NET, United Nations Environmental Programmes, 28th October, 2024. (online).
- Training on combatting Antimicrobial Resistance: Genome sequencing and bioinformatics. 19th February - 1st March and 26th July - 6th August, 2024 at WACCBIP, University of Ghana, Accra.
- Training in the use of TURN IT IN for academic writings, CCST, October 30, 2024, CSIR-FRI, Accra.
- Training workshop on "Regional Consultation on Synthetic Satellite Data Generation and Application to Hydrological Modelling", organized by the International Water Management Institute (IWMI), Ghana Office/ University of Lausanne – Switzerland, 22nd-23rd April 2024.
- Training workshop on "Digital Innovation for Water Secure Africa (DIWASA) - Developing Water Accounting Dashboard for the Volta Basin, organized by International Water Management Institute (IWMI), Ghana Office/ World Bank, 7th-10th May 2024.
- Training on Homestead Catfish Farming organised by CSIR-WRI, 9 - 10 October, 2024.
- Training on NDC tracking tools for West Africa, online. 22nd May 2024, African Technology Policy Studies Network (ATPS).
- Training workshop on Drought over Sub-Saharan Africa, WASCAL, Accra. 22nd October 2024, UK Centre for Hydrology and Ecology.
- Diploma in "SEBA Discharge Keeper (for stationary camera-based discharge measurement) and the survey equipment Disto S910 Theory and practical," 26th February – 1st March 2024, Ghana Hydrological Authority-Accra.
- Training workshop on Accessing and Using Earth Observation Data Layers and Products in Digital Earth Africa. 14th -16th October, 2024.
- Training of Research Assistants in fish feed trials, June 5th, 2024, Aquaculture Demonstration Centre of the Fisheries Commission, Ashaiman, Accra.
- Training on "Coastal Geomorphology Mapping and Shoreline Changes Analysis" organized by Regional Central for mapping Resources for Development (RCMRD) 7th February, 2024 (online).

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:

- African Union Inter-African Bureau for Animal Resources, Joint Verification Mission of Institutions as African Union Centres of Excellence in Aquatic Biodiversity and Ecosystems, 21 - 29 March 2024, University of Ghana, Ghana; Nairobi University, Kenya; Pwani University, Mombasa, Kenya.

- Aquaculture Ghana Conference, Exhibition and Awards, organized by the Ghana Chamber of Aquaculture, World Trade Centre, Accra. 30th - 31st May, 2024.
- Current state of AMR from Water Systems in Ghana: Development of Guidelines and Protocols for Antimicrobial Resistance (AMR) Detection in the Environment Sector in Ghana, FHI360 EpiC Ghana Global Health Security (GHS) project, 28th July to 31st August 2024, Capital View Hotel, Koforidua.
- CGIAR Portfolio25 Listening Session in Ghana, 13 February 2024, CSIR Head Office, Accra, Ghana.
- Consultation on IWMI West and Central Africa Priorities and Roadmap (2024-2030). 24 April 2024.
- Chains of Corruption: Whistleblowing as a Catalyst for Social Development in South Africa, Breaking the Chains of Corruption" Colloquium, held at the University of Johannesburg, from July 18th and 19th, 2024. Event website: https://news.uj.ac.za/news/uj-hosts-colloquium-on-whistleblowing-and-social-change-amidst-30-years-of-democracy.
- Drought Predictions over Sub-Saharan Africa on 29 February 2024, Accra, Ghana.
- DANIDA Science Engagement Seminar on Water and Maritime Research at the Danish Embassy in Accra, 6th June 2024.
- Environmental Sector players Stakeholder Engagement Prior to Commencement of the FHI 360 Activities, FHI360 EpiC Ghana Global Health Security (GHS) project, Monday 19th February 2024, FHI 360 Office Trade Fare, Accra.
- Fleming Fellowship Phase II Professional and Policy Fellowship Orientation Workshop, Aurum Institute Ghana in collaboration with Fleming Fund, 5th to 9th June 2024, Mensvic Grand Hotel (Accra).
- Fourth Annual Meeting of Mediterranean Geosciences union, 25-28 November 2024, Barcelona, Spain.
- Four Day technical Workshop to develop a National AMR Surveillance System as part of the AMR National Action plan (NAP), MoH & MoFA In collaboration with USAID through the FHI360 EpiC Ghana Global Health Security (GHS) project, 15th July to 20th July 2024, Hill Palace Hotel, Aburi.
- Gender Equity and Social Inclusion Training Workshop, Worldfish, 17th to 22nd November, 2024, Nairobi, Kenya.
- Integration of disaster risk reduction and climate change adaptation policies at local, national, and transboundary levels in the Volta Basin, 29th – 30th April 2024, Coconut Grove Regency Hotel, Accra.
- Innoecofood Six months Project Progress meeting. MAKU, European Horizon Project, INNOECOFOOD - The Lavender Hill Hotel, Turkey. 2-3 July, 2024.
- International Blue Carbon Scientific Working Group, 16th Annual Session September, 2nd – 5th 2024, Cape Town, South Africa.
- International Centre for Evaluation and Development (ICED) Stakeholder Engagement Workshop on 'Climate Change Adaptation, for Africa: An Evidence and Gap Map' at ISSER Conference Hall, University of Ghana, 2nd May 2024.
- Joint workshop on digital innovation for water secure Africa (DIWASA) programme and the World Bank Funded project on Developing Water Accounting Dashboard for the Volta Basin. 7-10 May, 2024.
- Joint Verification Mission of Institutions as African Union Centres of Excellence in Aquatic Biodiversity and Ecosystems, African Union InterAfrican Bureau for Animal Resources, 21st to 29th March 2024, University of Ghana, Ghana; Nairobi University, Kenya; Pwani University, Mombasa, Kenya.

- Launch of Meteorological and Climate Cooperation between Denmark and Ghana. 30 January 2024.
- Mid-term evaluation of field trials of selected tilapia feeds, September 5 - 8, 2024, Accra.
- National Workshop to develop Antimicrobial Resistance (AMR) Guidelines and Protocols for the Environment Sector in Ghana, July, 2024.
- National workshop on effective coordination and collaboration in the implementation of cross-border policies, plans, and guidelines for disaster risk reduction and climate change in the Volta Basin, 7th June 2024, Coconut Grove Regency Hotel, Accra.
- National workshop on Application to Access Resources Materials and References to Develop AMR Guidelines and Protocols for the Environmental sector. (Rep for Aquaculture and Fisheries). 18-20 July, 2024, Koforidua, Eastern Region.
- OHA Ghana Workshop. Ocean Country Partnership Program (OCPP) one-health Conference. Presenter on Research gaps and Policies in Ghana. Labadi Beach Hotel. 26th - 29th February, 2024.
- One-day workshop on the development of the second National Action Plan (NAP 2) to Review and discuss the overall process for developing NAP 2, AMR Secretariat, 7th November 2024, Bedtime Hotel, Koforidua.
- Participatory mapping of climate and flood risks for community members/representatives in the Lawra and Nandom Districts, 29th February - 1st March 2024.
- Post-Cop 28 Agriculture and Food Systems Dialogue Event organized by The International Water Management Institute (IWMI) and the Ministry of Food and Agriculture (MoFA) under the Resilience Against Climate Change-Social Transformation Research and Policy Advocacy (REACH-STR) project, at Alisa Hotel, 13th March 2024.
- Reviewing AMR Guidelines and Protocols for the Environment Sector, 15 - 17 December, 2024.
- Stakeholder meeting with NADMO to discuss additional technical support of GDZHIAO project to NADMO's activities, 8th October 2024.
- Stakeholder Validation Workshop on the Draft Fisheries Bill (Ministry of Fisheries and Aquaculture Development). La Palm Royal Beach Hotel, La-Accra. 18 October, 2024.
- Stakeholder training for 20 institutional stakeholders in the Nandom Municipal Assembly on the development of Flood Risk Contingency Plan, 26th - 27th February, 2024.
- Sensitization Workshop on GM Crops in Ghana (for CSIR Institutes in Accra), at STEPRI, 12th November, 2024.
- Sixth Mission on Ghana-World Bank Natural Capital Accounting (NCA), organized by the Environmental Protection Agency (EPA) and The World Bank, EPA and World Bank offices, 22-26th April 2024.
- Seminar on Standards and Certification Scheme on Household Water Treatment Products in Ghana, Coconut Grove Hotel, Accra, on 29th November, 2024.
- Sensitization Seminar on the use of antimicrobials in fish farms on the Lake Volta. Chamber of Aquaculture Ghana event. Erata Hotel-Accra, East Legon. 16th February 2024.
- Training workshop on GMES and AFRICA- The use of Crowd-Sourced Flood Reporter for Disaster Monitoring Organizations (DMOs) 19th – 21st November 2024.
- Technical cooperation programme project inception workshop, May 15th, 2024, Fiesta Royale Hotel, Accra.

- Technical Working Group (TWG) Meeting to undertake Drought Risk Modelling and Customization for Ghana. 2nd – 4th December 2024.
- Transdisciplinarity in collaboration for Early Career Researcher Development in Africa, held on 26 - 28 June 2024 at Kwame Nkrumah University for Science and Technology, Kumasi, Ghana.
- UNESCO-Regional IHP meeting, 14-16 May 2024, UNESCO Office in Accra, Ghana.
- UNESCHO-Ghana Committee meeting, 27th August 2024, EPA, Accra, Ghana.
- Validation Workshop of the National Fishery and Aquaculture Bill, November 2024
- World Antimicrobial Awareness Week (WAAW) seminar, CSIR-WRI; Microbiology Section, 18th November 2024, CSIR-WRI, Accra.
- Wetland Researchers and Decision-Makers Stakeholder Engagement Workshop organized Centre for Remote Sensing and Geographic Information Services (CERSGIS) on the GDZHIAO Project at the University of Ghana (Gave a presentation on 'Wetlands management for Ecosystem Resilience and Ecosystem Services'), 5th March 2024.
- West African Regional Workshop (WARW-2024) of GDZHIAO and MarCNoWA projects (GMES & Africa) in Dakar, Senegal, 24-26 July 2024.
- Worldfish, Gender Equity and Social Inclusion Training Workshop, 17 - 22 November, 2024, Nairobi, Kenya.
- Workshop on drought over Sub-Saharan Africa, 22 October 2024, UKCEH, Accra, Ghana.
- Workshop on Energy Infrastructures and Community Livelihoods in Ghana ('EnergyScapes' project inception workshop) at Department of Geography, University of Ghana, 23rd October, 2024.
- Workshop on reviewing AMR Guidelines and Protocols for the Environmental Sector, FHI360/USAID, 15th to 7th December, 2024, Capital View Hotel, Koforidua.
- 2nd Densu Ramsar site education centre stakeholders' meeting, 26th November 2024, Centre for Biodiversity Conservation Research (CBCR), University of Ghana.
- 1st Densu Ramsar site education centre stakeholders' meeting, 22nd March 2024, Centre for Biodiversity Conservation Research (CBCR), University of Ghana.
- 6th Mission on Ghana-World Bank Natural Capital Accounting (NCA) organized by the Environmental Protection Agency (EPA) and The World Bank at EPA and World Bank offices, 22nd - 26th April 2024.

2.6 Employee Relations

2.6.1 Retirements and Service Recognition

The 2024 Retirements and Service Recognition Awards took place during the end-of-year party on 20th December, 2024. Staff honoured for their contributions to the Institute are listed in Table 2.1.

Table 2.1: List of Retirees in 2024.

No.	Name(s)	Years Served
1	Dr. George Tetteh Mensah	21
2	Dr. (Mrs.) Marian Amu-Mensah	21
3	Mr. Alfred Adjetey Adjei	38
4	Mr. John Kofi Mensah	38
5	Mr. Mahmud Amidu	37
6	Ms. Deborah Adjei	37
7	Mr. George Asante	14

2.7 National Service and Industrial Attachment

The Institute supported tertiary institutions towards the training of students as part of its corporate social responsibility and national capacity building activities. The durations of the training programmes were eleven (11) months for national service, and between four (4) and twelve (12) weeks for industrial attachment. The details are presented in Appendix VI.

2.8 Visitors to the Institute

Some institutions/organizations visited the Institute during the year 2024. The details are shown in Table 2.2.

Table 2.2: Institutions that visited the Institute in 2024.

No.	Institution	Date of Visit
1	Ghana Plumbers Association	19th July, 2024
2	Physics Students' Association of Ghana (University of Ghana)	26th July, 2024
3	Aurum Institute	16th August, 2024
4	New Nation School	20th June, 2024

2.9 Membership of Committees and Boards

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

- Abstract and Poster Review Committee of the Aquaculture Ghana
- All-Atlantic Ocean Research and Innovation Alliance (AAORIA) Ghana Team
- Committee of Experts in Fish Feed Formulation, FC, Ghana
- CSIR Research Staff Association
- CSIR Strategic Plan Implementation Committee
- CSIR-WRI Editorial Committee
- CSIR-WRI Intellectual Property Right Committee
- CSIR-WRI Interim Management Committee
- CSIR-WRI Welfare Committee
- CSIR-WRI Database Management Committee
- CSIR WRI Facility Management Committee
- Fisheries Commission Board
- Ghana Environmental Protection Authority Board
- Ghana National AMR Platform
- Ghana Natural Capital Accounting (NCA) Ecosystem Services Technical Sub-Working Group
- Ghana National Platform for the Intergovernmental Science Policy Platform on Biodiversity and Ecosystem Services (IPBES)
- Ghana National Health Laboratory Working Group
- Ghana Laboratory Information Systems Stakeholders Committee
- Ghana UNESCO-IHP Committee
- Ghana Forum for Agriculture Advisory Service and Support (GFAASS)
- GhIE-Research and Awards Committee Member, Ghana Institution of Engineering
- Global Mangrove Watch (GMW)
- Ghana Science Association
- International Blue Carbon Scientific Working Group (IBCSWG)
- Mt. Zion Credit Union Board of Directors
- National Committee on Drinking Water Quality Management

- National Technical Committee for Drinking Water Quality
- National Decade Committee of UNESCO-IOC Ghana
- Technical Working Group (TWG) responsible for the development of a National Aquatic Animal Health Strategy (NAAHS)
- Technical Committee on Environmental Protection Standards on Effluent Quality
- UNESCO-Taskforce on the Prefeasibility Study for the UNESCO Water Sciences Report
- UNESCO-IOC Global Ocean Observing Systems (GOOS)
- UNEP Global Environment Monitoring Services for the Ocean and Coasts (GEMS Ocean) Programme Ghana Team
- Water Resources Commission Board
- Water Resources Information Platform Committee
- World Water Day National Committee

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 shown in Appendix VII.

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:

- Assessment of wastewater quality (Client: Cocoa Processing Company Limited)
- Assessment of wastewater quality (Client: Bunge Loaders Croklaan Industries Ltd.)
- Assessment of water quality of groundwater (boreholes and wells) at Amansaman in the Ga West Municipality (Client: Water Resources Commission)
- Assessment of product water and effluent quality (Client: Befesa *Desalination* Developments *Ghana* - Abengoa)
- Assessment of water quality of borehole in the Adentan municipality (Client: Water Resources Commission)
- Assessment of water quality (Client: Environmental Services Limited)
- Assessment of water safety in the Ga West Municipal Assembly in Accra (Client: Water Resources Commission)
- Bioprospecting of water resources for aquaculture in Anlo Traditional Area (Client: Anlo Traditional Leaders, His Royal Majesty Awadada and International Leadership Foundation)
- Baseline groundwater monitoring of community wells in the Ahafo North area for wet season (Client: Newmont Ghana Gold Limited, Ahafo-North)
- Baseline groundwater monitoring of community wells in the Ahafo North area for dry season (Client: Newmont Ghana Gold Limited, Ahafo-North)
- Drinking water quality assessment of water treatment system (Client: VALCO Company Limited)
- Environmental studies on biodiversity and wetland in the DSTF area (Client: Anglogold Ashanti Ghana Limited)
- Environmental monitoring of activity area (Client: Kama Industries)
- Feasibility studies for aquaculture along the Lake Volta and other water bodies (Client: Bulk Water Company Ltd.)

- Geophysical investigation at Tamale Bank of Ghana office and Regional Manager's residence, Tamale (Client: Bank of Ghana)
- Half-yearly water quality monitoring and assessment of the Coastal, Southwestern and Volta Rivers Systems of Ghana (Client: WRC)
- Inventory of Commercial Water Suppliers and Users in Pra and Volta Basins (Client: World Bank)
- Monthly assessment of final effluent quality (Client: Standard Chartered New Office Building)
- Monthly assessment of effluent quality (Client: Tema Lube Oil Co. Ltd.)
- Monthly assessment of effluent quality (Client: Meridian Port Services Limited)
- Monthly assessment of final effluent quality (Client: Accra Brewery Limited)
- Monitoring and maintenance of water treatment facility at the Regional Office of Bank of Ghana, Tamale (Client: Bank of Ghana, Tamale)
- Preliminary hydrological study (Client: Sahel Value Chain Ltd.)
- Quality control of culture media (Client: Dannex Aryton Starwin PLC Pharmaceutical Company)
- Quarterly assessment of effluent quality (Client: West Hills Mall Limited)
- Quarterly assessment of effluent quality (Client: Movenpick Ambassador Hotel, Accra)
- Quarterly assessment of water and sludge samples (Client: West African Fish Ltd., Asikuma)
- Quarterly assessment of final effluent quality (Client: Phyto-Riker - GIHOC Pharmaceuticals).
- Sahel Value Chain Development Project: Preliminary Study Report (Client: Sahel Value Chain Ltd.t)
- Sinsina dugout water quality assessment (Client: Saha Global)
- Studies on Environmental Biodiversity and Wetland (Client: AngloGold Ashanti Ghana, Obuasi Mine)
- Takyili dugout water quality assessment (Client: Saha Global)
- Use of SWAT to model water flow regulation and sediment retention in the Pra and Volta Basins (Client: World Bank)
- Water quality assessment of illegal mining sites in Northern Ghana (Client: TAMA Foundation Universal)
- Water quality monitoring of boreholes and tap water from selected communities (Client: Good News Theological Seminary, Oyibi)

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:

- Comprehensive Technical Training of 10 Ivorian Technical Officers under the FAO-FISH4ACP Program.
- Ghana Agriculture Workers Union (GAWU)/CSIR-WRI/ARDEC fish farming training using tarpaulin tank culture systems for child labour free communities along the lake Volta (Abotuase, Kpando Torkor and Aveme)
- Hands-on training on enhancing production and use of fish as part of healthy diets and agri-food chain development and businesses.
- Quarterly Fish farming training for Tilapia and Catfish grow-out production

- Two-day training on Catfish grow-out in tarpaulin tanks for 30 women at Kunchene, Jirapa in the Upper West region.
- Training of students from UDS, UENR, KNUST, UG and Technical Universities during their internship and National Service.

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

Postgraduate Thesis Examination

- PhD thesis by Twumasi Ankrah Kwarteng on Quality of Muni Lagoon and Its Tributaries in Effutu Municipality of Central Region, Ghana, for the Institute for Environment and Sanitation Studies, University of Ghana, June 2024.
- MPhil thesis by Ishmael Cudjoe Norvimagbe on Assessment of Persistent Organic Pollutant Contamination in Fish from the Lower Volta Basin in Ghana, for the CSIR College of Science and Technology, in September, 2024.
- MA Dissertation on "Livelihood Diversification and Sustainable Livelihoods: Assessment of Mixed Livelihoods Strategies Among Unemployed Youth in Rustenburg, South Africa. Submitted to Department of Sociology, University of Johannesburg.
- MPhil thesis by Francis Acheampong Osei on Determination of Ambient Noise Levels and the Effects on Auditory Health and Productivity of Teachers in Selected Basic Schools Within the Old Tafo Municipality, Ghana, for the Department of Environmental Science, Kwame Nkrumah University of Science and Technology, in January, 2024.
- PhD thesis on "Groundwater Augmentation in Granitic Aquifers - Integrated Approach to Managed Aquifer Recharge Sites Identification" by Albert Acheampong, Department of Civil Engineering.
- MPhil thesis on "Continuous Hydrological Modelling of the Pra River Basin In Ghana, A Comparative Study of the 'Deficit And Constant' and 'Soil Moisture Accounting' Loss Methods in HEC-HMS" by Jeremiah Anno-Onumah (student number: 20829730), Department of Civil Engineering

Postgraduate Student Thesis Supervision

- Esi Esuon Biney, 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).
- Bismark Akurugu; 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 (Submitted thesis to graduate school, University of Ghana).
- Martin Addi; 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 Basin for hydrological impact modeling (Submitted thesis to KNUST graduate school).
- Simeon Odametey; 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 (Ongoing).

- Mark Osei-Owusu; 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 (Ongoing).
- Franz Alex Gaisie-Essilfie; 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).
- 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 (Ongoing).
- Ishmael Norvimegbe; MPhil student enrolled at the CSIR College of Science and Technology, Department of Aquaculture and Fisheries Science - Assessment Of Persistent Organic Pollutant And Pesticides Contamination In Fish, Water And Sediment From The Lower Volta Basin In Ghana
- Felicia Dogbey; 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 Vea wetland agroecosystem (Ongoing)

2.13 Review of Manuscripts/Journals

- Spatiotemporal analysis in brown seaweed diversity and abundance of selected coastal locations in the Southern coast of Tamil Nadu, India: A way forward for conservation and sustainable utilization, (2024) for the Journal of Regional Studies in Marine Science (Elsiever).
- Evidence for long-term efficacy of a membrane filtration device in rural villages in Ghana, (2024) for Scientific Reports.
- Bacterial diversity of mineral well water from ten sources belonging to the Guarani aquifer system: assessment by cultivation dependent and cultivation-independent methods and their correlation with water physicochemical properties (2024) for Groundwater for Sustainable Development, *Elsevier Journals*
- Functional traits of ecosystem engineers as predictors of 2 associated fauna (2024) for Marine Environmental Research, *Elsevier Journals*
- Sustainable Water Resources Management (SWAM) Journal. Titled: The Role of Emotional Appeal in Water Conservation Communication: A Framework for Social Media Engagement. (Manuscript Number: SWAM-D-23-00761)

3.0 RESEARCH AND DEVELOPMENT ACTIVITIES

3.1 FOOD SECURITY AND POVERTY REDUCTION

3.1.1 FISHERY AND AQUACULTURE

3.1.1.1 Evaluation of Separate and Combined Nursing of the Nile Tilapia, *Oreochromis niloticus* and the African Catfish, *Clarias gariepinus* Fingerlings using Commercial Tilapia and Catfish Feeds and their 1:1 Mixture

(Research Team: Francis A. Anani – Principal Investigator, Patrick S. K. Fatsi, Kelvin K. Donkor, Felix A. Ayarika and Evans T. Danquah)

Introduction

Combined culture of two or more complementary aquaculture species such as the Nile tilapia, *Oreochromis niloticus* and the African catfish, *Clarias gariepinus* increases the maximum standing crop, maximizes the efficient use of water body, controls fish recruits, and it improves profitability. Additionally, intensive co-farming of species has many benefits, including higher production, efficient water use and employment opportunities creation. It was against this background that this study was initiated in 2023 and ended in the reporting year.

Objective

The main objective of the study was to determine the growth and the economic performance of separate and combined nursing of the Nile tilapia, *Oreochromis niloticus* and the African catfish, *Clarias gariepinus* fingerlings in hapa-in-pond systems using commercial tilapia and catfish feeds and their 1:1 mixture for 77 days.

Activities Undertaken

The following activities were undertaken during the reporting year:

- Initial weight range, mean weights of *O. niloticus* and *C. gariepinus* fingerlings were determined using digital weighing balance (0.1 g) whilst those of lengths were measured using fish measuring board (0.1 cm);
- The fingerlings were stocked at 60 hapa^{-1} at a ratio of 1:1 in 9 fine mesh net hapas, each of dimensions 5.0 x 2.0 x 1.2 m; installed in a 0.2-hectare earthen pond; and they were labelled *A* (fed with tilapia feed only), *B* (fed with catfish feed only) and *C* (fed with equal mixture of tilapia and catfish feeds);
- Nursed fingerlings were fed manually at a declining rate of 10.0-4.0% of their biomass hapa^{-1}, 3 times daily for 77 days and water quality parameters monitored weekly;
- Growth performance was determined in terms of: Survival Rate (SR), Weight Gain (WG), Specific Growth Rate (SGR), Feed Conversion Ratio (FCR) and Feed Efficiency (FE) at end of feeding period;
- Simple economic analyses were employed to assess the cost-effectiveness of composite nursing of *O. niloticus* and *C. gariepinus* fingerlings; and
- All data were statistically analysed.

Key results achieved so far

- Overall final mean weights of nursed fingerlings ranged from 31.6 ± 7.9 to 39.5 ± 6.1 g, with that of combined nursing being significantly higher (Tuker's HSDT, $P < 0.05$); and
- Returns on investment ranged from 161.40 ± 53.94 to 684.80 80 ± 17.81%, with that of combined nursing being significantly higher (Tuker's HSDT, $P < 0.05$).

Conclusion
Findings of the study indicated that combined nursing of *O. niloticus* and *C. gariepinus* fingerlings generated the highest gross yield and return on investment.

Recommendation
Combined nursing of *O. niloticus* and *C. gariepinus* fingerlings is recommended over nursing them separately.

Impact of the study on the national economy
The study is expected to help increase production, improve profitability and create employment opportunities within the fish farming industry in the country.

3.1.1.2 Condition Factor and Nutritional Value of Cultured African Catfish, *Clarias gariepinus* Fed with Commercial Catfish Feed, Tilapia Feed and their Equal Mixture

(Research Team: Francis A. Anani – Principal Investigator, Patrick S. K. Fatsi, Kelvin K. Donkor, Felix A. Ayarika and Evans T. Danquah)

Introduction
Fish must be healthy and in good condition to ensure cultured food fish is safe for human consumption. Among the factors that can be used to assess a safe food fish produced in any aquatic environment are its condition factor, *K,* and its nutritional value. Hence, this study was initiated and completed in the reporting year.

Objective
The objective was to assess the condition factor and the nutritional value of African catfish, *Claries gariepinus* fingerlings fed separately with catfish feed, tilapia feed and their equal mixture in hapa-in-pond system for 77days.

Activities Undertaken
The following activities were undertaken:

- Initial weight range, mean weights of *C. gariepinus* fingerlings were determined using digital weighing balance (0.1 g) whilst those of lengths were measured using fish measuring board (0.1 cm);
- The fingerlings were stocked at 60 hapa^{-1} in 9 fine mesh net hapas, each of dimensions 5.0 x 2.0 x 1.2 m; installed in a 0.2-hectare earthen ponds labelled accordingly;
- Nursed fingerlings were fed manually at a declining rate of 10.0-4.0% of their biomass hapa^{-1}, 3 times daily for 77 days and water quality parameters monitored weekly;
- A linear regression analyses were carried out using the length-weight relationship equation,
- $W = aL^b$ (Paully, 1983) which was log transformed as: $\mathrm{LogW} = \mathrm{loga} + \mathrm{blogL}$, where '$W$' is the body weight of the fish in grams, 'L' is its total length in centimetres, 'a' and 'b' are the intercept (constant) and the exponent (slope), respectively, obtained from the linear regression of the logarithm of L and W.
- The K was computed by employing the formula: $K = 100\mathrm{W}/\mathrm{L}^{\mathrm{b}}$ (Gayanilo and Pauly, 1997). Where W = weight of fish (g), L = Length of fish (cm);
- Nutritional value was determined by carrying out proximate analyses on the fillets of the cultured fish; and
- All data were statistically analysed.

Key results achieved so far

- The computed *K* were 1.2, 1.2 and 0.9 for *A*, *B* and *C*, respectively;
- Aside from ash, there were significant differences ($p < 0.05$) in nutrient and gross energy contents among the fillets; and
- The body fat contents of fish fed with all feed types were less than 5.0%, indicating lean fish.

Conclusion

The fish produced using the various feeds were in good and healthy conditions and they were safe for human consumption.

Recommendation

Based on availability and affordability, any of the feeds could be fed to *C. gariepinus* during its culture.

3.1.1.3 Impact of Water Lettuce *(Pistia stratiotes)* on Water Quality, Survival and Growth of African Catfish (*Clarias gariepinus*) in Concrete Tanks

(Research Team: Dr. Etornyo Agbeko – Principal Investigator, Fadilatu Halidu, Eric Kretsi, Dr. Ebenezer K. Appiah, Dr. Rhoda Lims Diyie, Dr. Patrick Fatsi, Mercy Johnson-Ashun, Kelvin Donkor, Cecil Nii Ayikai Tetteh)

Introduction

African catfish production is rapidly growing in urban communities in Ghana compared to that of Nile tilapia. Some reasons accounting for the surge in catfish production are its ease of culture, fast growth performance, and high nutritional value among others. Maintenance of water quality without compromising catfish growth rate has been a challenge. As a result, farmers are exploiting and adopting unconventional methods to control water quality deterioration for fish farming in concrete tanks, tarpaulin tanks and earthen ponds. One of the primary concerns, is the pollution of aquatic environments which stems from decomposition of feed waste and fish metabolism. Phytoremediation, viz. the use of plants to absorb, detoxify, or otherwise manage pollutants is emerging as one of the promising solutions to alleviate these environmental impacts. It is purported that water lettuce *(Pistia stratiotes)* has the ability for water nutrient uptake and thus renders it a potential plant that could improve water quality in fish culture systems.

Objective

The objective was to assess the effects of water lettuce *(Pistia stratiotes)* on physico-chemical parameters for African catfish survival and growth in concrete tanks.

Activities undertaken

This experiment was carried out at ARDEC in two rectangular outdoor tanks, TT (treatment tank) and CT (control tanks). The tanks were filled to a volume of 1.4 m^3. Each tank was stocked with 20 catfish of average weight 16.0 g. The TT was inoculated with 160.0 g fresh weight *P. stratiotes*. Water quality parameters, namely Temperature, Dissolved Oxygen (DO), pH, Salinity, Total Dissolved Solids (TDSs) and Conductivity were monitored weekly using a Combo Water Quality Meter probe. Feeding was done twice weekly for 70 days based on percentage body weight of fish for sustenance. The growth performance of fish was evaluated by calculating the mean weight gain, percent weight gain, feed conversion ratio, and survival

rate were determined. Various statistical analyses were performed using Microsoft Excel and the results presented in tables and in graphs.

Key results achieved so far

All the water quality parameters monitored were slightly higher in the treatment tanks (TT) than in that of the control (CT). However, all water quality values obtained were within acceptable limits for catfish farming. The recorded values ranged from 24.9 to 30.2, 3.8 to 9.1, 76.0 to 197.4, 6.29 to 9.10, 0.04 to 0.10 and 20.0 to 98.4 for temperature, DO, conductivity, pH, salinity and TDS, respectively for CT. Those for the TT were 24.8 to 31.1, 4.0 to 7.1, 76.0 to 307.0, 6.23 to 7.74, 0.03 to 0.07 and 20.0 to 69.9 for temperature, DO, conductivity, pH, salinity and TDS, respectively. The survival rate was 91% and 88% for TT and CT, respectively. The final mean weight of the cultured catfish was 153.8 g for TT and 146.2 g for CT.

Conclusion

The findings from the study suggest that the introduction of water lettuce into aquaculture systems not only aids in improving water quality and fish survival but also impacts fish growth positively. The petals and florescence of the water lettuce in the tanks attracted honey bees that could serve as opportunities for apiculture as well.

Recommendation

Further investigations are required to establish the conditions under which water lettuce can provide higher sustainability for urban fish farming.

Impact of the study on the national economy

The study could provide avenues for fish value chain enhancement to increase economic returns from fish farming and provide readily available catfish for most homes, "Point and Grill" restaurants and allied catfish business.

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. Benjamin Mintah, Dr. Lawrence Abbey, Dr. Mary Glover Amengo, Dr. Ebenezer Appiah, Dr. Patrick Fiatsi, Dr. Francis Anani, Dr. Rhoda Lims Diyie)

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

Introduction

Aquatic foods as healthy and sustainable food sources can be enhanced through harnessing of innovation and application of appropriate technologies in fish farming and other aquatic food production processes. The work involves training of rural farmers, youth, and women to innovatively produce and process nutritious farmed tilapia and catfish. Additionally, blue-green cyanobacteria *Spirulina*, and insect value chains will be processed into certified marketable human food products and feeds. The farm to fork approach called ECOHUBS will be deployed will be established to aid theoretical and practical training. The study began in the year under review and it is expected to end in 2026.

Objective
The objective was to establish innovative production/business (ECOHUBS) and improve local aquaculture farms using AI and ToT in six African countries.

Activities undertaken
CSIR-Ghana began the construction of the Ecohub structure in sections at ARDEC of CSIR-WRI in Akosombo. The foundation (sub-structural) works for five major Ecohub structure were at various stages of completion. *Spirulina* sampling activities from Lake Volta and other culture systems in Ghana was completed and the samples are being screened for selection of the best strain for culture in Ghana within the Ecohub. Training manuals were developed for training of trainers (ToT). Baseline data collection at the project communities along the Lake Volta was completed.

Key results achieved so far
Project kick-off and six-month progress meetings were held with all consortium partners. The main fish hatchery and grow-out structure for tilapia and catfish production were about 51% completed. Black Soldier Fly (BSF) structure is about 69% completed. Cricket/insect structure which meant for insect meal for nutritious snacks and other nutrient packed foods is about 70% completion. The fish processing structure is at the 53% sub-structure completion stage (Figure 3.1.1).

Figure 3.1.1: Ecohub structure at various stages of construction for Pre-fab installations.

Survey works for citing classroom for training of participants had been completed. Materials and equipment for the living labs had been fabricated and awaiting installation and AI sensors for tilapia and catfish production (Figure 3.1.2).

Figure 3.1.2: Living lab cages with walkway.

Conclusion
The various infrastructure development is in line with the Innoecofood Grant agreement for the construction of Ecohub in Ghana. The high cost and inflationary factors could affect the installation of the pre-fabricated materials for the completion of the super-structure sections and the recirculatory aquaculture systems with AI sensors for water quality monitoring and fish processing rooms.

Recommendation
To minimise the escalating cost of the pre-fab, only the upper sections and roofing should be installed with the pre-fabricated materials.

Impact of the study on the national economy
When upscaled to other regions, Ecohubs could contribute to meeting Ghana's fish production targets to minimise the nation's fish deficit and create jobs which would contribute to better gross domestic product (GDP).

3.1.1.5 Improving Growth and Development of the African Bony-Tongue (*Heterotis niloticus*, Cuvier 1829) in Earthen Ponds

(Research Team: Dr. Etornyo Agbeko – Principal Investigator, Samuel Birikorang, Eric Kretsi, Mercy Johnson-Ashun, Dr. Rhoda Lims Diyie, Dr. Ebenezer K. Appiah.)

Introduction
The African bony tongue, *Heterotis niloticus* is one of the largest omnivorous benthic fish species in African freshwater ecosystems. Information on culturing and breeding of the fish is paucity despite its being exploited for several decades. The African bony tongue exhibits good growth rate and its size ranges from 2,500 to 6,000 g at maturity in most fisheries. It has comparatively similar flesh qualities (i.e., white muscles, high protein levels, lean and good taste) as tilapia. Following the selective cross-breeding at ARDEC, the generation F1 was produced for further growth performance assessment. The current study was initiated in 2023 and it is expected to end in 2025.

Objective
The objective was to ascertain the growth performance of farmed African bony tongue, *Heterotis niloticus*, fingerlings (ARDEC breed F1) in earthen ponds.

Activities undertaken
Activities carried out during the year included stocking of ponds with *Heterotis niloticus*, fish and water sampling and collation of fish biodata for analyses. During the reporting year, Pond 4 was stocked with 800 fingerlings while Pond 23 was stocked with 134 fingerlings of *H. niloticus* with an average weight of 1,361.4g. A total of 628 fingerlings of average weight 3.4 g were stocked in Pond 20 on 20th September, 2024 for 61 days.

Key results achieved so far
The recorded mean, minimum and maximum physico-chemical parameters in the ponds were 6.68, 6.40 and 7.13 for pH; 29.41, 27.70 and 30.55 °C for temperature; 4.92, 3.43 and 7.80 mg L^{-1} for DO; 110.86, 81.85 and 142.35 µS cm^{-1} for conductivity; 56.36, 49.70 and 70.18 mg L^{-1} for TDSs; 0.05, 0.04 and 0.008 for salinity, respectively. The computed average daily growth rate (ADGR) was 10.09 g day^{-1} and it was higher than those of the wild *H. niloticus* for similar

culture period in the previous studies (Figures 3.1.3 and 3.1.4). During the reporting year a total of 184 *H. niloticus* brood stocks were produced out of the target of 200.

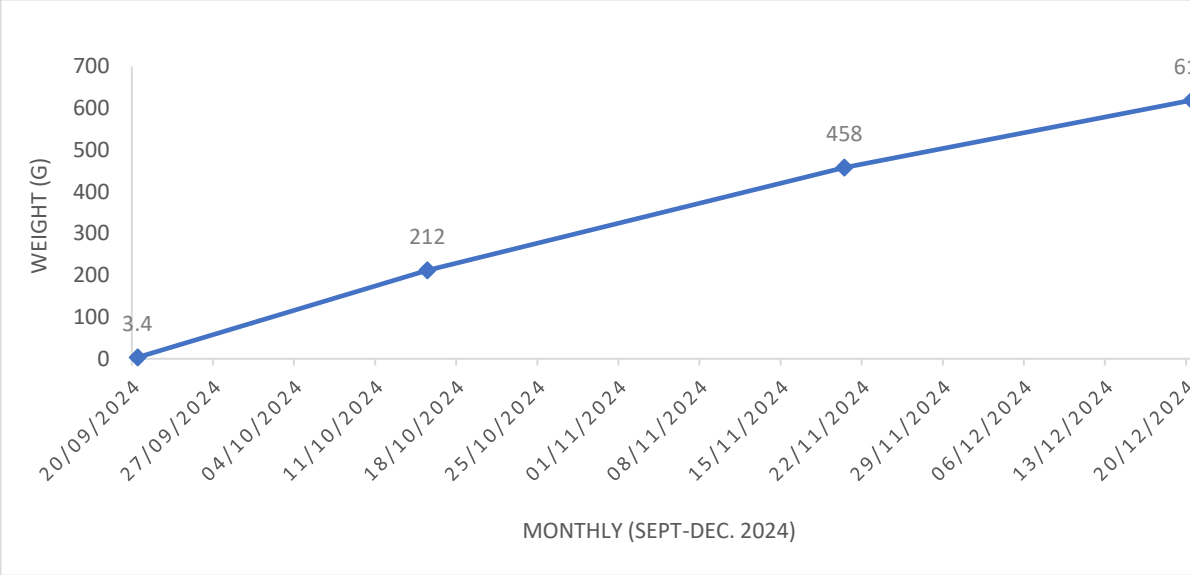


Figure 3.1.3: Growth curve of improved *Heterotis niloticus (F1)* at ARDEC in 2024.

Figure 3.1.4: Observed growth of *Heterotis niloticus* before stocking (left) and after harvesting (right).

Conclusion

The fast growth rate of *H. niloticus* observed in the current study was relatively good for African bony tongue farming in earthen ponds. Hence, *H. niloticus* could be an alternative fish to meet the increasing demand for fast growing culturable fish species.

Recommendation

The following were recommended after the study period:

i. The breeding value and genetics of ARDEC breed *H. niloticus* should be assessed for an enhanced selective breeding programme for the fish;
ii. Further confirmatory and comparative studies on the growth performance, survival, and profitability of the ARDEC F1 production in earthen ponds should be conducted; and
iii. Specialized sinking feed for *H. niloticus* should be developed to facilitate the growth of the fish under culture.

Impact of the study on the national economy
The fish has good aquaculture traits that are arguably comparable to Nile tilapia (*Oreochromis niloticus*) for sustainable commercial production and projected good economic returns.

3.1.1.6 Research and Development of Freshwater Prawns (*Macrobrachium vollenhovenii*) as Alternative Aquaculture Species - Understanding its Culture Requirements

(Research Team: Dr. Etornyo Agbeko - Principal Investigator, Eric Kretsi, Mercy Johnson-Ashun, Dr. Rhoda Lims Diyie, Samuel Birikorang, Dr. Ebenezer K. Appiah)

Introduction
Freshwater prawns are popular in aquaculture in other countries particularly in Asia, due to their fast growth rate, high consumer acceptance and high market demand. African freshwater prawns are crustaceans belonging to the family *Palaemonidae*. *Macrobrachium rosenbergii* (the giant freshwater prawn) is native to Asia whilst *M. vollenhovenii* (African river prawn) is that of West Africa. The latter has a paucity of data and it has not been fully exploited for aquaculture in most West African countries due to limited technical knowledge of its culture. The study was initiated and completed in the reporting year.

Objective
The objective was to investigate water quality and growth for freshwater prawn farming.

Activities undertaken
A total of 20 live freshwater prawns (FPs), with an average weight of 8 g, were acquired from local fishers along the Volta River. The FPs were transported using in-situ water in open containers to ARDEC circular-shaped research tanks of diameter 1.82 m with water depth of about 1.0 m. The FPs were conditioned in the tanks for 48 hours before first feeding. Natural granite stones with caves were constructed to mimic their natural environment. The volume of the water in the tank was maintained at 78.60 m^3. The initial water quality data was taken before introducing the prawns into the tank. A flow-through water system was installed to allow water exchange (10% per day). Water quality parameters such as Temperature (°C), DO (mg/l), pH, Salinity (ppt), Conductivity (µS/cm), TDS (ppm), Nitrite (mg/l), Nitrate (mg/l), Ammonia (mg/l), and Phosphate (mg/l) were monitored every three days. Ripen palm kernel fruits and tilapia feed mixed with water to enable them to sink to the bottom were distributed evenly across the bottom of the tank every day to ensure all prawns had access to food. FPs' health was monitored daily for any clinical signs during the period of culture.

Key results achieved so far
Water quality recorded during the culture of freshwater prawn (FP) was within acceptable range for most freshwater aquaculture species (Table 3.1.1). The water quality parameters were generally optimal, with stable temperature (26.6°C), pH (6.72), and low salinity (0.05 ppt), which support prawn growth. However, dissolved oxygen levels fluctuated significantly. Conductivity, TDS, and phosphate levels showed some variability. Nitrate, nitrite, and ammonia concentrations remained low and consistent.

The study indicated that freshwater prawns (FPs) growth could steadily increase in weight with rapid growth despite sustenance feeding once a day (Figure 3.1.5). Thus, under optimal feeding, growth could be exponential. No observable pathogens or FPs health challenges based on main clinical signs were noticed during and after the culture period (Figure 3.1.6). A few pereopods were lost in some FPs with observed shorter maxillipeds.

Table 3.1.1: Water quality values recorded for freshwater prawn cultured at ARDEC.

Parameters	Average	Range (Min - Max)	STD
Temperature (°C)	26.59	25.10 - 28.70	0.94
DO (mg L^{-1})	5.9	2.10 - 7.80	1.32
pH (pH units)	6.72	6.01 - 7.38	0.36
Salinity (ppt)	0.05	0.04 - 0.06	0.01
Conductivity (µS cm^{-1})	105.62	80.50 - 132.90	14.61
TDS (ppm)	55.24	39.7 - 66.50	7.39
Nitrate (mg L^{-1})	0.13	0.05 - 0.31	0.07
Nitrite (mg L^{-1})	0.05	0.01 - 0.12	0.03
Phosphate (mg L^{-1})	0.09	0.021 - 0.28	0.05
Ammonia (mg L^{-1})	0.04	0.001 - 0.10	0.02

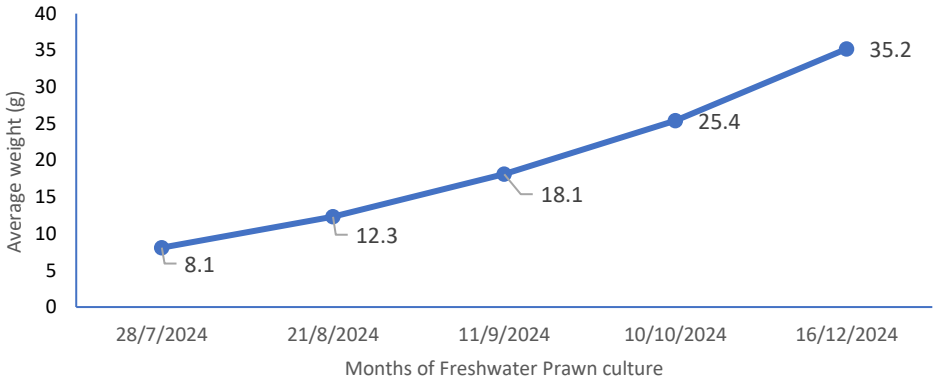


Figure 3.1.5: Growth trend of freshwater prawn fed once a day for 4 months.

Figure 3.1.6: Meristic data collection for freshwater prawn research at ARDEC.

Conclusion
The water quality in the freshwater prawn culture system was generally optimal characterized by fluctuations in dissolved oxygen (DO). Mortality may occur if, DO is <2.5 mg/l as observed in the study. The freshwater prawn growth was rapid initially, followed by slower growth as the fish approached maturity, thus highlighting the need for proper feed, feeding, and water quality adjustments during the culture period.

Recommendations
A flow-through or RAS coupled with aeration is required for improved water exchange to increase growth in freshwater prawn farming. Proper feed management and development of appropriate local ingredient-based FP feed will be needed.

Impact of the study on the national economy
The freshwater prawn farming has the potential to significantly contribute to the national economy by generating jobs, boosting export revenues, and enhancing food security.

3.1.1.7 Resilient Aquatic Food Systems Initiative

(Research Team: Dr Ruby Asmah - Principal Investigator, Dr Emmanuel Mensah, Mr Acheampong Addo, Dr Miriam Ameworwor, Ms Adelina Akuamoah Boateng)
Collaborating Agencies: International Water Management Institute, Fisheries Commission

Introduction
The northern parts of Ghana are among the most food insecure regions in the country. Men, women and youth in some of the communities also have limited sources of livelihood with crop farming and animal rearing being the most important income generating activities (Quaye, 2019). The Northeast Region of Ghana was the target for the pilot aquaculture project, and the selected communities for implementation were Nalerigu, Langbinsi, Tombu and Nansoni. The communities were selected based on suitability of their respective reservoirs or dams for caged fish production. IWMI coordinated the activities of the project whilst CSIR-WRI and FC were collaborators. CSIR-WRI was responsible for site selection, community entry, environmental impact assessment, training of fish farmers fish sampling and water quality monitoring. The study began in 2022 and ended in the reporting year.

Objective
The objective was to enhance fish production through the culture of caged tilapia in selected reservoirs in the North East region of Ghana.

Activities undertaken
Regular sampling of water from cages in the selected reservoirs and analysing of water quality were conducted during the fish culture period. The cultured fish were sampled monthly, and their respective lengths and weights were measured (Figures 3.1.7 and 3.1.8). The mean weight of fish in each cage was computed and the feeding rates were adjusted accordingly. The fish were harvested in July of the reporting year.

Figure 3.1.7: Sampling cultured fish for weighing.

Figure 3.1.8: Weighing of sampled fish.

Key results achieved so far

The quantities of fish stocked, the percentage recovery, total weight harvested and the sales value per community are presented in Table 3.1.2. Poor water quality due to high turbidity caused by erosion during the rainy season grossly affected cultured fish at Nalerigu and Langbinsi leading to high mortalities. After eight months of culture, the beneficiaries with support of CSIR-WRI and FC teams harvested and sorted the fish into three categories (i.e., large, medium and small) (Figure 3.1.9). The women degutted, packaged and sold the fish at GHS40.00, GHS38.00 and GHS35.00 of the large, medium and small, respectively. The revenue realized from the sales was deposited at the community groups' respective bank accounts. Participants in the pilot project were expected to invest the money generated into the next round of fish farming.

Table 3.1.2: Quantities of fish stocked, percentage recovery, total weight harvested and the sales value per community

Community	Tombu	Nansoni	Langbinsi	Nalerigu
Number of fish stocked	8,000	8,000	8,000	8,000
Recovery (%)	64.2	65.6	17.4	11.4
Weight harvested (kg)	1118.80	1289.20	298.20	237.00
Total sales (GHS)	**37,031.10**	**41,945.00**	**9,066.00**	**7,553.00**

Figure3.1.9: Harvested fish being sorted.

Conclusion
Results from the study established the suitability of selected reservoirs in northern Ghana for cage fish farming. Quantities of fish harvested at Langbinsi and Nalerigu were negatively impacted by deterioration in water quality leading to low fish recovery.

Recommendations
i. The Government of Ghana should make funding available for the project to be scaled up in other deprived communities whose reservoirs are perennial to increase the social economic value of the reservoirs to the communities.
ii. Fish should be stocked right after the rainy season and not before.

Impact of the study on the national economy
The project provided fish farming training as a potential alternative source of income to the youth and women who participated in the pilot programme; whose main source of income, otherwise, has been crop farming and/or livestock rearing.

3.1.1.8 Fishery Survey on the White and Black Volta in Northern Ghana: Its Implication on Bridge Construction on the Rivers

(Research Team: Dr. Emmanuel T.D. Mensah – Principal Investigator, Dr. Andrews Agyekumhene, Dr. Miriam Amerworwor, Mr. Martin Adakpeya, Ms. Yaa Asabea Agadzi)
Collaborating Agency: Dept. of Marine and Fisheries Sciences, University of Ghana

Introduction
Many developments, such as water abstraction for hydropower generation, dam construction, bridge construction and sand mining can affect fish populations. These developments have effects on fish passage (both upstream and downstream), migration patterns, alterations in habitat quality and quantity, morphological changes to the river corridor and physical damage to fish. These may have implications for socio-economic livelihoods of communities along the river course. It was against this background that the study was initiated and completed in the reporting year to assess the fisheries of the Black (at Buipe) and White Volta (at Yapei, Daboya and Nawuni) prior to possible bridge construction on these rivers.

Objectives
The objectives were to:
i. assess the abundance and diversity of fish species in the rivers;
ii. identify potential threats to the fishery resources; and
iii. provide recommendations for management and conservation efforts.

Activities undertaken
Four major landing sites with established fish markets along the Black Volta at Buipe and White Volta at Yapei (Figure 3.1.10), Daboya and Nawuni were selected for fish catch assessment. Other activities carried out included: fishing gear survey, canoe survey, catch landings, and length-weight measurement of dominant species. Some interviews were conducted among fishers, fish processors and fishery officers at Buipe and Yapei on fishing activities, the fishery and other livelihood support activities in the area.

Figure 3.1.10: Fish landing site at Yapei.

Key results achieved so far

There were between 150 to 300 fishers employed in the fishing activities at the various sites each. Various communities located along the river often converge at the landing sites to sell fish either fresh or smoked. The fishing gears employed in the rivers included gill nets, purse seine net, drag net, basket traps, brush parks, hook and line (Figure 3.1.11). The mesh sizes of their nets ranged from 0.6 to6.0 inches. Their fishing vessels, mainly wooden canoes were mostly motorized (15-30HP) with few using manual paddles. A total of 23 fish species belonging to 12 families were identified in the Black and the White Volta at the various sites. The most dominant species observed belonged to the families Mochokidae, Mormyridae and Alestidae with the least belonging to the families, Cichlidae Dorosomatidae Distichodontidae and Malapteruridae.

Figure 3.1.11: Some gears used in fishing.

Results from the morphometric measurements showed a general reduction in the length at first capture of the fish species indicating growth overfishing. The fishery activities in all sites support other livelihood activities such as canoe making and transportation on the river to other communities. These activities boost the local economy and generate income for persons involved in the act. Fresh harvested landings are sold to women involved in processing although some fish for subsistence (Figure 3.1.12). Fish are smoked (Figure 3.1.13) using the traditional 'chorkor smoker' and sold at nearby marketing centres in either major towns.

Figure 3.1.12: Interviewing a fish processor.

Figure 3.1.13: Smoked fish.

Conclusion

The assessment reveals that while the river supports a diverse fish population, certain areas are under significant stress due to anthropogenic activities. The fisheries assessment highlights the need for immediate conservation and management actions to protect the rivers' fish populations and the ecosystem. Sustainable practices and pollution control will be critical for maintaining the health of the rivers and supporting the livelihoods of communities that depend on their fisheries especially after the bridge construction.

Recommendation

The following recommendations are proposed: Fisheries management programmes (gear restrictions, closed periods, ban on destructive fishing practices), habitat restoration, alternative livelihood programmess, monitoring and research.

Impact of the study on the national economy

Positive impact: Improved transportation and trade, boost tourism, enhanced access to markets.
Negative impact: Disruption of fishing activities, decline in fisheries revenue, water pollution, destruction of the ecosystem.

3.1.1.9 UNESCO-IOC MSPglobal 2.0 Project - Ghana to Accelerate the Adoption of a National Marine Spatial Plan (MSP)

(Research Team: Professor Mike Yaw Osei-Atweneboana - Principal Investigator, Dr. Felix Addo-Yobo, Divine Worlanyo Hotor)

Collaborating Agencies: UNESCO-IOC, CSIR-Water Research Institute, the SDGs Advisory Unit, Land Use and Spatial Planning Authority (LUSPA), Environmental Protection Agency (EPA), National Development Planning Commission (NDPC)

Introduction

Ghana is implementing Marine Spatial Planning (MSP) under the MSPglobal 2.0 project to promote sustainable ocean governance. This initiative supports the Sustainable Ocean Plan (SOP)**,** set for completion by 2025, ensuring responsible marine resource use, conservation, and economic growth within the blue economy**.**

With increasing threats like habitat degradation, overfishing, and pollution, Ghana is advancing integrated marine governance through scientific research, policy innovation, and stakeholder engagement**.** The MSPglobal 2.0 training workshop**,** organized by CSIR-WRI, UNESCO-IOC Ghana, and the SDGs Advisory Unit**,** strengthened capacity building and regional collaboration with Togo, Benin, and Côte d'Ivoire**,** engaging government agencies, academia, NGOs, and local communities in data-driven marine planning. The project was initiated and completed in the reporting year.

Objectives

The objectives were to:

i. develop and implement a national MSP Framework;
ii. strengthen conservation and blue economy growth; and
iii. enhance collaboration and capacity building through regional partnerships (Togo, Benin and Côte d'Ivoire), multi-sectoral engagement, and technical training to support effective MSP implementation.

Activities undertaken

The following activities were carried out during the reporting year:

i. Phase one workshop focused on MSP concepts and best practices which explored innovative ways through which MSPs could boost Ghana's blue economy.
ii. Second phase involved introducing participants to the Rapid Assessment Methodology (RAM).
iii. Award of certificates to participants.

Key results achieved so far

i. Development of a draft MSP Action Plan – A strategic framework outlining steps for MSP implementation, including data collection, monitoring, and stakeholder engagement.
ii. Strengthened institutional and stakeholder collaboration – Increased participation from government agencies, NGOs, academia, and local communities, fostering a more inclusive marine governance process.
iii. Enhanced regional cooperation – Strengthened partnerships with promoting transboundary collaboration on marine governance.
iv. Progress toward establishing Marine Protected Areas (MPAs) – Initial frameworks for expanding MPAs and community-led conservation efforts to safeguard biodiversity.
v. Integration of MSP with Ghana's Sustainable Ocean Plan (SOP) – Aligning MSP initiatives with national and global frameworks, including SDG 14 (Life Below Water) and the UN Ocean Decade.

Conclusion

Ghana's MSP process represents a transformative approach to sustainable ocean governance, balancing ecological conservation with economic growth. By leveraging science, policy, and stakeholder engagement, the country is making significant strides toward a resilient and productive marine environment. Through continued capacity building, research-driven policies, and inclusive decision-making, Ghana is positioning itself as a leader in West Africa's sustainable blue economy (BE). The implementation of MSP is not just about conservation, it is about securing the ocean's future for generations to come.

Recommendation

i. Local expertise and technical capacity must be enhanced through targeted training programmes, technical partnerships and exchange programmes, educational outreach and community involvement
ii. There must be strong and continuous collaboration among diverse stakeholders.

Impact of the study on the national economy

The MSP initiative strengthens Ghana's blue economy by promoting sustainable fisheries, marine tourism, and renewable ocean energy**,** creating jobs and boosting coastal livelihoods. Additionally, it enhances marine resource management, reducing economic losses from overfishing, pollution, coastal erosion, and ensuring long-term economic resilience.

3.2 CLIMATE CHANGE, ENVIRONMENTAL MANAGEMENT AND GREEN TECHNOLOGY

3.2.1 POLLUTION AND WASTE MANAGEMENT

3.2.1.1 Monitoring and maintenance of water treatment facility at the Regional Office of the Bank of Ghana, Tamale

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

Collaborating Agency: Bank of Ghana, Tamale.

Introduction

The intake of water containing pathogenic organisms or toxic chemicals, often resulting from poor environmental conditions, poses 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 over time due to environmental factors. In October 2017, the Bank of Ghana, Tamale office, requested the CSIR-Water Research Institute, Tamale, after installing water treatment facilities on their premises on the 7th May, 2016, to continuously monitor the system to ensure effective operation of the installed water treatment devices and supply of good drinking water to its staff.

Objectives

The objectives were to:

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

Activities undertaken

Activities undertaken during the year included monthly replacement of water filters and quarterly bacteriological water quality assessment through the analysis of bacteriological parameters such as total coliform, faecal coliform, *Escherichia coli (E. coli)*, Faecal *enterococci*, *Pseudomonas aeruginosa*, *Clostridium perfringens*, and Total Heterotrophic Bacteria (THB).

Key results achieved so far

Results from the bacteriological analysis of water samples indicated that there was the presence of total and faecal coliforms and pathogenic organisms such as *Pseudomonas aeruginosa* in the source water. Total Heterotrophic Bacteria in the source water ranged from 160 to 1650 cfu/1ml. However, levels of all the analysed parameters in the treated water conformed to the Ghana Standards GS 175-1(2017) and WHO guidelines (2017) for potable use (Table 3.2.1).

Conclusion

It was concluded that the levels of the analysed bacteriological parameters of the treated water were completely satisfactory for use as a drinking source. Hence, the water treatment device was efficient in producing safe drinking water.

Table 3.2.1: Bacteriological analysis of water samples from the Bank of Ghana, Tamale.

First Quarter (January, 2024)	**Microbial analysis**						
ID/Parameter	**Total coliforms**	**Faecal coliform**	***E. coli***	**Faecal *enterococci***	***Pseudomonas aeruginosa***	***Clostriidum perfringes***	**THB**
Kitchen (Treated)	0	0	0	0	0	0	90
Main Premises (Source)	40	0	0	0	0	0	370
WHO Guidelines	0	0	0	0	0	0	-
Ghana Standards	0	0	0	0	0	0	≤500
Second Quarter (May, 2024)							
ID/Parameter	**Total coliforms**	**Faecal coliform**	***E. coli***	**Faecal *enterococci***	***Pseudomonas aeruginosa***	***Clostriidum perfringes***	**THB**
Kitchen (Treated)	0	0	0	0	0	0	280
Main Premises (Source)	10	0	0	0	0	0	1650
WHO Guideline	0	0	0	0	0	0	-
Ghana Standards	0	0	0	0	0	0	≤500
Third Quarter (July, 2024)							
(July, 2024)							
ID/Parameter	**Total coliforms**	**Faecal coliform**	***E. coli***	**Faecal *enterococci***	***Pseudomonas aeruginosa***	***Clostriidum perfringes***	**THB**
Kitchen (Treated)	0	0	0	0	0	0	120
Main Premises (Source)	20	0	0	0	0	0	1040
Who Guideline	0	0	0	0	0	0	-
Ghana Standards	0	0	0	0	0	0	≤500
Fourth/Final Quarter (October, 2024)							
ID/Parameter	**Total coliforms**	**Faecal coliform**	***E. coli***	**Faecal *enterococci***	***Pseudomonas aeruginosa***	***Clostriidum perfringes***	**THB**
Kitchen (Treated)	0	0	0	0	0	0	105
Main Premises (Source)	4	3	0	0	110	0	160
WHO Guideline	0	0	0	0	0	0	-
Ghana Standards	0	0	0	0	0	0	≤500

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

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.

Impact of the study on the national economy

The production of safe drinking water for the staff would reduce human health risks associated with the consumption of water of poor quality.

3.2.1.2 Microplastics in the Lower Volta Basin: Implications for Human Exposure

(Research Team: Pennante Bruce-Vanderpuije – Principal Investigator, Ruby Asmah)
Collaborating Agencies: Helmholtz-Zentrum Hereon, Institute of Coastal Environmental Chemistry, Geesthacht, Germany Ecology and Environment Research Centre

Introduction

Fish is a significant source of protein globally; however, contamination of aquatic environments by persistent organic pollutants (POPs) has been a global concern since the early 2000's. While many POPs are organic chemicals synthesized for beneficial purposes, serving as pesticides for pest control, their toxicity, resistance to degradation, and bioaccumulation in organisms, particularly in higher trophic levels like fish and humans highlight the global concern of POPs. The detrimental effects of POPs on fish and humans extend to reproductive, developmental, and hormonal processes, with the added potential of causing cancer in humans. These concerning properties of POPs resulted in the implementation of the Stockholm Convention in 2001 to minimize and eliminate their exposure to the environment. Despite the ratification of the Convention in 2003, Ghana is currently experiencing the detrimental effects of bioaccumulated POPs in its environment. In Ghana, POPs are continuously monitored to evaluate their current concentrations and potential health risks to the population under the convention. However, there is limited information on POPs in farmed fish in Ghana. Increasing cage farming activities within the Lower Volta Basin in Ghana underscores the importance of evaluating the concentrations of POPs in farmed fish within the basin. The study began in 2022 and ended in the reporting year.

Objective

The main objective was to assess the presence of POPs in freshwater fish from the Lower Volta Basin, and human exposure arising from the consumption of fish contaminated with POPs. The specific objectives were to:

- quantify the concentrations of POPs in farmed and wild fish;
- determine the spatiotemporal distribution of POPs in the Lower Volta Basin;
- estimate the sediment contamination of adsorbed POPs in the Lower Volta Basin; and
- assess the risk of human exposure from consumption of POP-contaminated freshwater fish.

Activities undertaken

During the year under review, data collected were analysed and comparison of results with that reported in literature was undertaken. Theses and technical report write-up were also considered.

Key results achieved so far

Most farmed and wild fish were free of PCBs, OCPs, and pesticide contamination, except farmed fish from Ada-Sogakope in the dry season. Chlorpyrifos was the dominant pesticide detected, but levels were below FAO/WHO safety limits. Sediments were contaminated with Chlorpyrifos across all sites in both seasons. Human health risk (HRI) was low for both adults and children consuming the fish.

Conclusion

The observations from this study showed that, except for farmed fish from Ada-Sogakope during the dry season, both farmed and wild freshwater fish were generally free from contamination by OCPs, PCBs, and OPs across sites during both dry and wet season. Chlorpyrifos emerged as the predominant organophosphate, with concentrations lower than the

maximum residue limit (MRL) proposed by FAO/WHO Codex Alimentarius. Sediment samples collected from all sampling sites were also found to be contaminated with OPs as Chlorpyrifos was the predominant pesticide during both dry and wet seasons. The health risk index (HRI) estimated did not exceed the threshold value of one (1). This indicates low human exposure to non-carcinogenic health risks for adults and children consuming fish heads (comprising mostly gills) and edible tissues of both farmed and wild freshwater fish across sampling sites along the Lower Volta Basin.

Recommendation

Recommendations given included:

i. Additional research could be conducted along the various sections of the Volta Basin to explore Organophoste (OP) occurrence and pathways of contamination in the Basin.
ii. Further research could be carried out to delve into species-specific contamination of pesticides. This would provide a detailed investigation into how different fish species within the Lower Volta Basin accumulate and are affected by pesticides.
iii. Further research could be carried out to compare concentrations of Chlorpyrifos and other OPs in fish, water, and sediment from the Volta Basin.
iv. Regulations on the use of Chlorpyrifos and other organophosphate pesticides in agricultural, industrial and household settings, could be strengthened and enforced. This would help minimize their concentrations in fish from the Lower Volta Basin.

Impact of the study on the national economy

The study will influence policy making and regulation of sources of POPs into the Volta Basin in Ghana, and contribute effectively to the promotion of good farm management practices which will significantly prevent organic chemical pollution of the Volta Basin in Ghana to enhance fish production from the aquaculture sector in Ghana.

3.2.1.3 TSS Measurements as a Snapshot of Water Quality in the Coastal, Southwestern, and Volta Rivers Systems of Ghana in 2024

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

Collaborating Agency: Water Resources Commission (WRC)

Introduction

Total Suspended Solids (TSS) is an important indicator of water quality, affecting aquatic ecosystems, biodiversity, and water usability for various purposes. Elevated TSS levels can reduce light penetration, disrupt aquatic life, and indicate severe pollution sources. Fine sediments in the water column increase turbidity, limit light penetration, and potentially reduce primary productivity (Kjelland, *et al*., 2015). The resultant decrease in primary production reduces food availability for aquatic organisms higher up the food chain (WRC, 2023; Wood and Armitage 1997). Ecotoxic substances such as heavy metals, pesticides, and nutrients such as phosphorus are adsorbed onto TSS and later settle on sediment to cause sediment pollution (Rossi *et al.,* 2006; Bilotta and Brazier, 2008). Suspended solids that settle out may smother or abrade benthic plants and animals, increasing invertebrate drift, and reducing the available habitat for benthic organisms (WRC,2023; Wood and Armitage, 1997). Where the TSS has a high organic content, the *in-situ* decomposition can deplete levels of dissolved oxygen in the water, producing a critical oxygen shortage condition called hypoxia, which can lead to fish kills. In 2024, a nationwide water quality monitoring programme was conducted across major rivers and lakes within the Coastal, Southwestern, and Volta Rivers Systems of Ghana to assess

the state of pollution using TSS as a key parameter. The study started in 2023 and is expected to end in 2030.

Objective

The objective was to evaluate the TSS levels in the three major river systems in Ghana to determine the extent of pollution and its implications for water quality management.

Activities undertaken

Field visits were conducted in February and July 2024 at designated monitoring stations across the three basins. Water samples were collected and transported to the laboratory for TSS analysis, as well as other physico-chemical parameters. The results were compared with the WRC (2003) guideline for TSS, which stipulates that levels should not exceed 100 mg/L in freshwaters.

Key results achieved so far

The TSS levels in the Coastal Systems were within the acceptable range (below 100 mg/L) in both February and July. In the Volta Systems, apart from Damango, Saboba, Sabari, Pwalugu, Daboya and Lawra, which had slight elevations of TSS above the guideline in July, levels of TSS in the other stations were within the guideline in both February and July. However, in the Southwestern Systems, alarming concentrations of TSS in the stations were recorded, with values reaching as high as 7,234 mg/l. Only three monitoring stations, Barekese Reservoir and Lake Bosomtwe (in both February and July), and Tanoso (in February only), recorded TSS levels below 100 mg/L (Figure 3.2.1). The extreme TSS levels indicate severe sedimentation and potential anthropogenic disturbances, such as deforestation, illegal mining, and industrial activities.

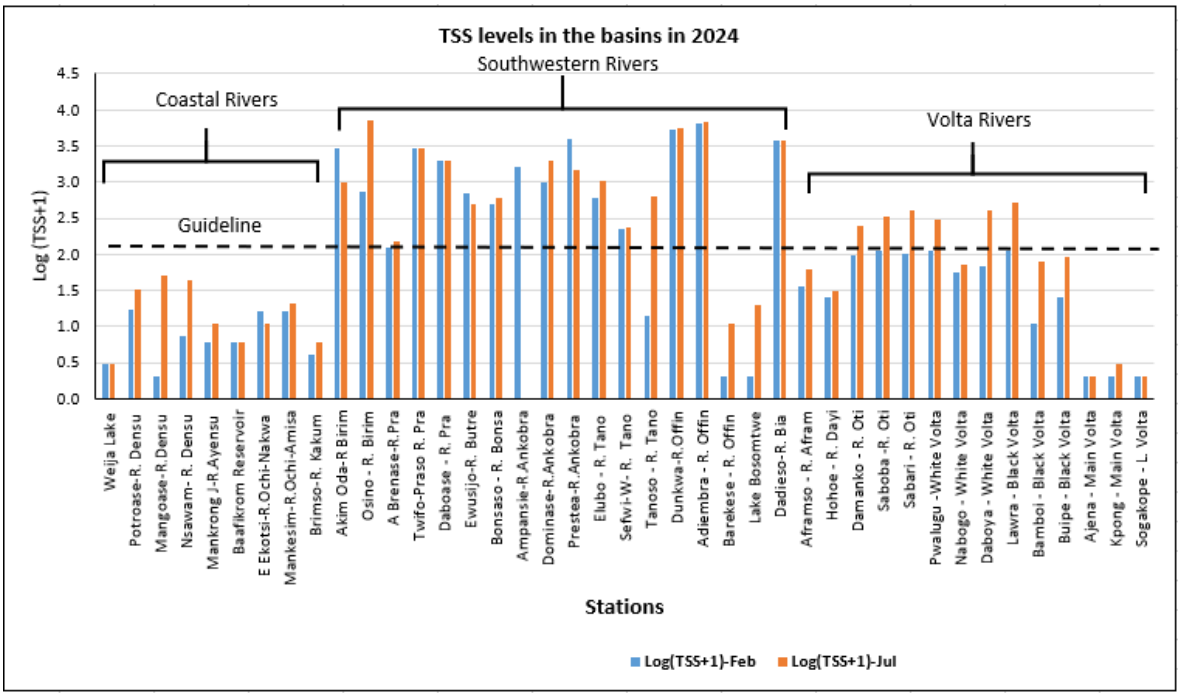


Figure 3.2.1: Seasonal concentrations of TSS in the River Systems in 2024.

Conclusion

Addressing TSS pollution is critical for sustaining aquatic biodiversity and ensuring the long-term viability of Ghana's freshwater resources. The monitoring results highlight significant disparities in TSS levels across the three River Systems. While the Coastal and Volta Systems

maintain good water quality concerning TSS, the Southwestern Systems exhibit extremely high levels, exceeding the WRC guideline by a wide margin. These findings call for urgent intervention measures to address sedimentation and pollution sources in the affected areas.

Recommendation

Recommendations given included:

- Investigation into the sources of high TSS in the Southwestern Systems, particularly in areas exceeding 100 mg/L.
- Implementation of sediment control measures such as reforestation and erosion control strategies.
- Strengthening regulations on land use and mining activities, which may be contributing to excessive sediment load.
- Regular monitoring and enforcement of water quality guidelines to maintain the ecological balance of the affected basins.

Impact of the study on the national economy

Water quality directly impacts national development by affecting drinking water supply, fisheries, agriculture, and industrial activities. High TSS levels can lead to increased water treatment costs, loss of biodiversity, and reduced fishery yields (Bilotta and Brazier, 2008; Bedu-Addo *et al.,* 2024), ultimately impacting food security and economic stability. The findings from this monitoring exercise provide crucial data for policymakers to formulate sustainable water management strategies, ensuring the long-term health of Ghana's water resources.

3.2.1.4 Community participation in governance and sustainability of rural water and sanitation systems in the Savannah Region, Ghana

(Research Team: Dr Prosper Bazaanah - Principal Investigator, Ing. Dr. Emmanuel Oboubie; Dr Sylvester Afram Boadi; Ing. Frank Oblim; Ing. Patricia Granaham and Mario Danban)

Collaborating Agencies: Future Africa Institute, University of Pretoria, Carnegie Corporation (New York), and Central Gonja District Assembly

Introduction

Access to clean water and sanitation is essential for human health, livelihoods, and overall well-being. Ensuring the sustainability of these critical services requires effective governance, where responsibility is shared between state agencies and citizens. Over time, governance systems have shifted away from top-down, hierarchical decision-making structures toward more participatory, bottom-up, and multi-level approaches. These models emphasize the inclusion of local communities in decision-making processes related to social amenities. In Ghana, despite efforts to improve water and sanitation services, many rural communities continue to face challenges in accessing these essential amenities. The persistence of these issues is attributed to a combination of inadequate infrastructure, governance inefficiencies, and poor maintenance practices. While state agencies and local governance structures have been established to address these challenges, the expected improvements have not been fully realized. To strengthen community involvement and ensure sustainability, the Community Ownership and Management Model (COMM) was introduced by the CWSA in 1994. This bottom-up approach aimed to foster local engagement, attract external funding, and integrate professional expertise into rural water and sanitation systems. However, the success of this model has been inconsistent. Many facilities, particularly in deprived areas, remain non-functional due to inadequate funding, weak community participation, and governance lapses. The Central Gonja District (CGD) exemplifies these struggles, with state-funded water and

sanitation facilities at risk due to governance and maintenance lapses. Although these systems are publicly funded, little research has been conducted to assess the effectiveness of governance structures established to maintain them at the community level. This study examines community participation in governance and the sustainability of drinking water and sanitation systems in the CGD, aiming to identify existing challenges and propose solutions for improved service delivery. The study began in 2022 and was completed in the reporting year.

Objectives

The main objective was to assess community participation in governance and sustainability of drinking water and sanitation systems at the Central Gonja District. The specific objectives were to:

- analyse the community residents' perceptions on the performance of community-based water and sanitation governance structures in rural settlements of the area;
- assess how the engagement of stakeholders in water governance decisions affects the sustainability of rural community water and sanitation systems, and finally; and
- propose strategies for enhancing participatory governance and sustainability of rural water and sanitation amenities in the district.

Activities undertaken

The study employed a mixed research approach, combining qualitative and quantitative methods to enhance data collection. A three-stage sampling procedure was used, beginning with stakeholder mapping to identify key institutional actors at the district level, including officials from the District Assembly, NGOs, and local government structures. The study involved a total of 420 participants, including 20 expert interviews and 400 household heads selected using Miller and Brewer's (2003) sample size formula. Households were proportionally sampled from various rural communities, and systematic random sampling ensured fair representation. Additionally, 24 community representatives participated in focus group discussions (FGDs) to provide insights into water and sanitation governance. The reconnaissance survey involved preliminary visits to map target communities, engage stakeholders, and gather demographic data, while a pilot study in Bilisikura helped refine data collection instruments before the main study. The research team included trained interpreters, assistants, and field data collectors to ensure accuracy and inclusivity. Stakeholder engagement protocols involved mapping key actors, analyzing relationships, and ensuring collaboration. FGDs were structured to allow gender-inclusive discussions, utilizing Participatory System Mapping to explore governance challenges and interventions. Data analysis was conducted using SPSS for quantitative insights and thematic coding for qualitative responses, with ethical considerations ensuring participant confidentiality. Secure data management practices, including encryption and cloud storage, were implemented to protect collected information. Additionally, validation forums were held to ensure participant input was accurately reflected in the final findings.

Key results achieved so far

Household drinking water and sanitation conditions: Most households access water from rivers and dams (45%), boreholes (31%), and pipe-borne sources (17%). Over half of these households (57%) must walk at least 16 minutes to fetch water, with 38% walking more than 20 minutes per trip. Only about 1% have water available on their premises. On average, 49% of households require 6 to 10 gallons (18 litres) of water daily, while approximately 36% need more than 10 gallons. Women, particularly adult females (82%) and female children (16%), bear the responsibility for fetching water, often spending hours walking due to the distances to

water sources. About, 74% of households do not treat drinking water before use. Solid waste is mostly disposed of by burning or incineration (14%) or in public pits (21%), while open defecation is common (89%). These practices are concerning as the primary water sources—*rivers and dams*—are vulnerable to pollution from runoff and waste.

Stakeholder engagement in water governance and sustainability of water and sanitation systems. The majority of respondents (79.8%) perceive their role as stakeholders to primarily involve providing labour support, such as addressing issues related to water and sanitation systems through hands-on tasks like repairs, maintenance, and operational assistance. Additionally, 43% contribute financially by funding repairs and facility upgrades, while 41% participate in decision-making processes, shaping policies, planning initiatives, and contributing to local regulations. Only a small percentage (9.3%) view their role as involving tariff setting, indicating limited stakeholder involvement in pricing and tariff decisions.

Perceptions on performance of water and sanitation governance structures in the communities: Respondents identified key local authorities involved in water and sanitation governance, including sanitary inspectors, chiefs, Unit Committees, Assembly members, and WATSAN. However, the performance of these authorities was generally viewed as poor. Many believed that these authorities lacked professional competence, sufficient commitment, and capacity to effectively manage water and sanitation issues. Additionally, residents perceived that decision-making processes did not fully involve the local communities. Concerns were also raised about the lack of accountability and transparency in governance, further undermining trust in these structures.

Strategies for enhancing participation in governance and sustainability of rural water and sanitation amenities: Key informant interviews revealed that while communities acknowledge the need for government support—particularly in the form of District Assembly funds, trained technicians (area mechanics), logistics, and capacity-building—they also emphasize the importance of active participation in decision-making. Ensuring that their interests and needs are integrated into water and sanitation policies requires direct community involvement. For participation to be meaningful, communities need access to adequate information and preparation. This can be achieved through targeted communication, education, and awareness campaigns, leveraging local media such as community radio and information vans to disseminate key messages effectively. During FGDs, participants stressed the need for stronger community mobilization, improved communication channels, and enhanced support systems, including inclusive leadership, funding, and labour contributions for the construction and maintenance of water and sanitation facilities. Key issues identified include the necessity to reduce dependence on external experts and to enhance local capacity for facility rehabilitation/ maintenance. This approach will promote ownership of infrastructure, ensuring their functionality and sustainability.

Conclusion

The results highlighted that communities in the district face challenges in water and sanitation amenities, resulting in the reliance on surface water sources and prevalence of open defecation. Pollution and health risks persist due to improper waste disposal practices. The weakness of the local governance structures in securing funds and engaging the community members exacerbates the situation. To improve governance and sustain these systems, stakeholder engagement, funding, and capacity-building initiatives should be strengthened. Communities need to be actively involved in decision-making and governance, ensuring that their needs and interests are reflected in policies and actions.

Recommendations

It was recommended that the District Assembly should:

i. strengthen community participation and build management capacities of the community water and sanitation governance structures;
ii. collaborate with CWSA to establish and train area mechanics/ community-led water facility maintenance teams and a regular maintenance schedule for water and waste management systems to minimize environmental contamination while ensuring their longevity; and
iii. develop and implement community awareness and education programs focusing on hygiene practices, the importance of water treatment, and proper sanitation methods.

Impact of the study on the national economy

Safe drinking water and basic sanitation are fundamental to economic growth, as they directly impact public health, livelihoods, and community well-being. However, the inefficiency of local governance structures in managing these resources underscores the need for a more comprehensive approach. Strengthening capacities and providing adequate resources for local structures are critical to achieving the national goal of universal access to water and sanitation. The study showed that sector strategies must be context-dependent and should be directed toward addressing governance, funding, capacities, leadership, and participatory challenges. This will empower residents to take ownership of their local water resources and encourage sustainable practices. The study points to the need to foster better collaboration between local authorities and residents, ensuring that governance reflects the needs and preferences of residents.

3.2.1.5 Environmental Studies- Biodiversity and Wetland for the Obuasi Redevelopment Project– Phase 3 (AngloGold Ashanti, Ghana)

(Research Team: Dr. Ruby Asmah - Principal Investigator, Dr. Kwadwo Ansong Asante, Dr. Mark Akrong, Dr. Frederick Logah, Mr. Theodore Quarcoopome, Dr. Collins Okrah, Dr. Deborah Darko, Dr. Prosper Bazaanah, Dr. Ayesha A. Amadu and Dr. Sylvester Boadi)

Introduction

AngloGold Ashanti Ghana Limited, Obuasi (AGAG) intends to construct a new Tailings Storage Facility called the Dokyiwa Tailings Storage Facility (DTSF) at its Obuasi Gold Mine site. The DTSF has a design capacity of 17.2 million tons of flotation tailings and an estimated operational life of 24 years (based on a tailing settled dry density of 1.5t/m^3). The DSTF is to be sited to the north of an existing facility (the South Tailings Storage Facility), which is close to the end of its operational life. The construction of the DTSF will require a diversion of the Supu stream, which flows from north-east to south-west of the mine through the proposed DTSF footprint, to flow from east to west and discharge into an adjacent valley north of DTSF. This is planned to ensure that storm waters from the upper reaches of the Supu stream flow into a clean environment downstream of the DTSF. The plan is that surface water affected within the footprint of the DTSF (Kwame Tawiah stream) will be collected through a system of underdrainage and decant barge and pumped back to the mine's holding dams for reuse while clean water around the perimeter of the DTSF will be diverted to the surrounding environment. In response to a request for consultancy services from AGAG, CSIR-Water Research Institute (CSIR-WRI) undertook among others, water quality assessment of the available water resources in the study area. The study was initiated and completed in the reporting year.

Objective

The specific objectives were to:

i. assess the present quality of water /ecological status in the study area;
ii. evaluate the availability of water resources in the study area; and
iii. evaluate the potential risk of the water resources to consumers downstream of the study areas upon construction of the Dokyiwa Tailings Storage Facility (DTSF).

Activities undertaken

Sampling was undertaken between 6th and 10th September, 2024. Nine surface water samples were collected from the Supu and Kwame Tawiah streams. In addition to the surface water, seven borehole samples were collected from four communities; Dokyiwa (2), Binsere (2), Ntonsua (2) and Ewiase (1) as well as four monitoring boreholes within the study area.

Key results achieved so far

The pH values of the surface waters ranged between 5.79 (Kwame Tawiah source) and 7.33 pH units (Kwame Tawiah Mid Stream). Except the source, the other values fell within the range of 6.0 to 8.5. The Supu source, Supu midstream, Kwame Tawiah source, Kwame Tawiah Regulatory Point and the site after Kwame Tawiah Regulatory Point, all exceeded the turbidity threshold of 5 NTU. Concentrations of calcium, magnesium, fluoride, chloride, potassium and sodium were predominantly low in the streams in relation to the water quality guidelines/standards. The sulphate levels measured at six of the nine sites were grossly above the WHO Guideline/Ghana Standard of 250 mg/L. The DO levels at Supu source and Supu midstream were relatively low considering the minimum of 5 mg/L for proper growth and development of aquatic life. Iron and manganese levels exceeded the WHO Guidelines/Ghana Standards at six and four of the sites, respectively.

The pH values of the community borehole samples fell between 5.45 (DOKYIWA DK-M1) and 6.90 pH units (BINSERE BS-HW6), with only BINSERE BS-HW6 satisfying the recommended WHO/GSA drinking water range of 6.5 – 8.5 pH units. For heavy metals, only iron concentrations from DOKYIWA DK-M1 and BINSERE BS-M1 were above the drinking water guideline/standard. The monitoring/control boreholes which are far from mining operations recorded pH values ranging between 5.83 (BH HG6-W) and 6.96 pH units (BH HG2-W). All the turbidity values of the monitoring boreholes exceeded the threshold of 5 NTU with borehole BH HG2-W having the highest of 207 NTU. Iron levels recorded for all the monitoring boreholes ranged between 0.388 and 3.10 mg/L, and were above the WHO Guideline/Ghana Standard. Also, concentration of manganese from BH HG6-W (10.5 mg/L) grossly exceeded the WHO Guideline/Ghana Standard of 0.4 mg/L. The levels of the other measured physico-chemical parameters for the community and monitoring boreholes were predominantly satisfactory.

For sediments, concentrations of copper from the Supu source as well as the Kwame Tawiah source exceeded the TEC limit. Additionally, the arsenic levels from the Supu Outlet, Supu 3 and especially the Supu-Kwame Tawiah confluence were above the TEC limit. The levels of the other heavy metals were however satisfactory. The percentage organic matter measured in the stream sediments ranged from 0.496 to 1.20%.

Recommendation

For the community boreholes, only one borehole from BINSERE-BS-HW6 (6.73 pH units) satisfied the WHO/GSA drinking water guideline/standard for pH (6.5 - 8.5 pH units). The rest

were acidic and therefore the boreholes must be limed and the pH adjusted to the acceptable range (6.5 - 8.5).
For heavy metals, iron concentrations from DOKYIWA (DK-M1) and BINSERE (BS-M1) were above the drinking water guideline/standard. These boreholes must be treated to reduce the iron concentration below the WHO/GSA drinking water guideline/standard of 0.3 mg/L

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

3.2.1.6 Removal of Phosphates from Aqueous Solution Using Oyster Shell

(Research Team: Mr. Jude Ofei Quansah - Principal Investigator, Mrs Sandra V. Asare, Dr Franklin Obiri-Nyarko)

Introduction
Industrialization and various human activities, including the discharge of untreated wastewater, have led to elevated nutrient levels (e.g., phosphate) in aquatic ecosystems across the country. This nutrient enrichment causes eutrophication, which can result in algal blooms, hypoxia, loss of biodiversity, and degradation of water quality–factors that can significantly impact human health. This environmental issue has prompted researchers to seek effective methods for phosphate removal and recovery from wastewater. One promising solution lies in utilizing oyster shell waste, which contains 37.4% calcium ions by dry weight. The calcium in oyster shells has the potential to adsorb phosphate ions from water, offering an eco-friendly approach to wastewater treatment. This study investigates the feasibility of using oyster shells to remove phosphate through batch adsorption experiments, focusing on key factors such as kinetics, equilibrium, thermodynamics, and the effects of pH. The study started in 2023 and ended in the reporting year

Objective
The main objective of the study was to investigate the adsorption capacity of oyster shells for removing of phosphate from water under batch experimental conditions.

Activities undertaken
Oyster shells were purchased from a local seafood market located in the southern part of the Greater Accra Region. The shells were thoroughly washed with distilled water to remove impurities and then air-dried at room temperature. After drying, the oyster shells were ground and sieved using a number 200 standard soil sieve (75 µm). The sieved material was thermally treated (activated) at 600 °C for 4 h. All prepared oyster shell samples were kept in a desiccator to prevent contamination. Batch adsorption experiments were performed by reacting 1.0 g of oyster shell with 50 mL of phosphate standard solution (10 mg/L) in 50 mL conical tubes at room temperature (25 °C) with agitation 150 rpm in a shaking incubator. Kinetic studies were carried out by varying the reaction time from 30 to 420 min using an initial phosphate concentration of 10 mg/l. Equilibrium batch experiments were performed using initial phosphate concentrations ranging from 5−100 mg/l and a reaction period of 1 h. Thermodynamic experiments were carried out by reacting 1.0 g of oyster shell with 50 mL phosphate solutions at temperatures of 15, 25, and 35 °C for 1 h. The effect of pH on phosphate adsorption was investigated using solutions adjusted to various pH levels with1 M HCl and 1 M NaOH. The pH of the solution was measured using an Oakton PC 450 pH meter.

Key results achieved so far

Kinetic studies

The adsorption kinetics of phosphate onto oyster shells were evaluated using pseudo-first-order and pseudo-second-order models. The results showed that phosphate adsorption was initially rapid, reaching equilibrium within the first three hours. This rapid uptake was followed by a slower adsorption phase, likely due to the saturation of available active sites on the oyster shell surface (Figure 3.2.2). The pseudo-second-order kinetic model provided a better fit to the experimental data, with a higher determination coefficient R^2 (0.998) compared to the pseudo-first-order model (Table 3.2.2). This suggests that the adsorption of phosphate ions onto the active sites of the oyster shell is governed by chemisorption.

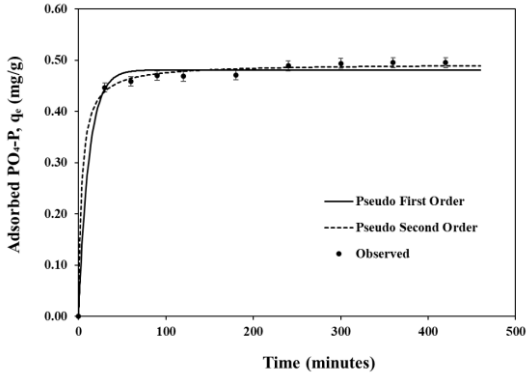


Figure 3.2.2: The kinetic adsorption of phosphate onto Oyster shell with the model fits of the pseudo-first order and pseudo-second order models (Initial concentration: 10 mg/L; Volume: 50 mL; Adsorbent dosage: 1.00 g; Reaction time: 0.5-7 h; Temperature: 25°C).

Table 3.2.2: Kinetics parameters for Phosphate adsorption onto Oyster shell.

Adsorbate	Pseudo-first-order				Pseudo-second-order		
	q_e (mg/g)	k_1(h^{-1})	R^2		q_e(mg/g)	k_2(mg/g/h)	R^2
Phosphate	0.497	6.51	0.750		0.493	0.551	0.998

Adsorption Isotherm

Adsorption isotherms describe the equilibrium distribution of target chemicals between liquid and solid phases. In this study, phosphate adsorption onto oyster shells was evaluated using the Freundlich, Langmuir, and Temkin isotherm and models. The Langmuir model, which assumes monolayer adsorption on a homogeneous surface, showed a maximum adsorption capacity of 3.42 mg/g (Table 3.2.3) and provided a better fit to the experimental data compared to the Freundlich and Temkin models (Figure 3.2.3). The favourability of the adsorption process was further tested using the dimensionless separation factor, R_L, as shown in Equation 1 below (Shoukat, *et al*., 2017).

$$R_L = 1/[1 + (K_L C_0)] \quad (1)$$

where K_L is Langmuir constant, and C_o is initial concentration. $0 < R_L < 1$ means positive absorption; $R_L > 1$ indicates an unfavourable adsorption.

The RL values for phosphate at initial concentrations of 5-100 mg/L fell within the range $0 < RL < 1$, indicating favourable phosphate adsorption onto oyster shells. The heat of adsorption was observed to decrease linearly with increasing sorption coverage due to interactions between adsorbent and adsorbate.

Table 3.2.3: Langmuir, Freundlich and Temkin isotherm constants for phosphate adsorption onto Oyster shell.

Langmuir isotherm			Freundlich Isotherm			Temkin isotherm		
Q_m (mg/g)	K_L (L/mg)	R^2	K_F (L/g)	n	R^2	b_T (kJ/mol)	K_T (L/mg)	R^2
3.42	5.18	0.991	0.090	1.39	0.975	3.94	0.239	0.976

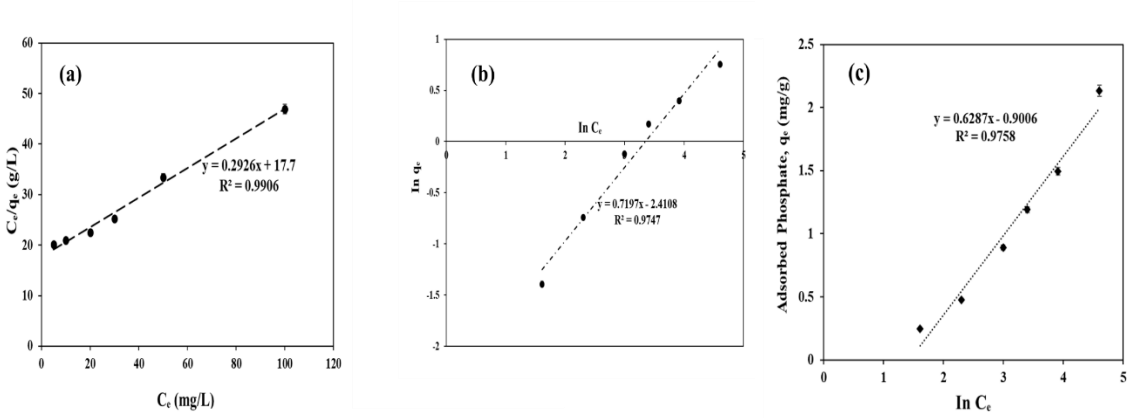


Figure 3.2.3: Phosphate adsorption to Oyster Shell as a function of equilibrium concentrations with (a) Langmuir (b) Freundlich and (c) Temkin isotherm model fits (Initial concentration: 5-100 mg/L; Volume: 50 mL; Adsorbent dosage: 1.0 g; Reaction time: 1 h; Temperature: 25°C).

Thermodynamics

The adsorption of phosphate onto oyster shells was found to be spontaneous, as indicated by the negative Gibbs free energy change values. Higher temperatures favour phosphate adsorption due to increased mobility and interaction between phosphate ions and the oyster shell surface. Phosphate adsorption shows positive enthalpy values, confirming that the adsorption is endothermic and increases with temperature. Additionally, the positive entropy change (ΔS°) reflects increased randomness at the solid-liquid interface, which is typical of chemisorption. (Table 3.2.4).

Table 3.2.4: Thermodynamic parameters for adsorption of phosphate on oyster shell (Initial concentration: 10 mg/L; volume: 50 mL; adsorbent dosage: 1.0 g; reaction time: 1 h; temperature: 25, 50, 75 °C).

Adsorbate	Temperature (K)	ΔH° (kJ/mol)	ΔS° (J/mol K)	ΔG° (kJ/mol)
Phosphate	298	66.3	0.242	-5.41
	323			-12.6
	348			-17.4

Effects of solution pH

Phosphate adsorption onto oyster shell at 25 °C, with an initial concentration of 10 mg/L, and an oyster shell dose of 1.0 g, investigated across a pH range of 2 – 12 is shown in Figure 3.2.4. Adsorption capacity of oyster shells increased rapidly with phosphate removal efficiency rising from 91.7% to 95.9%as the pH increased from 2 to pH = 4. This indicates that at lower pH levels the oyster shell surface becomes positively charged, enhancing phosphate removal through electrostatic attraction between the negatively charged phosphate ions and the protonated adsorbent surface

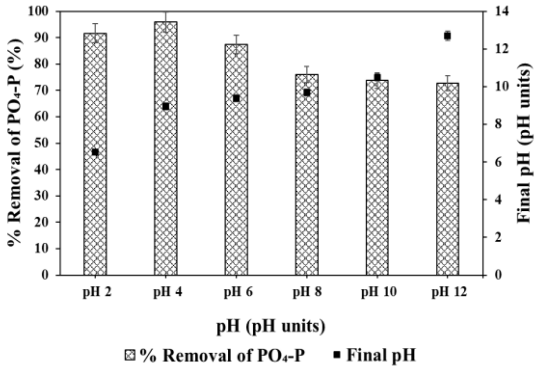


Figure 3.2.4: Influence of solution pH (2-12) on Phosphate-adsorption.

Conclusion

The study demonstrated that oyster shells are an efficient and cost-effective adsorbent for removing phosphate from wastewater, exhibiting ahigh adsorption capacity and a strong dependence on solution pH. However, further research is needed to explore the long-term stability of the oyster shells, optimize the adsorption process for large-scale applications, and assess their potential for removing other contaminants in diverse environmental conditions.

Impact of the study on the national economy

The study has shown the potential of oyster shells as a cost-effective adsorbent for removing phosphate from wastewater. These materials, readily available in large quantities, offer a viable solution to address the widespread pollution of aquatic systems across the country, particularly from nutrient contamination like phosphate.

3.2.1.7 Energising Landscapes: Lands, Livelihoods, and Energy Infrastructures in Ghana (EnergyScapes)

(Research Team: Ing. Dr. Deborah Darko – Co-Investigator)

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

Introduction

Energy availability and availability 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 study was initiated in the reporting year and is expected to end in 2026.

Objectives

The objective 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
The following were the activities undertaken during the reporting year:

Preliminary site visits and community entry: In the reporting period, the project team comprising researchers from Newcastle University, Durham University, University of Ghana, and University for Development Studies undertook preliminary site visits to the resettled and host communities in the three case study sites, to familiarise ourselves with the different contexts, to meet the leadership of the communities, mobilise support for the project and to recruit enumerators for the household surveys.

Development of research instruments: Also in this reporting period, the project team developed the research instruments, including semi-structured questionnaires and question guides for the household surveys as well as institutional and key informant interviews. The ethical clearance for the research was applied for and approved by the Newcastle University Review Board and the CSIR Institutional Review Board.

Recruitment and training of enumerators: A training workshop was conducted for 6 data enumerators recruited from the three case study sites. The training workshop was conducted online. Further, testing of the household instruments were also conducted and concluded in the case study sites.

Household surveys and institutional interviews: In this reporting period, household surveys were initiated in all case study sites. Additionally, institution and key informant interviews were commenced in the reporting period.

Key results achieved so far
The following were achieved in the reporting year:
i. Inception Workshop completed.
ii. Ethical clearance obtained.
iii. Household surveys completed in all three study sites.
iv. Post-doc Fellow recruitment processes concluded, and Post-doc Fellow recruited by Newcastle University.

Impact of the study on the national economy
Material impacts and outcomes will be well articulated towards the completion of the project.

3.2.1.8 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. The project was initiated in 2019 and is expected to end in 2025.

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; and
vi. enhance the capacity of researchers, PhD students and stakeholders of how to incorporate climate resilience into water management.

Activities undertaken

Project Co-ordination/leadership: The CREAM team at CSIR-WRI led by the PI/Coordinator (Ing. Dr. Emmanuel Obuobie) coordinated efforts of all project partners and work packages in the implementation of project activities planned for the 2024 year. Additionally, the PI/Coordinator led the preparation of the project's 2023 technical report and supported the finance team to prepare the project's 2023 financial report, both of which were submitted to the DANIDA Fellowship Centre.

Hydro-meteorological data collection and maintenance of field equipment: Four rounds of routine data collection from groundwater, streamflow and meteorological equipment installed in the Pra and Densu River Basins were conducted in March, June, September and December of 2024. Specific data collected were river water levels and discharges, groundwater levels, rainfall, minimum and maximum temperatures and relative humidity. The data have been

processed and archived. In addition to the data collection, routine maintenance works were performed on all the data collection equipment. During the data collection and equipment maintenance, the research team engaged with Science Teachers and Students of Nyameyehene Primary and Junior High School (Figure 3.2.5), Nyameyehene, near Nyinahin in the Ashanti Region and used the climate station installed on their school premises to educate them on climate science including the measurement of weather parameters as well as climate change and its impact on water resources.

Figure 3.2.5: CREAM project team engaging with JHS Science Teachers (left) and students (right) of Nyameyehene Primary and Junior High School, Nyameyehene, Ashanti Region.

Data analysis, modelling and PhD students theses compilation: In the reporting year, the different work packages of the project made good and varied progress with data analysis, modelling, compilation of PhD theses and preparation of manuscripts for publication. Except for work package 2, which had 90% modelling and data analysis completion level, all the work packages completed their modelling and data analysis by December 2024. Two of the 7 PhD students on the project successfuly defended their theses and graduated. Two other students submitted their theses to the graduate schools at the University of Ghana and KNUST for evaluation towards completion of their studies. The remaining 3 students are on track to complete and submit their theses by March 2025.

Participation in Science Engagement at the Danish Embassy: In June 2024, 5 project staff, led by the PI/Coordinator (Emmanuel Obuobie) participated in a science engagement meeting organized by the project funding agency, Danida Fellowship Centre (DFC) at the Danish Embassy in Accra. The meeting brought together the 5 projects in Ghana that are currently funded by DFC, to share and exchange knowledge on common elements and to learn from each other in areas that each project had excelled. The Project PI presented an overview of the CREAM project including progress made, challenges encountered and how the challenges were resolved. The team made new contacts for future research collaborations.

Project visit by DFC: A project management team from DFC, comprising Project Manager (Line Richter) and Senior financial Controller (Samieh Shumar), visited the CREAM project team on 7th June, to interact with both the technical and financial staff of the project and to discuss detailed progress made as well as challenges encountered with respect to the technical and financial implementation of the project. Most project staff, both technical and accounts, availed themselves for the meeting, which was a successful one. The project coordinator, work package leads, PhD students and project accountant made presentations on progress made. This was followed with discussions on the presentations and what new lessons there were for improving the management of the DFC funding arrangements in general. The DFC team was

impressed with progress made on both the technical and financial fronts and took some lessons from the CREAM project for informing the general administration of DFC projects.

Second mid-term reporting to DFC: The second mid-term report for the DFC was prepared and submitted following the one-year project extension, which was primarily due to COVID-19 related delays. This comprehensive progress report was compiled by the Project PI/Coordinator, incorporating contributions from work package leaders and PhD students. The report was submitted to the DFC on June 27th, 2024, and subsequently approved on September 25th, 2024.

Conference attendance for dissermination of results: Four project staff, led by the PI/Coordinator, participated in the 4th Annual Meeting of the Mediterranean Geosciences Union held in Barcelona, Spain, from 25th to 28th November 2024. The team made 3 presentations, based on 3 abstracts submitted and accepted. The abstracts were:

i. Odametey, S., Obuobie, E., Mensah, A. Nukpeza, D. and Pabi, O. Towards Water-related Ecosystem Services (WRES) assessments in the Densu River Basin (DRB) of Ghana: evaluating water supply and sediment retention dynamics over time. Mediteeanean Geoscience Union 4th Annual Meeting, 25-28 November 2024, Barcelona, Spain.
ii. Osei-Owusu, M., Obuobie, E., Adjei, K.A. and Stisen, S. Evaluating the performance of single and multi-site calibration to simulate streamflow and estimation of water balance in the Pra River Basin using the SWAT model. Mediteeanean Geoscience Union 4th Annual Meeting, 25-28 November 2024, Barcelona, Spain.
iii. Akurugu, B.A., Stisen, S., Yidana, S.M., Seidenfaden, I.K., Obuobie, E. and Chegbeleh, L.P. Assessing the potential impacts of abstraction and recharge using numerical groundwater flow modelling for the Densu River Basin, Ghana. Mediteeanean Geoscience Union 4th Annual Meeting, 25-28 November 2024, Barcelona, Spain.

Publications and Draft manuscripts: No publication was made in 2024. However, the project team drafted 3 journal manuscripts; 1 acepted, 1 submitted to a journal for review and publication and 1 manuscript under internal review by co-authors, all of which have been listed below:

i. ***Manuscript accepted for publication*****:** Akurugu, B.A., Yidana, S.M., Obuobie, E., Seidenfaden, I.K., Stisen, S., Chegbeleh, L.P. Groundwater Recharge Estimation from Multiple Independent Methods in the Fractured Hard Rock Aquifers in the Densu River Basin, Ghana, Sustainable Water Resources Management, *accepted and under production for publication.*
ii. ***Manuscript Submitted*****:** Osei-Owusu, M., Adjei, K.A., Koch, J., Stisen, S., Seidenfaden, I.K. and Obuobie, E. Evaluating the effectiveness of three imputation techniques to reconstruct gaps in daily streamflow time series. Journal of hydrological Sciences (*under review*).
iii. ***Manuscript under internal review*****:** Obuobie, E., Osei-M.A., Agyekum, J., Addi, M., Boadi, S.A. and Oblim, F.T. Spatio-temporal changes in extreme rainfall and temperature in CORDEX-CMIP5 models at the Pra River Basin in Ghana, West Africa (*to be submitted to Climate Change Journal in December 2024*).

Key results achieved so far

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 drafted journal manuscripts for publication;
iv. Two completed student theses; and
v. Two PhD graduates

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 (SDGs), particularly goals 1 (no poverty), 6 (clean water and sanitation) and 13 (climate action).

3.2.1.9 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 (Senigal), Centre for Space Science and Technology Education (CSSTE, Nigeria), Institut Supérieur d'Etudes Spatiales et Télécomunications (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 includes 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 began in 2022 and is expected to end in 2026.

Objectives
The specific objectives of the Institute's 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:

Flood contingency planning: In February 2024, the CSIR-WRI team for the GDZHIOA project, led by the coordinator Ing. Dr. Emmanuel Obuobie, partnered with the National Disaster Management Organization (NADMO) National Office to enhance the flood contingency planning capabilities of 20 institutional and local stakeholders. These stakeholders were drawn from a diverse range of organizations, including the Ghana Police Service, Ghana Fire Service, Red Cross, Water Resources Commission, Ghana Ambulance Service, Nandom Municipal Assembly, Nandom Agricultural Department, Nandom FM Station, NADMO District and Regional Offices, and selected local communities. The CSIR-WRI and NADMO team guided and supported the stakeholders in developing a draft flood contingency plan specifically for the Nandom Municipal Assembly. This draft plan underwent a table-top simulation exercise, which effectively identified both its strengths and weaknesses. Following the simulation, the stakeholders collaboratively discussed and recommended solutions to address the identified weaknesses. The drafted flood contingency plan was subsequently utilized during the 2024 flood season and is currently being finalized by the Nandom Municipal Assembly and NADMO for ongoing implementation. Figure 3.2.6 illustrates scenes from the flood contingency planning workshop.

Figure 3.2.6: A section of stakeholders trained in flood contingency planning in the Nandom Municipal Assembly.

Empowering individuals and local communities to adapt to climate and flood risks: To co-identify flood and climate threats affecting individuals and communities in the Nandom and Lawra Municipalities, the CSIR-WRI team, led by Ing. Dr. Emmanuel Obuobie and supported by the NADMO-Nandom District Office and the Water Resources Commission, conducted a two-day workshop. This workshop engaged 20 representatives from 19 communities within the two districts. Participants also discussed existing adaptation strategies employed by individuals and communities to address these identified risks. Furthermore, the workshop served as a platform to introduce successful and innovative interventions from other regions in Ghana and globally facing similar flood and climate challenges. Brief surveys were administered to participants to assess the suitability and acceptability of these new interventions within their local contexts, evaluate the potential opportunity costs associated with their adoption, and understand participants' intentions to implement any of the introduced measures. Figure 3.2.7 presents scenes from the flood and climate risks workshop with community members.

Database on past and ongoing flood initiatives and programmes in Ghana: In the reporting period, data collection continued on past and ongoing flood initiatives and programmes in Ghana. Seven additional initiatives were identified, comprising 5 past projects and 2 ongoing projects. All relevant data on each initiative was collected and archived in the geo-referenced database developed in 2023.

Figure 3.2.7: Participants in Lawra (left) and Nandom (right) being led by CSIR-WRI facilitators to discuss and identify climate and flood risks to individuals and communities in their respective districts.

Supervision of MSc Student internship/thesis: The supervision of the internship and thesis of the GDZHIAO project's student (Felicia Dogbey – KNUST) was completed in the reporting period. Felicia successfully completed her internship with CSIR-WRI in March 2024 and submitted her MSc thesis to the graduate school of KNUST in September 2024. She is awaiting feedback from KNUST's external examiner and date from KNUST for her thesis defence and graduation.

Preparation of journal and mass media publications: Two mass media publications in the form of blogs have been drafted. One covers the processes used for the development of the draft flood contingency plan for the Nandom Municipal Assembly, while the other was based on the flood/climate risks workshop. Outlines for 2 journal papers, also based on the flood contingency planning and the flood/climate risks were developed. These will form the basis for developing 2 peer reviewed journal papers in 2025.

Key results achieved so far

Result achieved in the reporting period included:

i. Draft flood contingency plan prepared for the Nandom Municipal Assembly.
ii. Flood/climate risks to individuals and communities in the Nandom and Lawra Districts co-identified, together with current and new potential interventions.
iii. Data on flood projects, programmes and initiatives in Ghana collected and archived.

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.

3.3 BIOMEDICAL AND PUBLIC HEALTH

3.3.1 BIOMEDICAL, BIOSAFETY AND ETHICS

3.3.1.1 Developing Appropriate Prescription and Guidelines for the Treatment and Prevention of Urinary Tract Infections in Elderly Nursing Homes in Accra; The Molecular Way

Subtitle: Virulence Genes Profiling of Candida Species Isolated from Urine Samples of the Aged in Ghana

(Research Team: Emmanuel Armah - Principal Investigator, Lawrencia Osae-Nyarko, Mawutor Kwame Ahiabu, Isaac Agyapong, Bright Idun, Freda Kwarteng Boampong, Grace Kwaku-Anim, Judith Wayo, Naa Adjeley Kuma, Queenstar Dedei Quarshie, Abena Konadu Owusu-Senyah Enninful, Faisal Nuru-Ahmed, Frank T. Aboagye, Steven Tawiah, Jessica Acquaye, Mike Yaw Osei-Atweneboana, Nicholas Dayie)

Collaborating Agency: The foundation to prevent antimicrobial resistance (PAR foundation)

Introduction

Urinary tract infection (UTI) remains one of the most prevalent infections in both nosocomial and community-acquired infections. UTI can be caused by both bacteria and fungi. In the past decade, the incidence of UTIs caused by fungal species, especially *candida species* (candiduria), has increased by 2-3 times. Candiduria can exist as either asymptomatic or symptomatic, although majority of patients who excrete Candida in their urine are asymptomatic. The pathogenicity of both symptomatic and asymptomatic candiduria are determined by various virulence factors. These virulence factors are yet to be fully understood. Elucidating the mechanism employed by these virulence factors in emerging drug-resistant yeast pathogens will contribute immensely to the development of novel target-specific drugs in future. In this study, we identified different candida species that exist amongst the elderly in a nursing care home and a tertiary hospital in Accra, Ghana. We also identified the various virulence that underline their pathogenicity. The study began in 2022 and is expected to end in 2025.

Objectives

The objectives were to:

- identify the various species of candida from urine cultures; and
- determine the virulence gene profile of fungal isolates species.

Activities undertaken

The following activities were undertaken during the reporting period:

- ***Sample collection for hospitals and nursing homes***
  A cross-sectional design was employed for this study, which was conducted from September 2022 to December 2024 and focused on 100 consenting adults at nursing care homes and the 37 Military hospital in the Greater Accra Region of Ghana.
- ***Microbial isolation***
  The urine samples were cultured on Sabourouth Dextrose Agar (SDA) for primary isolation of fungal pathogens. They were then sub-cultured on Candida differential chrom Agar. The various colors of the fungal isolates were used to identify the type of candida.

- ***Molecular detection of virulence genes***
  QIAGEN extraction kit was used to extract the DNA of the pure colonies of the candida species based on the manufacturer's protocol. The extracted DNAs were subjected to a multiplex PCR to screen for four virulence genes. (Table 3.3.1)

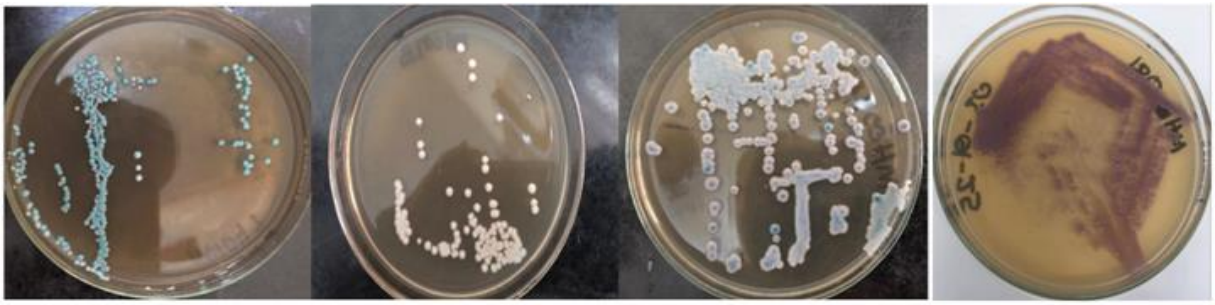
Table 3.3.1: Primers used to amplify virulence genes of candida species.

Primer	Primer Sequence	SIZE (bp)
INTI	F-AAGTATTTGGGAGAAGGGAAAGGG	310
	R-AAAATGGGCATTAAGGAAAAGAGC	
SAP 1	F-TCAATCAATTTACTCTTCCATTTCTAACA R-CCAGTAGCATTAACAGGAGTTTTAATGAC	161
ALSI	F-GACTAGTGAACCAACAAATACCAGA R-CCAGAAGAAACAGCAGGTGA	318
ICL1	F-TGA TGC TGA CACTGGTCATGGTG R-CTCTGGCAACATCCCAGTTGAAG	599

Key results achieved so far

Microbial differentiation of candida albicans species

Out of the 100 isolates, 30 of them were identified as candida species and were subjected to microbial differentiation using Hichrome Candida Differential Agar (Figure 3.3.1). Based on the colours and morphology of these candida species, they were identified as *C. krusei* (10, 30%), *C. albicans* (6, 20%), *C. tropicalis* (7, 23.3%) and *C. glabrata* (7, 23.3%) (Table 3.3.2).



C. krusei *C. albicans* *C. tropicalis* *C. glabrata*

Figure 3.3.1: Microbial identification of candida species.

Table 3.3.2: Prevalence of candida species.

Candida species	Number, n=30	Percentage (%)	Colony colour
C. glabrata	10	30	purple
C. albicans	6	20	Cream
C.tropicalis	7	23.3	Whitish blue
C.krusei	7	23.3	blue

Virulence factor profiling of fungal isolates

The DNAs of all the 100 fungi isolates were screened for the presence of various virulence genes using quadruplex PCR. The various virulence were detected in 70 of these samples (Figure 3.3.2), as follows: Agglutinin-like sequence 1 ALS1(25, 35.72%), Secreted aspartyl proteases 1 SAP 1 (13, 18.57%), Induced Chitinase-Like protein ICL 1, (17, 24.29%) and Intracellular protein INT 1 (15, 21.24%) (Table 3.3.3).

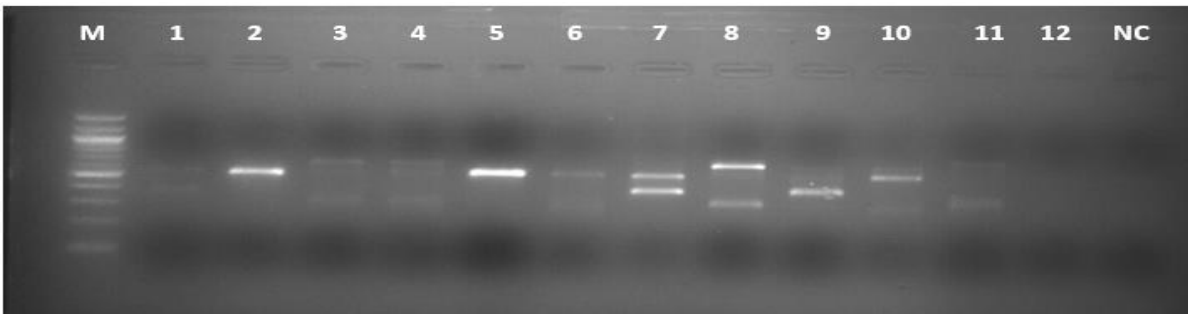


Figure 3.3.2: PCR gel image showing virulence gene profiling (M is marker and NC is negative control, samples 1 to 11 show amplification for various virulence genes, sample 12 is negative)

Table 3.3.3: Prevalence of virulence genes amongst fungal isolates		
Virulence factor	**Number n=70**	**Percentage (%)**
Agglutinin-like sequence 1 (ALS1)	25	35.72
Secreted aspartyl proteases 1 (SAP 1)	13	18.57
Induced Chitinase-Like protein *(ICL 1)*	17	24.29
Intracellular protein (INT 1)	15	21.42

Conclusion

The study has been able to use microbial and molecular tools to characterize candida species and also to determine the virulence gene profile of the fungal isolates.

Recommendation

Further researches should focus on virulence of fungi, especially candida species.

Impact of the project on national economy

Investigations have revealed the need to tackle the issue of urinary tract infections and candidiasis in immunocompromised elderly generation. In a long run, this report would contribute to tackling UTIs and would ensure a healthy elderly Ghanaian generation.

3.3.1.2 Whole genome sequencing of multidrug resistant *E. coli* isolates

(Research Team: Dr. Balagra Kasim Sumabe - Principal Investigator)

Collaborating Agency: West African Center for Cell Biology of Infectious Pathogens (WACCBIP)

Introduction

Antibiotic resistance is a global public health problem and is associated with increased hospitalizations, health costs, and mortality, the result of which is the exertion of selective pressure to favour the emergence of resistant strains. The misuse of antibiotics by the public is a major factor contributing to the rise of antimicrobial resistance (AMR). Antibiotics are also misused in poultry and animal farms, contributing to the rise in AMR through resistant gene transfer from animal/poultry to humans and vice versa. The project uses whole genome sequencing approach to study the pattern of AMR resistance in *E. coli* isolates from poultry and humans. It was initiated in the reporting year and is expected to end in 2025.

Objective

The objective was to identify antibiotic resistant genes, mobile genetic elements and diversity of multidrug resistant (MDR) *E. coli* isolates

Activities undertaken

The following activities were carried out during the year:

i. generated pure culture of MDR *E. coli* isolates
ii. isolated the DNA of selected MDR *E. coli* isolates
iii. DNA library preparation and sequencing of 20 selected MDR *E. coli* isolates
iv. Bioinformatic analysis of sequenced data

Key results achieved so far
During the reporting period, antibiotic resistant and virulence genes in MDR *E. coli* isolates were identified. However, analysis of sequence data was ongoing.

Conclusion
Whole genomes of selected *E. coli* isolates from poultry and humans were successfully sequenced and assembled as shown in the Quality check (QC) report. Relevant plasmids, virulent and AMR genes isolates have been identified. Analysis of the sequence data is still ongoing.

Impact of the study on the national economy
Antimicrobial resistance is a global public health threat that contribute significantly to high mortality and high cost of treatment particularly in developing countries including Ghana. Investigating the prevalence and patterns of virulence and AMR genes between humans and poultry will contribute to knowledge on how to combat antimicrobial resistance.

3.3.1.3 In-silico assessment of *Cryptolepis sanguinolenta* compounds as potential anti-schistosomiasis therapy

(Research Team: Gideon Twieku, Manfred Dakorah Asiedu, Charity Serwaa, Theodora Agbotui, Lawrencia Osae-Nyarko, Naa Adjeley Kuma, Mike Yaw Osei-Atweneboana, Samuel Armoo)

Introduction
Schistosomiasis is a neglected tropical disease which affects 250 million individuals worldwide, with the majority in Sub-Saharan Africa. Current disease management involves mass drug administration (MDA) with praziquantel. However, low patient compliance and ineffectiveness against immature stages of the parasite have resulted in treatment failures. The Glutathione S-transferases (GSTs) of the *Schistosoma mansoni* parasite is responsible for detoxification and protection from the human host immune system. Due to the importance of GST to the parasite, inhibiting this protein could lead to the accumulation of toxins and death. Plant-based therapeutics have been used throughout history with wide acceptability across the world due to their affordability and availability. *Cryptolepis sanguinolenta* (Ghanaian quinine) is a plant native to West African, and used for the treatment of malaria and hypertension, and could also be repurposed for the treatment of other parasitic infections. Recent advances in computer-aided drug designing (CADD) platforms have resulted in cost- and time-efficient drug development pathways. As such, coupling the rich source of information in plants and traditional medicine with advanced computational tools could serve as an ideal platform for identifying new therapies for schistosomiasis. The study was initiated and completed in the reporting year.

Objective
The objective was to identify *Cryptolepis sanguinolenta* compounds that can potentially treat schistosomiasis infections.

Activities undertaken
Compounds from *C. sanguinolenta* which were used in a molecular docking simulation against Schistosoma mansoni GST (SmGST) using praziquantel as a reference drug. The compounds were further assessed for drug likeness and toxicity. Compounds that passed all these parameters were then used in a molecular dynamics simulation to assess the stability of their binding interactions with SmGST.

Key results achieved so far
Ten compounds were identified to have better binding affinities than praziquantel. However, only four of these compounds passed all drug-likeness parameters and showed considerable toxicity patterns with cryptolepinoic acid identified as an ideal lead compound for drug development. Molecular dynamics simulations further showed that the interactions of these compounds were stable and had slightly higher binding free energies than praziquantel.

Conclusion
Cryptolepinoic acid was identified as an ideal compound for further testing as a potential lead compound for developing schistosomiasis therapeutics. The high number of inhibitors identified from the docking runs indicates *C. sanguinolenta* is rich in compounds that could be extracted for schistosomiasis treatment.

Recommendation
It was recommended that further studies should be conducted on *C. sanguinolenta* to obtain extracts that can be tested against the larval stages of the *Schistosoma* parasite. It is also recommended that cryptolepinoic acid should be extracted and tested as a lead compound in a formulation for schistosomiasis therapy.

Impact of the study on the national economy
C. sanguinolenta is a common plant used to treat malaria in Ghana with great success. Repurposing this plant for schistosomiasis treatment would boost the herbal medicine market, increase the availability of medication for disease treatment and also help efforts to eliminate schistosomiasis by 2030.

APPENDICES

APPENDIX I: Membership of the Management Board

No.	Name	Designation
1.	Mr. Anthony Boateng	Chairman
2.	Prof. Mike Y. Osei-Atweneboana	Member
3.	Ing. Dr. Worlanyo K. Siabi	Member
4.	Mr. Samuel K. Appenteng	Member
5.	Mr. Magnus Nunoo	Member
6.	Mrs. Genevieve Yankey	Member
7.	Ing. Dr. Daniel Asenso-Gyambibi	Member
8.	Mr. Emmanuel Asiedu-Darko	Secretary

APPENDIX II: Membership of the Internal Management Committee (IMC)

No.	Name	Designation
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. Etornyo Agbeko	Officer-In-Charge, ARDEC – Akosombo
13.	Dr. Emmanuel Tetteh-Doku Mensah	Officer-In-Charge, Tamale Office
14.	Dr. William Wilson Anku	President, Research Staff Association (RSA) – Local
15.	Mr. Samuel Kanati	Rep. CSIR Administrators Association Ghana (CAAG)
16.	Mr. Evans Osei	Rep. Senior Staff Association (SSA)
17.	Mr. Francis A. Boakye	Chairman, Trade Union Congress (TUC) – Local
18.	Mrs. Rebecca Tekpertey	Administrative Officer (Secretary)

APPENDIX III: 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.	Mr. Emmanuel Asiedu-Darko	Principal Administrative Officer
5.	Mr. Frederick Yeboah	Principal Accountant
6.	Ing. (Dr.) Emmanuel Obuobie	Senior Research Scientist
7.	Ing. (Dr.) Frederick Y. Logah	Senior Research Scientist
8.	Dr. Collins Okrah	Senior Research Scientist
9.	Mr. Humphrey F. Darko	Senior Research Scientist
10.	Mr. Theodore Quarcoopome	Senior Research Scientist
11.	Mrs. Regina Banu	Senior Research Scientist
12.	Dr. Mark O. Akrong	Senior Research Scientist
13.	Dr. Michael Kumi	Senior Research Scientist
14.	Mrs. Sarah Penstil	Senior Research Scientist
15.	Dr. Samuel Armoo	Senior Research Scientist
16.	Dr. Francis A. Anani	Senior Research Scientist
17.	Ing. Dr. (Mrs.) Deborah Darko	Senior Research Scientist
18.	Dr. Emmanuel Tetteh-Doku Mensah	Senior Research Scientist
19.	Dr. Agbeko Etornyo	Senior Research Scientist
20.	Dr. Seth K. Agyakwah	Research Scientist
21.	Dr. Elias Asuming-Brempong	Research Scientist
22.	Dr. Franklin Obiri-Nyarko	Research Scientist
23.	Mr. Patrick A. Mainoo	Research Scientist
24.	Dr. Gerard Quarcoo	Research Scientist
25.	Mr. Solomon A. Owiredu	Research Scientist
26.	Ms. Saada Mohammed	Research Scientist
27.	Mr. Evans Manu	Research Scientist
28.	Dr. (Mrs.) Rhoda Lims Diyie	Research Scientist
29.	Mr. Michael Dorleku	Research Scientist
30.	Mr. William E. Arko	Research Scientist
31.	Mrs. Zita Naangmenyele Abuntori	Research Scientist
32.	Mr. Edward J. Tettevi	Research Scientist
33.	Dr. Pennante N. A. Bruce-Vanderpuije	Research Scientist
34.	Dr. Mariam Y. Ameveworwor	Research Scientist
35.	Dr. Frank Adu-Nti	Research Scientist
36.	Dr. Raymond Kojo Agbadi	Research Scientist
37.	Dr. Yaw Adjei Anane	Research Scientist
38.	Dr. Prosper Bazaanah	Research Scientist
39.	Dr. Patrick S. K. Fatsi	Research Scientist
40.	Dr. Emmanuel Koboja Magna	Research Scientist
41.	Dr. Lawrencia Osae-Nyarko	Research Scientist
42.	Dr. Betty Bandoh Oppong	Research Scientist
43.	Dr. Akua Kyerewa Botwe	Research Scientist
44.	Dr. Appiah Ebenezer Koranteng	Research Scientist
45.	Dr. Sylvester A. Boadi	Research Scientist
46.	Dr. Jacob Agyekum	Research Scientist
47.	Dr. Sumabe Kasim Balagra	Research Scientist
48.	Dr. Ayesha A. Amadu	Research Scientist
49.	Dr. Joseph Harold Osei Nyarko	Research Scientist
50.	Mr. Kwabena O. Benson	Scientific Secretary
51.	Mr. Emmanuel O. Armah	Assistant Research Scientist

No.	Name	Designation
52.	Ing. Ralph Tagoe	Assistant Research Scientist
53.	Mrs. Martha Agyemang Duku	Assistant Research Scientist
54.	Mrs. Sandra V. Asare	Assistant Research Scientist
55.	Mrs. Mercy Johnson-Ashun	Assistant Research Scientist
56.	Ms. Hawa Ahmed	Assistant Research Scientist
57.	Mr. Bismark A. Akurugu	Assistant Research Scientist
58.	Ing. Gabriel Appiah	Assistant Research Scientist
59.	Mr. Franz A. Gaisie-Essilfie	Assistant Research Scientist
60.	Mr. Faisal A. Nuru-Ahmed	Assistant Research Scientist
61.	Mr. Mark Osei-Owusu	Assistant Research Scientist
62.	Mr. Jude O. Quansah	Assistant Research Scientist
63.	Mr. Martin A. Adakpeya	Assistant Research Scientist
64.	Mrs. Lady B. A. Adomako	Assistant Research Scientist
65.	Mrs. Theodora L. E. Agbotui	Assistant Research Scientist
66.	Mr. Haruna Zaid	Assistant Research Scientist
67.	Mr. Divine W. Hotor	Assistant Research Scientist
68.	Mr. Emmanuel Adu-Ofori	Assistant Research Scientist
69.	Mr. Deryl N. O. Kuevi	Assistant Research Scientist
70.	Dr. Nyamadi Akpene Aku	Assistant Research Scientist
71.	Mr. Imoro Nfayem	Assistant Research Scientist
72.	Mrs. Abigail N. Akuetteh	Assistant Research Scientist
73.	Mr. Eugene Sintim Gyabaah	Assistant Research Scientist
74.	Ms. Adelina Akuamoah Boateng	Assistant Research Scientist
75.	Ing. Patricia Granaham	Assistant Research Scientist
76.	Ing. Frank T. Oblim	Assistant Research Scientist
77.	Mrs. Karyn Ewurama Quansah	Assistant Research Scientist
78.	Nana Aso Amonoo	Assistant Research Scientist
79.	Ms. Queenstar Dedei Quarshie	Assistant Research Scientist
80.	Mr. Acheampong Addo	Assistant Research Scientist
81.	Mrs. Dora D. Ocran	Assistant Research Scientist
82.	Mr. Daniel K. Amoah	Assistant Research Scientist
83.	Ms. Millicent Adu-Boakye	Assistant Research Scientist
84.	Ms. Yaa Asabea Agadzi	Assistant Research Scientist
85.	Mr. Simeon Nii Laryea Odametey	Assistant Research Scientist
86.	Mr. Ebenezer Ofosu-Nkrumah	Marketing Officer
87.	Mr. Samuel Kanati	Administrative Officer
88.	Mrs. Rebecca Tekpertey	Administrative Officer
89.	Mrs. Lydia Kusi	Administrative Officer
90.	Ms. Sylvia Amponsah	Public Relations Officer
91.	Mrs. Doris Damoah	Accountant
92.	Mrs. Regina A. Atsu	Accountant
93.	Ms. Sem Shelipstics	Accountant
94.	Engr. Simon K. Anane	Estate Officer
95.	Mrs. Esther Mate-Ahmed	Accountant
96.	Ms. Matilda A. Tagoe	Accountant
97.	Ms. Salima Abdulai	Administrative Officer
98.	Ms. Clarissa Y. Nutsugah	Marketing Officer
99.	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. Richard K. Kwapong	Principal Assistant Printer
26.	Mr. Ebenezer D. Mensah	Principal Works Superintendent
27.	Mrs. Doris Derpog Neequaye	Principal Administrative Assistant
28.	Mr. Bright K. Idun	Principal Technical Officer
29.	Mr. Isaac Kwarteng	Senior Works Superintendent
30.	Mr. Lawrence Yawson	Senior Technical Officer
31.	Ms. Naa Adjeley Kuma	Senior Technical Officer
32.	Mr. Emmanuel Boadu Kwakye	Senior Technical Officer
33.	Mr. Isaac Agyapong	Technical Officer
34.	Mr. Bright Selorm Amedorme	Technical Officer
35.	Mr. Manfred Dakorah Asiedu	Technical Officer
36.	Ms. Freda Kwarteng	Technical Officer
37.	Mr. Felix J. Ofosu	Technical Officer
38.	Mr. Abdul-Rahaman Mohammed-Sadat	Technical Officer
39.	Ms. Dorothy Lomo-Mainoo	Technical Officer
40.	Ms. Getrude Nortey	Technical Officer
41.	Ms. Nawal Moro Buri	Technical Officer
42.	Mr. Mario Chrisk	Technical Officer
43.	Mr. Samuel Birikorang	Technical Officer
44.	Mr. Evans Tarko Dankwa	Technical Officer
45.	Mr. Thompson G. Nyamesah	Technical Officer
46.	Mr. Issahaku Tofic	Technical Officer
47.	Mr. Samuel Kwadwo Debrah	Technical Officer
48.	Mr. Kelvin Kweku Donkor	Technical Officer
49.	Ms. Grace Kwaku-Anim	Technical Officer
50.	Ms. Joyce Kplorla Kusorgbor	Technical Officer
51.	Mr. Joel John Otchere-Baffour	Technical Officer
52.	Ms. Abena Konadu Owusu-Senya	Technical Officer
53.	Mr. Gideon Twieku	Technical Officer
54.	Mr. Frank Twumasi Oppong	Technical Officer
55.	Ms. Cindy Xolali Anane	Technical Officer

No.	Name	Designation
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 Boakye 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.	Mr. Joseph Danso	Assistant Transport Officer
70.	Ms. Felicity Hope Mortey	Auditing Assistant
71.	Ms. Abigail Sefah	Marketing Assistant
72.	Ms. Rejoice Darkey	Marketing Assistant
73.	Mr. Ebenezer Okantey	Marketing Assistant
74.	Ms. Lucy Adu	Administrative Assistant
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. Charles S. Bonful	Security Officer
84.	Mr. Kassim B. Seidu	Security Officer
85.	Mr. Jones Ofori	Security Officer
86.	Mr. Anthony K. Morkeh	Security Officer
87.	Mr. Mike Ben Niekye	Security Officer
88.	Mrs. Doris Obeng Bekoe	Front Desk Officer
89.	Mr. Alexander Siaw	Works Superintendent

Staff Distribution among the Divisions and Sections

Division/Section	Senior Members	Senior Staff	Junior Staff	Total
Directorate	3	-	-	3
Commercialization	4	10	1	15
Surface and Climate Change	12	1	-	13
Ground Water and Geoscience	8	5	-	13
Environmental Chemistry and Sanitation Engineering	14	10	-	24
Environmental Biology, Biotechnology & Health	7	8	-	15
Biomedical and Public Health Research Unit	20	12	-	32
Fishery and Aquaculture	18	5	9	32
Finance	6	9	-	15
Audit Unit	1	1	-	2
Administration	5	16	1	22
• Transport	-	4	5	9
• Estate Section	1	1	10	12
• Security Section	-	7	13	20
Total	99	89	39	227
Contract Appointment				
• Directorate	1	1	-	2
• CSIR College of Science and Technology (CCST)	1	-	-	1
• Fishery and Aquaculture Division	-	1	5	6
• Research Support Office	1	-	-	1
• Estate	-	-	3	3
Total	3	1	8	13
Overall Total	102	91	47	240

APPENDIX IV: Human Resource Activities

Post Retirement Contract Appointment /Contract Appointment

No.	Name	Designation	Staff Category	Division	Effective Date
1.	Prof. Joseph A. Ampofo (PRC)	Chief Research Scientist	Senior Member	CSIR-WRI	31-Dec.- 2023 to 30 Dec.-2025
2.	Ms. Grace Narh	Labourer	Junior Staff	FAD	01-Feb.-2024 to 31 Jan.-2025
3.	Mr. Enoch Ahadzi	Labourer	Junior Staff	FAD	01-Feb.-2024 to 31 Jan.-2025
4.	Mr. Mohammed Sani	Labourer	Junior Staff	FAD	01-Feb.-2024 to 31 Jan.-2025
5.	Mr. Owiredu Darkwah	Labourer	Junior Staff	FAD	01-Feb.-2024 to 31 Jan.-2025
6.	Mr. Stephen Amanor Tetteh	Farm Hand	Junior Staff	FAD	01-Feb.-2024 to 31 Jan.-2025
7	Ms. Phillipa Akuamoah Boateng	Assistant Farm Manager	Senior Staff	FAD	29-Jan.-2024-28-Jan.-2025
8	Mr. Samuel Annang	Driver	Senior Staff	Admin	02 Apr.-2024 to 31 Mar.-2025
9	Ms. Sogloba Disayikom	Cleaner	Junior Staff	Estate	10 Jan.-2024 to 9 Jan.-2025
10	Mr. Eric Kresti	Technical Officer	Senior Staff	FAD	02 Apr.-2024 to 30 Sept. 2024
11	Mr. Joseph Daani	Gardener	Junior Staff	Estate	01 Nov.-2023 to 31 Oct.-2024
12	Ms. Abigail Adobea	Cleaner	Junior Staff	Estate	01 Nov.-2023 to 31 Oct.-2024

Promotion/Upgrading

Senior Members

No.	Name	Division	Previous Designation	Current Designation	Effective Date
1	Dr. Michael Kumi	ECSED	Senior Research Scientist-Non-PhD	Senior Research Scientist- PhD Scale	10-May-2023
2	Dr. Gerard Quarcoo	EBBHD	Research Scientist	Research Scientist-PhD Scale	1-Nov.-2024
3	Ms. Millicent Adu-Boakye	ECSED	Chief Technical Officer	Assistant Research Scientist	12-Nov.-2022
4	Ms. Yaa Asabea Agadzi	FAD	Chief Technical Officer	Assistant Research Scientist	30-Sept.-2023
5.	Ms. Matilda Asinor Tagoe	Finance	Principal Accounting Assistant	Accountant	3-Sept.-2023

Transfer

No.	Name	Designation	Category of Staff	Division/ Section	From	To	Effective Date
1.	Mr. Frederick Yeboah	Principal Accountant	Senior Member	Finance	CSIR-Head Office	CSIR-WRI	15-Apr.-2024
2.	Mr. Emmanuel Kwakye Boadu	Senior Technical Officer	Senior Staff	FAD	CSIR-Head Office	CSIR-WRI	02-May -2024

Senior Staff

No.	Name	Division	Previous Designation	Current Designation	Effective Date
1	Ms. Lucy Adu	ADMIN.	Administrative Assistant	Senior Administrative Assistant	1-Jan.-2024
2	Mrs. Dorothy Krodua	ADMIN.	Principal Admin. Assistant	Chief Admin. Assistant	1-Jan.-2024
3	Mr. Lawson Maximillian Abaah	CD	Principal Technical Officer	Chief Technical Officer	1-Jan.-2024
4	Mr. Fredrick Sakyi	Finance	Principal Stores Superintendent	Chief Stores Superintendent	1-Jan.-2024
5	Mr. Eric Yaw Darko	GWGD	Principal Technical Officer	Chief Technical Officer	1-Jan.-2024
6	Ms. Millicent Amegazo	ADMIN.	Senior Catering Assistant	Technical Officer (Catering Officer)	1-Jan.-2016
7	Ms. Judith Wayo	BPHRU	Technical Assistant	Technical Officer	4-Dec.-2023
8	Mr. Frank Twum Aboagye	BPHRU	Technical Assistant	Technical Officer	19-Dec.-2022

Resignations

No.	Name	Designation	Category of Staff	Division/ Section	Effective Date
1.	Dr. Ruth Ayanful-Torgby	Research Scientist	Senior Member	BPHRU	2-May-2024
2.	Dr. Obed Fiifi Fynn	Research Scientist	Senior Member	GWGD	26-Oct.-2024
3	Dr. Aaron Albert Aryee	Research Scientist	Senior Member	ECSED	1-Oct.-2024
4	Dr. William Wilson Anku	Research Scientist	Senior Member	ECSED	31-Dec.-2024
5	Mr. Emmanuel Kwabena Opoku	Assistant Research Scientist	Senior Member	SWCCD	1-Jul.-2024
6	Ms. Lilly Konadu Osei	Assistant Research Scientist	Senior Member	FAD	18-Nov.-2024
7	Mr. Victor Agyeman	Administrative Officer	Senior Member	ADMIN.	1-Aug.-2024
8	Ms. Joyce Ofosuah Appiah	Principal Administrative Assistant	Senior Staff	ADMIN.	1-Feb.-2024
9	Mr. Kwame Mawutor Ahiabu	Technical Officer	Senior Staff	BPHRU	30-Jun.-2024
10	Mrs. Doretta Aboagye-Debrah	Purchasing Assistant	Senior Staff	Finance	2-Nov.-2024
11	Mr. Kwame Anim Afriyie	Technical Officer	Senior Staff	ECSED	2-Sept.-2024
12	Mr. Michael Mawuenyiga Agbeti	Technical Officer	Senior Staff	FAD	12-Dec.-2024

Terminations

No.	Name	Designation	Category of Staff	Division/ Section	Effective Date of Termination
1.	Mr. Richard Kuddy	Principal Technical Officer	Senior Staff	ECSED	10-Aug.-2024
2.	Ms. Linda Akosua Nuamah	Principal Technical Officer	Senior Staff	EBBHD	05-Oct.-2024

Death

No.	Name	Designation	Category of Staff	Division/Section	Effective Date of Death
1.	Mr. Obed Asamoah	Junior Foreman	Junior Staff	ADMIN. (Estate)	10-May-2024

Compulsory Retirements

No.	Name	Designation	Category of Staff	Division/ Section	Effective Date of Retirement
1.	Dr. George Tetteh Mensah	Senior Research Scientist	Senior Member	EBBHD	10-Aug.-2024
2.	Dr. (Mrs.) Marian Amu-Mensah	Senior Research Scientist	Senior Member	ECSED	05-Oct.-2024
3.	Ms. Deborah Adjei	Technical Officer	Senior Staff	FAD	27-Dec.-2024
4.	Mr. Mahmud Amidu	Administrative Assistant	Senior Staff	ADMIN.	22-Feb.-2024
5.	Mr. John Kofi Mensah	Senior Stores Superintendent	Senior Staff	Finance	12-Aug.-2024
6.	Mr. Alfred Adjetey Adjei	Chief Accounting Assistant	Senior Staff	Finance	11-Aug.-2024
7.	Mr. George Asante	Supervisor Grade I	Junior Staff	ADMIN. (Estate)	19-Jan.-2024

APPENDIX V: Human Resource Development - Staff Pursuing Various Courses – 2024

No.	Name of Officer	Designation	Training Required	Division/ Section	Date Started	Programme Duration	Expected Date for Completion	Full Time/ Weekend	Status
1.	Mr. Michael Dorleku	Research Scientist	PhD. Analytical Chemistry (UCC)	ECSED	Aug, 2019	3 years	Aug, 2023	Local (Full-Time)	Submitted Thesis for assessment
2.	Ms. Saada Mohammed	Research Scientist	PhD. Environment and Health (Vrije Universiteit, Amsterdam)	ECSED	Sept, 2017	4 years	Aug, 2021	Foreign (Full time)	Awaiting Graduation
3.	Mrs. Regina Banu	Senior Research Scientist	PhD. Environmental Sanitation and Waste Management (KNUST)	EBB&HD	Sept, 2017	4 years	Sept, 2021	Local (Full-Time)	Ongoing
4.	Mrs. Lady Asantewah Boamah Adomako	Assistant Research Scientist	PhD. Medical Microbiology (Univ. of Ghana, Legon)	EBB&HD	Jan, 2023	4 years	Jan, 2025	Local (Full-Time)	Ongoing
5.	Mr. Mark Osei Owusu	Assistant Research Scientist	PhD. Water Resources Engineering Management (KNUST)	SWCCD	Sept, 2019	4years	Sept, 2023	Local (Full-Time)	Final stages of thesis
6.	Mr. Serapis Asiedu Appiah	Chief Technical Officer	MPhil Environmental Science (Sanitation and Engineering) (Univ. of Ghana)	ECSED	Nov, 2021	2years	Nov, 2023	Local (Full-Time)	Awaiting Graduation
7.	Mr. Franz Alex Gaise Essilfie	Assistant Research Scientist	PhD Climate Change and Land Use (KNUST)	SWCCD	Sept, 2019	4years	Sept, 2023	Local (Full-Time)	Final stages of thesis
8.	Mr. William Ekow Arko	Research Scientist	PhD Environmental Engineering (China Univ. of Geosciences, Wuhan)	ECSED	Sept, 2019	4years	Sept, 2023	Foreign (Full-Time)	Extended
9.	Mr. Patrick A. Mainoo	Research Scientist	PhD. Geophysics (KNUST)	GWGD	Sept, 2019	4years	Sept, 2023	Local (Full-Time)	Extended
10.	Mr. Victor Mante	Chief Technical Officer	MSc. Water Supply and Environment Sanitation (KNUST)	ECSED	Jan, 2023	2years	Jan, 2025	Local (Full-Time)	Ongoing

11.	Mr. Selorm Borbor	Principal Technical Officer	MPhil. Microbiology (Univ. of Ghana)	EBB&HD	Jan, 2023	2years	Jan, 2025	Local (Full-Time)	Ongoing
12.	Ms. Gertrude Nortey	Technical Officer	MPhil. Environmental Science (Univ. of Ghana)	EBB&HD	Jan, 2023	2years	Jan, 2025	Local (Full-Time)	Ongoing
13.	Mr. Sadat Abdul Rahman	Technical Officer	MPhil. Statistics Biostatistics and Data Analysis (Univ. of Ghana)	BPHRU	Jan, 2023	2years	Jan, 2025	Local (Full-Time)	Ongoing
14.	Mr. Samuel Kanati	Administrative Officer	Chartered Institute of Human Resource Management (CIHRM)	Admin	Jan, 2023	2years	Jan, 2025	Weekend	Ongoing
15.	Ms. Dorothy Lomo-Mainoo	Technical Officer	MPhil. Applied Parasitology (Univ. of Ghana)	EBB&HD	Jan, 2022	2years	Jan, 2024	Local (Full-Time)	Ongoing
16.	Mr. Faisal A. Nuru	Assistant Research Scientist	PhD. Applied Health Sciences (Univ. of Aberdeen, UK)	BPHRU	March, 2022	3years	March, 2024	Foreign (Full-Time)	Ongoing
17.	Mr. Emmanuel Odartei Armah	Assistant Research Scientist	PhD. Microbiology (Univ. of Ghana)	BPHRU	Jan, 2023	4years	Jan, 2027	Local (Full-Time)	Ongoing
18.	Mr. Solomon Amoah Owiredu	Research Scientist	PhD. Fisheries Oceanography (Jesu National University, Korea)	FAD	Sep, 2019	4years	Sept, 2023	Foreign (Full-Time)	Extended
19.	Ms. Hawa Ahmed	Assistant Research Scientist	PhD. Biomedical Science (The Nottingham Trent University)	EBB&HD	Oct, 2023	4years	Oct, 2027	Foreign (Full-Time)	Ongoing
20.	Mr. Evans Manu	Research Scientist	PhD Hydrogeology (German Research Center for Geosciences)	GWGD	Aug, 2016	4years	July, 2020	Foreign (Full-Time)	Extended (Programme & Institution Changed)
21.	Mrs. Benedicta Osei-Tutu	Chief Administrative Assistant	MBA. Human Resource Management (Methodist Univ. Ghana)	Admin.	August, 2023	2 years	Aug, 2025	Local (Weekend)	Ongoing
22.	Mrs. Priscilla Ampofo-Yeboah	Chief Administrative Assistant	MBA. Human Resource Management (Central University)	Admin.	Oct, 2023	2 years	Oct, 2025	Local (Weekend)	Ongoing
23.	Ms. Joyce K. Kusorgbor	Technical Officer	MPhil. Aquaculture (CCST)	FAD	Oct, 2022	2 years	Oct, 2024	Local (Full-Time)	Ongoing

24.	Mr. Benjamin Tenkorang Boakye	Purchasing Assistant	MBA Accounting and Finance (UPSA)	Finance	September, 2023	2 years	Sept, 2025	Local (Weekend)	Ongoing
25.	Mr. Gideon Tweiku	Technical Officer	MPhil Molecular Medicine (KNUST)	BPHRU	January, 2023	2 years	Jan, 2025	Local (Full time)	Ongoing
26.	Mrs. Zita Naangmenyele Abuntori	Research Scientist	PhD. Irrigation and Drainage Engineering (UDS)	ECSED (Tamale)	Nov, 2020	3 years	Nov, 2023	Local (Full time)	Final stages of thesis
27.	Ms. Amanda Maasoyuor Karbo	Administrative Assistant	MBA. Human Resource Management (Wisconsin Intl. Univ. Col.)	Admin.	Mar, 2024	2 years	Mar, 2026	Local (Weekend)	Ongoing
28.	Mrs. Rebecca Tekpertey	Administrative Officer	Chartered Institute of Human Resource Management	Admin.	September, 2024	10 months	July, 2025	Local (Weekend)	Ongoing
29.	Ms. Rejoice Darkey	Marketing Assistant	MBA. Corporate Communications (UPSA)	CD	September, 2024	2 years	August, 2026	Local (Weekend)	Ongoing
30.	Mrs. Theodora L.E Agbotui	Assistant Research Scientist	PhD. Chemistry (Univ. of Ghana, Legon)	BPHRU	October, 2024	4 years	September, 2028	Local (Full-Time)	Ongoing
31.	Ms. Cindy Xolali Anane	Technical Officer	MPhil. Medical Microbiology (Univ. of Ghana)	EBB&HD	October, 2024	2 years	October, 2026	Local (Full-Time)	Ongoing
32.	Nana Afua O. Boateng	Administrative Assistant	MBA. Human Resource Management (Univ. of Ghana, Legon)	Admin.	October, 2024	2 years	September, 2026	Local (Weekend)	Ongoing
33.	Esther Anyeley Sowah	Chief Technical Officer	MPhil Environmental Science (Univ. of Ghana, Legon)	ECSED	October, 2024	2 years	September, 2026	Local (Full time)	Ongoing
34.	Michael Afram Danquah		MPhil Environmental Science (Univ. of Ghana, Legon)	ECSED	October, 2024	2 years	September, 2026	Local (Full time)	Ongoing
35.	Alex Yeboah	Chief Accounting Assistant	MBA Accounting (Univ. of Cape Coast)	Finance	December, 2024	2 years	November, 2026	Local (Full time)	Ongoing

APPENDIX VI: National Service and Industrial Attachment

National Service Personnel Posted to the Institute in 2024

NO.	NAME	INSTITUTION	PROGRAMME	DIVISION
1	Appiah Jackline Yaa Anima	KNUST	BSc. Chemistry	ECSED
2.	Assan Emmanuel Sylvester	ATU	HND Science Laboratory Technology	ECSED
3.	Amenuvor Vincent Mawuko	ATU	HND Science Laboratory Technology	ECSED
4.	Halidu Osman Umar	KNUST	BSc. Petrochemical Engineering	ECSED
5.	Dakurah Genevieve	Dr. Hilla Limann Technical University	HND Science Laboratory Technology	ECSED
6.	Haruna Abdul-Rashid Iman	ATU	HND Science Lab. Tech.	ECSED
7.	Akoto Akosua Nhyira	UG	BSc. Physical Science (Chemistry)	ECSED
8.	Masawudu Nasiru Larry	KNUST	BSc. Petrochemical Engineering	ECSED
9.	Quainoo Abena	KNUST	BSc. Chemistry	ECSED
10.	Owusu Success	ATU	HND Science Laboratory Technology	ECSED
11.	Dornyo Kingsley Mawuko	UG	BSc. Physical Sciences (Chemistry)	ECSED
12.	Ohene-Aboagye Edmund Junior	ATU	HND Science Laboratory Technology	ECSED
13.	Viala Emmanuel Albert	KNUST	BSc. Natural Resource Mgt.	FAD
14.	Akissi Mimi	KNUST	BSc. Aquaculture & Water Res. Mgt	FAD
15.	Blavo Wisdom Listowell	KNUST	BSc. Aquaculture & Water Resource Mgt.	FAD
16.	Ankobea-Ansah Vanessa Agatha	KNUST	BSc. Aquaculture & Water Resource Mgt.	FAD
17.	Ewudzie-Baah Rushud	KNUST	BSc. Aquaculture & Water Resource Mgt.	FAD
18.	Shardow Yasin	KNUST	BSc. Agriculture	FAD
19.	Nutsukpo John Sena	UG	BSc. (Earth Sciences)	GWGD
20.	Nkrumah Francis Kojo	KNUST	BSc. Geological Eng.	GWGD
21.	Ackom Jabez Kweku	KNUST	BSc. Physics	GWGD

NO.	NAME	INSTITUTION	PROGRAMME	DIVISION
22.	Mensah Yvonne	KNUST	BSc. Physics	GWGD
23.	Kpanka Aida	ATU	HND Civil Engineering	SWCCD
24.	Asante Elizabeth	KTU	BTech Civil Engineering	SWCCD
25.	Ablordeppey Patience	KTU	BTech Civil Engineering	SWCCD
26.	Mensah Gabriel Dela	KNUST	BSc. Agricultural Engineering	SWCCD
27.	Ahwa Naa Tekour	KNUST	BSc. Agricultural Engineering	SWCCD
28.	Kom-Teye Grace Korkor	UG	BSc. Biological Sciences	EBB&HD
29.	Mustapha Codjoe Zainab	UG	BSc. Biological Sciences	EBB&HD
30.	Antwi Priscilla	UENR	BSc. Biological Sciences	EBB&HD
31.	Ampofo-Yeboah Akua Akomah	KNUST	BSc. Biological Sciences	EBB&HD
32.	Konotey Mabel Tetekie	KNUST	BSc. Biological Sciences	EBB&HD
33.	Antonio Lydia Wendy Daikuor	KNUST	BSc. Biological Sciences	EBB&HD
34.	Okyere Christbani Daniel	UG	BSc. Biological Sciences	EBB&HD
35.	Blessed Princess	UG	BSc. Biological Sciences	EBB&HD
36.	Berning Sandra Serwaa	UG	BSc. Biological Sciences	EBB&HD
37.	Safori Augustina Dartebea	UG	BSc. Biological Sciences	EBB&HD
38.	Osei Eric Darko	UHAS	BSc. Medical Biochemistry & Molecular Biology	BPHRU
39.	Nyave Lovinger Mckeown	UCC	BSc. Biomedical Sciences	BPHRU
40.	Osei Frederick	KNUST	BSc. Agriculture Biotechnology	BPHRU
41.	Boamah Nana Kojo	KNUST	BSc. Agricultural Biotechnology	BPHRU
42.	Brown Isaac Ato	KNUST	BSc. Biochemistry	BPHRU
43.	Acquaye Jessica	KNUST	BSc. Biochemistry	BPHRU
44.	Anane Kwaku Hanani Judah	UHAS	BSc. BSc. Medical Biochemistry & Molecular Biology	BPHRU

NO.	NAME	INSTITUTION	PROGRAMME	DIVISION
45.	Lartey Dennis Nii Lartey	ATU	BTech Medical Lab. Science	BPHRU
46.	Sasu George Dwamena	UCC	BSc. Molecular Biology and Biotechnology	BPHRU
47.	Owusu Josephine	All Nations University	BE. Biomedical Engineering	BPHRU
48.	Atuahene Dennis	UCC	BA Population and Health	BPHRU
49.	Acolatse Seyram Mawulorm Awo	KNUST	BSc. Herbal Medicine	BPHRU
50.	Akpaglo Vastyn-Wonderssen	UHAS	BSc. Medical Biochemistry and Molecular Biology	BPHRU
51.	Mutalib Billkiss	All Nations University	BE. Biomedical Engineering	BPHRU
52.	Hammond Ringland Dei	UG	BA. Information Studies & Political Science	CD
53.	Dornu Jeremiah Teye	UG	BSc. Administration (Marketing)	CD
54.	Inkoom Gyan Alex	KNUST	BA. Communication Design	CD
55.	Osman Ida	UG	BA Accounting and Sociology	CD
56.	Amarh Christian Ashitey	UPSA	BA in Public Relations Management	CD
57.	Tagri Francis	ATU	HND Purchasing & Supply	Finance
58.	Ahiabu Jacqueline Fafa	UG	BSc. Administration (Accounting Option)	Finance
59.	Oblado Albert Owusu Yaw	UG	BA Economics with Mathematics	Finance
60.	Anang Godwin Akpor	ATU	HND Secretaryship & Mgt. Studies	Administration
61.	Oti Boakye Gladys Serwaah	UG	Diploma in Public Admin.	Administration
62.	Sarfo Kantanka Cheyenne	UPSA	BBA Human Resource	Administration
63.	Coomson Gideon Arhin	Central University	BA in Theology	Administration
64.	Alice Mensah	University of Ghana	BA Psychology	Administration
65.	Kojo Osei Bonsu	GIMPA	BSc Public Administration	Administration

Attachment Students Posted to the Institute in 2024

No	NAME OF STUDENT	INSTITUTION	PROGRAM	DIVISION
1.	Adom Kwasi Osei- Fofie	Hohai University (China)	BSc Harbour, Costal & Offshore Engineering	SWCCD
2.	Jessica Sedjoah Wepare	University of Ghana (UG)	BA Geography and Sociology	SWCCD
3.	Julius Komla Agbanyo	UG	BA Geography and Sociology	SWCCD
4.	David Barnor	KNUST	BSc Aquaculture & Water Resources Management	FAD
5.	Inusah Sugri Princess	UG	BSc Fisheries Science	FAD
6.	Senah Ellen Adubea	UG	BSc Agricultural Science	FAD
7.	Beatrice Emefa Goka	UG	BSc Marine Science	FAD
8.	Juliet Korkor Teye	UG	BSc Biological Science	EBB&HD
9.	Erica Nana Ama Esaaba Buabin	UG	BSc Biological Science	EBB&HD
10.	Kingsley Asante	UG	BSc Animal Biology and Conservation Science	EBB&HD
11.	Frempong Afia Amoah	UG	BSc Biological Science	EBB&HD
12.	Huldah Narkie	UG	Bachelor of Arts	CD (LIBRARY)
13.	Ringland Dei Hammond	UG	BA Information Studies and Political Science	CD (LIBRARY)
14.	Christiana Adjeley Badu	Pentecost University (PU)	BSc Engineering Science & Computing	CD
15.	Emmanuel Abrokwah	UG	Bachelor of Arts	CD (LIBRARY)
16.	Dexter Ababisa	UG	BA Political Science & Info Studies	Administration
17.	Amanda Owusua Appiah	UPSA	BA Public Relations Management	Administration

18.	Maxwell Della Norvienu	UG	BSc Biological Sciences	BPHRU
19.	Phyllis Deladem Akagah	UG	BSc Biological Sciences	BPHRU
20.	Benjamin Ankamah	College of Health and Wellness, Kintampo	BSc Physician Assistantship	BPHRU
21.	Abigail Duodu	UG	BSc Earth Science	GWGD
22.	Naomi Mwinsom Dery	UG	BSc Earth Science	GWGD
23.	Gerald Kwao	UG	BSc Earth Science	GWGD
24.	Jeremiah Teye Dornu	UG	BSc Administration	CD
25.	Philomena Asare	UG	BSc Administration	CD
26.	Agbadji Atirma	Alliance Francaise	English Course	CD
27.	Borby Enam	UPSA	BSc Business Administration	Administration
28.	Wee Geortee	Central University (CU)	BSc Public Health	BPHRU
29.	Gifty Ayimpoka Aduko	CU	BSc Public Health	BPHRU
30.	Blessing Asante	CU	BSc Public Health	BPHRU
31.	Emmanuel Nai Larsey	Valley View University (VVU)	BSc Information Technology	CD
32.	Gmafu Napoleon	UDS	BSc Environmental Biology, Biotechnology &Health Division	EBB&HD
33.	Muntari Miriam Ibrahim	ATU	BSc Science Laboratory Technology	ECSED
34.	Sedem Akasreku	UHAS	BSc Biochemistry & Molecular Biology	BPHRU
35.	Honya Prince	UHAS	BSc Biochemistry & Molecular Biology	BPHRU

36.	Janet Sam	UHAS	BSc Medical Biochemistry & Allied Science	BHPRU
37.	Addo Emmanuella	UHAS	BSc Biochemistry & Molecular Biology	BHPRU
38.	Yvonne Asante	UG	BSc Earth Science	EBBH
39.	Tumaku Julius	ATU	BSc Science Laboratory Technology	ECSED
40.	Senyo Yao Adza	UG	BSc Marine Science	EBB&HD
41.	Mensah Ebenezer	ATU	Ba Secretary and Management Studies	Administration
42.	Ellen Gloria Arthur	UG	BSc Earth Science	GWGD
43.	Opare Clifford	GCTU	BSc Computer Engineering	CD
44.	Wayo Prince Ashraf Awundre	KNUST	BSc Biological Science	EBB&HD
45.	Asaaya Festus Ayine	KNUST	BSc Science Laboratory Technology	GWGD
46.	Nana Kwadwo Danquah	KNUST	BSc Science Laboratory Technology	GWGD
47.	Nornor- Quadze Mathias	KNUST	BSc Petrochemical Engineering	ECSED
48.	Wiredu Cecil Kwabena	KNUST	BSc Chemical Engineering	ECSED
49.	Juliet Mawuenyegah Akaglo	KNUST	BSc Biological Sciences	EBB&HD
50.	Hussain Mariam	ATU	BSc Science Laboratory Technology	BPHRU
51.	Nana Kofi Mensah	KNUST	BSc Science Laboratory Technology	GWGD
52.	Mawutor Jonas Kojo	KNUST	BSc Science Laboratory Technology	GWGD
53.	Okyere Yvette Kukua	UCC	BSc Molecular Biology and Biotechnology	BPHRU

54.	Asomaning Priscilla Efi	ATU	BSc Science Laboratory Technology	EBB&HD
55.	Asare Yaa Ayebea	KNUST	BSc Meteorology & Climate Science	SWCCD
56.	Adams Sumaila	ATU	BSc Science Laboratory Technology	BPHRU
57.	Cosby Parker Koomson	UCC	BSc Molecular Biology and Biotechnology	BPHRU
58.	Akuetteh Samuel Adjetey	ATU	BSc Science Laboratory Technology	BPHRU
59.	Afum Elizabeth	ATU	BSc Science Laboratory Technology	ECSED
60.	Marilyn Gyaesayer Addo	KNUST	BSc Agriculture	FAD
61.	Donkor Maame Abena Kumi	KNUST	BSc Biological Sciences	EBB&HD
62.	Dawson Dorothy	UMAT	BSc Environmental & Safety Engineering	ECSED
63.	Abdul-Rahman Rashida	KNUST	BSc Chemistry	ECSED
64.	Elsie Tawiah Danso	ATU	BSc Science Laboratory Technology	ECSED
65.	Aboagye Clarice afia	KNUST	BSc Biological Science	ECSED
66.	Fordjour Emmanuel Opoku	KNUST	BSc Biological Science	EBB&HD
67.	Adam Masruratu Wunpini	KNUST	BSc Biological Science	EBB&HD
68.	Confidence M. Afemeku	UG	BSc Nuclear & Environmental Protection	ECSED
69.	Amewortse Elikplim Jones	KNUST	BSc Biochemistry	BPHRU
70.	Asare Aboagye Stephen	UMAT	BSc Minerals Engineering	SWCCD
71.	Sapathy Esther Ewoenam	ATU	BSc Science Laboratory Technician	ESCED

72.	Benedicta Tawiah	KNUST	BSc Meteorology and Climate Science	SWCCD
73.	Nancy Akolpoka Apuriyaare	UMAT	BSc Geological Engineering	GWGD
74.	Ofosua Erica Ofosua	KNUST	BSc Natural Resources Management	FAD
75.	Claudia Lartey	KNUST	BSc Agricultural Biotechnology	FAD
76.	Joel Siaw	KNUST	BSc Physics	GWGD
77.	Yitaa Mary	KNUST	BSc Biological Science	EBB&HD
78.	Stephen Nana Yaw Tawiah	UG	BSc Molecular Cell Biology of Infectious Pathogens	BPHRU
79.	Rita Oforiwaa Kwakye	KNUST	BSc Chemical Engineering	ECSED
80.	George Kwesi Boateng	KNUST	BSc Aquaculture & Water Resources Management	FAD
81.	Onome Olivia Omotekovie	KNUST	BSc Biological Science	EBB&HD
82.	Jason Denkyira Ofori	KNUST	BSc Petrochemical Engineering	ECSED
83.	Oppong Kelvin Nyamekye	KNUST	BSc Biochemistry	ECSED
84.	Emmanuel Kinney	KNUST	BSc Biological Science	EBB&HD
85.	Bright Tetteh	KNUST	BSc Chemistry	ECSED
86.	Tei Enoch Junior	UENR	BSc Biological Science	EBB&HD
87.	Amanfu-Arthur Michael	KNUST	BSc Biological Science	EBB&HD
88.	Darkwah Roughmaths	ATU	BSc Science Laboratory Technology	ESCED
89.	Coffie Samuel	KNUST	BSc Geological Engineering	GWGD
90.	Justice Christians Gbemu	KNUST	BSc Geological Engineering	GWGD

91.	Rutilus Ngmenoba Gornaah	KNUST	BSc Geological Engineering	GWGD
92.	Acquah Gifty Badu	KNUST	BSc Geological Engineering	GWGD
93.	Ofori Ernest	KNUST	BSc Geological Engineering	GWGD
94.	Ohemeng Michelle	UENR	BSc Biological Science	EBB&HD
95.	Mensah Abigail Aba	KNUST	BSc Biological Science	EBB&HD
96.	Secherey Prosper George	KNUST	BSc Theoretical &Applied Biology	EBB&HD
97.	Nigel Ben Narh	KNUST	BSc Biological Science	EBB&HD
98.	Sarah Aryeetey	ATU	BTech. Science Laboratory Technology	ESCED
99.	Nkornu Isaac	KNUST	BSc Biological Science	EBB&HD
100.	Angsuanuuri Bright Joseph	ATU	BSc Science Laboratory Technology (Analytical Chemistry)	ESCED
101.	Quansah Ekua	ATU	BSc Science in Lab Technology	ESCED
102.	Issaka Mohammed Kamil	ATU	BSc Science Laboratory Technology	ESCED
103.	Ahmed Osman	ATU	BSc Science Laboratory Technology	ESCED
104.	Anaafi Paakwasi Prince	KNUST	BSc Geological Engineering	GWGD
105.	Jasmine Aseye Amankwa	ATU	BTech Science Laboratory Technology	ESCED
106.	Mishiame Comfort Selassie	ATU	BSc Science Laboratory Technology	ECSED

Summary of National Service /Industrial Attachment in 2024

Institution of National Service Personnel	Number of Students	Institution of Industrial Attachment Personnel	Number of Students
Kwame Nkrumah University of Science and Technology	24	Kwame Nkrumah University of Science and Technology	40
University of Ghana	16	University of Ghana	25
University of Cape Coast	3	University of Cape Coast	2
All Nations University	2	Hohai University	1
Accra Technical University	9	Accra Technical University	18
Koforidua Technical University	2	Pentecost University	1
University for Professional Studies	2	University for Professional Studies	2
GIMPA	1	University of Energy and Natural Resources	2
University of Energy and Natural Resources	1	University of Mines and Technology	3
Dr. Hilla Limann Technical University	1	College of Health & Wellness	1
University of Health & Allied Sciences	3	Central University	3
Central University	1	Valley View University	1
		University of Development Studies	1
		University of Health & Allied Sciences	4
		GCTU	1
		Alliance Francaise	1
Total	65	Total	106

APPENDIX VI: LIST OF STAFF PUBLICATIONS

Journal Papers

1. Abu, M.; Akurugu, B. A.; Egbueri, J. C. (2024) Understanding groundwater mineralization controls and the implications on its quality (Southwestern Ghana): Insights from hydrochemistry, multivariate statistics, and multi-linear regression models, Acta Geophysica, Springer. https://doi.org/10.1007/s11600-023-01271-6
2. Addo I., Agyakwah, S.K., Amevenku F.K.Y., Asmah R., Mensah, E.T-D., Ragasa C., Trong Q.T. (2024). Assessment of production and profitability of stocking sizes and densities of Nile tilapia (*Oreochromis niloticus*) for small–scale pond culture in Ghana. *Global Scientific Journal* 12(4) 1390-1415
3. Addo, A., Armah, E. O., Agyakwah, S. K., Asmah, R., Mensah, E. T-D, Diyie, R. L., Amewu, S., Ragasa, S., Abban, E. K. & Osei-Atweneboana, M. Y. (2024) Microsatellite-Based Genetic Variations and Relationships Among Some Farmed Nile Tilapia Populations in Ghana: Implications for Nile Tilapia Culture. *Journal of Ghana Science Association*, 22(1): 1-8.
4. Akurugu, B.A., Yidana, S.M., Obuobie, E., Seidenfaden, I.K., Stisen, S., Chegbeleh, L.P. (2024). Groundwater Recharge Estimation from Multiple Independent Methods in the Fractured Hard Rock Aquifers in the Densu River Basin, Ghana, Sustainable Water Resources Management. *Accepted (October 2024) and under production for publication*.
5. Anani, F. A., Atsakpo, P. D. K., Donkor, K. K., Ayarika, F. A., Johnson-Ashun, M. and Danquah, E. T. (2024). Profitability of using five different commercial tilapia starter feeds on the Ghanaian market in Nile tilapia, *Oreochromis niloticus* fingerlings production. Aquaculture Studies, 24(2), AQUAST1343. http://doi.org/10.4194/AQUAST1343
6. Appiah, E. K., Fatsi, P. S. K., Magna, E. K., Saito, H., Omura, M., & Kawai, K. (2024). Immunomodulatory effects of Mallotus japonicus extract on innate immune responses in Heterotilapia buttikoferi infected with Aeromonas hydrophila. The Microbe. https://doi.org/10.1016/j.microb.2024.100088
7. Arko, W. E., Zhao, S., Ma, J., Tian, L., Asante, K. A., Arko, F. E., Qi, S. and Zhang, G. (2024)- Quantification of halogenated flame retardants and dechlorane plus in the atmosphere of Ghana using PUF-PAS: seasonal trends, spatial distribution and human health exposure. *Submitted to Chemosphere Journal*.

8. Arko, W. E., Ma, J., Tian, L., Asante, K. A., Amoah, D. K., Qi, S., Zhang, G. and Zhao, S. (2024)- Impact of Anthropogenic Activities on Atmospheric Chlorinated Paraffins in Ghana Using Polyurethane Foam Disk - Passive Air Sampler. *Science of the Total Environment*, 954, 176252.
9. Armah, E.; Osae-Nyarko, L.; Idun, B.; Ahiabu, M.K.; Agyapong, I.; Kwarteng, F.B.; Oppong, M.; Mohammed, N.; Kotey, F.C.N.; Osei-Atweneboana, M.Y. and Dayie, N. T. K. D. (2024) High Prevalence of ESBL Genes in Commensal Escherichia coli of the Urinary Tract: Implications for Antibiotic Stewardship among Residents of Ghanaian Elderly Nursing Care Homes. Genes, 15,985. https://doi.org/10.3390/genes15080985
10. Bazaanah, P., Buthelezi, S. J., & Oppong, D. A. K. (2024). Qualitative study of drinking water, sanitation, and hygiene access: Perspectives from the Central Gonja District, Ghana, and Mtubatuba Municipality, South Africa. *Journal of Water, Sanitation and Hygiene for Development*. https://doi.org/10.2166/washdev.2024.021
11. Bazaanah P., Obuobie E., Boadi S. A., Oblime F. T., Granaham P., and Danban M. K. (2024). Citizens' perceptions of water and sanitation governance in Bilsikura of the Central Gonja District, Ghana, *Social sciences &humanities* open, (Under review).
12. Bazaanah, P. and Ngcobo, P. (2024) Shadow of justice: review on women's struggle against gender-based violence in Ghana and South Africa. *SN Social Sciences*, 4:126, Springer. https://doi.org/10.1007/s43545-024-00926-5.
13. Bekoe, E.M.O., Quarcoo, G., Dankwa, P., Zita, N., Adu-Boakye, M., Mensah, E.T., Kumi, M. (2024). Health risk assessment of surface water resources in the Nandom Municipality of Ghana. Discov Public Health 21, 35 (2024). https://doi.org/10.1186/s12982-024-00150-9
14. Bruce-Vanderpuije, P., Asmah, R., Ameworwor, M. Y., Hotor, D. W., Hildebrandt, L., Proefrock, D., Ebinghaus, R., Haruna, Z., Norvimagbe, C. N., Asante, K. A., Nunoo, A. A. and Osei-Atweneboana, M. Y. (2024). Quantitative Assessment of Microplastics in fish from the Gulf of Guinea, Ghana using LDIR Spectroscopy: Implications for Marine Food Safety and Health Risk Evaluation. Submitted to the *Environmental Pollution* Journal.
15. Bruce-Vanderpuije P, Agadzi, YA, Norvimagbe, IC, Asmah, R, Hildebrandt, L, Proefrock, D, Ebinghaus, R, Asante, KA. (2025). Microplastics in the lower Volta Basin, Ghana: Quantitation and fish dietary exposure assessment using advanced spectroscopic techniques (2025). *Chemosphere* 375, 144236 https://doi.org/10.1016/j.chemosphere 2025.144236

16. Bruce-Vanderpuije, P., Agadzi, Y. A., Norvimagbe, I. C., Asmah, R., Hildebrandt, L., Proefrock, D., Ebinghaus, R. and Asante, K. A. (2024) Quantitation and distribution of microplastics in the lower Volta Basin, utilizing Laser Direct Infrared Spectroscopy and Fourier Transform Infrared-Attenuated Total Reflection: Implications for human exposure (Submitted to the Journal of Hazardous Materials).
17. Chikezie, F. M., Veriegh, F. B. D., Armoo, S., Boakye, D. A., Taylor, M. and Osei-Atweneboana, M. Y. (2024) Ongoing transmission of onchocerciasis in the Pru District of Ghana after two decades of mass drug administration with ivermectin and comparative identification of members of the *Simulium damnosum* complex using cytological and morphological techniques, *Parasites & Vectors*, *17:394.* https://doi.org/10.1186/s13071-024-06333-2
18. Crawford, K.E., Hedtke, S.M., Doyle, S.R., Kuesel, A.C., Armoo, S., Osei-Atweneboana, M.Y. and Grant, W.N., (2024). Genome-based tools for onchocerciasis elimination: Utility of the mitochondrial genome for delineating *Onchocerca volvulus* transmission zones. International Journal for Parasitology, 54(3-4), pp.171-183.
19. Diyie, R. L., Osei-Atweneboana, M. Y., Armah, E., Asmah, R., Appenteng, P. & Aheto D. W. (2024). Genetic Diversity of Fungal Pathogens Affecting the Health of Cultured Fish in Ghana. *Journal of Ghana Science Association*, Volume 22 (2). ISSN: 2737-713X
20. Diyie, R.L., Osei-Atweneboana, M.Y.O, Armah, E., Yankson, K, and Aheto, D. W. (2024). Contamination of Fish Feed with Pathogenic Organisms: Implications on Fish Diseases in Aquaculture Systems. *Ghana Journal of Science, Technology and Development* | Vol. 9, Issue 2, ISSN: 2343-6727 DOI: https://doi.org/
21. Emeji, I. C., M. Kumi and R. Meijboom (2024). "Performance Evaluation of Benzyl Alcohol Oxidation with tert-Butyl Hydroperoxide to Benzaldehyde Using the Response Surface Methodology, Artificial Neural Network, and Adaptive Neuro-Fuzzy Inference System Model." ACS Omega.
22. Fatsi P.S.K., Kawai K., Asmah R., Bandoh Oppong B., Appiah E.K., Hashem S., Addo A. Kusorgbor J.K., Magna E.K., Obeng A.K., Quansah L., Saba C.K.S., Bawah J., Setufe S.B., Adu-Nti F., Ameworwor M.Y. Quansah C.R., Saito, H., Johnson-Ashun M., Osei L.K., Agbeko E., Anani F.A., Agyakwah S.K. (2024) Immunomodulation and Humoral Immune Response in Teleost Immunized with Aeromonas-Derived Antigenic Extracellular Bioactive Molecules. *Indian Journal of Microbiology*. https://doi.org/10.1007/s12088-024-01254-1.

23. Hamidu B. A., Tettevi E. J., Larbi J. A., Idun B. K., Asuming-Brempong E. K., Osei-Atweneboana M. Y. (2024). The effectiveness of Albendazole against Hookworm infections and the impact of Bi-annual treatment on anaemia and Body Mass Index of school children in the Kpandai District of Northern Ghana. PLoS ONE 19(3): e0294977. https://doi.org/10.1371/journal.pone.0294977
24. Hashem, S., Kawai, K., Kushida, T., Hamaoka, E., Fatsi, P. S. K., & Saito, H. (2024). Genetic relationships between and within some Malawian cichlid genera. *Journal of Fish Biology*, 1–13. https://doi.org/10.1111/jfb.15848
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26. Idowu IG, Megson D, Ekpe OD, Bruce-Vanderpuije P, Sandau, CD (2025). Systematic Review of Methods for the Analysis of Total Per- and Polyfluoroalkyl Substances (PFAS). *Science of Total Environment*, 967, 178644 https://doi.org/10.1016/j.scitotenv 2025.178644
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28. Kazapoe, R. W., Amuah, E. E. Y., Dankwa, P., Fynn, O. F., Addai, M. O., Berdie, B. S., and Douti, N. B. (2024). Fluoride in groundwater sources in Ghana: A multifaceted and country-wide review. Heliyon.
29. Magna E.K, Ofosu-Koranteng F, Asmah R, Mensah E.T-D., Appiah EK, Fatsi PS, Adu-Nti F, Kpodo ZC, Lente I. (2024). Preliminary investigation on the occurrence and health risk assessment of antibiotics in cultured tilapia retailed at a commercial outlet in Tema, Ghana. *Heliyon*, 18;10(6):e28193. https://doi:10.1016/j.heliyon.2024.e28193
30. Magna, E. K., Appiah, E. K., Fatsi, P. S. K., Abarike, E. D., Asante, K. A., Kogbe, M., Ayarika, F., Dabi, M. and Sakna, J. K. (2024)- Potential Role of Aquaculture Fish to the Recommended Nutritional Intake (RNI) of Children, Adults, Pregnant and Lactating Women in the Asuogyaman Municipality, Ghana. (*Submitted to the Food Analytical Methods Journal*).

31. Martin, E., Bekoe, O., Quarcoo, G., Dankwa, P., Naangmenyele, Z., Adu-Boakye, M., Emmanuel, ·, Mensah, T.-D., & Kumi, · Michael. (2024). Health risk assessment of surface water resources in the Nandom Municipality of Ghana. *Discover Public Health*, *21*(35), 35. https://doi.org/10.1186/s12982-024-00150-9
32. Megson D, Bruce-Vanderpuije P, Idowu IG, Ekpe OD, Sandau CD (2024). A systematic review for non-targeted analysis of per- and polyfluoroalkyl substances (PFAS). *Science of The Total Environment*, 960, 178240. https://doi.org/10.1016/j.scitotenv.2024.178240
33. Mensah, N.O., Asare, J.K., Mensah, E.T-D., Amrago, E.C., Osei Tutu, F. & Donkor, A. (2024). Determinants and framework for implementing sustainable climate-smart aquaculture insurance system for fish farmers: Evidence from Ghana, *Aquaculture*, Vol. 581, 740354, https://doi.org/10.1016/j.aquaculture.2023.740354
34. Nditanchou, R.; Agyemang, D.; Dixon, R.; D'Souza, S.; Selby, R.; Opare, J.; Tettevi, E. J.; Asiedu, M. D.; Idun, B.; Chailloux, A.; Schmidt, E.; Hamill, L.; Senyonjo, L. and Osei-Atweneboana, M. Y. (2024) Persistent transmission of onchocerciasis in Kwanware-Ottou focus in Wenchi health district, Ghana, *BMC Infectious Diseases*, 24:1156. https://doi.org/10.1186/s12879-024-10071-2
35. Obiri-Nyarko, F., Quansah, J. O., Asare, S. V., Fynn, O. F., Okrah, C., Debrah, S. K. and Karikari, A. Y. (2024). Determination of threshold values and heavy metal pollution assessment of soils in an industrial area in Ghana. *Environmental Monitoring and Assessment*, 196(6), 546.
36. Obuobie, E., Osei-Owusu, M., Anornu, G. K., Asante-Sasu, C., & Asmah, R. (2024). Estimation of suspended sediment load to the Volta Lake under changing climate using empirical discharge-sediment equations. *International Journal of River Basin Management*, 1–12. https://doi.org/10.1080/15715124.2024.2382175.
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38. Odinakachukwu, C. E., Adjei, K. A., Andam-Akorful, S. A., Gyamfi, C. Darko, D., Odai, S. N. (2024). Evaluation of near-real-time satellite rainfall estimates for extreme precipitation analysis over the Volta Basin, West Africa. *Submitted to Tanzania Journal of Engineering and Technology (accepted).*

39. Okafor, G. C., Ogbu, K. N., Agyekum, J., Limantol, A. M., & Larbi, I. (2024). Rainfall projections under different climate scenarios over the Kaduna River Basin, Nigeria. Discover Environment, 2(1), 89.
40. Owiredu, S. A.; Onyango, S. O.; Song, E.-A.; Kim, K.-I.; Kim, B.-Y. and Lee, K.-H (2024) Enhancing Chub Mackerel Catch Per Unit Effort (CPUE) Standardization through High-Resolution Analysis of Korean Large Purse Seine Catch and Effort Using AIS Data, *Sustainability,* 16,1307. https://doi.org/10.3390/su16031307
41. Quarcoopome, T., Asante, K. A., Akrong, M. O., Amevenku, F. K. Y. and Addico, G. (2024). State of Keta and Songor Lagoon Ecosystems in Ghana – Post Sea Defence Intervention. *International Aquatic Research*. In press, Manuscript ID: IAR-2408-1737
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Book Chapters

1. Akrong, M.O., Ansa, E.D.O., Anku, W.W., Issahaku, A., Akon-Yamga, G. (2024). Microbiological Reduction Strategy of Treated Wastewater for Safe Vegetable Production in Accra, Ghana. In: Mannina, G., Cosenza, A., Mineo, A. (eds) Resource Recovery from Wastewater Treatment. ICWRR 2024. Lecture Notes in Civil Engineering, vol 524. Springer, Cham. https://doi.org/10.1007/978-3-031-63353-9_53
2. Anku, W.W., Ansa, E.D.O., Akrong, M.O., Issahaku, A., Akon-Yamga, G. (2024) Optimizing Wastewater Quality for Safe Vegetable Irrigation: A Ghana Case Study of the Wideruptake Project. In: Mannina, G., Cosenza, A., Mineo, A. (eds) Resource Recovery from Wastewater Treatment. ICWRR 2024. Lecture Notes in Civil Engineering, vol 524. Springer, DOI: https://doi.org/10.1007/978-3-031-63353-9_34

Conference Papers

1. Anani, A.F., Donkor, K.K., Ayarika, A.F., Dankwa, T.E., Fatsi, P.S.K., Diame, A.E., & Opoku, M., (2024). Growth Performance and Cost-Effectiveness of Composite Nursing of Nile Tilapia (*Oreochromis niloticus*) and African catfish (*Clarias gariepinus*) Fingerlings in Hapa-In-Pond systems. Aquaculture Ghana, Book of Abstract 2024
2. Arko, W. E., Ma, J., Tian, L., Asante, K. A., Amoah, D. K., Qi, S., Zhang, G. and Zhao, S.- Impact of Anthropogenic Activities on Atmospheric Chlorinated Paraffins in Ghana. Levels, Sources and Human Health. Presented at the SETAC Asia-Pacific 14th Biennial Meeting from 21st – 25th September in Tianjin, China.
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1. Gerard Quarcoo (2024) Pathogenic Microbes and Endocrine Disrupting Chemicals in Wastewater Used in Urban Agriculture in The Northern and Greater Accra Regions of Ghana. A Thesis Submitted to the Department of Theoretical and Applied Biology, Kwame Nkrumah University of Science and Technology, in partial fulfilment of the requirement for the award degree of Doctor of Philosophy.

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1. Buisson, M.-C.; Zane, G.; Appiah, S.; Mapedza, E., Asmah, R.; Ahiah, L.; Mensah, E. T-D. (2024). Fish cage culture in small water bodies in North East Region of Ghana: Technical and institutional guiding principles for sustainable and inclusive uptake
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3. Zane, G.; Appiah, S.; Buisson, M.-C.; Ahiah, L.; Mensah, E.T-D.: Asmah, R. (2024). Aquaculture in small reservoirs in Ghana's North-East Region. The IWMI-led initiative is turning local dams into sources of growth and development. CGIAR Initiative on Aquatic Foods

Posters

1. Bruce-Vanderpuije, P., Norvimagbe, I., Asmah, R., Asante, K. A. (2024). In-person presentation: Distribution of microplastics in sediment, surface water, and fish of the Lower Volta basin, Ghana: Implications for human exposure; American Chemical Society Fall 2024 Conference, August 18-22, 2024 in Denver, Colorado, USA
2. Cecil Nii Ayikai Tetteh, Etornyo Agbeko, Fadila Halidu, Ebenezer K. Appiah, Francis A., Anani, Rhoda Lims Diyie, Mercy Johnson-Ashun, Kelvin Donkor (2024). Preliminary Pathological Effects of Integrated Culture of African Catfish (Clarias Gariepinus) With Water Lettuce (Pistia Stratiotes). Poster Presentation at Aquaculture Ghana Conference: Chamber of Aquaculture (COA). 29-30 May, 2024, World Trade Centre, Accra, Ghana.
3. F.T Oblim, C. Gyamfi and F.Y. Logah (2024). Enhancing Crop Water Productivity in Southern Ghana with Earth Observation and Ground-Based Data. A poster presented at the 6th CSIR-RSA Annual Conference, 23 October 2024, online.

Mass Media Publications

1. Aquaculture in small reservoirs in Ghana's North-East Region, 6th August 2024. https://www.iwmi.cgiar.org/news/aquaculture-in-small-reservoirs-in-ghanas-north-east-region/
2. Ghana trains 10 Ivoire Coast Fish farmers under FISH4ACP, https://fr.apanews.net/cote-divoire/dix-ivoiriens-formes-sur-la-production-dalevins-au-ghana/
3. A staff at the ECSED was interviewed by BBC which was featured in their online news item on 11th December, 2024.
4. A staff at the ECSED did a documentary with TV3 which was featured on TV news on 6th October, 2024.
5. A staff represented the Director as the Chairman at a forum on Promoting Agroecology and Environmental Sustainability in Ghana, organised by the Media Foundation for West Africa on 5th June, 2024, as part of the World Environment Day. This was featured in the Ghanaian Times Edition of Thursday, 6th June, 2024.

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THURSDAY, JUNE 6, 2024

WED:

Ghanaians urged to protect environment for greener, safer, better future

BY TIMES REPORTERS

GHANA yesterday commemorated World Environment Day to press home the need to adopt sustainable land management practices to protect the planet for greener, safer and better future for all.

The day is celebrated every year on June 5, and aims at raising awareness and celebrating environmental action, with a focus this year on "land restoration, desertification and drought resilience".

This year's global event, hosted by the Kingdom of Saudi Arabia, highlights the pioneering efforts made by nations towards the UN Decade on Ecosystem Restoration (2021-2030).

The Minister of Environment, Science, Technology and Innovation (MESTI), Ophelia Mensah Hayford, called on Ghanaians to prioritise environmental preservation.

"Let us unite in our efforts to safeguard the environment and leave behind a legacy of environmental stewardship for generations to come," she said in a statement issued in Accra yesterday.

The ministry emphasised the critical need for collective action to protect the earth for future generations through efforts including restoring degraded landscapes, combating desertification, and building resilience to drought.

AGNES OWUSU reported that Ghanaians had been urged to adopt eco-friendly farming practices in order to ensure sustainability of the environment to boost the economy.

The Head of Environmental Chemistry and Sanitation Engineering Division of the Council for Scientific and Industrial Research (CSIR), Dr Kwadwo Ansong Asante, who gave the advice, said it would help ensure food security and improve the standard of living of citizens in the country.

Speaking at a forum organised by the Media Foundation for West Africa (MFWA) in Accra yesterday in commemoration of this year's World Environment Day, Dr Asante advocated the use of natural ways to grow crops in order to protect nature and keep the soil healthy.

Dr Asante said that sustainable practices sought to reduce dependency on chemical inputs, which could be harmful to both the environment and human health, hence the need to adopt it.

"Conventional farming practices often lead to soil degradation and deforestation, which exacerbate climate change. It is imperative that we shift towards more sustainable methods to safeguard our environment for future generations," he said.

Mr Asante noted that the use of chemicals in farming practices contributed to the deterioration of food quality and hastened its decay.

The Board Chairman of A Rocha Ghana, Professor Alfred Oteng Yeboah, said many farmers were not aware of sustainable practices or lacked the skills to implement them.

The Executive Director of MFWA, Sulemana Bonnah, in a speech read on his behalf, said that there was the need for collaborated efforts to help promote agroecology.

CECILIA LAGBA YADA reported from an exhibition held to mark the Day that the Executive Director of Environmental Protection Agency (EPA), Mr John Kragu, advocated the development of holistic solutions to make the environment sustainable.

He said state institutions, academic institutions and local communities should work together by sharing knowledge, resources and best practices to curb environmental challenges.

He said Land degradation, driven by unsustainable practices and exacerbated by climate change, posed a significant threat to ecosystems and human livelihoods.

He said desertification and drought were not only environmental issues but also socio-economic crisis that impacted millions of people worldwide, especially in the most vulnerable regions.

Dr Kwadwo Ansong Asante (inset) speaking at the programme