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IDRC CITIES & CLIMATE CHANGE PROJECT

Integrated Climate Smart Flood Management for Accra – Ghana

**FINAL TECHNICAL REPORT
JANUARY 2020**

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List of Acronyms

AdMA	: Adentan Municipal Assembly
AMA	: Accra Metropolitan Assembly
AR5	: Fifth assessment report
DRR	: Disaster Risk Reduction
EPA	: Environmental Protection Agency
FGDs	: Focus Group Discussions
GAMA	: Greater Accra Metropolitan Area
GAMADA	: Ga Mashie Development Agency
Gh-NDCs	: Ghana’s Nationally Determined Contributions (Paris Climate Agreement)
HPLF	: High Level Political Forum
IPCC	: Intergovernmental Panel on Climate Change
LUSPA	: Land Use and Spatial Planning Authority
MCEs	: Metropolitan Chief Executives
MLGRD	: Ministry of Local Government and Rural Development
MMDAs	: Ministries, Departments and Agencies
MoF	: Ministry of Finance
MTDP	: Medium Term Development Plan
NADMO	: National Disaster Management Organisation
NDPC	: National Development Planning Commission
OHLGS	: Office of the Head of Local Government Service
PAA	: Population Association of America meeting
SDGs	: Sustainable Development Goals
SDRRF	: Sendai Disaster Risk Reduction Framework
VNR	: Voluntary National Reviews

1. EXECUTIVE SUMMARY

1.1 Vulnerability, Impacts and Adaptation

The study suggests that any intervention that seeks after an integrated flood risk management should address the challenges of physical infrastructure within the Greater Accra Metropolitan Area (GAMA) in Ghana. Yet there are disagreements amongst the policy community that managing infrastructure such as the existing drains to adapt to the increasing surface runoff of rainwater was a challenge in reducing flood risks rather than poor spatial planning and law enforcement. Household surveys show major causes of flooding in the Greater Accra Metropolitan Area (GAMA) as follows (i) building along water ways (42% of respondents); (ii) poor construction of drains (20.2%) and (iii) choked gutters (15.6%). On the factors not identified as major causes of flooding were the effects of heavy storms, represented by the responses of 3.4% of households. Gender representations were key to opinions from communities as findings from the focus group discussions (FGDs) revealed that whereas both female adults and youth groups ranked flooding as the major environmental problem in their communities, male adults ranked poor sanitation as the major environmental problem and followed by flooding. Flood risks were also associated with other environmental problems identified as inadequate toilet facilities and gutters, lack of refuse dumps, choked gutters, untarred roads causing dust and lack of storm drains or improperly built drainages. On the impacts of flooding and associated coping strategies, all three FGD groups above identified the destruction and loss of properties as the main impact followed by morbidity and displacement. The impact of institutions and flood management variables on the probability of flooding were mixed. We found that an inclusion of a waste disposal fee makes the impact of rainfall variation on the probability of flooding insignificant. Subsequently, psychological and socio-economic factors influence households' flood protective response in the Greater Accra Metropolitan Area of Ghana (GAMA) and that public information on flooding does not appear to influence private protective responses. The probability of residents relocating as a result of floods decreases with increased public adaptive measures suggesting that public adaptive measure has the propensity to reduce vulnerability to floods in GAMA. Flood hazard is exacerbated by poor waste management, lack of / poor flood management infrastructure and spatial planning. The levels of exposure to floods does not similarly match the level of vulnerability. There is no clearly defined governance structure for flood response due to poor policy coherence and lack of capacity.

Though the Focus Groups were aware of adaptation solutions, response measures taken by individuals and households such as the washing or drying of wet belongings to enable reuse was not sustainable. Likewise, are the relief items and handouts given to flood victims by the National Disaster Management Organisation (NADMO). Communities therefore suggested more sustainable adaptation options such as the expansion of drains; concealment of existing drains as well as the formulation of land use and land regulations management and enforcement of by-laws related to solid waste disposal. A contingent valuation technique was used to analyze the overall household economic value of adaptation to flood risk. The analysis was based on the households' response to a scenario for their Willingness to Pay (WTP) for a flood adaptation strategy project. The willingness of citizens and residents to contribute resources towards the provision of a public good is premised on the assumption that they (the contributors) trust that recipients will be able to use the resources for the intended purpose that maximizes their welfare. Survey respondents have about 39.7% confidence in the Government of Ghana to effectively implement adaptation intervention to respond to flood, if given the resources. Certain proportion of the respondents - 38.9%, 43.5% and 56.8% trusted respectively, the (i) Private Sector Profit Making organizations, (ii) Private Sector Non-Profit Making organizations and (iii) International Development Agencies, to complement efforts by public institutions. Thus, given the resources, respondents will see to the effective implementation of flood adaptation strategies in their communities, suggesting that state or the government could not be relied on to directly implement or engage in flood response measures. Significant policy options across different sectors of the economy exist to enable District Assemblies to properly integrate waste management and flood reduction strategies towards minimizing trade-offs and waste of state resources. Solid waste has been found to be a major cause of flooding hence this is human-made and can be resolved through intense citizen engagement and public awareness. Citizen engagement would forewarn and help the population to prepare for eminent floods beyond some of the strategies being used by the population. Managing solid waste and the related issues of sanitation and floods should come with clearly identified hotspots such as proximity to water bodies and drains using spatial technology of Remote Sensing (RS) and Geographical Information Systems (GIS) origins.

1.2 Transformative Action

Transforming governance and institutions to mainstream adaptation solutions into planning requires the three communities of change which are (i) science, (ii) policy and (iii) practice acting concurrently under a common framework. Yet, such transformations must be guided by relevant mix of methods of understanding problems on the ground, responding to recent calls to make methods for data collection and analysis on cities exciting to managers. Thus, the methodological nexus in this project motivated transdisciplinary and multi-stakeholder approaches to co-develop metrics that enabled the Work Packages of the research team to match the research outcomes of different disciplinary perspectives, the conceptual origins and demand of stakeholders. The co-incorporation of human and biophysical dimensions of assessing flood risks in aspects of exposure within the Districts was a major step for stakeholders' roles to thrive in preventing flood risks and providing adaptation solutions by availing platforms for simple solutions to adapt to complex challenges. For example, the flood inundation maps developed from the spatial analysis and combined with survey outputs can be shared with residents in flood prone environments. These maps are useful for depicting the probable impact of an approaching flood which have relevance for public awareness and emergency preparedness. The synergistic effects of the methods to support resilience building lock into developing multi-sector plans to manage flood risks and flooding regimes, including designing appropriate legislation, governance reforms and re-zoning of low-lying areas. The combined methods further elicit information on climate change as an external perturbation, in ensuring that climate elements are very well integrated into flood management and national level development planning towards a Climate Smart Integrated Flood Management (CSIFM). The CSIFM therefore provides pathways for formulating research and policy questions that are demand-driven by cities which are institutionally trapped in responding to the challenges and the opportunities that flood risk might present to managers and the citizenry. The CSIFM could be described as not terminal in character but provides opportunities for monitoring flood management plans and interventions and getting to review and appraise the options for response measures. Importantly, the CSIFM framework provides pathways for empowerment to pursue actions on adaptation, whilst enhancing further research, policy and adaptation solutions that bring about resilience building to flood risks through the bridging of the gaps between science and policy, and theory and practice, and key to the Sustainable Development Goal (SDG) 11. Thus, *“Make cities and human settlements inclusive, safe, resilient and sustainable”*.

1.3 Policy Influence and Vertical Integration

- i. Membership of decision making bodies such as the Accra Metropolitan Authority (AMA) Climate Action Planning Steering Committee
- ii. Supporting the National Disaster Management Organisation (NADMO), the Ministry of Environment, Science, Technology and Innovation (MESTI), and the Ministry of Local Government and Rural Development (MLGRD) through the National Development Planning Commission (NDPC) on operationalizing the Sendai Framework for Disaster Risk Reduction Framework.
- iii. Building capacity of local government agencies on assessment of flood risks and development of action plans
- iv. Working with private sector players such as the Ghana Private Enterprise Federation to mobilize its membership made up several private sector associations, cooperatives, etc.
- v. Capacitating the cities and climate change District Assembly fellows to use findings of the research in their Medium Term Development Planning Framework
- vi. Development of Policy Briefs and Project Handbook / Manual

1.4 Research and Development Impact

The surveys on the economic issues especially using the Willingness to Pay (WTP) was an eye opener to households on how their voluntary contributions could be accounted for and monetized towards better appreciating participating in communal level actions on flood adaptation interventions. The collaboration with state-level organizations such as the National Development Planning Commission (NDPC) and National Disaster Management Organisation (NADMO) provided policy dialogue platforms for the project to contribute to ongoing national level discourse on disaster risk management, to be incorporated into the Voluntary National Review (VNR) of the Sustainable Development Goals (SDGs). The Policy Dialogue was based on the Sendai Disaster Risk Reduction Framework (SDRRF), which from the perspective of this project has become a major cornerstone of disseminating project findings because of its adoption by Ghana as the main instrument for disaster risk reduction. The outcome synthesis report of the Policy Dialogue thus highlights progress on the Sendai Framework for Disaster Risk Reduction, facilitated through the Cities and Climate Change Project.

Dissemination meetings with district assemblies have not only enhanced relationship between academia, research and policy and governance but also helped to establish the reality of the importance of research for development planning. The outcome of this relationship translated finally into the co-hosting of the project's final dissemination conference (CCPOP-Ghana2019) with the Accra Metropolitan Assembly, bringing together all project districts. The preliminary joint work plan of the project with partners constituted a form of capacity building to enable them to fit their own programming into flood risk management issues whilst empowering them to expand their scope of work and partnership across scale, policy and agency. Strategic institutional partnership with institutions such as the Land Use and Spatial Planning Authority (LUSPA), responsible for national urban and spatial planning have provided lead to nurturing the project's relationship with similar activities in the spatial planning space. The Conference of Parties (COP) of the Framework Convention on Climate Change (UNFCCC) activities was important platform for the project nationally and internationally in partnership with the Ministry of Environment, Science, Technology and Innovation (MESTI) through Ghana's Focal Point to the UNFCCC. Pre-CoP events provided the platform for not only technical and policy stakeholders to share knowledge about climate adaptation linkages with agriculture, flood risks and the SDGs but also young people in Senior High Schools were given the opportunity to learn and interact with experts on the issues discussed. Considering the success rate of the climate festival, plans were put in place to collaborate with the Environmental Protection Agency (EPA) to host a stocktaking colloquium (Post - CoP) after the negotiations in Bonn in 2017. It was to help strategize towards engaging policy makers on critical areas for redress in Ghana, regarding climate change. The Post-COP event provided the platform for not only technical and policy stakeholders to share knowledge about their lessons from the COP 23 including climate financing, investments and coordination of climate action, corporate emission cuts and government ratifications; but also an avenue for the African Group of Negotiators (AGN) to collate views from citizens to be included in further discussions within international climate change negotiations.

Through interests expressed by some development partners such as the World Bank and the United Nations Development Program (UNDP) in the project, the project's data was key to the World Bank's City Strength Diagnostics and UNDP's Advocacy and Capacity Building for Disaster Risk Reduction and Preparedness programs. Both boundary partners provided critical opportunities for institutional collaboration and policy enhancement towards interventions where the project team received

invitations to participate in a number of related fora. Other impacts of the project include synergies with projects such as the Making All Voices (MAVC) project. Establishing and working with such identifiable synergies was crucial as the Cities and Climate Change project provided the framework intervention for MAVC. Additionally, the 100 Resilient Cities (100 RCs) project hosted by the Accra Metropolitan Assembly (AMA) with support from the Rockefeller foundation, was provided with relevant information on the Cities project with the aim of helping cities around the world become more resilient to the physical, social, and economic challenges that are a growing part of the 21st century. Also through our partnership with the National Disaster Management Organisation (NADMO), data on contingency plan on droughts and floods in Ghana was contributed from our field work to support NADMO's contributions to the African Risk Capacity (ARC) program. The cumulative effects of the project's research output were the joint training of 26 out of 29 District Assemblies in GAMA to develop their own Climate Actions Plans in a joint collaboration with C40 Cities Climate Leadership Program, representing significant upscale of the project from the initial 7 Districts.

2. THE RESEARCH PROBLEM

2.1 Knowledge Gaps

Globally, The challenges of population growth are compromising spatial planning in urban and peri-urban communities and cities across the world. Haphazard development of human settlement such as building on waterways and green spaces as well as increased demand for housing and industries has exposed several residential sites especially that of people living in low-lying areas to increased flood risks. In coastal environments such as the Greater Accra Metropolitan Area (GAMA) in Ghana, accelerated sea level rise has compounded flood risks leading to inundation of settlements and erosion of the shoreline. Recent floods in GAMA coupled with fatal deaths and injuries; damage to property, infrastructure and/or the environment; and the disruption of life and the functioning of the community also presents institutions and society with new challenges of adaptation solutions. However, not much leadership has been demonstrated in integrating climate resilience into city planning and flood management. Thus, this three-year research project on Managing socio-demographic change and climate induced flood risks in the Greater Accra Metropolitan Area (GAMA) is built on the fifth assessment report (AR5) of the IPCC which affirms an increased frequency of floods in coastal cities and the apparent disruptions of infrastructure that may occur.

Such global assessments have been shown and confirmed locally through various projects funded by IDRC, USAID, UNITAR and CDKN at the Regional Institute for Population Studies (RIPS), University of Ghana upon which the Cities and Resilience project has been formulated. Recent floods in GAMA and associated death, injury or disease; damage to property, infrastructure or the environment; and / or disruption of life and the functioning of the community presents institutions and society with new challenges of adaptation solutions. However, not much leadership has been demonstrated in integrating climate resilience into city planning and flood management. Therefore several barriers exist in delivering on adaptation solutions to flood risks in GAMA in developing indicators that are climate sensitive with the goal of instituting climate smart integrated flood management framework that drives city planning including policies and interventions to reduce annual losses attributed to floods. In an attempt to fill the knowledge and intervention gaps, this project is intended to engage the policy community, civil society and private sector actors on integrating determinants and drivers of social-demographic change into climate resilient flood management.

Additionally, in Ghana's ambitious Intended Nationally Determined Contributions (INDCs) to the UNFCCC, developing and managing climate resilient infrastructure was one of the major focal areas for adaptation and thus underscoring the relevance of this project. Efforts of policy, practice and civil society to address issues arising from climate change are challenged by lack of intersectoral collaboration, technocratic approaches, weakly integrated understandings of population dynamics, insufficient use of evidence in decision making, and imbalances in community, civil and private sector input to decision-making. The lack of gender sensitive indicators, poor land use planning and enforcement of laws, limited collaboration amongst stakeholders and general lack of awareness of planned adaptation still hang over attaining a resilient city goal in GAMA. Additionally, policy, planning, practice, and private interests in cities often reflect traditional development approaches (e.g. regional urban planning) that compounds flood risks because the unit of management is often zonal or regional beyond the reach of local dynamics. The project has five technical objectives that are expected to deliver on social, economic, awareness enhancement, gender dynamics and policy frameworks and outcomes towards providing adaptation solutions to floods in the GAMA. The project will provide the requisite platform to integrate the population – flood risk nexus into (i) national governance, (ii) awareness and education, (iii) flood risk reduction and early warning and (iv) mitigation and preparedness measures of government, to constitute "Climate Smart Integrated Flood Management (CSIFM)" framework for Ghana. Thus the aim of the project is to frame innovative adaptation solutions and means of implementation that seek to remove barriers to the adoption of research-into-use in flood prone areas through multi-criteria decision-making.

2.2 Overall Objective

The overall research objective is to engage policy, civil society and private sector actors on integrating determinants and drivers of social-demographic change into climate resilient flood management, whilst supporting Ghana's INDCs to the UNFCCC on resilient infrastructure (Dovie 2015, Dovie et al. 2015).

2.3 Specific Objectives

(i) Strengthen framework for aligning and analyzing population-related social, economic and environmental determinants of flood risks and provision of adaptation solutions.

(ii) Appraise capacity of managers to use technologies such as Geographical Information Systems (GIS) and Satellite Imagery alongside digitized maps and economic tools (e.g. cost-benefit analysis) to manage human dimensions of climate change and flood risks.

(iii) Design gender-sensitive multi-criteria decision framework for resource and knowledge mobilization on surveillance systems for effective flood risk reduction.

(iv) Evaluate Research-into-Use (RIU) practice, barriers and opportunities of adaptation solutions at the nexus of population growth, hydro-climatic risks and city planning.

(v) Analyze climate smart indicators to recommend technical feasibility, economic efficiency, social acceptability and environmental viability of adaptation solutions for consideration for Medium Term Development Planning

(vi) Training of PhDs, MAs and Non-degree Short Courses

2.4 Expanded Research Objectives

Objectives/Work Package (WP)	Description	Results / Interventions
Objective 1 (WP1) - Strengthen framework for aligning and analyzing population-related social, economic and environmental determinants of flood risks and provision of adaptation solutions.	This objective seeks to use information from within the study areas to target development policy frameworks such as Ghana’s Medium Term Development Plan and the Climate Change Policy on how the goals of such frameworks meet the needs of the population in terms of socioeconomic development (e.g. poverty alleviation, livelihoods) in concert with how the population is able to adapt to flooding. Thus, there is the need for us to understand the barriers and opportunities of these framework towards recommending relevant policy interventions	<ul style="list-style-type: none"> • Decision support / Policy framework / guide for mainstreaming development planning, climate change adaptation and flood risk management
Objective 2 (WP2) - Appraise capacity of managers to use technologies such as Geographical Information Systems (GIS) and Satellite Imagery alongside digitized maps and economic tools (e.g. cost-benefit analysis) to manage human	The objective will help us to unearth what resources and tools are available to managers within the local government, civil society and the private sectors and whether or not they meet the requirements of helping management to respond to floods and in the process we will go through some of the tools and analyses with them and testing them towards their acquaintance and sustainability	<ul style="list-style-type: none"> • Demarcation of flood prone areas in GAMA • Development and dissemination of flood maps • Toolkits for capacity building of technocrats for awareness creation

dimensions of climate change and flood risks.		
Objective 3 (WP3) - Design gender-sensitive multi-criteria decision framework for resource and knowledge mobilization on surveillance systems for effective flood risk reduction.	Referring to development policy frameworks as mentioned for objective 1 to understand how they meet gender requirements towards assisting the major stakeholders to introduce indicators that conscious targets vulnerable groups especially women in using climate information and being able to respond to floods through early warning and forecasting.	<ul style="list-style-type: none"> • Recommended designs for flood management e.g. market stalls and drains (structural) and poster / education materials (non-structural) • Early warning systems and contingency plan for GAMA
Objective 4 (WP4) - Evaluate Research-into-Use (RIU) practice, barriers and opportunities of adaptation solutions at the nexus of population growth, hydroclimatic risks and city planning.	Objective 4 is intended to analyze the adoption of existing and on-going research nationally to understand adaptation solutions that have been applied in the area of flooding and associated dynamics including success stories based on which a harmonizing framework will be proposed for implanting specific adaptation solutions that will be recommended.	<ul style="list-style-type: none"> • Investment options for upscale and out-scale by industry and the private sector • Recommended tangible options for adaptation solutions for budget mainstreaming and funding by public and private sectors
Objective 5 (WP5) - Analyse climate smart indicators to recommend technical feasibility, economic efficiency, social acceptability and environmental viability of adaptation solutions for consideration for Medium Term Development Planning.	The objective 5 will help us to understand costs and benefits associated with on-going adaptation to floods and proposal of adaptation solutions to emerge from this project. This implies that we will monetize such costs and benefits to inform decision making on options that the population choose when responding to the impacts of flooding.	<ul style="list-style-type: none"> • Budgets associated with recommended investment and adaptation solutions to respond to flood • Comprehensive impact assessment report on identified adaptation solutions • Flood response / adaptation strategy document (viz: Climate Smart Integrated Flood Management, CSIFM)
WP6 – Training of PhDs, MAs and Non-degree Short Courses	The WP6 is intended to draw on the five objectives in building and sustaining capacity in our formal and informal training to bring with its mentorship whilst ensuring that their project topics are acceptable without any administrative barriers.	<ul style="list-style-type: none"> • Increased leadership • Maintenance of institutional memory • Sustainability of project goals

3. PROGRESS TOWARDS MILESTONES

3.1 Months 01 – 06 Milestones

Milestone	Outputs / Events / Markers
Project agreements finalized	<ul style="list-style-type: none"> a. Project proposal revised from the original based on comments from the Program Specialist b. Terms negotiated and contract signed
Project coordinator recruited	<ul style="list-style-type: none"> a. To work closely with the PI, deputy PI, Researchers, Consultants, Administrative staff, Projects' accountant, etc. b. To organize planned and unplanned Management meetings, Team meetings, Stakeholder meetings, workshops, seminars, conferences, etc. c. To organize planned and unplanned travels for projects team d. To coordinate planned and unplanned consortium and work package level meetings as may be defined by the PI e. To ensure timely delivery of outputs such as reports, minutes, etc. f. To communicate with the consortium coordinator (where applicable) weekly g. To ensure the circulation of relevant project information to Projects Teams and other levels (e.g. consortium level) where applicable h. To review finances and keep track of budgets i. To assist with Project Monitoring and Evaluating j. To gather and provide material for management of the Projects websites and social media k. To be the first point of call for queries regarding the Projects l. To provide support to Work Package leads through timely communication with the Project partners m. To be an excellent ambassador for the Projects, promoting activities and innovations in the interest of the Projects and implement other tasks as may be assigned by the PI.
Partner institutions informed and terms appraised and agreed	<ul style="list-style-type: none"> a. Meeting was held with all the frontline partners to appraise them of the project objectives and their roles. b. The meeting aimed at drawing synergies from other organizations who are working on projects related to creating resilient cities in Ghana. c. The meeting ultimately provides a platform where the identified partners could have a discussion on what they intend to do on the project.
Informed participating districts and specific project communities / sites	<ul style="list-style-type: none"> a. District Assemblies and representatives of the various communities were informed in writing and invited to the project launch and inception. b. In all, 7 District Assemblies were chosen and two communities each selected to bring the total communities to 14, as opposed to the initial 6 Districts and 12 communities. The additional District was demand-driven by other Districts to have the additional one due to confounding interrelatedness of issues to the selected ones.
Steering Committee meeting	<ul style="list-style-type: none"> a. A nine- member Steering committee was identified to represent the public sector, private sector/industry, Academia, civil society, media, National development agency and two ex-officio members. b. The Steering Committee was responsible for the provisioning of support, guidance and oversight of project progress.
Scientific committee meetings	<ul style="list-style-type: none"> a. Joint scientific meetings were organized to synthesize the roles of the Work packages and realign activities to the project objectives. b. In addition to this there have been adhoc specialized meetings by the respective Work Packages to reappraise their methodologies and data collection approaches based on baseline reviews gathered
Boundary partners / other collaborators identified	Relevant organizations other than partners decided (e.g. NADMO, Ministry of Water Resources and Sanitation)
Official project launch	

Milestone	Outputs / Events / Markers
Project inception workshop	The project launch and inception workshop provided the platform to create national and international awareness about the project. It was well attended by a total of fifty-five (55) participants representing the project partners, Development planning and Town and Country Planning Officials from the seven (7) research districts, district assembly representatives, sponsors, Faculty members, PhD students and the media. Out of this number twenty-eight (28) were men and the remaining twenty-seven (27) were women.
Procurement finalization of logistics and equipment	<ul style="list-style-type: none"> a. Twelve (12) computers have been purchased for use by each work package, PhD students and the Coordinator's use. b. Additionally, one (1) Canon Advance Image runner and cartridges have been purchased for the project's management office.
Overall update on progress	Progress markers / indicators identified and agreed
Baseline report / output on the state of flood risks and adaptation in GAMA	<ul style="list-style-type: none"> a. The framework for collecting field data was developed with a target sample from two (2) communities each within the seven research districts. b. Research instruments drafted for surveys and focus group discussions components established for adult male and female populations separately
Policy interventions and adaptation solutions synergy established	Protocols for understanding total economic impact of policies and adaptation interventions established
GIS and Remote Sensing analysis of flood hazards	<ul style="list-style-type: none"> a. The IPCC concept of flood hazard, with the components of risk which are exposure, hazard and vulnerability have been adopted to manage the human dimensions of climate change and flood risks. Digitized maps of the study districts and communities have been developed using Global Positioning Systems (GPS). Appropriate digital instruments have been identified to be purchased for the project. b. Reconnaissance visits have also been made to these communities to confirm and validate their selection c. A geo-spatial approach is adopted for the flood risk assessment using, largely, ArcGIS. Other suitable software would be deployed, where necessary. A map of selected districts and communities for the project implementation has been composed
Flood risk assessment fieldwork	
District information / data management	Awareness of data needs and sources discussed with relevant focal points
Research into Use [RIU] Practice	Determinants of the barriers to / and opportunities of adaptation solutions identified
Selection of policy fellows	<ul style="list-style-type: none"> a. Focus disciplinary areas identified and linked to selected relevant departments of the District Assemblies b. Concept of the fellowship also underwent a revision
Master's degree scholarships / admissions	First Master's student to pursue studies in Environmental Science recruited
Three junior scientists / researchers recruited	Three (3) PhD Students pursuing studies in Population Studies, and Development Economics.
First policy dialogue / roundtable	Framework for public-private-partnership for flood management established with the Private Enterprise Foundation
Household interviews communities	Instrument for establishing baseline data on household level adaptation solutions going through ethical considerations and approvals
Finalization of baseline indicators for monitoring and evaluation	<ul style="list-style-type: none"> a. A participatory impact monitoring tool has been developed to monitor progress made within the project in alignment with the objectives. b. The baseline indicators will be finalized for the entire project by the next reporting period to further inform the monitoring process.
Finalization of framework for project information and results dissemination	Change / transformation agents identified and included in the designing of a communication strategy for the outcome and finding mechanisms of converting scientific knowledge into practical usable materials for the communities.

3.2 Months 07 – 12 Milestones

Milestone	Outputs / Events / Markers
Steering Committee meetings	Steering Committee meetings held, discussed the progress of the project and opportunity to address emerging boundary issues.
Scientists / combined work package meetings	Scientists and Work Package members met to discuss progress of the project in general and specifically plan towards a write shop retreat scheduled for May. Scientists shared updates on the activities planned and undertaken during the period under review. Each WP shared their plans for publication(s), indicating the proposed topic, data to be considered as well as other team members whose support will be needed for the development of the paper and the intended contribution of the paper. The highlights of the discussions included: <ul style="list-style-type: none"> a. the scheduled cross-sectional paper on the methods/frameworks used by the different WPs (Integrated framework) to focus on synthesizing methodologies adopted by all the WPs in their work implementation. b. The confirmation from the lead WP for the surveys, that analysis on flood risks and flood management could be done either using the perspectives of individuals, households, communities and/or the district provided focus for scientists in determining their publication focus. c. Additionally, the preliminary findings from the institutional analysis was being developed into a paper d. The development of a gender sensitive decision support framework for flood risks (to individuals) and levels of sensitivities e. Scientists shall utilize the write shop retreat to conduct peer reviews of papers developed to enable effective revisions from authors during the write shop
Draft impact analysis report	Indicators established for consensus with scientists towards data collection
GIS and Remote Sensing analysis of flood hazards continues	Flood prone / hazards maps generated as inputs into physical vulnerability mapping
Flood risk assessment fieldwork continues	
Flood response (e.g. solid waste & drainage network management)	<ul style="list-style-type: none"> a. Desk analysis completed b. Drainage master plan for GAMA reviewed and comments submitted to government
Investments framework for waste, recycle and drain infrastructure management	Concept drafted and using the AMA as the case-specific study because of all the seven districts, only the AMA had initiated a Resilience Action Plan
Established capacities and barriers to policies and measures related to Ghana's iNDC	Indicators for policy framework to mainstream climate resilient infrastructure established and follow-up discussions with NADMO and the NDPC carried out
Policy brief on the project science	Content drafted and passed on the project objectives and expected results of the project science
District information / data management	District Assembly level consultations through Townhall meetings and desk analysis carried out
Project representation at conferences	Participation in the Resilient Cities Forum in Bonn, Germany in organizing a Reality Check Workshop with contributions from: <ul style="list-style-type: none"> a. Regional Institute for Population Studies, University of Ghana, Legon, Ghana b. National Disaster Management Organisation, Accra, Ghana c. Cities Alliance, Future Cities Africa Project, Ghana d. Department of Climate Change & Food Security, University for Development Studies, Tamale, Ghana
Principal investigator international meeting	<ul style="list-style-type: none"> a. Presented on the topic "Impacts of climate change on the determinants of population health and implications for health resilience building" as platform to speak about project

Milestone	Outputs / Events / Markers
	b. This was followed by a Project Poster on the basic indicators / determinants
Policy fellows continue	Intervention proposal by fellows invited for analysis and selection
MA/MSc candidates finalize study	a. Two Master's degree candidates added and bring the number to 3. b. First recruit presented a draft thesis report
Three junior scientists / researchers continued (PhDs)	Coursework completed by two and the third also finalized fieldwork protocol / instruments
Short course module finalized	a. A two-day's Scientific writing short course was organized for active researchers and those under training working for universities and research institutions in Ghana with goals to publish in international and high Impact Factor Journals. b. The short course was organized on the back of the Regional Institute for Population Studies' flagship conference on Climate Change and Population (CCPOP). Applications were received from a total of sixty (60) applicants from public and private Universities with Post-Graduate and/or Doctoral qualifications. c. Twenty-five (25) applicants were selected to participate in the training which was conducted by Faculty members from the Institute as well as some external resource persons.
Policy dialogue / roundtable	Government and private sector engagement: State of integrated risk management, loss and damage functions in Ghana a. Risk management involves the private and public sectors. The need to encourage and support the private sector in enhancing its awareness and understanding of risks posed by natural hazards, especially floods, storms and agricultural drought attributed to global environmental change, global warming and climate change, in Ghana was long overdue. b. The private sector and subsequently industry should also consider adopting appropriate structural and non-structural risk management tools through forging partnerships domestically and internationally to support Ghana's commitment to climate change adaptation.
Focus groups	Focus Group Instruments completed and waiting on Initial results of the household interviews / surveys to be analyzed and key community level issues incorporated
Household interviews	Instruments completed (enumerators identified and trained, household listing completed, pre-testing / pilot analyzed and actual fieldwork started)
Monitoring and evaluation	Progress markers and indicators measured and continued
Project information and results documentation continues	Recognized and indicators incorporated to draft communication strategy
Virtual knowledge platform	Online information sharing database / clearing house established as part of the RIPS official website

3.3 Months 13 – 18 Milestones

Milestone	Outputs / Events / Markers
Steering Committee meeting	<ul style="list-style-type: none"> a. Steering Committee meetings held to discuss the progress of the project over the reporting period. b. Two new members representing the Land Use and Spatial Planning Authority (LUSPA) under MESTI and Private Sector Enterprise joined the committee.
Scientific committee meetings	<p>Scientists met on the updates of WP activities and to collectively review the first batch of applications submitted by prospective fellows from the district assemblies. Prior to the first round of assessment by scientists, a total of eight (8) applications were received mainly from the Planning and NADMO officials from the project district assembly offices. Applicants were assessed based on the following criteria:</p> <ul style="list-style-type: none"> a. Proposal focused on actions to be undertaken that will reduce susceptibility to floods by not using physical structures b. Ability to demonstrate achievable goals using little or no financial resources likely to be borne by project or applicant c. Fellowship activity potentially implemented jointly by applicant and other officials in the district.
Monitoring and evaluation continue	Progress markers and indicators assessed
Reports finalized on physical / spatial problem analysis	A total 1,290 households, drawn from 30 households in each of the 43 EAs across the seven (7) study districts were interviewed.
Research into Use [RIU] Practice	Barriers to / and opportunities of adaptation solutions identified
Investments framework for waste, recycle and drain infrastructure management (climate finance model)	<p>Framework established for trapping of solid wastes, collection, cleaning, bagging and transfers</p> <ul style="list-style-type: none"> a. Several types of stakeholders are usually involved in solid waste management. These include policy-makers at the regional and local levels who set and enforce standards; waste management agencies who participate in monitoring and complying with standards; individual community members who manage waste on a day-to-day basis; other downstream groups affected by the waste (e.g. businesses) and environmental interests. b. This activity will involve fixing nets at different points across the Odaw and Onyeasi streams using line nets that cut across the canal width and anchored to the base of the drains to the height exceeding the depth of the canals e.g. 5m in height at Odawna to ensure that insignificant waste can escape. The waste that gets trapped will solely depend on the flow of water and collected at different times of the day based on the quantum collected. This is to ensure that waste does not accumulate to become impediment to flow. Rafters will be provided to enable swimmers who will be part of the enterprise to perform the collection along the net and using sweeping devices to move sunken wastes. c. Once the wastes are offshore, separation will be done based on the types of waste (e.g. plastics, glasses, metal scrap, papers, wood debris), cleaning where necessary will be carried before bagging which will including weighing is carried out in readiness for transfer to the buying centers. Leftovers will be disposed will now be disposed of in the most appropriate manner
Finalized models on climate change scenarios with and without adaptation solutions	<ul style="list-style-type: none"> a. Both public and private precautionary measures undertaken in the past complement rather than impede private protective responses while public information on flooding does not appear to influence private protective response. b. We recommend policy choices to focus on the provision of the needed community level flood protection infrastructure since it stimulates private flood precautionary measures while paying less.
Evaluation of updated results against Ghana's iNDC on climate resilient infrastructure	Flood action plans and policy mainstreaming indicators established

Milestone	Outputs / Events / Markers
Focus groups in all districts	Baseline data on community level adaptation solutions on-going
District information management on validation and policy mainstreaming	Started with building capacity of fellows to facilitate the engagement process on validating the survey data and the focus group outputs
Flood maps ready for awareness creation	Framework for flood risk management concluded
Flood early warning decision making system	Climate smart integrated flood management defined and shared with the district assemblies
Virtual knowledge platform continues	Active online information sharing continued
Three junior scientists / researchers continue (PhDs)	a. One MPhil student has graduated b. Data entry, validation and exploration in progress for PhDs
Policy fellows continue	Capacity building continued

3.4 Months 19 – 24 Milestones

Milestone	Outputs / Events / Markers
Scientific committee meetings	<p>Scientists met to discuss progress of the project in general and specifically plan towards a write shop retreat scheduled for May. Scientists shared updates on the activities planned and undertaken during the period under review. Each WP shared their plans for publication(s), indicating the proposed topic, data to be considered as well as other team members whose support will be needed for the development of the paper and the intended contribution of the paper. The highlights of the discussions included:</p> <ol style="list-style-type: none"> the scheduled cross-sectional paper on the methods/frameworks used by the different WPs (Integrated framework) to focus on synthesizing methodologies adopted by all the WPs in their work implementation. The confirmation from the lead WP for the surveys, that analysis on flood risks and flood management could be done either using the perspectives of individuals, households, communities and/or the district provided focus for scientists in determining their publication focus. Additionally, the preliminary findings from the institutional analysis was being developed into a paper The development of a gender sensitive decision support framework for flood risks (to individuals) and levels of sensitivities Scientists shall utilize the write shop retreat to conduct peer reviews of papers developed to enable effective revisions from authors during the write shop
Steering Committee meetings	<p>Meetings / communications continued in different forms including a field trip.</p> <ol style="list-style-type: none"> Steering Committee members visited Ogoja, a community in the Adentan Municipal Assembly to experience first-hand incidence of flood risks exposure experienced by the community. It was observed that poorly constructed drains and unlawful construction of residential structures are contributing factors to the flood situation in the district. Members agreed to take up some of the issues and petition the Department of Urban and Feeder Roads of the Ministry of Roads and Highways to address some of these structural issues with road contractors and property owners.
Monitoring and evaluation continue	Progress markers and indicators assessed
Finalized models of adaptation solutions	<ol style="list-style-type: none"> Strategic investment framework on-going Gender mainstreaming determinants analyzed
District Strategic Environmental Assessment (SEA) of floods	Climate viability, sustainability and compatibility of interventions assessed using the Choice experiment
District Social Impact Assessment (SIA)	Social acceptance and barriers to adoption identified
District information management on validation and policy mainstreaming	Government and stakeholders engaged on validating data for policy implications
GIS-based flood awareness creation	On-going
Policy brief on adaptation solutions	4-pager A4 sized document produced
Project representation at conferences	<ol style="list-style-type: none"> During the 6th CCPOP, project scientists convened a panel to share research experiences and preliminary findings from the project with participants at the conference. Also, in attendance were the district assembly policy fellows.
Principal investigator international meeting	There was no participation due to unavailability of opportunities
Virtual knowledge platform continues	Active online information sharing continued

Junior scientists / researchers continue (PhDs)	One PhD candidate has submitted his thesis for examination
Visiting policy fellows continue	Enhanced policy influence with mentoring continued

3.5 Months 25 – 30 Milestones

Milestone	Outputs / Events / Markers
Scientific committee meetings	<p>Scientists met to take stock of project scientists' work to assume responsibilities of action plans in previous meeting:</p> <ul style="list-style-type: none"> a. Finalization of draft scientific manuscripts and submission to international journals b. Participation in international conferences. Specifically, the gender work package to be nominated to possibly participate in the Women Deliver conference in Vancouver, Canada if selected and the scientific team to be represented at the Resilient Cities conferences in Bonn, Germany if proposed panel is approved.
Steering Committee meeting	<p>Steering Committee meeting of the project was hosted by its Chairman, also the Vice Chancellor of the Regional Maritime University (RMU), Ghana</p> <ul style="list-style-type: none"> a. Present was the IDRC Programme Specialist, Ms Edith Adera. b. Major discussions during the meeting included the adoption of a proactive communication strategy to respond to climate change impacts and utilize this in communicating the project findings in effective ways. c. Key among the list of implementation strategies was the convening of a pilot Photo Exhibition within the project communities, highlighting stories of flooding and effects of human actions and inactions on flooding in Ghana. This would be done in collaboration with the project's partners of which the Ga Mashie Development Authority (GAMADA) will lead. d. An intention of a no-cost extension of the project was expressed. This was against the backdrop that the project could not be completed within the agreed time frame because of delays in the release of the project funds for the 4th period activities.
Monitoring and evaluation continue	Progress markers and indicators assessed
District information management on action plans, project impacts, and dissemination	Implementation, climate finance and communication frameworks introduced to Policy Fellows of the various District Assemblies
National level interventions matrix (hard and soft), e.g. policy change, infrastructure design, investments	<ul style="list-style-type: none"> a. Climate smart integrated flood management framework established as the baseline b. Intervention matrix developed for solid waste management to respond to flooding
Institutional / national readiness for interventions	Institutional mainstreaming of adaptation solutions analyzed
Finalization of preparations for 1no. non-technical one-time policy / intervention dissemination meeting / event	Preparations progressed well in collaboration with the RIPS Climate Change Resource Centre – Ghana and the City of Accra (AMA)
Junior scientists / researchers continue (PhDs)	Confirmed results studies and initial field report from two PhDs received

3.6 Months 31 – 36 Milestones

Milestone	Outputs / Events / Markers
Scientific committee meetings to evaluate work packages	Work Package reports appraised
Steering Committee meeting	Meeting held and sustainability of project outcomes discussed
Monitoring and evaluation continue	Progress markers and indicators assessed
District information management on action plans, project impacts, and dissemination	Two district level dissemination meetings were held with the Adentan Municipal Assembly (AdMA) and Accra Metropolitan Assembly (AMA) to share preliminary findings from the household survey and focus group discussions (FGDs) conducted. a. District specific data was shared with key officials from the districts representing departments or units for development planning, statistics, health, waste management, works and housing, National Disaster Management Organisation (NADMO), as well as Coordinating Directors and Municipal/Metropolitan Chief Executives (MCEs). Also, in attendance in AMA were district Human Resource officers and Resilience and Sustainability Officers. b. Representatives from the communities where the research was conducted were also present.
Scientific publications	<ul style="list-style-type: none"> • Papers at various stages of publishing discussed
Project representation at conferences	This was done. Internationally, part of the findings of the project was shared at the 2019 Population Association of America meeting (PAA) in Austin, Texas, USA. The paper led by the WP 1 team and titled “Drivers of Social Vulnerability to Flooding in an Urban Context: A Case Study of the Greater Accra Metropolitan Area” was presented in the session on Empirical Assessments of Linked Human-Ecological Adaptive Responses to Climate Change. Full abstract at http://paa2019.populationassociation.org/uploads/193944
Principal investigator international meeting	Participated in PAA 2019 in Austin, Texas, USA as Co-author of the Project Paper “Drivers of Social Vulnerability to Flooding in an Urban Context: A Case Study of the Greater Accra Metropolitan Area”
Policy brief on project’s policy influence / reflection published	4-pager A4 sized document drafted
Non-technical one time policy / intervention dissemination meeting / event	<ul style="list-style-type: none"> a. CCPOP-Ghana 2019 dedicated to the Cities and Climate Change Project confirmed for 12-14 November 2019 b. Joint hosting with the Accra Metropolitan Assembly confirmed c. Post conference side event with C40 Cities’ Climate Leadership also confirmed to include scaling out the project findings and use as capacity building for 29 District Assemblies in GAMA from 10-11 December
Project outcomes handbook	<ul style="list-style-type: none"> • CSIFM concept and contingency planning toolkit in progress
Junior scientists / researchers continue	<ul style="list-style-type: none"> • Scheduled to complete July 2020 • Two Masters (overflow from support for the originally two already graduated)

3.7 Months 37 – 42 Milestones

Milestone	Outputs / Events / Markers
Scientific committee meetings to evaluate work packages	<ul style="list-style-type: none"> a. Scientists met to finalize their first set of draft scientific results subject to peer to peer review b. Scientists also seized the opportunity to mentor graduate students yet to submit their dissertations and theses by reviewing and commenting on their write-ups
Steering Committee meeting	There was no steering committee meeting during the period due to the unavailability of the Co-Chairs
Monitoring and evaluation continue	Progress markers and indicators assessed
District information management on action plans, project impacts, and dissemination	Five districts levels dissemination meetings were held in the form of Townhall meetings to discuss the findings of the surveys and focus groups as part of feedback process to the Assemblies involved and building consensus around providing adaptation solutions. These were LadMA, AshMA, TMA, KKMA, and LEKMA
Scientific publications	<ul style="list-style-type: none"> a. Eight papers in the draft stage and heading for finalization and submission to Journals b. At least three of the said papers have been finalized and submitted to various Journals
Project representation at conferences	<ul style="list-style-type: none"> a. The project team organized a Pre-Formed Panel at the 16th International Conference on Urban Health People Oriented Urbanization: Transforming Cities for Health and Well-Being: 4 - 8 November 2019 Xiamen, China (http://www.isuhconference.org/) b. The Panel entitled “Interoperability of human well-being, climate change, and flood risk towards Accra's resilience in Ghana” under the theme numbered 2 of the conference “Climate Change and Healthy Cities” http://www.isuhconference.org/conference-topics.asp
Principal investigator international meeting	Participated in Resilient Cities Forum 2019 in Bonn Germany on an IDRC Global Sessions and spoke on the topic “Managing Flood Risks, Scale and Policy Incoherence in Accra, Ghana” and also on a CDKN Panel on the topic “Climatic hazards and livelihood assets by trade within the coastal urban landscape of Greater Accra Metropolitan Area, GHANA”
Roadmap for implementing the project’s communication strategy	<ul style="list-style-type: none"> a. Capacities of district assembly fellows and journalists earmarked for the long-term management of the communication strategy b. Key indicators / determinants and guidelines identified as entry points for the implementation and monitoring through institutional mainstreaming of key partners
1no. non-technical one-time policy / intervention dissemination meeting / event	<ul style="list-style-type: none"> a. CCPOP-Ghana 2019 dedicated to the Cities and Climate Change Project was organized from 12-14 November 2019 and co-hosted with the Accra Metropolitan Assembly with over 200 Participants on the Opening Day half of which stayed for the Scientific Sections and Days 2 and 3. Amongst the dignitaries on the opening day were: b. Post conference side event with C40 Cities’ Climate Leadership was also organized for District Assemblies in GAMA from 10-11 December 2019
Junior scientists / researchers continue	<ul style="list-style-type: none"> a. Scheduled to complete July 2020 b. Two Masters (overflow from support for the originally two already graduated)
Capacity building of District Assembly Departments on Project upscale	Capacity built for District Assembly Fellows of the 7 project districts on doing Climate Action Plan using data / information from the cities and climate change project. In all 26 of the 29 District Assemblies in GAMA were represented and up to 55 participants from departments of physical and development planning.

4. SYNTHESIS OF RESEARCH RESULTS AND DEVELOPMENT OUTCOMES

4.1 Value of Adaptation within GAMA

On the willingness of respondents to contribute either labor, cash or both to implement the flood adaptation project 89.1% did, with over 80% of them certain that they will make the contributions. Of these, 70.4% were willing to contribute at least 8 hours of work per month to implement projects, whilst 68.7% of respondents were over 80% certain that they will contribute at least 8 hours per month. Monetizing this was estimated at Gh¢38.0 per capita per day, which is in excess of the daily minimum wage of Gh¢9.7 per capita per day as at 2018. About 8.2% of the respondents indicated their willingness to contribute between 8 labor hours once per week and once per year inclusive towards implementing a project. This amounts to cash equivalent of between Gh¢38.01 and Gh¢1,976.52 per household per year. Respondents of up to 14.5% of indicated their Willingness to Pay (WTP) cash of more than GH¢100 per year to implement an intervention project, with 7.0% of the households showing WTP GH¢40 or more but less than GH¢100 per year compared to 10.4% which indicated a WTP less than GH¢40 per year towards a project. Overall, about 10.9% of the respondent households indicated they were not willing to contribute either cash or labor for the implementation of the project, because not all households experienced flooding, managing floods is the responsibility of the government through developing the communities, prevalent poverty and lack of physique to provide labor. Generally, households in GAMA would accept both the structured and non-structured flood adaptation options. The household survey showed that a major cause of flooding in the Greater Accra Metropolitan Area (GAMA) is building in / along water ways (42% of respondents); poor construction of drains (20.2%) and choked gutters (15.6%). Effects of heavy storms was not identified as a major cause of flooding (3.4% of respondents).

4.2 Strategic Interventions of Flood Risk Reduction in GAMA

Prior to the above research findings, institutional assessments were conducted on some key institutions responsible for flood risk management in Ghana namely: Land use and Spatial Planning Authority (LUSPA), Ministry of Local Government & Rural Development, Ministry of Environment, Science, Technology and Innovation (MESTI), Environmental Protection Agency (EPA), Ministry of Works and Housing, National Disaster Management Organization (NADMO), Ministry of Lands and Forestry, National Development Planning Commission (NDPC). The assessment gathered data and

information through in-depth interviews and discussion with relevant institutions and agencies to identify specific flood management-related roles/responsibilities, management structures and processes that exist in these institutions. The following findings were made from these assessments:

- a. General deficits in knowledge, skills and logistics for flood risk management exist
- b. Low institutional appreciation of integrated flood risk management where all elements are fully considered in flood management.
- c. Non-existence of operational integrated planning at MMDAs
- d. No standard procedure for integrated flood risk assessment exists.
- e. Actual risk maps based on hazard and vulnerabilities are not available; where maps exist, they are hazards of flood inundations at scales and resolutions not suitable for operational decisions for low lying and subtle variability in elevation of landscape of GAMA.
- f. Low publicity of policies that relate to flood risks

Overall, emerging flood adaptation solutions can be grouped into four major strategic areas as below with diverse options which will have differing details for each community and District.

<i>Strategy</i>	<i>Options</i>
Reducing Flooding	Dams and reservoirs Dikes, levees, and flood embankments High flow diversions Catchment management Channel improvements
Reducing Susceptibility to Damage	Flood plain regulation Development and redevelopment policies Design and location of facilities Housing and building codes Flood-proofing
Mitigating the Impacts of Flooding	Flood forecasting and warning Information and education Disaster preparedness Post flood recovery Flood insurance
Preserving the Natural Resources of Flood Plains	Flood plain zoning and regulation

4.3 Spatio-Temporal Assessment of Flood Exposure Pathways

There is increased exposure of people and critical livelihood assets to flooding globally, and this is projected to rise in the coming decades. Studies on exposure to flooding have however focused on quantifying the proportion of people and livelihood assets, differential exposure across regions, and socio-economic disparities in the exposed population. This leaves knowledge gaps in the exposure pathways of flooding. This study assesses the degree of anthropogenic influence on the natural socio-

ecological landscape and discusses the implications on exposure of urban population to flooding in two districts-AMA and AdMA in Accra for the defined periods 1970 and 2017. The novelty of this study is the use transdisciplinary techniques across the social and biophysical sciences that encompassed participatory learning approaches and Remote Sensing/GIS. Biophysical observations were discussed with segments of the populations disaggregated by age and sex. The results indicate rapid conversion of natural landscape such as forests, wetlands and water bodies into settlements and other concretized surfaces. Expressly, more than a quarter of vegetation cover and about a tenth of water bodies in AdMA were converted to settlements and open spaces between 1991 and 2017. Up to about 56.5% and 78.9% respective proportions of natural land cover in AMA and AdMA is projected to be lost by 2060 with increased flood hazard given the current land use practices. Evidence from the participatory methods indicates that flood hazard is exacerbated by poor waste management, lack of/ poor flood management infrastructure, and poor spatial planning.

4.4 The Choice of Adaptation Strategies to Flood Risk Management

This section investigates the psychological and socio-economic factors as well as the constraints that inhibit private precautionary flood-risk mitigation measures among urban households in Greater Accra Metropolitan Area of Ghana using the Protection Motivation Theory and data from the Integrated Climate-smart Flood Risk Management Survey undertaken by the Regional Institute of Population Studies of the University of Ghana. We find that both psychological and socio-economic factors influence households flood protective response in the Greater Accra Metropolitan Area of Ghana and that the Protection Motivation Theory is relevant in explaining private protective and non-protective responses to floods in flood-prone areas in the Greater Accra Metropolitan Area of Ghana. Also, both public and private precautionary measures undertaken in the past complement rather than impede private protective responses while public information on flooding does not appear to influence private protective response. We recommend policy choices to focus on the provision of the needed community level flood protection infrastructure since it stimulates private flood precautionary measures while paying less.

4.5 Determinants of Relocation Against Flood Risk in Urban Households

In this study, we investigate the factors influencing households' willingness to relocate from flood-prone areas in the Greater Accra Metropolitan Area using the probit model and data from a household survey. The results indicate that households are less likely to relocate as they grow, but the likelihood increases at later ages possibly as a result of increased vulnerability to flooding risk as one grows while households that receive flood information are more likely to relocate compared to those who do not. The probability of relocating decreases with increased public adaptive measures suggesting that public adaptive measure has the propensity to reduce relocation in the metropolis. We observe that households that perceive the level of flood risk to have increased in the past five years are more likely to relocate compared to those who perceive it to have remained the same. The extent of losses in previous floods matters as households that lost income and assets from previous flood are more likely to relocate compared to those that did not lose income and assets.

Further, households that have stayed in their communities for less than five years or between five and ten years, are more likely to relocate compared to those that have stayed there for more than ten years while those that have secondary/technical education have a higher probability of relocating compared to those without formal education. Expectedly, tenants have a higher probability of relocating compared to homeowners. We recommend the implementation of smart engineering solution such as building tanks, drainage channels and the protection and recovering of swamps and wetlands that serve as natural tanks while designing relocation programmes to focus on large households, non-indigenes, tenants, households' headed by female as well as those that have suffered losses in income and assets.

4.6 State of Waste Management, Sanitation And Flooding

The increasing trend in urbanization of Ghana's population alongside the pace of development has led to increased strain on limited social, commercial and physical infrastructure resulting in congestion, overcrowding, urban sprawl and the growth of slums. At a projected average urban growth rate of about 3% between 2000 and 2030, Ghana's urban population is expected to increase by 25% from about 52% of the total population in 2010 to around 65% by 2030. Cities will become the major destination with Accra already showing signs of its inability to cope with the pressure as total economic cost of resource degradation and poor environmental management including poor sanitation has been estimated at, at least 10% of GDP. Water, sanitation and waste management are being heavily impacted and expected to be worsened by climate change. This is because climate

change has increased frequency and intensity of rainfall meaning that there will be more water on the ground and drains in shorter time periods than before. Poor disposal of solid waste will further drive the severity of the floods from choked drainage networks in the city yet there are both formal and informal sector players with jurisdiction to keep the city and drains clean and void of foreign materials. About 20 – 30% of domestic, commercial and industry solid waste generated by the citizens daily is not collected and finds its way into open spaces and drains. Funds from central government is scanty and yet there are equally important sectors such as waste management hence not all issue of water, sanitation and waste management service delivery can be resolved. It would require some conscious and timely interventions to sustainably manage waste in Accra. The analysis suggests that there is need for deeper partnership between the private sector, AMA and the citizenry calling for co-evolution of new forms of managing waste to ensure that appropriate technologies on managing sanitation and waste are introduced. Accra's location between the ocean and the catchments of the Akwapim mountain ranges means that new forms of sanitation and waste management can no longer be avoided due to the dual influences of ocean and storm waters which often bring with it huge amounts of debris into some water channels and communities to cause flooding. The analysis suggests that there is a general lack of institutional capacity to manage solid waste and floods and that most of the challenges were severe. The need to now view waste management as a cross-sector activity was long overdue and there is the need to plan across sectors. Also, based on the household survey, community level strategies such as education on waste separation will be necessary. There is a demand for extra bins to facilitate separation of waste and to reduce waste being stored in plastic bags which makes indiscriminate disposal easy. More than half of the household's waste disposal is carried out by women and as such there should be gendered-based interventions for managing waste at community level. Majority (over 90%) of household are willing to patronize private sector collection should services improve; thus, efforts must be made by both the Assemblies and Waste Companies to address citizens challenges in house-to-house waste collection. Water and sanitation, and waste management impose major pressures on public health and productivity which is also gendered such that women and poor people tended to suffer disproportionately when there is ailment or injury. In aspects of financing, there are suggestions that the current unit pricing of waste collection is not sustainable and that more innovative approach such as financing through housing rental schemes. Therefore, sanitation and waste management are no longer the sole preserve of city authorities but also the citizenry and financial sectors which must be part of the planning process and very well informed about the types of relevant instruments that meet the needs of all stakeholders.

There is great potential for enhanced recycling, recovery, and re-use of waste to such an extent that some waste could be converted to energy, particularly to be undertaken by communities themselves. It has become obvious that it is mostly those who earn some regular income are able to subscribe to waste collection and management services hence there is need for pro-poor sanitation schemes which could economically empower those who patronize waste collection.

4.7 Probability of Flooding in Greater Accra Metropolitan Area: Implications for Flood Risk Adaptation

Increasingly, incidence of flood disasters is evident globally, notably in cities. This has the likelihood to compromise the cities' sustainability and resilience of dwellers, except appropriate adaptation actions are taken. Risk-based adaptation derived from the probability of the risks are most effective. Studies on the probability of flooding are mostly from engineering and hydrological perspectives that ignores the anthropogenic and behavioral drivers of flooding. Using the Greater Accra Metropolitan Area (GAMA) as case study, the paper examines the influences of climatic, bio-physical, anthropogenic and behavioral factors that drive the probability of flooding. Data from 1,102 households covering 42 Enumeration Areas in 14 localities from 7 Districts in the Greater Accra Region was analyzed. These data, together with rainfall data from Ghana Meteorological Agency and Digital Elevation Model were analyzed using a multinomial logistic regression model. In a stepwise analysis, we found that an increase in rainfall variation, land cover change, waste and sanitation and number of household members employed variables respectively, increases the probability of seasonal flooding, once flooding between one and two years and one flood in seven years relative to no flooding in seven years, holding all other variables constant. In contrast, an increase in the elevation of household location, and the number of household members with secondary education respectively, decreases the probability of seasonal flooding, once flooding between one and two years and one flood in seven years relative to no flooding in seven years. Institutions and flood management variables impact on the probability of flooding were mixed. We found that an inclusion of a waste disposal fee makes the impact of rainfall variation on the probability of flooding insignificant. Further, how marginal changes and relative risks ratios of these variables influence flood outcomes in GAMA were demonstrated. We recommend a blend of improvement in functional institutions on land use and flood management, optimal waste disposal fees and improved waste collection system.

4.8 Public Organizational Capacity and Integrated Flood Risk Management

Prior to 1996, there were forms of organizational arrangements in charge of all manner of disasters in Ghana. Since September 1996, in fulfilling of its obligations to international conventions, and particularly the United Nation's Declaration of 1990-1999 as the International Decade for Natural Disaster Reduction (UN/IDNDR), significant initiatives to formalize establishment of organizational structures and processes to manage disasters. The over-arching global goal for the 1990s: increase awareness, foster disaster prevention and reduce the risk of natural disasters through the widespread application of science and technology, was nationally adopted. In this study, organizations identified with direct or indirect roles related flood disaster management were multi-sectoral. The multi-organizational structure composed, dominantly, of public organizations that existed earlier, with statutory core mandates. Thus, their *raison d'être* was not the day to day management of flood disasters: it was a rather marginal one.

4.9 The Climate-Smart Integrated Flood Management Framework (CSIFM)

The highly urbanized Ghana's coastal zones experience cross-border effects of global change origins, hosting to over 25 percent of Ghana's population. The Greater Accra Metropolitan Area (GAMA) of Ghana, located within a limiting coastal landscape and characterized by increasing citizenry demand for services has contributed to increased exposure to annual floods. Yet GAMA faces data paucity to respond to climatic risks, attributed mainly to (i) gaps between science and practice, and (ii) weak partnerships with city managers. Floods have strongly emerged as complex outcome of climatic risks because of the underlying multiple stresses and exposures. Although flood risks assessments using qualitative, quantitative and spatial techniques exist, loss and damage of floods continue to increase. Hence, this article aims to establish how harmonizing methodological differences for assessing flood risks within urban landscapes yield desirable outcomes for flood risk management. Systematic review of SCOPUS articles reveals (i) clear differences in approaches to flood risk assessment as a result of disciplinary divide, effort and interest and (ii) obscured link between theory and practice of flood risk reduction. Outputs of Participatory Learning Approaches (PLA), Key Informant Interviews, Household Surveys, Gender Profiling and Townhall Meetings and Tools such as Community-based Risk Screening Tool – Adaptation and Livelihoods (CRiSTAL), overlaid on Spatial and Visual techniques offered synergies for adaptation solutions towards resilience building. There is need to integrate the effects of small area estimation in detecting socio-demographic and biophysical change against flood risks and to capture heterogeneity in resilience elements across scale to minimize risks of floods. Although

the different methods did not always share common assessment denominators, they produced efficient and far-reaching interlocking outcomes, known as “Climate Smart Integrated Flood Management Framework (CSIFM)”. The CSIFM which is multifaceted and beyond business-as-usual represents strong incentive for understanding complex political economy of flood risks.

5. PROJECT METHODOLOGY

5.1 Conceptual Framework and Overview of Approach

The project emerged from and was built on the outcomes of previous studies undertaken at the Regional Institute for Population Studies (RIPS) at the University of Ghana that established that flooding was posing serious threats to different population groups, businesses and industry, settlements and infrastructure as well as the overall coastline and shorelines of Accra. Thus the previous studies have shown that flood risks come in three fold, namely heavy storms, surface runoff, and sea level rise with varied impacts on the communities in the city of Accra irrespective of social and demographic attributes of inhabitants which have been acknowledged by the Accra Metropolitan Assembly as needing further research intervention, hence demand-driven. Of the several specific impacts ranging from inundations of settlements, displacement and destruction of property, impacts on infrastructure are said to be the highest in recent times. Such impacts on infrastructure range from the collapse of buildings, bridges, drainage networks, industry, market stalls to the houses of mostly the vulnerable with severe ripple effects on economic returns in the city of Accra.

The Greater Accra Metropolitan Area (GAMA) has suffered such consequences in recent past as a result of many factors including poor planning and enforcement of laws in the city. These have been compounded by the impacts of climate change manifested through late onset of rains which are also intense and stormy yet occurring within shorter time periods and thus are able to disrupt life and businesses. Lack of climate sensitive planning modalities and failure to subject infrastructure designs to gender and climate change metrics are leading to social, economic, financial and environmental losses in the city, yet the extent of the monetary values of these losses are either unknown or underestimated due to the lack of both human and logistical supports to carry out such assessments and evaluations. The flood situation has been aggravated by the lack of collaboration and partnerships amongst various stakeholders from the public and private sectors in addition to poor policy processes.

Thus interventions to resolve flooding of the city of Accra have suffered several setbacks due partially to lack of scientific evidence and failure to engage research-into-use through relevant stakeholder participation. This has created several gaps in knowledge on how to sustainably manage floods and yet using indicators and tools that are climate sensitive through a climate smart integrated flood

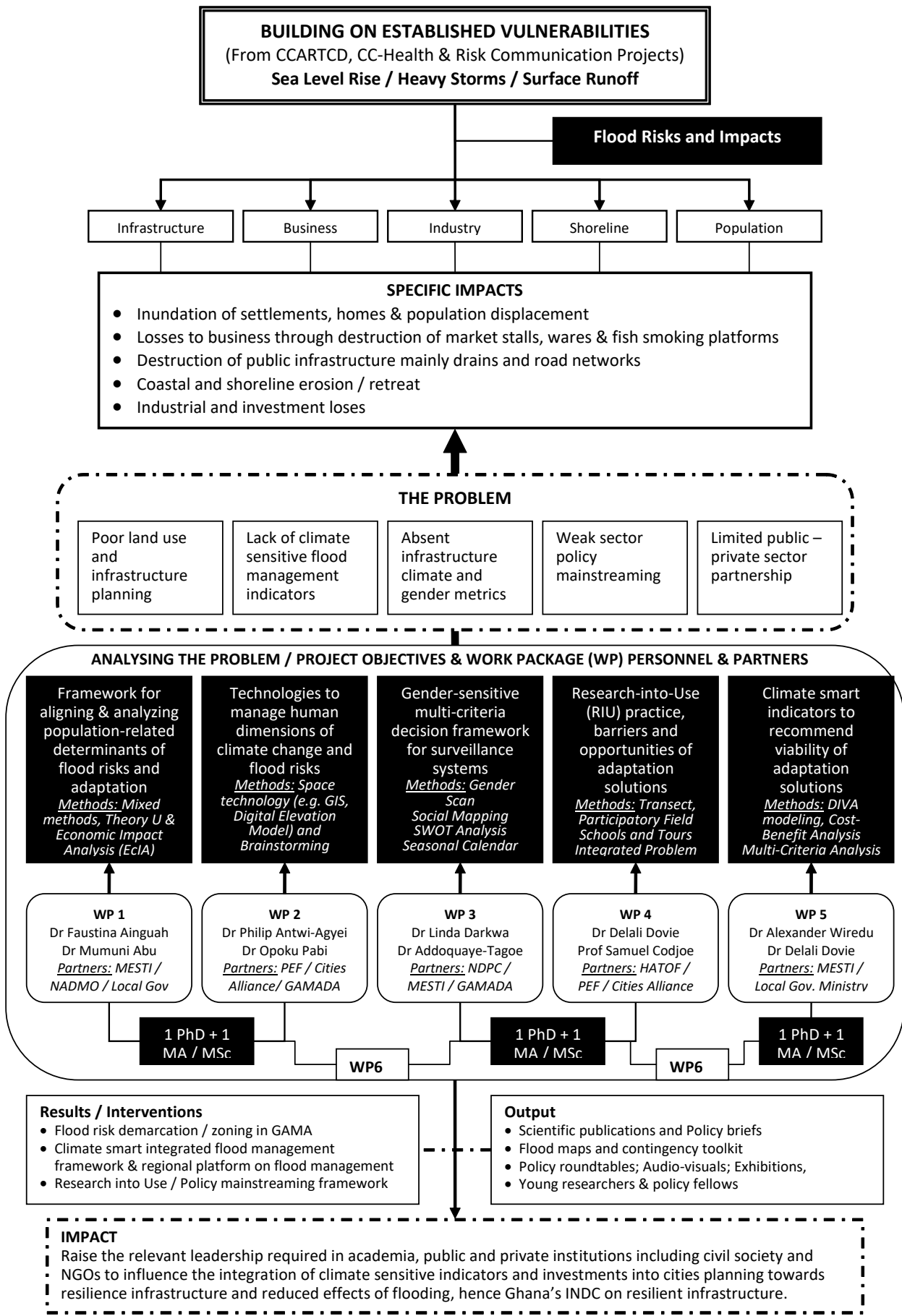
management framework which this intervention research will seek to achieve. The project will be undertaken in 6 districts within the GAMA and spread across the breadth and length of the region to represent all the issues and the adaptation solutions that have been identified. The demand-driven orientation of the project led to the segmentation of the project into soft and policy intervention measures and drawing on five objectives within six Work Packages (WPs).

There are five objectives which cut across technical issues and identified by five work packages and a sixth overseeing training and capacity building goals and dependent on the first five WPs. The WP1 seeks to use socio-demographic data from within the study areas to with expected interventions that mainstream flood response into development policy frameworks such as Ghana's Medium Term Development Plan and the National Climate Change Policy using relevant mixed methods of both quantitative and qualitative origins such as surveys, policy dialogues and the Theory U Process. The WP1 is expected to result in decision support framework that engages flood risk challenges in development planning, including barriers and opportunities, towards influencing and changing approaches to development planning that focuses on local rather than regional issues, or a mix of the two. Thus the emerging planning approach will guide flood risk mapping as integral part of medium term development planning at the local level and finally as part of the national planning process. The WP2 will impart the use technologies such as Geographical Information Systems (GIS) and economic tools (e.g. cost-benefit analysis) for creating awareness of the nexus of planning, climate change and flood risks, including understanding what resources and tools are available to managers within the local government, civil society and the private sectors to respond to future floods. The goal will be to establish zoning systems for flood risks and flood prone areas, and produce maps using space technology, participatory learning and guidelines that ultimately minimize losses and displacements that are associated with floods at homes and places of work. The WP3 focuses on building synergies between gender specific indicators and flood risk determinants using gender mainstreaming tools and approaches with the aim of coming out with flood early warnings that are sensitive to climate elements and responsive to needs of vulnerable groups such as women, children and the elderly and their environments and efforts at resilience building. WP3 is partially dependent on WP2 for GIS Application with Hydrological Models such as the Water Evaluation and Planning (WEAP) model overlaid on historical floods data using a gender sensitive seasonal calendar to launch the early warning platform. In-field based techniques such as transects and impact evaluation will underlie WP4 with the objective to analyze the extent (including barriers and opportunities) of the

adoption of existing and on-going public and private flood response strategies that have emerged as Research-into-Use to elicit investable flood adaptation options. The information will subsequently support the deployment of new investment opportunities that are climate sensitive and able to minimize flooding and its effects and emphasizing on physical planning and infrastructure management. The WP5 will focus on monetizing flood adaptation options using economic tools such as the DIVA and CBA to assess the best options available for adaptation whilst providing opportunities for knowing future incremental costs of the interventions towards protecting investments and making baseline finance inputs into national planning especially towards resilient infrastructure under Ghana's INDCs. The WP6 will serve the capacity building and training needs of the other WPs by engaging young researchers, personnel in management positions and boundary partners through formal and non-formal training as crucial change actors and pillars to facilitate change and maintaining institutional memory.

Each WP will be led by a senior scientist and supported by personnel with highly specialized skills in specific issues especially in using relevant tools and methods. It is expected that up to 3 PhDs and 3 Masters would be produced in addition to 6 policy fellows representing our partnering districts that number 6 in total. Additionally, the workshops and seminars to be ran will provide other forms of training to several development actors other than the partners already defined from the public and private sector institutions.

Subsequently the research strategy would seek to raise the relevant leadership required in academia, public and private institutions including civil society and NGOs tailored to influence the integration of climate sensitive indicators into cities planning. This will positively impact on planning for resilient societies and reduced flood impacts, whilst contributing significant baseline information and flood response model to Ghana's INDC on resilient infrastructure in aspects of policy mainstreaming, adaptation investment financing and early warning.



5.2 Methods for flood risk assessment

The methods range from household surveys through participatory learning approaches (PLA) involving focus group discussions and mapping events to the combination of some elements of qualitative and quantitative techniques that engage scenarios, modelling and spatial analysis (e.g. GIS). The research Work Package 1 (WP1) investigated demographic, economic, environment, health, social, water and sanitation indicators to inform the flood vulnerability assessment using quantitative and qualitative methods (e.g. household survey, focus group discussions). Overall, WP1 activities which were on developing a decision support framework for mainstreaming the management of floods into development planning, including barriers and opportunities, generated baseline data inputs with variables relevant to the remaining work packages.

Work Package 2 (WP2) mainly engaged the use of spatial techniques such as Remote Sensing and Geographical Information Systems (GIS) in analyzing the urban landscape vulnerabilities, climate change and flood risks, and results overlaid on institutional analyses of serious concern to capacity of city managers. The WP2 established the zoning systems for flood risks and flood prone areas, and produced maps associated with floods within GAMA, and elicited the capacity of government institutions to respond to floods.

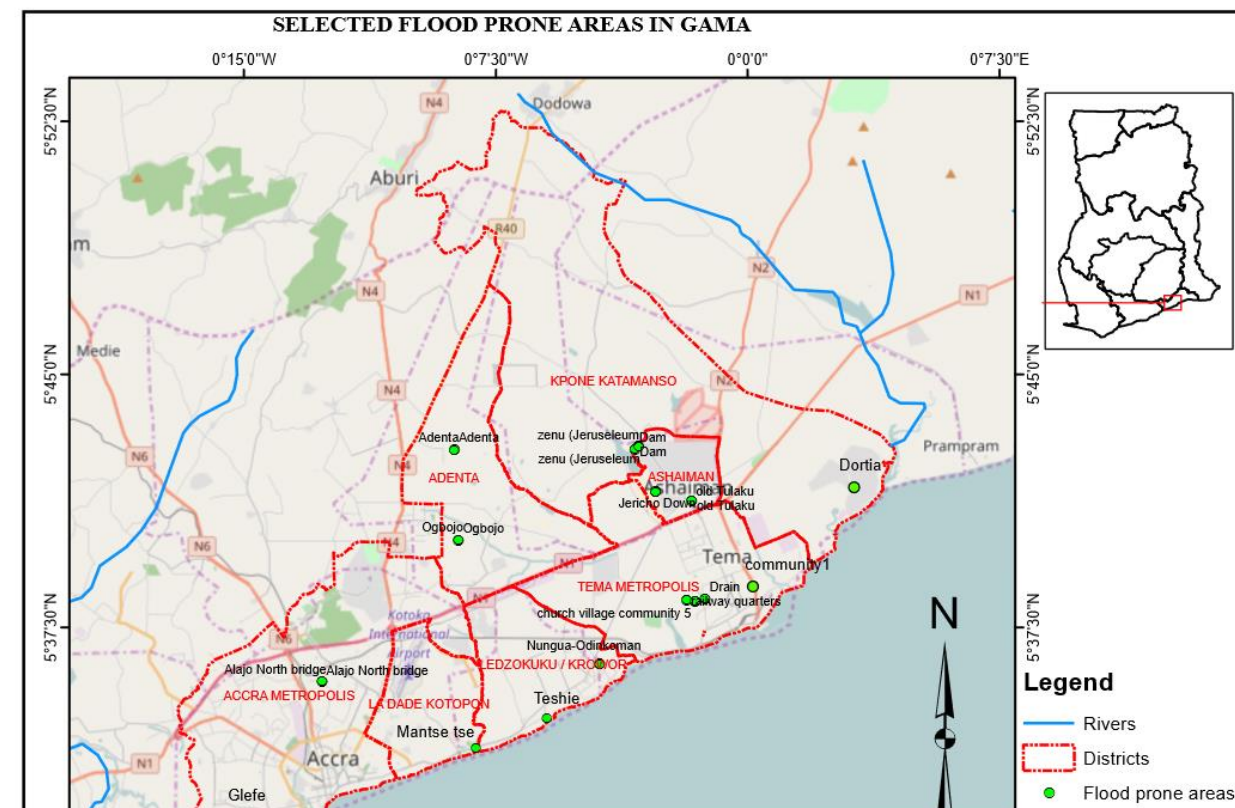
The focus of Work Package 3 (WP3) was on building synergies between gender specific indicators and flood risk determinants and the extent to which adaptation solutions were sensitive and responsive to needs of vulnerable groups such as women, children and the elderly.

The Work Package 4 (WP4) analyzed the adoption of flood response measures by communities and links with research-into-use based on in-field methods such as transects and participant observation to elicit investable flood adaptation options especially for infrastructure to assist city managers to deploy climate resilient interventions.

The Work Package 5 (WP5) focused on monetizing flood adaptation options using economic models and the Choice Experiment, building into it, future incremental costs of interventions. Halsnæs and Trærup (2009) have suggested approaches for mainstreaming economic aspects of adaptation into planning although it was not within the concurrent premise of biophysical methods as proposed in this paper.

5.3 Site selection and underlying physical vulnerabilities

Assessing flood risks in GAMA commenced with establishing the potential of floods as hazards and analyzing the physical vulnerabilities (Figure 3), using a combination of satellite and ground truthing data to select and prioritize hotspots areas. Two broad locations (i) distant from and (ii) along the coastline provided reference points for data gathering. This activity comprised of identifying key informants who joined in transect walks across communities and neighborhoods. Water marks on physical structures were observed as part of the indicators of exposure of population to floods, explained further through interaction with residents. Step-by-step specific activities were: (i) Construction of digital elevation maps to determine the low lying areas with highest exposure to floods hazards, (ii) Development of simple socio-demographic and flood hazard matrices of the ground truthing which led to the selection of seven District Assemblies (local government units), (iii) Consultation with the seven District Assemblies that confirmed the prioritization of 14 communities (within the 7 selected District Assemblies) in which the research methods were administered, (iv) Stakeholder analysis and mapping ensured greater representation of key institutions, individuals, political and policy constituents in reappraising the activities and the workplans of the WPs, (v) Consensus building with relevant institutions using the District Assemblies' structure on the planned exercise in the different dimensions of the research objectives.



5.4 Data origins and character of Work Packages

Work Package (WP) Objectives	Major Themes / Variables / Type of Data		Description of Approaches, Methods, Techniques, Tools, etc
	Quantitative	Qualitative	
WP1 Objective - Strengthen framework for aligning and analyzing population-related social, economic and environmental determinants of flood risks and provision of adaptation solutions.	<ul style="list-style-type: none"> Primary data collection: Household characteristics, employment and health, Housing characteristics and assets Drivers of flooding Water and sanitation Impacts of flooding Adaptive capacity and resilience of households 	<ul style="list-style-type: none"> Selection of study communities based on the same Districts and communities used for the Quantitative interviews Stakeholder mapping 	<ul style="list-style-type: none"> Town hall meetings Reconnaissance visit Sampling and Household listing Questionnaire administration interviews using CAPI approach
	<ul style="list-style-type: none"> Secondary data from Ghana Statistical Service Demographics and socioeconomic situation of study area 	<ul style="list-style-type: none"> Study areas from the quantitative study 	

Work Package (WP) Objectives	Major Themes / Variables / Type of Data		Description of Approaches, Methods, Techniques, Tools, etc
	Quantitative	Qualitative	
	<ul style="list-style-type: none"> Population data by district and community Shape files of study area 	<ul style="list-style-type: none"> Flood risk management Adaptation to flooding 	<ul style="list-style-type: none"> Interview guides Focus group discussions Pair-wise ranking Cross-impact matrix
<p>WP2 Objective - Appraise capacity of managers to use technologies such as Geographical Information Systems (GIS) and Satellite Imagery alongside digitized maps and economic tools (e.g. cost-benefit analysis) to manage human dimensions of climate change and flood risks.</p>	<ul style="list-style-type: none"> Types and availability of spatial technologies and their applications Types of institutions and agencies involved in flood risk management 	<p>Institutional structure, capacity, processes</p> <ul style="list-style-type: none"> Multi-sectoral, Integration and coordination, Roles, responsibilities, skills Public participation Application of flood risk reduction Climate change integration Knowledge and information management, communication, technology, innovation. Flood risk assessment Logistics adequacy 	<ul style="list-style-type: none"> Focus group discussions and key informant interviews Meetings, surveys, direct observations Purposive sampling Checklists and interview schedules Desk reviews
	<p>Flood Hazard Vulnerability (exposure, sensitivity and adaptive capacity.</p> <ul style="list-style-type: none"> Flood hazard models <ul style="list-style-type: none"> Elevation Land use and land cover Water bodies Rainfall 		<ul style="list-style-type: none"> Spatial and temporal modelling, risk simulation, hazard and vulnerability variations using GIS and remote sensing. Georeferencing of socioeconomic factors using GPS. Integrated data analysis and processing using ArcGIS 10.4, ENVI and SAGA software
	<p><i>Exposure index</i></p> <ul style="list-style-type: none"> Surfaces (Flow depth and speed, flooding frequency) Vector shapes (District, Communities, 	<ul style="list-style-type: none"> Open-ended questions within the household survey Focus group discussions with community 	<ul style="list-style-type: none"> Overlaying of demographic parameters over hazard characteristics of flow depth, speed, frequency and index of exposure integration (Depth + Speed + frequency).

Work Package (WP) Objectives	Major Themes / Variables / Type of Data		Description of Approaches, Methods, Techniques, Tools, etc
	Quantitative	Qualitative	
	enumeration areas, houses	members to highlight key exposures and stressors within the study area	<ul style="list-style-type: none"> • Surveys, direct observations, Population and housing census • Spatial data analysis and integration
	Flood risk assessment <ul style="list-style-type: none"> • Hazard index, Sensitivity index • Adaptive capacity index, exposure index 		<ul style="list-style-type: none"> • Spatial integration of indices • Vulnerability computation • Flood risk computation • Spatial display of risk variability
WP3 Objective - Design gender-sensitive multi-criteria decision framework for resource and knowledge mobilization on surveillance systems for effective flood risk reduction.	<ul style="list-style-type: none"> • Gendered Household experience of flooding • Valuation of flood damage cost and losses • Gendered effects of flooding • Gender dimensions of waste management 	<ul style="list-style-type: none"> • Knowledge and information management, communication, technology, innovation • Adaptive capacity 	<ul style="list-style-type: none"> • Desk review • Triangulation of methods • Thematic analysis of data • Gender profiling historical mapping • Life history analysis • Focus Group Discussion
WP4 Objective - Evaluate Research-into-Use (RIU) practice, barriers and opportunities of adaptation solutions at the nexus of population growth, hydroclimatic risks and city planning.		<ul style="list-style-type: none"> • Structural measures on stream channels such as channelization, flood walls • Retaining rainwater where it falls • Land use management (house building codes) • Land regulation (non-development of low-lying areas) • Dams and reservoirs • Diversion channels • Flood emergency measures 	<ul style="list-style-type: none"> • Focus Group Discussion • Pairwise Ranking • Transect Walks • Participant Observation • Key informant interviews
WP5 Objective - Analyse climate-smart indicators to recommend technical feasibility, economic efficiency, social acceptability and	<ul style="list-style-type: none"> • Likelihood of flooding • Elevation (using the GPS coordinates), drainage, waste and sanitation 	<ul style="list-style-type: none"> • Flood occurrences and impacts on households 	<ul style="list-style-type: none"> • Remote sensing and GIS application • Household surveys

Work Package (WP) Objectives	Major Themes / Variables / Type of Data		Description of Approaches, Methods, Techniques, Tools, etc
	Quantitative	Qualitative	
environmental viability of adaptation solutions for consideration for Medium-Term Development Planning.	<ul style="list-style-type: none"> Household experience of flooding Measurement of household previous flood levels Valuation of flood damage cost and losses 	<ul style="list-style-type: none"> Flood impact Adaptive capacity ratings Household and neighborhood assets 	<ul style="list-style-type: none"> Household surveys Desk reviews
	<ul style="list-style-type: none"> Time and risk preference Household and individual members' income and expenditure Household characteristics and spending Flood reduction, adaptation, mitigation and other related spending Household and individual employment and expenditure Time and risk preference 		<p>Economic Valuation</p> <ul style="list-style-type: none"> Stated Preference <ul style="list-style-type: none"> Contingent Valuation of Flood Adaptation Choice Experiment of Flood Adaptation Options Revealed Preference

5.5 Town hall meetings

Stakeholder analysis and reappraisal of the research content for each of the seven District Assemblies through Town Hall meetings and dialogues brought together change actors from the communities, civil society, NGOs, developers, public officials, cooperatives and unions, etc. It was to understand the heterogeneity and complexity associated with floods that confronted each district in its unique ways, and included (i) Identification of flood hotspot issues and facilitators from within the selected research communities, (ii) Identification of change actors within assemblies called Policy Fellows, (iii) Identification of community facilitators, (iv) Reappraisal of field design and sampling (use of census EAs and identification of HHs).

5.6 Key inputs of parameters into quantitative and qualitative methods

The study applied cross-sectional approach to investigate how residents and households within the GAMA manage flood risks and to obtain in-depth information about transition to resilience within study communities to prevent, prepare, respond to and recover from flood risks. The research used the updated National Master Sampling Frame constructed from the 2010 Ghana Population and Housing Census, by the Ghana Statistical Service; to accurately select households for the surveys. The Greater Accra Region consists of 16 districts of which the seven used in this study are part of the GAMA territory which are urbanized. Two communities in each of the seven districts were purposively selected based on prior information on history of proneness to floods using flood risk prone map. The research framework also examined whether coastal communities and/or landlocked (inland) communities within the GAMA districts experienced floods in the same way and possible strategies undertaken to mitigate the emerging effects. At the first stage of sampling, three enumeration areas (EAs) or primary sampling units (PSUs) were selected randomly from each of the 14 GAMA selected communities respectively and an additional EA was adopted to capture non-response of the population. An extensive listing and map-spotting exercise of all eligible households in the selected EAs were carried out to update the list of all households of usual residence within the selected areas. The list of names and detailed addresses of all households within the canvassed EAs formed the frame for the selection of households. The next stage involved the selection of 30 households, done systematically from the ordered sampling frame, using an equal probability procedure. A total sample of 1,290 households

were selected. Of these, 1,252 households were identified for the interviews in which 1,230 households were completed using the computer assisted personal interviews, yielding a response rate of 95.3%.

Participatory Learning Actions which involved (i) Transect walks, (ii) Participant observation, (iii) Focus group discussion, (iv) Community-based Risk Screening Tool – Adaptation and Livelihoods (Cristal), (v) Pairwise ranking, were adopted.

5.7 Physical vulnerability assessment

GIS and Remote Sensing / Using Digital Elevation Model (DEM) and Digital Terrain Model (DTM), Geo-spatial technologies of GPS, Remote Sensing and GIS were innovatively deployed and leveraged as tools and approaches for data capture, data processing, modelling, integrated analysis and display. ArcGIS 10.4, SAGA and ENVI were used as the main software for spatial analysis and modelling of flood risk. Flood disaster risk was modelled as an index from the component indices of exposure, sensitivity, adaptive capacity and flood hazard. Flood hazard scenarios at basin levels were modelled and simulated using spatial models, including the rational runoff model, based on various scenario configurations of the drivers of elevation surfaces, land cover and rainfall intensities for different time periods at different basin scales.

5.8 Inputs into key informant interviews for institutional analysis

These inputs were defined at national levels to (i) ascertain effective use of technology and capacities for flood management, (ii) assess key challenges confronting these institutions and (iii) Identify gaps in existing capacities.

5.9 Public policy dialogue

This involved engaging the Theory “U” process on the process of change towards planning of adaptation solutions and resilience building. Theory U-Process, an innovative participatory approach adopted from Dovie (2017) was used to generate new and creative approaches to address the issue of climate change and flood risks within coastal urban areas.

5.10 Project Implementation and Management

A four-tier system to promote integration was used. These are

- i. The Project Management Team based at RIPS led by the Principal Lead and responsible for the day to day running of the project activities including coordination component handled by a Project Coordinator.
- ii. The Scientific Team which did design and conducted the research on the ground reported to the Project Management Team, making significant and timely inputs into reporting back to project districts, communities and relevant stakeholders.
- iii. Public, private and civil society partnership, which ensured that the aims, objectives and relevant findings of the research was communicated to targeted audiences in languages understood by them. These partners included: National Development Planning Commission and the Planning Ministry, Ga Mashie Development Authority, Private Enterprise Foundation, the Ministry of Local Government and Rural Development, etc. By this mechanism, partners also helped to connect to other organizations when dealing with key national issues such as operationalizing the Sendai Disaster Risk Reduction Framework for Ghana, preparing for Conference of Parties of the United Nations Framework Convention on Climate Change (UNFCCC) and the Nationally Determined Contributions (NDCs), the Sustainable Development Goals (SDG), etc.
- iv. Project Steering Committee, with the responsibility to provide independent oversight of the operations of the entire project. The membership also represented key areas of parties in ensuring that the findings and activities of the project make impact at various levels of governance, whilst bringing their influence to bear on key national level policy issues.

5.11 Dissemination and Post-Project Stakeholder Engagement

Project Dissemination was carried out using four major pathways as follows:

Community Level

- a) Drama by community-based theater groups
- b) Exhibition by basic schools in their communities
- c) Policy Briefs

Local Level (Districts, Municipals, Metropolitans)

- a) Direct engagement at the District Assembly level
- b) District assembly Fellow interventions / activities
- c) Students' Masters and PhD Degree Theses / Dissertation Reports
- d) Policy Briefs
- e) Training of Physical and Development Planners

Regional / National

- a) Through events / activities organized by project partners
- b) Newspaper articles
- c) Students' Masters and PhD Degree Theses / Dissertation Reports
- d) Policy Briefs

International

- a) Attendances at conference and making relevant Oral and Poster Presentations. E.g. Population Association of America (PAA) Meetings, Resilient Cities Forum, International Conference on the Urban Environment (ICUH)
- b) Inputs into Conference of Parties (COP) discussions of the UNFCCC, by participating in preparations of National Communications and organizing Pre-COP events
- c) Organizing Large-Scale Conference Dissemination, through hosting the 2019 International Climate Change and Population Conference on Africa (www.ccpopghana.org)
- d) Web postings of activities and presentations
- e) Policy Briefs
- f) Students' Masters and PhD Degree Theses / Dissertation Reports

6. PROJECT OUTPUTS

6.1 Organized 2 No. National Policy Dialogues on mainstreaming the Sendai Disaster Risk Reduction Framework and embedding climate smart response to floods

The project partnered with the National Development Planning Commission (NDPC) to organize two levels of stakeholder engagements to discuss the status of Disaster Risk Reduction at the local, regional and national levels and more specifically to highlight the role of partnership between academia/research and government in increasing preparedness for flood response and recovery in Ghana's cities.

The first of the policy dialogue / consultative meeting was held with officials from over 25 institutions also with media presence to review the implementation arrangement for the Sendai Framework for Disaster Risk Reduction and identify critical gaps that needed to be addressed. This was aimed at identifying and discussing critical disaster risk reduction issues in Ghana and to develop measures to reduce the risk of disaster and build resilience to existing and new disaster risks. The second of the policy dialogue was a round table discussion with high level participants mainly heads at Ministerial levels from government, traditional leaders, private sector, disaster risk reduction in Ghana and to develop broad strategies and action plans to meet obligations under the Sendai Framework. Over 25 institutions were represented, some of which were also part of the technical dialogue and ensuring critical policy and technical mainstreaming of the framework lessons.

1. www.ghananewsagency.org/social/stakeholders-express-concern-over-population-growth-challenges-hampering-spatial-planning-147992
2. https://www.graphic.com.gh/news/general_-news/ghana-has-no-disaster-risk-plan.html
3. <https://www.ghanaweb.com/GhanaHomePage/NewsArchive/Stakeholders-express-concern-over-population-growth-challenges-hampering-spatial-planning-735915>
4. <https://www.ghanaweb.com/GhanaHomePage/television/videos.php?ID=65394>
5. www.peacefmonline.com/pages/local/news/201904/379476.php
6. <http://www.ghanaiantimes.com.gh/consultative-meeting-on-disaster-risk-reduction-ends-in-accra/>

6.2 High level Pre - CoP Meeting – 2017 Pre-CoP Climate Festival

In preparation towards COP 23 happening in Bonn, Germany from November 6 – 17, 2017 a Pre-CoP Climate Festival was convened in collaboration with the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), National Disaster Management Organisation, the Ministry of Finance and the Ministry of Food and Agriculture; on October 24, 2017 at the Ghana Academy of Arts and Sciences (GAAS) in Accra on the theme: “The Risks We Do Not Want”. The festival was organized with the aim of providing a knowledge sharing platform to enable stakeholders to reflect and take stock of adaptation measures across climate-sensitive sectors from agriculture to water. . Especially rural population in the northern parts of the country exposed to disastrous weather events like severe droughts and precipitation-fed floods and similarly, increased frequency and intensity of flooding of cities in the south.

The high level high-level event was well attended by a total of two hundred and twenty five (225) participants beyond the 150 planned for, of which, 54 were females and 171 males. Participants represented Government Ministries, Departments and Agencies (MDAS), District Assemblies, international and local NGOs, faith based organizations, social enterprises as well as students from second cycle institutions within Accra.

1. <https://www.ghanaweb.com/GhanaHomePage/NewsArchive/Canada-is-helping-Ghana-manage-flood-risk-High-Commissioner-594794>
2. <http://agricinghana.com/2017/10/25/ghana-stages-pre-cop23-climate-festival/>
3. <https://www.thefinderonline.com/feature/item/10524-ghana-holds-pre-cop-festival-ahead-of-23rd-annual-international-climate-change-gathering>

6.3 District Assembly Level Communications

The communication documents represent the positions of the seven Municipals, Metros and District Assemblies within which the project was carried out. Thus they represent consensus statements of the Assemblies generated at Townhall meetings during the dissemination of the project results.

6.4 Produced 8 No. Research Papers (unpublished)

- i. Spatio-Temporal Assessment of Flood Exposure Pathways
- ii. The Choice of Adaptation Strategies to Flood Risk Management
- iii. Determinants of Relocation Against Flood Risk in Urban Households
- iv. State Of Waste Management, Sanitation And Flooding
- v. An Estimate of the Probability of Flooding in Greater Accra Metropolitan Area
- vi. An Examination of Households' Willingness to Pay for Flood Risks Adaptation in GAMA
- vii. Public Organizational Capacity and Integrated Flood Risk Management
- viii. The Climate-Smart Integrated Flood Management Framework (CSIFM)

6.5 Post-COP 23 climate change stocktaking

The project partnered with the Environmental Protection Agency (EPA), and the Africa Group of Negotiators to the UNFCCC to organize a 2017 Post-COP 23 climate change stocktaking colloquium in Accra. The Post-COP Stocktaking Colloquium brought together stakeholders and international partners who had participated in the COP 23 held in Bonn, Germany from 6th – 17th November 2017; to discuss policy actions towards some of the outcomes of the conference in relation to climate financing, investments and coordination of climate action, corporate emission cuts and government ratifications, to inform Ghana's NDCs as project's contribution.

6.6 Conference Proceedings on Cities and Climate Change

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6.7 District Assemblies’ Training

Trained 56 Physical and Development Planning Officers in 26 out of the 29 GAMA Local Government District Assemblies (i.e. Districts, Municipals, and Metros)

Session	Day 1 – Prioritizing adaptation actions	Day 2 – Developing implementation road maps
1	Welcome and introductions Aims and objectives for the workshop	Recap and Outcomes of Day 1
2	Presentation: Developing a Climate Action Plan compatible with the Paris Agreement: Accra’s experience	Presentation: Mainstreaming climate change and sustainable development and Case study: Flood contingency planning and framework
3	Presentation: Climate hazard and risk analysis for Greater Accra: Results of IDRC / CDKN projects	Training & Group Exercise: Detail prioritized adaptation actions using the Road Map templates
4	Presentation: Defining / Downscaling Ghana’s Nationally Determined Contributions (NDC) adaptation targets to areas Assembly level	Training & Group Exercise: Stakeholder mapping using power-interest
5	Training & Group Exercise: Strategy development: set a vision, translate the vision into goals and a plan	Training & Group Exercise: Spatial mapping of actions to identify synergies across actions
6	Training & Group Exercise: Prioritizing adaptation actions using multi-criteria analysis	Training & Group Exercise: Indicators and how to build accountability as a catalyst for change

6.8 Produced 2 No. Policy Briefs

Number 1: Learning outcomes for policy

Number 2: Project science for policy recommendation

6.9 Project Manual

Project Manual (toolkit) on Implementing Flood Risk management that is Climate Smart *

6.10 Organized one large scale dissemination of project results (CCPOP-Ghana 2019 conference)

The 2019 conference is a product of an innovative research project entitled “Climate Smart Integrated Flood Management” within seven District Assemblies in Greater Accra Metropolitan Area in responding to climate change challenges in Cities vis-à-vis urban landscapes. This is timely for emerging debates on population and development related nuances, with momentum for the Sustainable Development Goals (SDGs), the Sendai Disaster Risk Reduction Framework, and the Paris Climate Agreement. The conference theme “Transforming Cities’ Resilience to Climate Change” calls for transformative and smart solutions to overcome the most dangerous effects and impacts of climate change. 100 people participated in the conference.

6.11 Produced a Communication Strategy on managing flood risks **

The Development of appropriate strategies for communicating information on climate induced flood risks are key to the overall task of managing socio-demographic change and climate induced flood risks in the GAMA. The implementation of the strategies will contribute to the successful achievement of the project goals and objectives as well as enhance the visibility of project activities and outputs.

The strategy is divided into two for successful implementation:

1. Internal Communication Strategy that identifies the internal targets and how they will share information with and among each other.
2. External Communication Strategy targets audiences outside the implementing team.

6.12 Trained 7 Graduates at the PhD and Master's degree levels in Population Studies, Environmental Science, and Economics

1. Reuben Tete Larbi: Spatio-Temporal Assessment of Flood Exposure Pathways in Two Distinct Socio-Ecological Areas in Accra Ghana using Pluralistic Methods. *PhD*
2. Emmanuel Ayine Ayimpuhah: An Economic Analysis of Flood Risks and Adaptation Options in Greater Accra Metropolitan Area (GAMA). *PhD*
3. Crystal Bubune Letsa: Population dynamics, changes in land use/cover and flood risk in Greater Accra Metropolitan Area. *PhD*
4. Adwoa Bema: Assessment Of Institutional Flood Risk Management In Greater Accra Metropolitan Area. *Master's*
5. Benjamin Memeh: Socio-Demographic Drivers Of The Geophysical Resilience Of Households To Flood Risk In The Greater Accra Metropolitan Area (GAMA). *Master's*
6. Ernest Owusu: Urban household flood preparedness in Ghana: A case study of the Greater Accra Metropolitan Area (GAMA). *Master's*
7. Ekow Akyen Anderson: Flood Control And Assessment Using The WEAP Hydrological Model. *Master's*

6.13 Established a Network of Fellows at the Local Government Level within the District, Municipal and Metropolitan Assemblies.

We continued to engage Policy Fellows of the Districts in framing strategic plans for the management of flood risks in their respective district assemblies. A management team meeting was held during the period as well as motivating meetings by the individual work packages. The project team further partnered the Ga Mashie Development Agency (GAMADA) to initiate some dissemination activities with the Basic schools within the Accra Metropolitan Area (AMA) as part of the implementation of community sensitization and awareness enhancement using photo exhibition.

The development of the Policy Fellows has also included having to share some of the findings with them towards giving them the opportunity to appreciate the issues on the ground in their effort to assist in providing solutions. The Policy Fellows have also been involved in the consultative meetings organized on disaster risk reduction

7. PROBLEMS AND CHALLENGES

Partner Interests: Although the project partners have been well integrated into the operations of the project which focuses on adaptation solutions rather than mitigation, some still want to do things on mitigation once it is about cities. An example is PEF which does both adaptation and mitigation and has successfully organized an adaptation solution activity and now wants to examine the transport sector in reducing emissions. PEF has therefore been asked to use the principle of “co-benefits” by introducing flood risk issue into their transport and emission models In ensuring that adaptation becomes very visible. One way that has been suggested is the use of the concept of the Unban NEXUS that promotes synergies and benefits

Fellows: The concept of the District Assembly Policy Fellows to inform change within their jurisdictions is very relevant and on-going but needed time make the expected impact. This is because the fellows are also conferring with their colleagues who might not be available when needed, challenges of time commitments and forward looking challenges of financial resources to sustain the initiative. The project decided to strongly bring in the National Development Planning Commission (NDPC) already with influence on what happens at the District Assemblies levels. Therefore in order to manage the challenges of time constraints and availability, the NDPC made it easier by working with the fellows during the official national planning workshops organized by the NDPC for the Districts. Subsequently, some fellows have done initial work plans which include proposed officials within the district and other stakeholders who need to be engaged in the realization of the action plans.

8. ADMINISTRATIVE REFLECTIONS AND RECOMMENDATIONS

In as much as technical advice from critical project partners is crucial in effective project management, it is necessary to understand the local context within which the project is being implemented. Such consensual understanding will enable project management achieve the intended goals of the project while utilizing the unique local context of implementation as well as historical experiences of working in similar situations. Moving forward, IDRC should work with grantees to scan and document the most efficient local context within which activities could be implemented in an effective manner.

For example conditions for the last tranche of payment (hold-back funds) should be reviewed and if possible activities to service providers could be paid directly from IDRC to the service providers. The question about where to raise funds to carry out remaining activities came up strongly in this project due to new financial regulations by the University that prevented projects depending on others for support. Our experience of not being able to access the hold-back funds when we needed it most, and as an academic institution which is non-profit making, had to force us into new partnerships came at cost to the institution.

9. CONCLUDING REMARKS

9.1 Contributions to Field of Study

- i. First, cities and climate change have received very little attention in the past but has strongly emerged in recent years because cities have now been accepted globally as the future of the world's development. Yet there is limited understanding of how the growth of cities provides opportunities for adapting to climate change as climate change induced disasters such as floods have risen sharply in cities. Second, floods have always been considered as geophysical dynamics than socioeconomic and demographic and placed limitations on policy responses hence the exposure units i.e. human dimensions which received little or no attention.
- ii. The research showed that gender, economic, health and housing attributes of households are major drivers of floods exposure and proximate correlates of coping mechanisms that must be tackled in policy responses. Yet inappropriate governance measures due to limited capacity and policy misalignment undermine the integration of flood risk management into development planning.
- iii. Subsequently, the project co-evolved the climate-smart integrated flood management framework, a participatory cyclical research and planning tool that guides decision-making in governing flood risk assessment and management whilst promoting horizontal policy integration e.g. with the Sustainable Development Goals (SDGs) and Ghana's Nationally Determined Contributions (GH-NDCs) through climate action plans (CAP) of District Assemblies.

9.2 Unintended outcomes and impact

- i. Communication Strategy [*This first emerged during a project management meeting on how to timely disseminate project information / results which then informed the recommendation of a communication expert with background in Journalism to be part of the Project Steering Committee. The discussion was then intensified at a Project Steering Committee meeting in the presence of the Program Specialist which resulted in the commission of the exercise. There have been some press releases as a result which has engendered the interest of the media in the project*].

- ii. Institutional Analysis paper [*This was a paper produced by the Work Package 2 with original mandate to appraise the capacity of managers on using key and emerging technologies for governing climate change issues such as floods. However, challenges of policy incoherence amongst key institutions with mandates related to flood management emerged hence the need to expand the scope of the appraisal to include the assessment of relevant resources of key institutions at the National level and cascading into District levels*].
- iii. Partnership with C40 Cities – Climate Leadership Group on capacity building of District Assemblies within GAMA [*The C40 needed key data to reinforce its support of action plan on adaptation initially for the Accra Metropolitan Assembly (AMA), which it invited the Cities and Climate Change project to complement its efforts. The scope of the Action Plan was the expanded / scaled up to cover 25 additional GAMA Districts out of 29, meaning that more District Assemblies now can develop their own Climate Action Plan (CAP)*].
- iv. Technical advise to the Road Ministry on flood infrastructure in Adentan Municipal Assembly (AdMA) [*The Project Steering Committee received invitation from one of its Municipalities, AdMA on policy needs assessment through which issues on the ground showed that road infrastructure was increasing flood risks hence the project officially informed the Road Ministry to take action*]
- v. Photo Exhibition by Basic Schools within the AMA [*Emerged from the collaborative efforts between the AMA, Ga Mashie Development Agency (GAMADA), the Local Government Ministry and the Project Steering Committee, emphasising poor solid waste management as key to flooding. Waste bins were distributed to schools involved and presented with Cameras to continuously use photography to enhance awareness on flood risks*].
- vi. Partnership with AMA on 100 Resilient Cities programme by the Rockefeller Foundation towards the Accra Resilience Strategy [*Emerged as a result of data needs for the project and the AMA has since launched the Accra resilience strategy*].
- vii. Memorandum of understanding initiated between RIPS and the Ghana Meteorological Agency (GMet) [*This was after GMet recognised that community engagement and socio-demographic data were key to effective weather information and early warning, as they lacked the capacity to do so, which came up strongly during a Panel organised*

by RIPS and GMet at the project's large dissemination conference on ICT and Weather information Development].

9.3 Policy Mainstreaming and Entry Points

The National Development Planning Commission (NDPC) and more recently, the Ministry of Planning could provide the much required coordination roles that cut down duplication roles of institutions involved in flood disaster risk reduction towards a more value addition approach. Lessons from the project so far are suggesting planning challenges cutting across scales from local to national and therefore, deeper engagement with the NDPC is an opportunity for change. In the coming weeks therefore, the project will reappraise its strategies to further engage there NDPC and its sector ministry when relating to the other partners and also during the feedback sessions with the Districts.

The Sendai Framework provides the most comprehensive entry point to address flood disaster risk reduction in GAMA. This is because it involves the “building of resilience to disasters with a renewed sense of urgency within the context of sustainable development and poverty eradication, and to integrate, as appropriate, both disaster risk reduction and the building of resilience into policies, plans, programs and budgets at all levels and to consider both within relevant frameworks”. Therefore the concept of the Climate-Smart Integrated Flood Management which puts climate change and socio-demographics at the center of planning fits into the Sendai framework and making this project an important national asset.