Assessing Community Coping Strategies in Sustainable Flood Management. A Case Study of Kaemibre and Walantu in Kasoa Municipality, Ghana

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Abstract

Community based flood management has become fundamental in increasing societies' resilience to flooding. As climate change and urbanization continue to worsen flood disaster events, it is practical to examine local adaptation to floods. To achieve this objective, multi criteria analysis, using Geographic Information System and Digital Elevation Model for flood modelling and risk mapping assessment, buttressed by questionnaires, was employed to evaluate human relationship and response to flood risks management. A landuse map of Satellite remote sensing Level 1B satellite images from Landsat ETM Plus for the month of October 2018 was created, using Environment for Visualising Images Software and Geographic Information System for estimating changes in the land cover during the modelling process. The most affected communities were defined from the overlay of the risk map on the topographic map of the same scale. It was revealed that even though flood risk map shows communities' risk of flooding, socio-economic and cultural factors play major role in flood risk management. The coping strategies of the affected communities involved bolstering walls and increasing compound elevation above flood level, desilting drains, and changing jobs. The study recommends the integration of flood hazard maps into sustainable flood management of communities.

Keywords: Flood Risk Modelling, Digital elevation model, Geographic Information System, Climate Change, Coping Strategies.

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Introduction

Flooding is a disaster that could cause serious disruption of the normal functioning of society, causing widespread human, material or environmental losses, which exceed the ability of affected society to cope on its own resources (Cutter, 2018). A disaster occurs when a significant number of vulnerable people experience a hazard and suffer severe damage and/or disruption of their livelihood system in such a way that recovery is unlikely without external aid (Ndah and Odihi, 2017). Heavy precipitation, which in many contexts is produced by convective storm, is considered as the main cause of flooding because it provides the amount of water necessary for flood occurrence (Gupta and Ahmad, 1999; Gyekye, 2013; Schumacher, 2017).

Flooding is the most common environmental hazard worldwide because of its widespread geographical distribution, which covers river floodplains and low-lying lands and coasts and their long-standing attractions for human settlement. According to the World Bank's Global Subnational Atlas of Global Monitoring Database, it estimated that 1.47 billion people or 19% of the world population are directly exposed to the risk of intense flooding. It is further estimated that over 600 million of them are poor (Rentschler and Salhab, 2020), and an estimated 236, 000 annual drowning deaths worldwide, making drowning a major public health problem (Rojas et al., 2022), accounting for 7% of global injury-related deaths, and a combined economic flooding impact of more than USD700 billion.

The factors that influence flooding are multiple and highly correlated. These factors include climate change, topography, high population growth, migration, unplanned settlement, and environmental degradation (Mansur et al., 2016, Glago, 2021, Khanam et al., 2021). The issue of flooding has been of profound interest to humanity, especially in recent years, where the effect of climate change is believed to have compounded the changing weather conditions in many places. This is understood to have led to extreme conditions such as flood (Mansur et al., 2016).

There is a widespread increase in the risk of flooding in many human settlements (Montz et al, 2017). However, the coastal and lowland settlements as the most affected areas (Kummu et al., 2016). Many of them fall below the poverty index level (Johnson, 2017) and cannot afford any suitable housing hence they are reluctant to evacuate even during acute flood (Pelling, 1997).

Flood and drought are some of the major climatic hazards in the semi-arid areas of Sub-Saharan Africa (SSA). Climate change affects the periodicity and severity of such hazards, and eventually the well-being of many rural communities in semi-arid and coastal communities Ghana (Boafo et al., 2020). Within the past decades, flooding has become a global pandemic, which hampers economic and social development. This global phenomenon has led to the loss of lives and economic damages in many countries including Ghana (Asumadu-Sarkodie et al., 2017).

Floods and droughts have devastating impacts on the environment (Amoako et al., 2018). A case in point was in August, 2007, when floods in the Northern parts of the country alone affected about 350,000 people with 49 casualties; causing an estimated damage of over 130 million United States Dollars (US$), not including long term losses. Other notable flood disaster places are Accra and Elmina. These disasters often affect negatively on social, economic and environmental sustenance of households, and loss of lives (Amoako et al., 2018). In urban areas, the effect of flood has great consequence on urban infrastructure: roads, bridges, buildings, power transmission; consequently, systematic flood risk mapping is critical for effective planning and disaster risk reduction and to help improve the capacity of communities to respond to flood.

The study examines the coping strategies of the people of Walantu and Kaemibre of Kasoa municipality against floods, focusing on the factors that influence the choice of coping strategy, which evolves income levels, the relationship between changes in land use pattern and flooding, and how these influence the susceptibility of residents to flooding and their adaptive strategies.

One of the biggest challenges associated with flooding in developing countries is how to plan and manage developments in flood-prone areas. Worldwide, planning system plays a major national and local role in ensuring that developments that take place in flood-prone areas are guided in a way that is sustainable (Akola et. al., 2019). To address impact of flooding, the adoption of appropriate coping strategies aimed at strengthening local capacity to cope with flooding is important. Therefore, the objective of this study is to understand the relationship between coping strategies as a determinant factor for flood prevention and management and how this relationship influences flooding.

Coping strategies according to (Zoleta-Nantes, 2007; Akola et al., 2019), are mechanisms that households or a community employ to handle stress situations by mobilizing the assets or capital resources, while Few (2003) argues that the capacity of people to cope with the incidence of flooding determines their level of vulnerability. Pelling (1997) outlined three components of flooding; namely exposure, resilience and resistance, which he argued, are the product of the social, political and economic structures that operate within a particular context of flood. At the national level, planning and dissemination of information on time is crucial among people who may be hard hit by floods and assessment of a community capacity in flood mitigation by the level of its assets to minimise exposure and improve resiliency (Few, 2003: Dewi, 2007: Rad et al., 2017). A number of approaches have been introduced to assess vulnerability; however, the selection of an appropriate methodology is important for reliable results and for efficient monitoring. The more reliable methods for assessment can be categorized into four groups: curve method, disaster loos data method, computer modelling methods and indicator-based methods (Rad et al., 2017). The study reviewed these methods and compared their advantages and disadvantages. The indicator-based approach gives a more precise vision of overall flood vulnerability in each area rather than other approaches.

Managing flood with the aim of safety and wellbeing of people and their environment is one of the main responsibilities of city authorities in flood prone areas, this is well emphasised in the indicator-based approach of safety (Rehman et al., 2021). For achieving this goal, vulnerability reduction and increasing resilience are significant approaches. One of the main steps in this process is measuring vulnerability to identify vulnerable areas (Nasiri et al., 2016) and adopting effective measures to address flood problems.

Another aspect of risk assessment is exposure, which refers to the risk of floodwater incursion into living spaces (Williams et al., 2020). On the other hand, resistance and resilience refer to human capacity to minimize the impact of that incursion through some form of adaptation (Williams et al., 2020) which can be achieved through economic, physical or technical, social or cultural coping strategies as indicated below which Eakin et al. (2016) referred to as the availability of resources to cope with flood.

i. Economic strategies

These refer to the totality of measures taken by households or communities affected by floods to reduce expenditure or generate more income. This may involve diversifying flood victims' sources of income by engaging in new forms of income generating activities that were not considered until the event (Le De et al., 2013). Rahman (2010) identifies a number of economic coping strategies adopted by the poor. These strategies include relying upon less expensive food items, reducing the amount of food per meal, reducing the number of meals per day. The others are, purchasing or borrowing food on credit, borrowing money from NGOs and moneylenders, spending money from savings and, in some rare cases, selling assets such as land to raise money as capital to invest in other income generating activities that may not be affected by floods;

ii. Technical coping strategies

This implies modifications to physical structures in the environment by residents during and after floods (Winsemius et al., 2018). This involves simple structural changes such as raising the foundation of new buildings above flood level (Carter et al., 2015) and constructing wider and deeper drainage facilities around the houses to carry excess water away, retaining walls and sand bags may be used by residents to prevent water from invading their compounds.

iii. Social and Organizational Strategies

The development of social networks or capital is an essential factor in flood management Pelling (1998). Kim and Hastak (2018) indicate that in terms of social coping strategies, social capital is very important to flood victims. It is the bonding and linking relationships that build trust and common interests and the networks that support them within, between and beyond communities, which the individual or the household affected by flood can rely on to call for on the support of others (Akbar et al., 2018). These networks include friends, family members, extended family members and neighbours. The help from these people may be in the form of financial, shelter and kind among others. Social network may also include national organization, NGOS, churches and philanthropist for help, the most reliable to them during the event of flood (Zoleta-Nante, 2007). However, losses incurred by the poor had serious implication for their livelihoods; as a result, they place more emphasis on developing durable social networks that will insure them during periods of flooding.

iv. Cultural coping strategies

In Ghana, cultural coping strategies are exemplified with perceptions and religious belief (Almoradie, et al., 2020). Some people living in the path of flood may therefore, pray and fast to the Supreme Being they worship so that they are not affected by floods during the rainy season. The above may influence the decision of some people in the choice of coping strategies.

Managing floods effect requires Flood Hazard Mapping, an essential asset for sustainable land use planning, managing flood, identify areas of risk, and prioritize their mitigation or response efforts.

The regulation of flood hazard areas coupled with enactment and enforcement of flood hazard zoning laws could prevent damage of property and life and improve livelihood conditions in the long term (Kankam et al., 2013). Flood management is necessary not only for prevention of flood disaster that causes heavy toll on the society, but also for efficient control of water resource vital for socio economic development. This cannot become technically feasible without effective flood hazard maps-a vital component in flood mitigation measures, land use planning. Using historical data on river basin stages and discharge of previous floods, along with topographic data, maps can be constructed to show areas expected to be covered with floodwaters for various discharges or stages. Flood risk maps are easily read, rapidly accessible which facilitates planners to map out areas of risk and prioritize their mitigation efforts.

Conceptual framework

Several theoretical frameworks for addressing urban flood risk management have been proposed. One of such theory is the framework of flood induced changes in urban land values, which integrates literature from flood hazard research and urban economics to explain changes in residential land values following flood events (Tobin & Newton, 1986). Others are the Analytic Hierarchy Process (AHP), a multi-criteria analysis technique that can be applied for structuring of complex decision-making problems involving multiple stakeholders, and scenarios in flood management. The AHP Process has also been integrated with the Delphi technique to identify and calibrate the criteria and the sub-criteria to address the uncertainty inherent to the decision-making process of flood risk management (Herath and Wijesekera, 2021). Furthermore, the framework for uncertainty analysis in flood risk management decisions, which supports the decision making process by identifying the most influential sources of uncertainty, the implications of uncertainty for the preference ordering between flood management options (Hall and Solomatine, 2008). There is also the behavioural turn in flood risk management, which examines the assumptions and potential implications of risk (Kuhlicke et al., 2020). Theoretical frameworks for understanding of flood risk management have advanced over the years but there are limitations in the operationalization concepts and methods making it difficult to apply these theories fairly. One of the main reason is the lack of a common framework for clear recognition and understanding of the components of flood risk management for all stakeholders. This is because the situation and the circumstances varied broadly and therefore, the operationalization of each theory or concept needs to be approached with caution. Consequently, a solution model for assessing the complexity of flood risk management is vital.While all these framewoks by their characteristics require huge data for multiparametric analys in food risk management, they are at the same time involved in multiple stakeholders and flood risk management decisions that support decision-making process. Ciurean, 2013 indicated that multi-risk evaluation and framework for assessing vulnerability to floods in urban areas is necessary however, focusing more on basic flood risk element are important. Dwelling on this premise, this study adopted a framework that attempts to conceptualise three important elements as the underlying factors that influence the levels of flood victims namely, risk, hazard and the vulnerabilty factors (Figure 1) taken into account staleholders participation. The concept, as illustrated in the framework, defines and examines the elements of risk, hazards and vullnerability in three main stages.

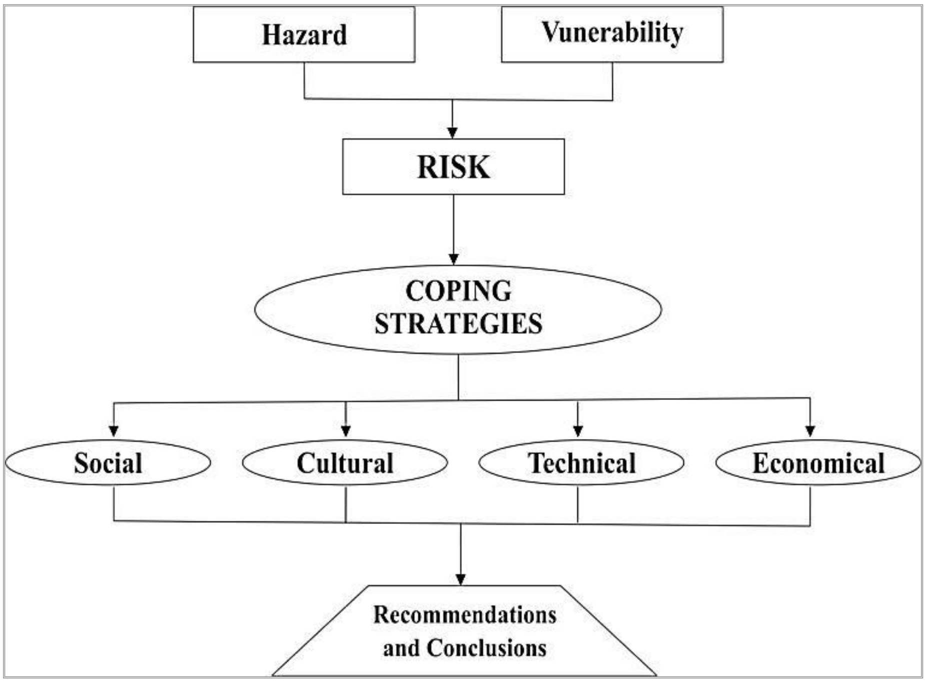

Fig. 1. Conceptual framework indicating elements of risk, hazards and vulnerability (derived from the theory of *Vulnerability Assessment for Natural Hazard Risk Reduction*, Ciurean et. al., 2013).

Risk is the probability that loss will occur as the result of an adverse event and it is the product of hazard and vulnerability. *Hazard* is the potential or existing condition that may cause harm to people or damage properties or the environment, *while vulnerability* is defined as the extent to which a community, structure, service, or geographic area is likely to be damaged or disrupted by the impact of a particular hazard. The framework was grouped into three main stages:

Stage One: Risk has two factors; hazard (flood) and vunerability as opined by Bollin et al. (2006), and Birkmann (2006). When it floods, people and their environment become easily prone to harm (vunerability). The degree of flood hazard therefore, determines the level of damage which also determines the vunerability extent of the people affected.

Stage Two: coping strategies are the survival mechanisms people use to deal with floods which can be subdivided into four components namely, the social, cultural, technical and economical. The social aspect of coping strategies has to do with the cummunal way of minimizing flood impacts. Cultural ways relate to peoples beliefs and beliefs in their supreme beings; technical ways involve scientific approaches within one's means, to curb the impact of post flood hazards including improving service conditions.

Stage Three: Finally, Economical coping strategies show how affected people cope with their expenses to meet current expenditure situation, whiles the conclusion stage is the synthesis of the coping mechanisms that leads to appropriate recommendations (Ciurean et al., 2013).

Methodology and Materials

Study Area

Kasoa is located in the Awutu Senya East Municipal Assembly in the Central Region of Ghana on latitude 5º 31'12''N and longitude 0º 28' 48'' (Figure 2). Its elevation is 18m above sea level and has a population of 44, 227. Kasoa is the district capital for the Awutu Senya East Municipal Assembly.

Storms and coastal flooding are characteristics of this study area with Crispol City, Opeikuma, Ashtown Down, Part of ICGC, New Ofaakor, Asempa Down, Good Feelings, Attaqwa and Abattoir as some of the most flood prone areas (Peprah et. al., 2015).

Fig. 2: Map of the Awutu Senya East District showing, Kaemibre, Walantu and Kasoa. Fieldwork 2018

Kaemibre and Walantu are communities in Kasoa sited in close proximity to flood prone zone. According to Peprah et. al., 2015, Kasoa is divided into two broad flood zones. These are Walantu, which stretches from Traffic Light on the right of the Accra-Winneba Road to the Shell Filling Station off the Nyanyanu road is classified as zone one while Kaemibre which stretches from opposite the International Commercial Bank towards the Kasoa New Market falls within zone two. Floods in the study area have been attributed to the presence of the Okrudu River and its tributaries. The Okrudu takes it source from Awuku-Bretu Highlands and flows southwards to Manyano Lagoon, Kasoa. The choice for the selection of the two study areas is based on their periodic flooding which pose serious threat to the socio-economic life of the people and the environment. It is thus critical to investigate this problem in order to provide sustainable flood mitigation measures to address it. Even though similar studies on flooding have been conducted by Ahadzie et al., (2010.), on flooding and post flooding response strategies in Ghana with reference to Kasoa and Kasoa New road, Adugbila (2019), on assessing the impact of road expansion in Peri-Urban areas, such studies did not use multi criteria assessment to determine the variable factors that influence flooding. This is therefore a research gap that is filled by this study using thematic mapping data in analysis which provides detailed spatial variations, interactive functionality and how they influence flood risk.

Research design

The study employed the mixed method convergent design of conducting research, where elements of qualitative and quantitative viewpoints, data collection and analysis were used in understanding the research problem (Creswell and Clark, 2017). It was deemed relevant to use this approach because it enhances a better understanding of the research questions than using either approach exclusively (Teye, 2012). The method of investigation showing data collection approach, elements and applications, analysis and conclusions is represented in Figure 3. With this design, the study collected and analysed both qualitative and quantitative data during the same phase of the research process to provide a comprehensive analysis of the research problem.

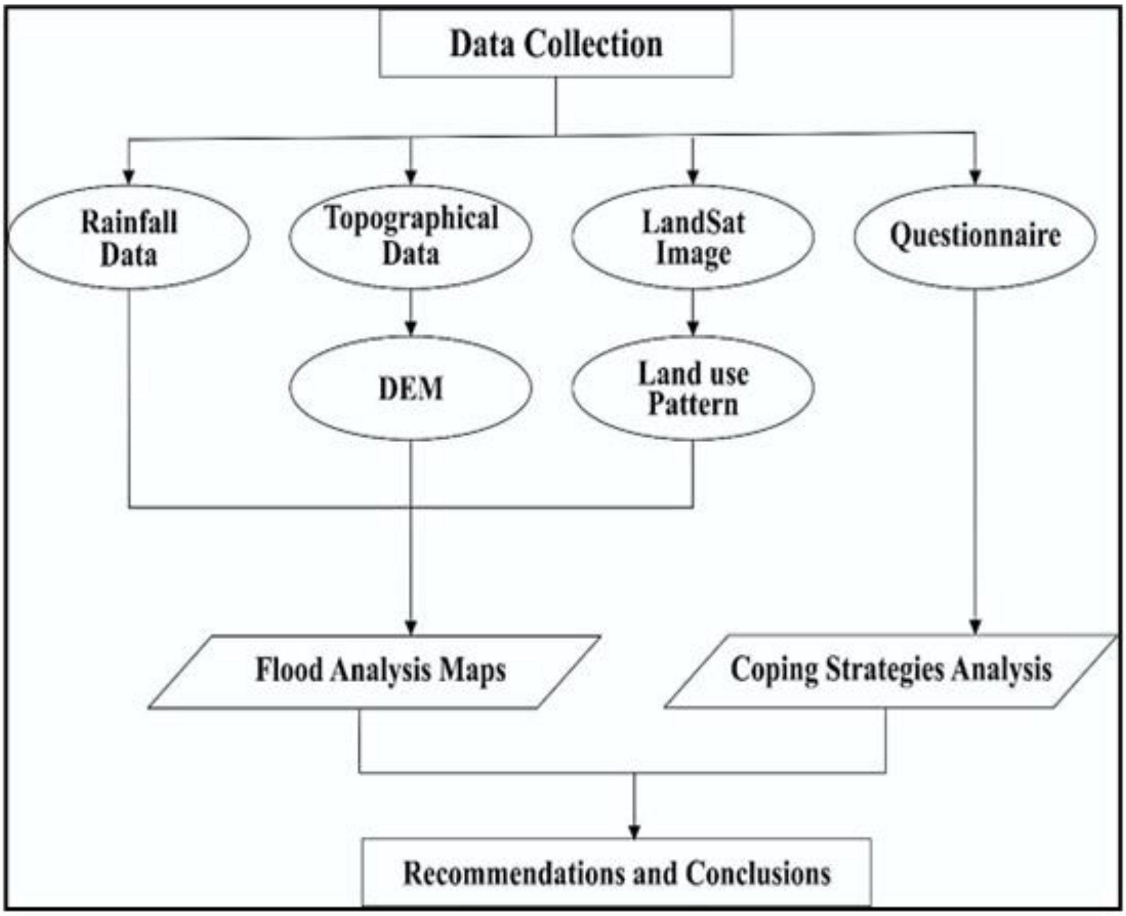

Fig.3: Flow chart of methodology for flood coping strategies. Fieldwork, 2018

Source of data and data collection

Data collection was divided into three sections namely, pre-fieldwork, fieldwork and post-fieldwork. The **pre-fieldwork** stage involved literatures that were reviewed to get in-depth understanding of the research problems to be investigated and to help formulate relevant research questions and questionnaires for the study areas. Data for topographical map of Ghana, 1.25,000,000, monthly rainfall and soil map of Ghana of the study area were gathered to help create different flood maps for the areas. The type and source of data includes topographic analysis obtained from Remote Sensing and Geographic Information Systems Laboratory, University of Ghana (RS-GIS Lab, UG), rainfall data were obtained from Ghana at a Glance, (https://climateknowledgeportal.worldbank.org). Others include local government reports on flooding from Awutu Senya East Municipal Assembly.

Fieldwork was undertaken involved personal observation and interacting with people in their natural settings with the aim of understanding field situation and interpreting the social interactions and connections of a group of people whose lives are tied to flood challenges; and using questionnaires to obtained information relevant to the situation.

Post fieldwork involved using Geographical Information (GIS) and Remote Sensing (RS), ArcGIS Environment for Visualising Images (ENVI), software for creating flood related maps and analysing different flood scenarios. The topography data was used to create the Digital Elevation Model (DEM). Using various geo-processing tools like Clip, Merge, and Raster Reclassify, data conversion, maps were created which included Buffer Map, Surface Map, Slope Map, Drainage pattern Map, and Flood Risk Map while the ENVI software was used for the classification of the image. The location of the study area was expurgated for the main image. Using the Maximum Likelihood Method Approach, the subset was classified into five land use/ land cover types namely, Bare Land, Shrubs, Thick Vegetation, Built-up and Water bodies for land use/land cover change analysis. Due to lack of data, the land use map was used to assess its likelihood impact on flooding rather than undertaking time series analysis. Statistical analysis software IBM SPSS (Statistical Package for Social Sciences) was used to enter and code in field data whiles questionnaires were converted to tables and graphs for analysis using MS Excel.

Method

Multi criteria analysis, which describes any structured approach used to determine the overall impact of factors on a geographical phenomenon, was used. Techniques involving land use and land cover change, hydrological, and soils data analysis were used to create and evaluate flood risk assessment. The details are presented below.

Flood Hazard Mapping (FHM)

The key contributing factors to flood hazard include annual rainfall, size and slope of watershed, gradient of river and stream, drainage density, type of soil and land use; these were considered for rating the degree of hazard by means of weighting and grouping them according to their weights (Table 1). The final classification helps in delineating areas of different flood risk levels. Using ArcGIS 10.1, thematic maps of annual rainfall, slope of the watershed, drainage density, soil types and land use of the watershed were created and used in the creation of the final flood risk map as briefly described below:

For average annual rainfall (Zonation map), rainfall map was prepared by an isohyetal method. In this case, the rainfall map of the study area was created and the important section was extracted from a larger area.

ii) Slope Percentage of Watershed: Slope has an overriding effect on the contribution of the flow of water into streams. It controls the duration of overland flow, infiltration and subsurface flow. The slope map was prepared from the Triangular Irregular Network (TIN) of the region. The output TIN was then reclassified into five different classes.

iii) Drainage density: The drainage of the study area was defined using the ArcHydro extension of ArcGIS. Drainage density map was derived from the drainage map and the map was analysed using the spatial analysis tool of the ArcToolbox. Line density was used to achieve this purpose.

iv)Land use of watershed: The land use of the study area was prepared using the maximum likelihood method of the supervised classification method in ENVI (Environment for Visualising Images). Five samples were collected and used for this purpose. Land use map gives the land cover types in an area comprising Built-up areas, Water bodies, Thick vegetation, Shrubs and Bare land.

v) Soil Map: The soil data was acquired from soil database (CERGIS) based on which the two predominant types of soils namely, clay~~ey~~ and sand were selected.

After gathering all these maps, the rank of each factor was given based on its estimated significance in causing flooding as indicted in Table 1. Consequently, each factor was divided into a number of classes and each class weighted according to the estimated significance for causing flooding. The maximum weight for each class of every factor is 8, whilst the minimum is 2. The total weight used for considering the rate of probability of flooding, defined as score is calculated as follows: Score of each factor = rank of factor X weight of factor class. Subsequently, the scored results were reclassified into five; from very high risk (high score values) through to very low risk (low score values) as shown in Table 1.

Table 1: Rank and score of factors that cause flood (fieldwork 2018).

Factors	**Rank**	**Score results**
Average annual rainfall	5	Very high risk
Slope of watershed	4	High risk
Drainage density	3	Moderate risk
Land use	2	Low risk
Soil type	1	Very low risk

Sampling Technique for questionnaires.

The study adopted a multi stage sampling technique due to the mixed nature of the entire population and within each community. The first stage involved the clustering of each community into defined blocks using major roads and footpaths as visible landmarks. Each community was divided into three clusters of blocks, northern, central and southern blocks. The simple random and convenient sampling techniques were then used to select houses for questionnaire administration within each block of cluster. An estimation of houses with assistance from an assembly member aided the use of the simple random sampling technique to reach out to houses. Finally, household heads were selected as the main respondents. In cases where household heads were absent, any available person who have stayed in the area for at least, 5-15 years and more with adequate knowledge about flooding were interviewed. The total number of sampled respondents was 105; the breakdown is as follows. A combination of random and convenient sampling were used to interview 50 respondents from each community, while purposive sampling was used to select 5 respondents from Awutu Senya East Municipal Assembly as key informants: National Disaster Management Organization (NADMO): Emergency operation centre (2), Rapid response unit (1), Town and Country Planning Unit: Planning Officer (1), Environmental Health officer (1). Different questionnaires were used based on the area of enquiry and the unit concerned.

Results and Discussions

Socio Economic Characteristics of Surveyed Location

Using data from interviews, this section explores people's indigenous survival strategies and variations in people's ability to cope with floods in the two flood prone communities. In order to better understand this, the socio-economic factors that affect their choice of coping strategy were analysed; this includes age, gender, housing status, education, employment status, and income levels among others.

Background of Respondents

The background of respondents highlighted on the role of gender in coping with flood. The percentage distribution of sex of sampled respondents in both Walantu and Kaemibre indicated that out of the 50 respondents in Walantu, 72% (36) are females with 28% (14) being males. In Kaemibre, 68% (34) are females and 32% (16) are males. Thus, out of the total sample size of 100 respondents, 70% (70) are females with the remaining 30% (30) being males.

Age of Respondents

The age structure of the respondents is important to find the connection between their ages and coping strategy adopted. Figure 4 represents the age distribution of respondents. The percentage of respondents decrease with increasing age group as evident in figure 4 with the least numbers 0 and 2.5% for the age group 87 and above, Figure 4. In Kaemibre, the bulk of the respondents were within 28-37 age group (27.5%) followed by the age group 38-47 (20%), and 58-67 (22.5%), and 78-87(2.5%). Generally, the age distribution revealed a predominant youthful population within the age group, 18-27 to 38-47 years but shows a sharp decreasing trend from 48-57 and above (Figure 4). Awareness creation involving such youthful population is vital for sustainable flood management.

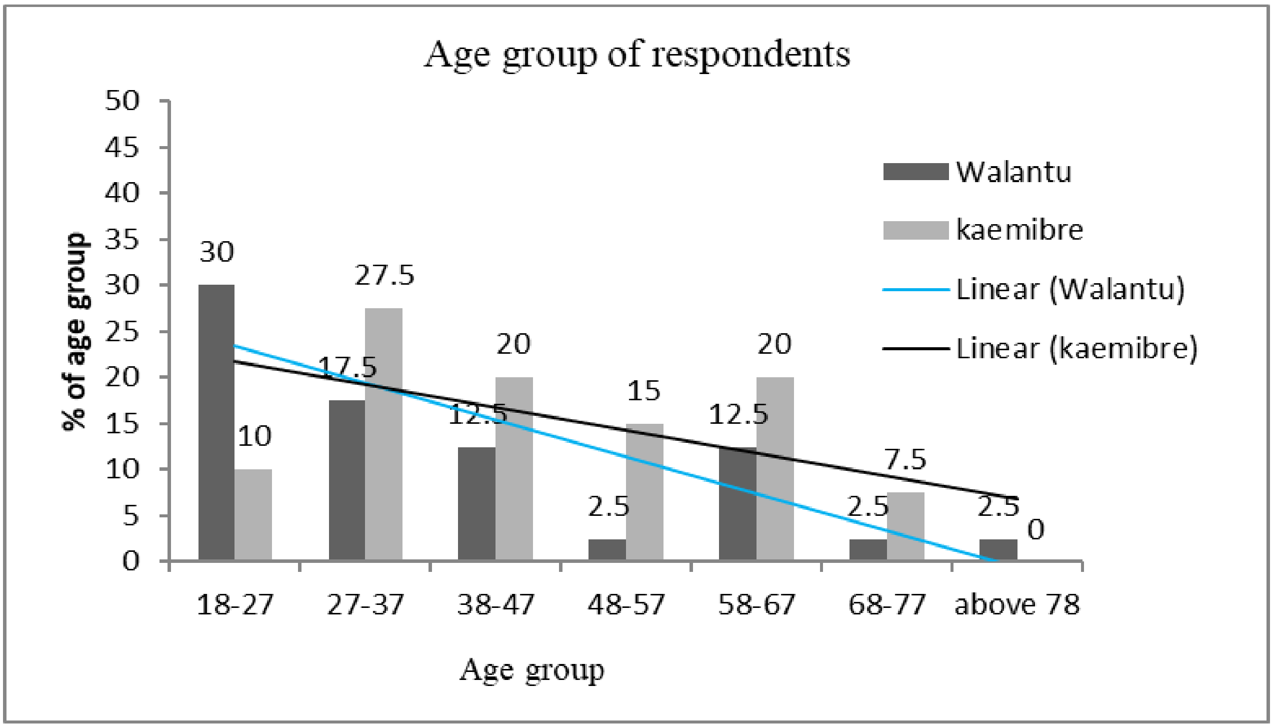

Fig. 4: Age distribution of respondents

Education of Respondents

The educational level attained of respondents was found to be an important element for coping strategy. Figure 5 shows the level of education of the two communities, Kaemibre and Walantu.

Respondents without any kind of education constituted 27.5% for Walantu and 23% for Kaemibre. Those with Primary and Junior High Schools also recorded a lower percentage of 22.5% for each community. Other forms of education constituted 9.5%. There was nobody with tertiary education. The case of Kaemibre was quite different; a bulk of its respondents, 44.5%, completed Junior High education; 22.5% had no education, 2.5% had tertiary education, and 2.5%, attained other forms of education (informal education).

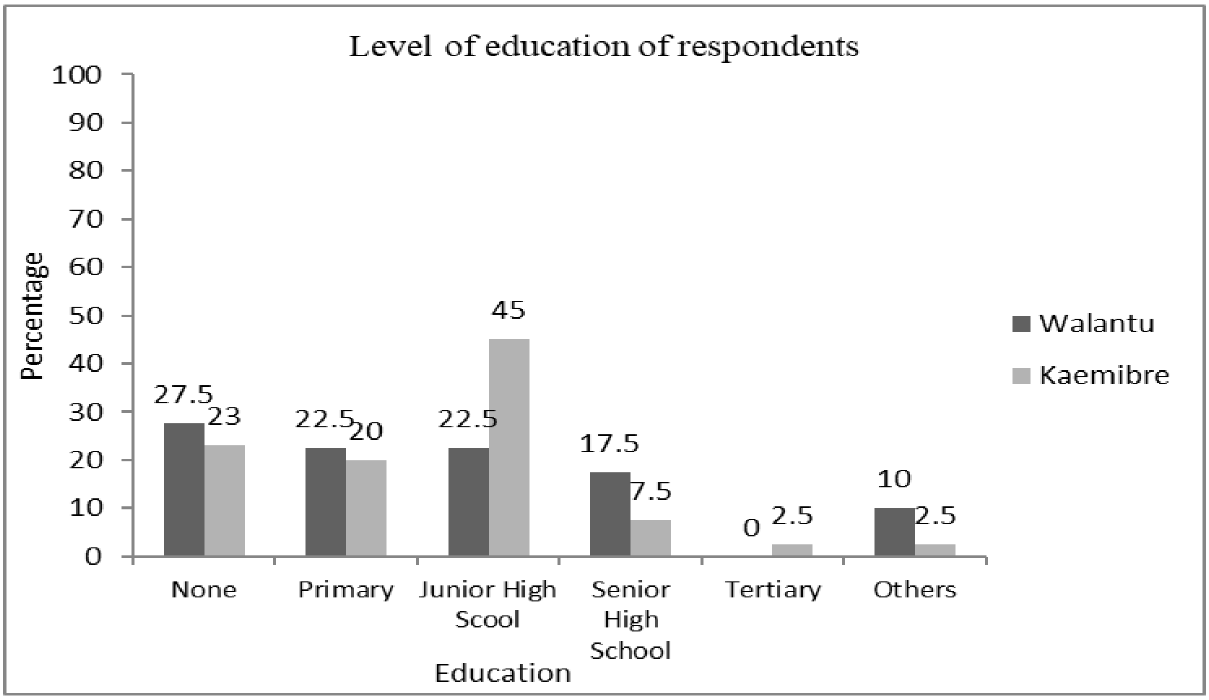

Fig. 5: Level of education of Walantu and Kaemibre

Occupation status of respondents

Analysis of employment status of respondents was undertaken in order to determine the relationship between employment of respondents and their ability to cope with the effects of floods. 30% of the total population are unemployed while 70% employed in the informal sector of the economy, (Figure 6). Information on occupation of respondents indicated that 40% of those in Walantu are self-employed, 25% are traders, 30% unemployed and only 5% are employed in the government sector. Kaemibre on the other hand had 53% as traders, 17% are self-employed, and 30% unemployed. On the whole, 39% of the respondents are traders of different kinds engaged in food, sachet water vendors, second hand clothes vending, among others; 29% were self-employed in ventures like carpentry, hairdressing, seamstress and tailoring, shop owners etc., 2% in the government sector with 30% of the people are unemployed.

Fig. 6: Employment status of Walantu and Kaemibre (fieldwork 2018)

Income Levels

The income level of respondents is one basic means to invest in flood management. It also talks about their capacity to reduce flood risks and to influence their choice of coping strategy. It was assumed that the kind of job people are engaged in determines their salary or income levels, which would inferably affect their priorities hence coping strategy. The polynomial trend line in Figure 7 shows the sharp fluctuations in income level of respondents for the two communities. From Figure 7, 30% of respondents from Walantu earned 100 GHC monthly, 37.5% earned below 200 Ghana Cedis

(GHC) monthly, and another 30% earned between 200-300 GHC; no respondent earned above 400 GHC.

Kaemibre also has a similar percentage trend of respondents being unemployed, thus 30%, 27.5% earn below 200 GHC and the remaining earned between 200-300 GHC, and only 5% earned between 400-500 GHC. The results show wide income disparities but generally low-income levels in both two communities. The assumption that the higher one income is the higher the probability would be for the one to be in a good position to adopt a better coping strategy was found not to be the case. From the survey, it was noted that respondents' income levels do not necessarily correspond with their choice of coping strategy. This implies that one's coping strategy may depend on a number of factors not considered by the study. In fact, the income assessment of respondents revealed that majority of respondent fell within low-income status, which makes it difficult for them to afford decent accommodation elsewhere and therefore prefer to stay in these flood enclaves where rent charges are low hence cannot invest in flood coping strategy.

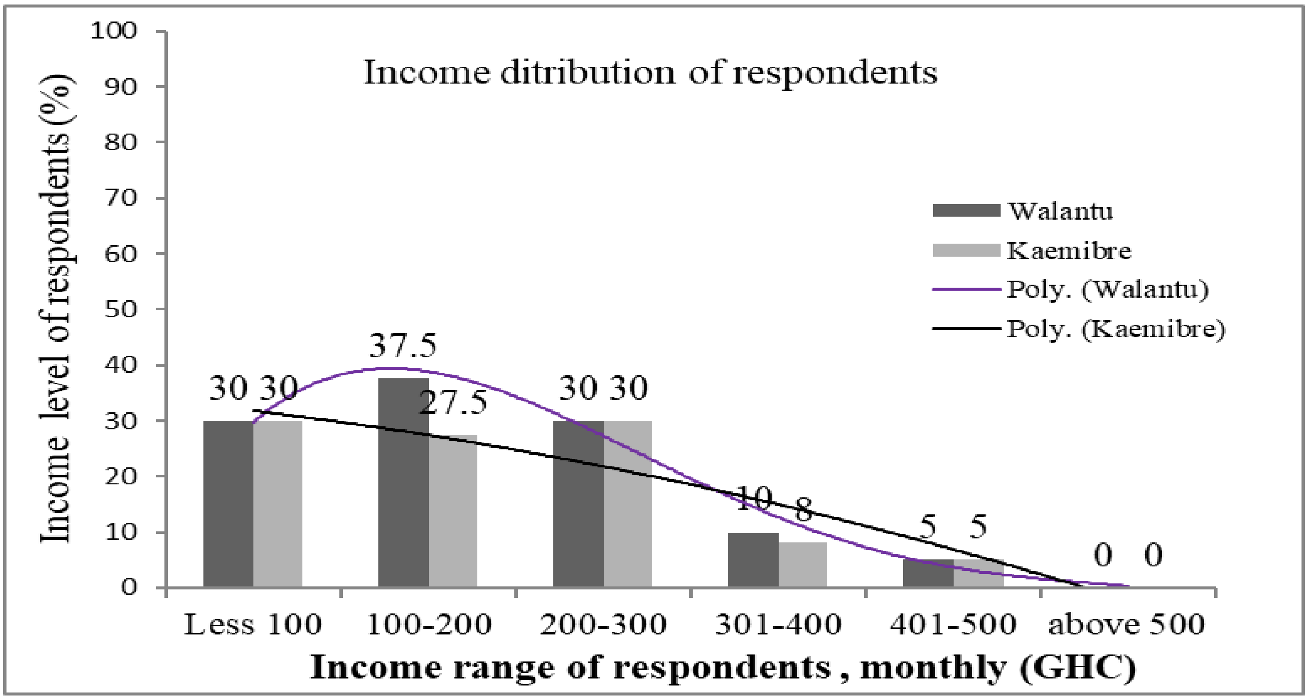

Fig. 7: Income level of respondents in relation to their choice for flood coping strategies

Housing Status of Respondents and coping strategy

The housing status gives an idea of how respondents prioritise coping strategy. The chance of a property owner considering undertaking maintenance or selecting good coping strategy is higher than that of a caretaker or a tenant. Thus, ownership responsibility encourages reducing flood risk and putting in place coping strategies to prevent losses as compared to a tenant despite the fact that both have properties to lose. Thus, the issue of ownership is critical in taking a decision on coping strategies.

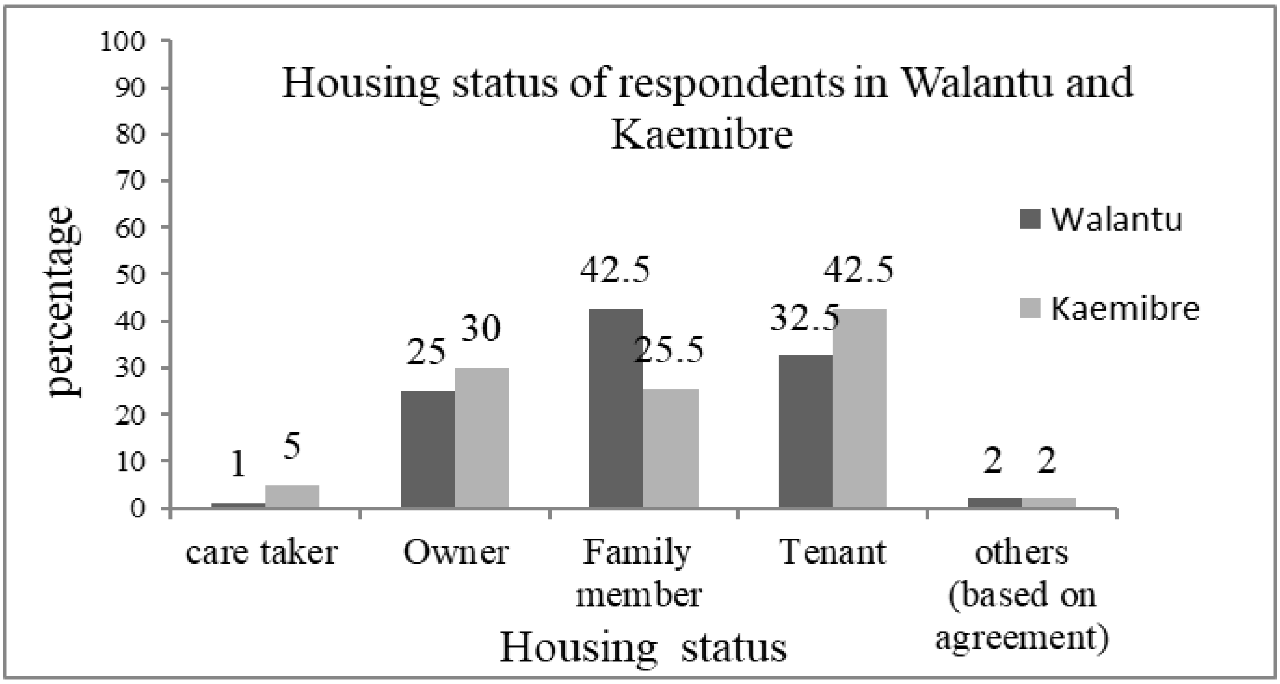

Fig. 8: Housing status of respondents in Walantu and Kaemibre

As indicated in Figure.8, Walantu has 43% of its residents as rent-free family members, mainly the compound house system, 33% as tenants, 25% as house owners without caretakers. The distribution for Kaemibre shows similar pattern indicating the homogeneous nature of housing status where about 68% of residents do not pay rent.

The findings revealed that the most common and affordable coping strategies employed were fortified building walls, raising porch walls and stair-cases, constructing gutters, desilting drains, among others and were found to be dominant among rent-free family members and land owners. Another coping strategy that was found to be common among the surveyed groups was the construction of shelves or using very tall tables on which their valuables are kept to prevent them from flooding. In Kaemibre, housing category includes tenants, 43%, owners, 30%, rent-free family members, 23%, and caretakers, 5%.

Coping strategy was not really a priority in this area, even though they live closer to the Okrudu River which floods seasonally. There are no striking differences in coping strategies between Walantu and Kaemibre. The most common coping strategies at household level are use of sandbags and tree logs, provision of water outlet pipes above plinth level, construction of embankments, protection walls and elevation of house and compound foundation.

In Kaemibre just as in Walantu, ownership factor plays significant role in undertaking coping strategy. The above findings reflect the outcomes of studies undertaken in many poor income residents in flood prone areas and marginal lands where development is not guided by any physical planning or do not have building permit and therefore coping strategy is not a priority (Porio, 2014).

Flood Related Illnesses

Flood related diseases such as malaria, diarrhoea, typhoid; skin rashes were common among respondents (Figure 9). Fifty-seven (57%) respondents in Walantu claimed to have treated some flood related diseases of the above. Another 17.5% were on self-medication; 25% did not experience any of such illness. In contrast to Walantu, in Kaemibre, 62.5% claimed they did not experience any illnesses related to floods, whiles 25% confirmed they experienced malaria, typhoid and dysentery and received treatment at the hospital; 12.5% said they indulged in self-medication for malaria treatment. Thus, in Kaemibre, the respondents recorded low numbers of flood related illness; this finding has broad implications on seasonal ecology of diseases related to flood incidences and a challenge to public health authorities. It is not quite clear what the cause of these marked variations in flood related diseases between the two communities may be. As Ayanfu-Torgby et al. (2018)

indicated, such variations might be due to varying parasite prevalence exhibiting seasonal variations in the prevalence of diseases and environmental specific condition. As indicated in Fig 9, traditional medicine is well patronised in these communities as compared to orthodox medicine, which is of concern because of the unknown potency of such medicine.

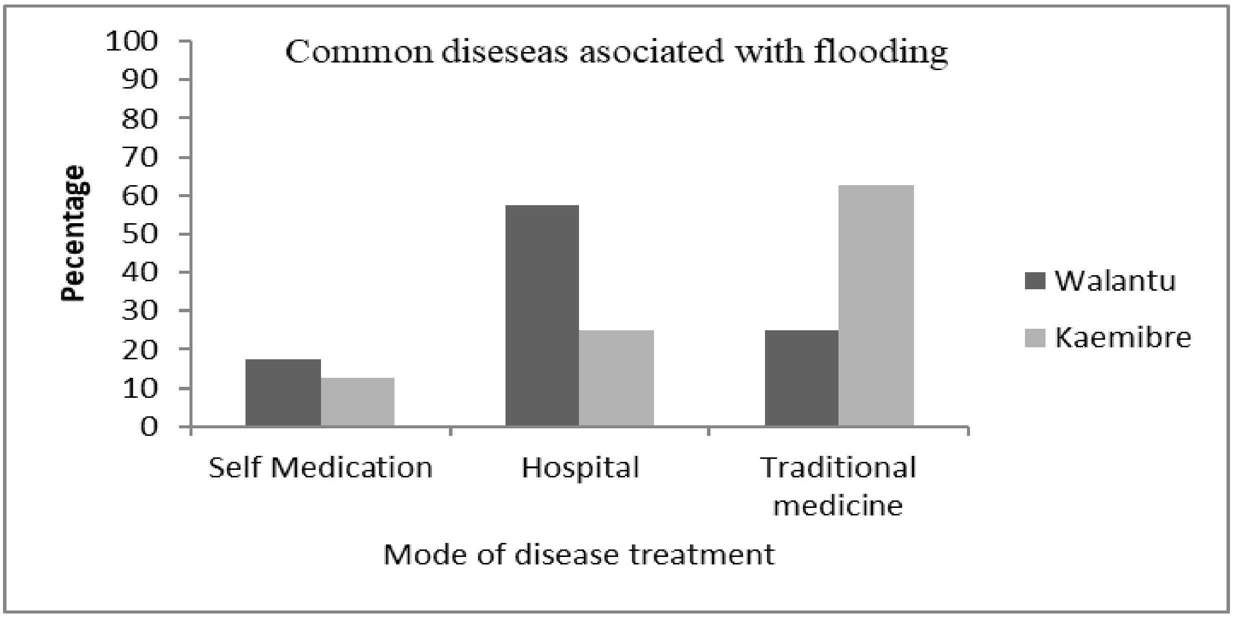

Fig. 9: Type and treatment of common flood-related diseases in Walantu and Kaemibre.

Alternative livelihoods as adaptation strategy

Alternative livelihood has been a tactical measure to broaden livelihood scope in order to become more resilient to disaster related impact such as flood. The data available showed that 30% of the respondents whose activities were located close to their residences undertook adaptation mechanism, and owned provision shops in front of their houses, trade in miscellaneous items like sugar, gari, and soap kitchen and toiletries at home. The remaining 70% respondents did not change their work because most of them work outside their place of abode as traders who either sell or own shops outside and therefore were not affected by floods. These features are similar to many floods endemic regions of developing countries characterised by poor planning and lack of basic services, overcrowded, poverty, limited livelihood opportunities and low capacity to address flood problems (Osbahr, 2007).

GIS Analysis of land use and flood risk assessment

The adoption of GIS in this study is to provide a quantitative assessment of the nature of land use and the flood situation in the study area. As part of the data analysis, various maps were produced to give a better understanding of the flood situation. The land use pattern, the flood hazard map and the hydro analysis maps were analysed

Land Use Map

Land use is influenced by several factors such as, topography, geographical location and availability of infrastructure, urban flooding among others. The cumulative and dynamic nature of these resources makes classification of these resources important for their sustainable management and for flood control. As indicated, the weight effect of land use on flood risk assessment is the main focus and not land use change over time for trend analysis. The classification method used for the land use map is the supervised classification. Land use was classified into five groups namely Water bodies, Built-up areas, bare land, Shrubs and Thick vegetation (Figure 10). These classes have their different capacities of managing floodwater. The main characteristic is their ability to hold water, and this is what the weightings were based on. The more the water holding capacity, the more the flooding potential of the particular land use class. The built-up areas would be the most susceptible to flood after the water bodies because of changes in soil conditions through compaction, cementation, paving, preventing storm water from percolating the ground. The bare land is next. The absence of land cover exposes land to severe flooding because when rainwater hits the ground it moves faster than it would have been on a covered surface hence causing erosion that increases flood impact. The shrub and thick vegetation are less susceptible to flood impact due to the land cover, which intercepts and reduces flow rate; this allows soil to absorb water, reduce surface run off and flooding for that matter. Since the study is not based on time series analysis but rather on factor analysis, land use characteristics provide useful explanation on the integrated impact of these factors on flooding.

Kaemibre by land use is built up and bare surface; from the streamline delineation and hydro accumulation maps, it is highly susceptible to flooding due to its land use and closeness to Okrudu and especially during heavy and prolong rains.

Walantu is located south of Kaemibre and it is highly drained by the Okrudu river but has a low-medium range of flood risk and therefore less affected by flooding as compare to Kaemibre however both areas are potentially at risk of flooding. From the land use status, Walantu is built-up, shrubs and bare surface. From the above, it can be concluded that land use the differences in land use strongly accounts for the extent of flooding in the two areas of close proximity; hence future flood mutation response need to consider land use as an important factor.

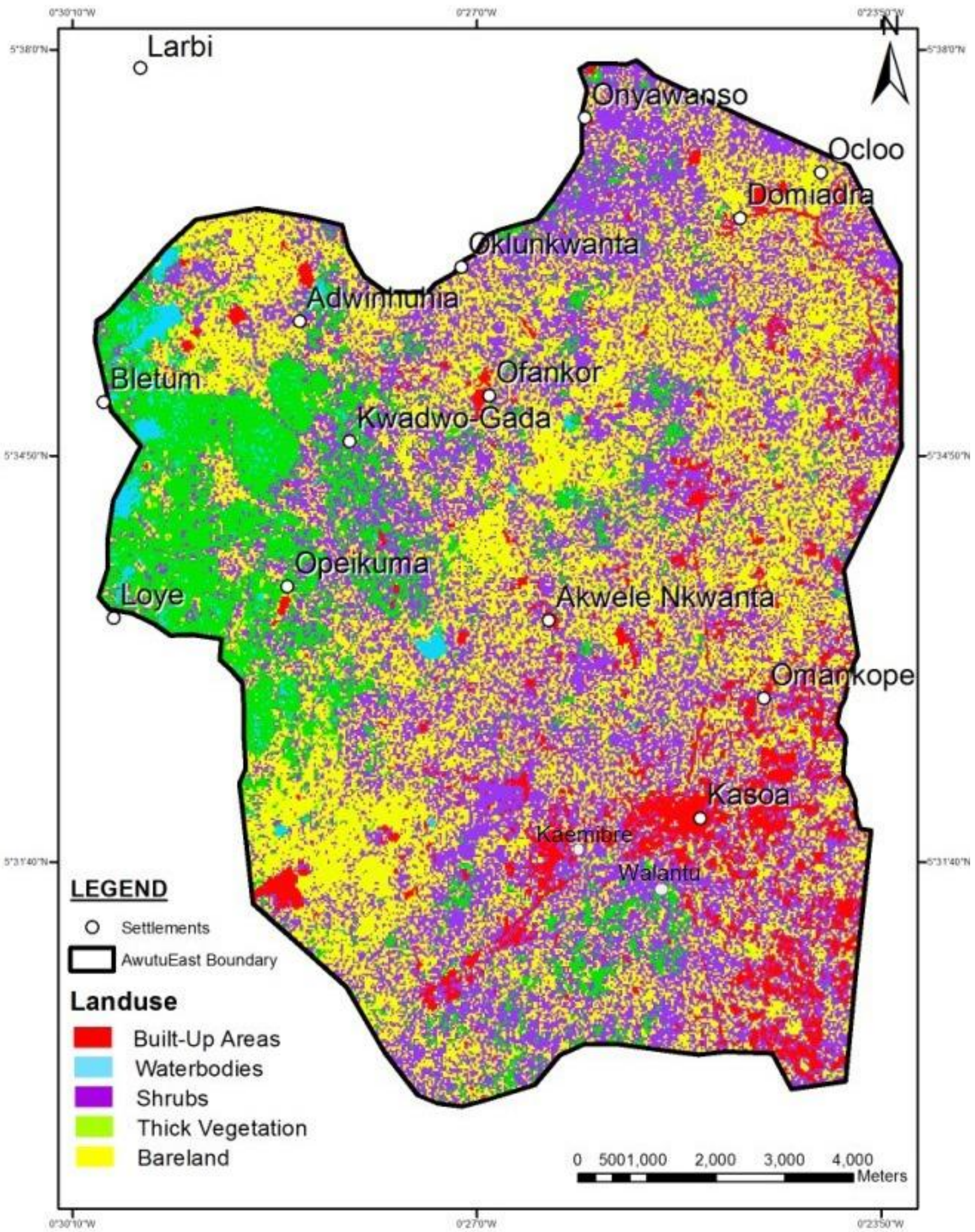

Fig.10: Land use map of Awutu East District, 2018 (GIS/RS, DGRD)

Hydrographical Analysis

Flow Accumulation

The flow accumulation for the study area gives a pattern, which shows the gathering momentum of water when it rains; when this happens, water accumulates as shown in Figure 11. Flow accumulation is influenced by several hydrological conditions as described above, including drainage basin characteristics- width, depth, order of tributaries and other environmental factors such as geological structure and land use and land cover, all these factors are variable in Kaemibre and Walantu.

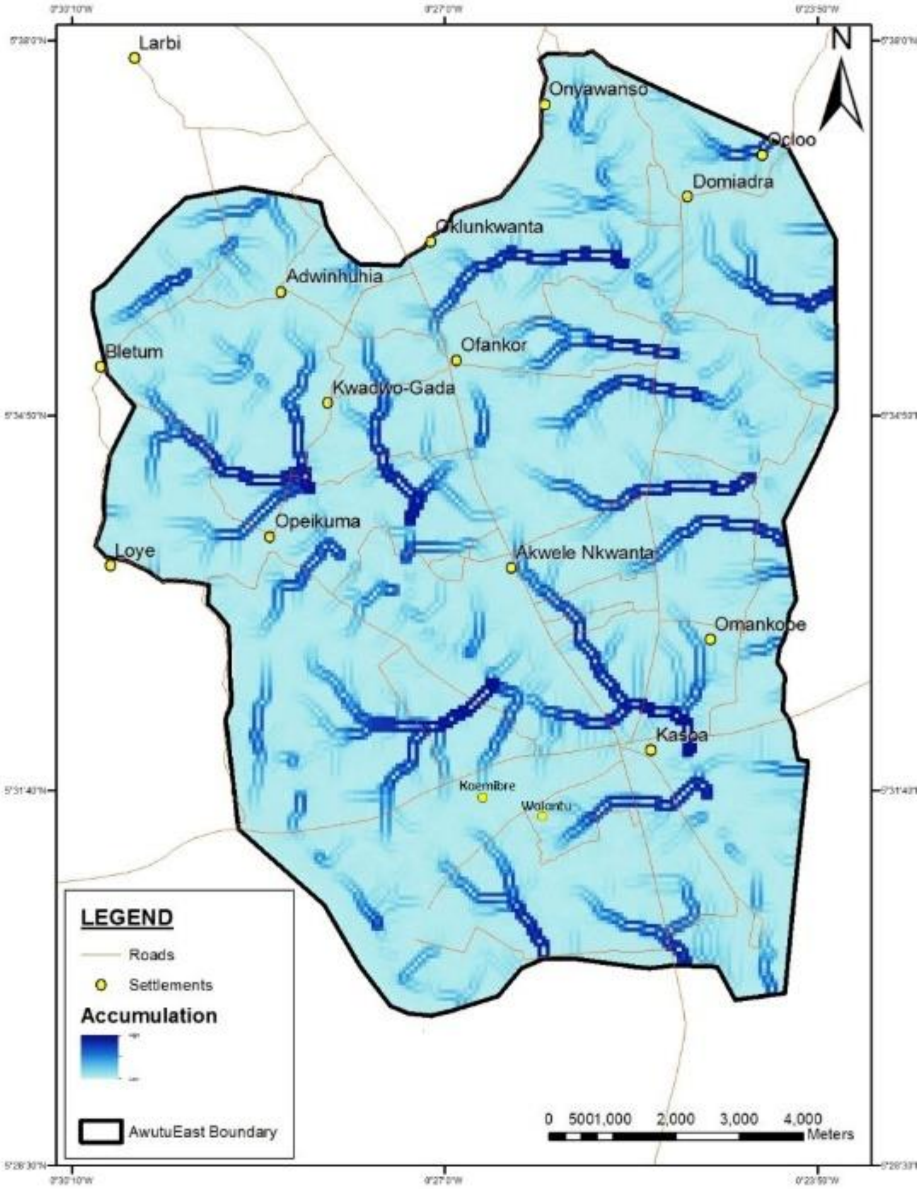

Fig. 11: Hydro accumulation map showing flow accumulation output, 2018 (GIS/RS, DGRD)

Streamline Definition

Based on the accumulation of water, the streamline for river Okrudu was defined. It shows areas along the river in close proximity to the river basin that are likely to be flooded or turned into streams based on rainfall and flow accumulation of the area (Figure 12). Form the result, it can be noted that most settlements are likely to be affected by flooding should there be an increased in rainfall amount beyond threshold. The buffer zone limit of 10m to 30m along both banks of major drains and watercourses in Accra-Tema metropolitan area (Dorm-Adzobu & Ampomah (2014). compliance is breached and houses are found 5meters and less to the riverbanks. The vulnerability of these areas to flood hazard is aggravated by the high degree of the planning violation.

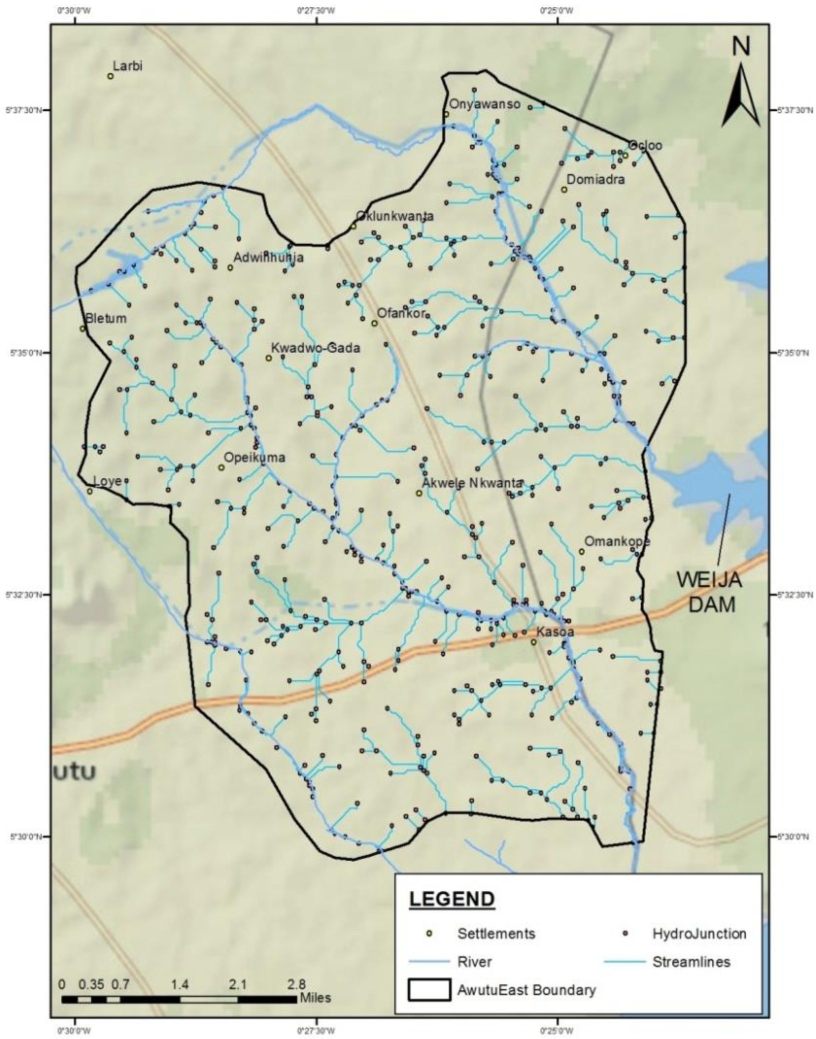

Fig.12: Streamline Definition Output of study area, 2018 (GIS/RS, DGRD)

Flood Risk Map

Sustainable management of flood aimed at safety and supporting livelihoods of people and their environment is one of the main responsibilities of city authorities in flood prone areas. For achieving this goal, vulnerability reduction and increasing resilience are significant elements that need to be considered. One of the main steps in achieving this goal is measuring vulnerability to identify vulnerable areas, classify and adopt effective flood preventive measures with the help of flood risk map (Nasiri et al., 2016). Indeed, urban flood vulnerability varies from time to time and in diverse places because of the changing natural environmental conditions (Ahmad and Simonovic, 2013). A number of factors were considered in creating the flood risk map of the study area. The weight of each factor is based on the potential of the factor that causes flood; the combined effect of these factors brings to bare the exact flood risk pattern of the area. The factor with the highest risk is the rainfall data. The reason is that the effect of rainfall on floods is the highest of the five factors gathered. Based on rainfall, the area was divided into two rainfall zones which recorded average annual rainfall values of 1100 – 1000 mm for Kaemibre and 1000 – 900 mm for Walantu.

The second highest factor is the slope of watershed obtained from the topographic data, which gives an exact representation of the nature of the surface of the land of the area. It is the second factor with more effect on flooding. Slope concentrates and intensifies the rate of overland flow high grounds to lower grounds, hence flooding. This means that lower grounds will be at a higher risk of flooding and vice versa for higher grounds.

The third factor, with a lesser weight, is drainage density and water bodies. The presence of streamlines, tributaries and water bodies in general increase the risk of flooding. This is because as it rains and rivers overflow their banks, settlements nearer the water bodies will be affected most by spill-water.

The fourth factor is land use pattern of the area, which shows the variations of land use types and how it relates to rainwater and surface run off. Land use types like built-up areas, limits infiltration of surface run off into soil, from hydrological perspectives, because of changes in soil structure due to urbanization.

The last in the group of factors is the soil type because it has the least effect on flooding. Although the type and nature of soil affects the water holding capacity of the soil, its effect cannot be compared to the other factors discussed. The area has two main types of soil namely, Luvisols and Lixisols. Luvisols have higher water retaining capacity than Lixisols because of its compact nature as compared to the latter. These factors together bring out the flood risk pattern when they are weighed and combined. It means that the highest risk areas are those with higher rainfall, lower topography, and closer to water bodies and in areas with higher water holding capacity as indicated in Figure 13. Considering all the above factors, Kaemibre by its location is more vulnerable to floods than Walantu.

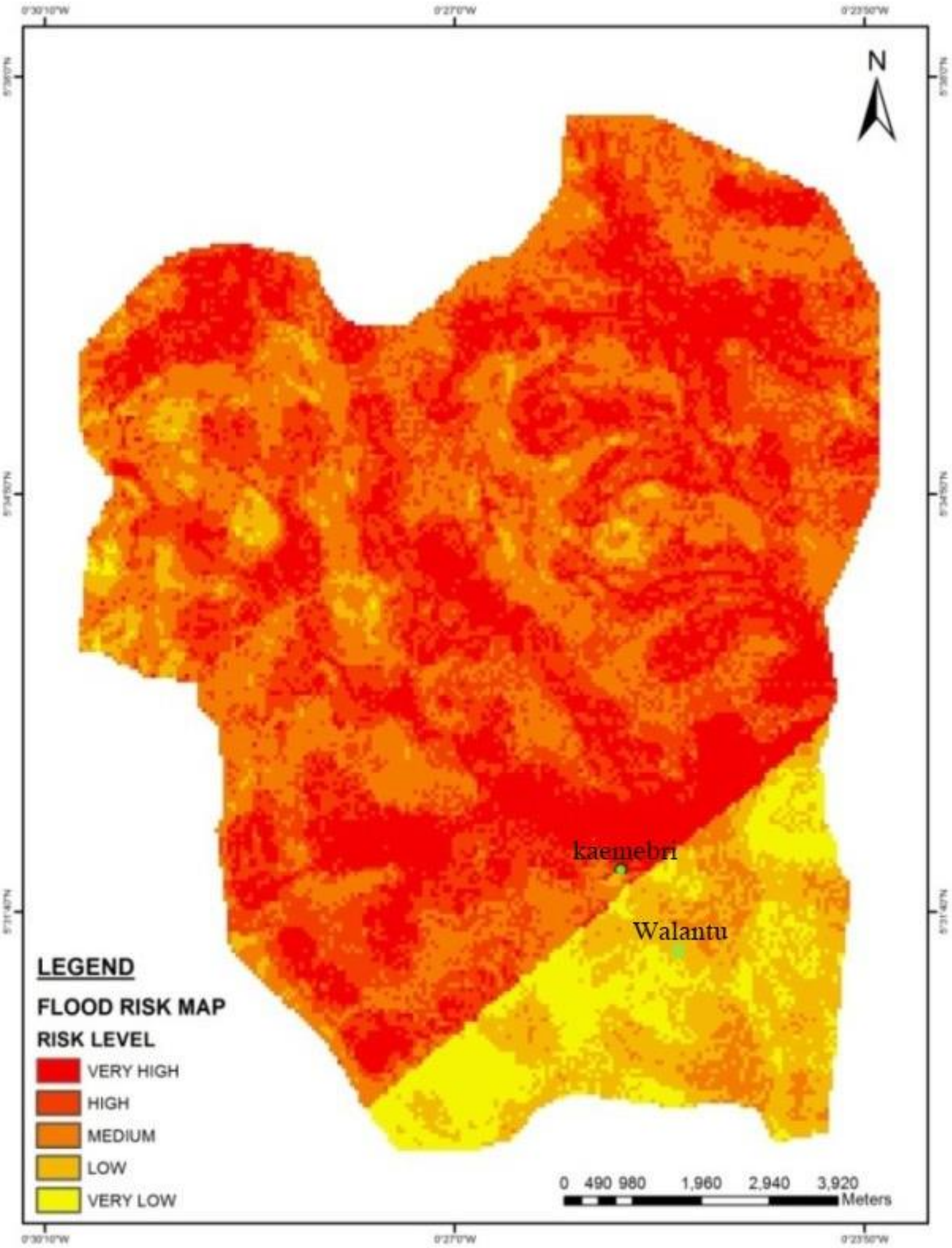

Fig. 13: Flood risk map of Awutu Senya East district 2018 (GIS/RS, DGRD)

Relationship between Flood Risk Map and Coping Strategy

The flood risk map is a combination of average annual rainfall, land use, soil type, drainage density and slope of watershed maps and shows which areas are more prone to floods impact than others are.

The knowledge about how susceptible one is to floods helps in taking a decision on the most appropriate coping strategy. Residents of Kaemibre who are in the very high-risk zone (predominantly built up, shrub, low drainage areas) but generally do not adopt any technical coping strategy. Strategies adopted include creating barriers in front of houses, cementing walls, filling house with stones and sand to raise compound, and placing valuable items on higher platforms among others. In Walantu which is located in a range of low-medium flood risk zone (characterised by land use-built, bare surfaces, shrubs, low elevation, and high drainage) residents coping strategies involved constructing walls, barriers and gutters, desilting drains, creating small trenches for water way, and retrofitting buildings and walls; comparatively. Even though Walantu is not at a higher risk zone as compared to Kaemibre, flood impact hits Walantu most. This is due to the low-lying area with virtually no artificial drainage systems whiles the few earth drains either are choked with rubbish or are too small to carry high volume run off water. Thus, the efficient use of flood risk map would also require efficient land use planning including drainage to regulate flooding.

Institutional responsibility

Institutional responsibly in flood disaster management has been a policy directive effort by the government of Ghana in developing action plan for disaster risk reduction.

An interview with the National Disaster Management Organization (NADMO), Town and Country Panning Unit, and Awutu East District Assembly on roles and responsibilities of NADMO in urban flood risk reduction indicated that some policies on preparedness, response, prevention among others have been made. However, the department is faced with challenges such as cost of management and public cooperation in addressing flood issues. Nevertheless, measures have been designed and being operationalized to reduce the short- and long-term impacts of the hazard. At a macro-level, they include formal flood warning systems and evacuation programmes, awareness and capacity building of communities through training and practices that could enhance knowledge and skills of communities in flood risk management, and relief items supply to flood victims among others. The representative officer of the Town and Country Planning Unit informed that measures such as land use controls on flood-prone sites, building regulations and monitoring to prevent incursion of floodwaters, while the waste management unit providing waste management services to affected communities. Interactions with respondents in the two communities revealed that lack of financial commitment to address flood related problems is their major challenge. This underscores the fact that it is the poor that occupy an environment in which the consequences of flooding are more serious and they lack the economic capacity, social cohesion, and organisation, and cultural vision to manage flood disaster (Almoradie et al., 2020).

Conclusion

Assessment of housing status of the residents and their coping strategy indicated that tenants and caretakers did very little to cope with the impacts of floods while rent free family members and owners implemented a number of coping strategies within their limit to protect their properties than the tenants who felt they had nothing much to lose. The underscoring factor in poor scoping strategy of respondents is poverty, which is reflected in relatively low monthly income level of greater percentage respondents (70%), who earn 100-200 GHC, which does not serve the impetus to undertake any flood coping measures. On the other hand, those who earn, on the average, 300 Ghana Cedis monthly employed adequate coping strategies even than those who earned higher income but a less affected by floods. Higher income earners are not so much affected by flood because of their housing location but are ready to adopt efficient coping strategy. Households with lower income and less access to assets face higher exposure to the risk of flooding. Disparity in income and asset distribution at community level furthermore tends to be higher hence increases risk exposure levels, implying that individually, vulnerable households are also collectively more vulnerable.

The effect of land use change on flooding was substantially high. Classification of land use into built up areas, bare land, water bodies, shrubs and thick vegetation showed that areas with shrubs and vegetation in both Walantu and Kaemibre are not within high flood risk zones. In Kaemibre, land use is a combination of shrub-bare and built types implying that shrub related species are either sensitive to or could absorb and retain water (Schlauderaff, 2021), while bare surface allows easy passage and increase the rate of surface runoff due to changes in soil structure from urbanization. Even though one of the prime prerequisites for better use of land is information on existing land changes in land use through time, the present distribution of land use provides the basis to assess future changes in land use and extent of their impact on flooding. From the land use distribution map, it was noted that built-up, shrub and bare surface are land cover types that are likely to be transform into other types of land use and therefore they could change the dynamics of urban flooding hence the nature of urban flood risk.

From the flood risk map, risk was found to be variable ranging from very high to very low risk. Kaemibre is very prone to flood risk because of the presence of the Okrudu River; Walantu is in a high flood risk zone due to its low relief and, poor drains and clay soil type, among others. Generally, settlements sited close to the riverbanks and have no flood protection measures are more susceptible to flooding and erosion, increasing people's vulnerability to flooding.

Key flood mitigation measures by the community as noted are mostly nonstructural but are not being patronized due to poor poverty. Other flood coping strategies comprise relocating, change of work as well as acquiring new jobs. From the study, it was revealed that the types of coping strategies adopted by respondents were temporal and common among floods communities who do not have the necessary capacity to mitigate flood problems. This implies that their low ability to cope with flood disaster could make them rely on external assistance for mitigation, which is not sustainable in the long term. The flood risk and the land use maps form an important component of urban planning, hence could be used as the basis for urban flood risk reduction through planning, monitoring and flood management programmes for the communities. In addition, there is the need to build the capacity of communities to be more resilient to flood and its mitigation.

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