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FLOOD RISK MANAGEMENT AND RUNOFFS INTO DRAINAGE SYSTEMS ASSESSMENT IN KOFROM – KUMASI, ASHANTI REGION OF GHANA

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ABSTRACT

Flood risk management is of utmost importance when it comes to drainage designs and flood management to save victims yearly. Runoff generation from catchment to downstream areas results in the increase in overland flows and if drains are of inadequate capacities, flooding occurs. This research basically looks at how floods are managed in Kofrom in the Ashanti Region of Ghana as a result of bad drainage designs from contractors or engineers and flood experts. Method employed for this study include feasibility studies and drainage engineering studies of the study area to assess the hydraulic structures and drain capacities. It was established that most of the drains are of inadequate capacity with a high degree of siltation. The drains are of inadequate capacity to take all runoffs from its catchment since urbanization has increased within a catchment and hence increasing the runoff generation. This decreased drain capacity results in high levels of overland flows and floods each year. Investigations for this research work was done in collaboration with Ghana Highway Authority, Hydrological Service Department and NADMO as they are in charge of all runoff generation on our roads and in drains and flood impact assessment and actions. It was established that in order to prevent future floods in the study area, there is the need for widening, increment, designing and construction of drainage structures to cater for the increase in runoffs generated due to increase in impervious areas. There is the need for drainage engineers to do serious feasibility studies and apply technologies employed in great engineering countries like Dubai, United States of America and the United Kingdom in drain designs and constructions. Field investigations revealed that most newly constructed drains are left half filled with soils, bitumen and chippings after road constructions by road contractors. Strategic understanding of floods in areas in Accra should be well studied and applied to prevent future floods in Kofrom in the Ashanti Region of Ghana.

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Key Words: Flood, risk management, drainage, NADMO, Climate Change, Kofrom

1 INTRODUCTION

1.1 Background of the study

Situations where we experience extreme rainfall events have always been a problem and a challenge in the urban areas like Kumasi. When they happen in such areas, the consequences can be striking with severe flooding and damage to properties and infrastructure worth Billions of US dollars. In June 2011, a heavy rain event stroke Accra city and in two hours as much precipitation fall as normally falls during a week resulting in floods over the city. Several big roads were blocked, the subway was closed for several hours. Afterwards the insurance costs have been calculated to several billions of US dollars and thereto comes the costs for the society and the individuals (for instance insecurity and loss of affective values (Moberg, 2012).

The last decade climate change has been an increasing issue in Ghana and worldwide. Most studies conducted agree on climate change being a reality, but the opinions about the severity and the prognosis on the future climate differs. Some studies states that extreme events like heavy precipitation will occur more frequently in the future (IPCC 2007; Christensen, 2002) whereas other studies states that measured precipitation series does not indicates an increased frequency of heavy rain events. A British study agrees on extreme rain events occurring more frequently, but also makes an important statement that the vulnerability for extreme rain event exists already today. Events like those in Accra over the years testify on this vulnerability. Consequently, already today, there exists a need of preparation and mitigation actions against floods. Floods has been a serious issue in urban areas as inundation occurs over impervious areas. The seriousness of the problem becomes very drastic in areas where drains have been filled with all forms of debris and waste. This result in a decrease in the size of the drain resulting in overland flow as drains capacity is unable to accumulate all runoffs from the catchment area.

It therefore becomes very necessary to design structures and facilities that has the ability to take all water from the catchment and drain them downstream to a primary drain or water body. But it's most at times difficult to design stormwater pipe systems and structures that has the ability to carry the stormwater due to economical and practical reasons. There is also the possibility of increasing the capacity of the drainage structures for greater runoff intake from the catchment area. There exists examples on large underground sewer constructions that can handle very heavy events but there will however always be a possibility for a more severe scenario than the scenario design for, meaning one can never protect against all rain events.

Urban storm water structures in Kumasi are normally designed so that the pressure level in the pipe network will not exceed the ground or basement level for a rain event with a return period of ten years (Svenskt Vatten, 2004). For rain events with

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a return period that greatly exceeds the design return period, whatever it might be, the focus needs to be shifted into mitigation of flood consequences. This could be done by a proactive approach where the surface water flow patterns and storage areas are known and controlled, if possible. This has in a Swedish study been addressed as "Plan B", and in the same study a methodology for flood control investigations are described (Ahlman, 2011). Most people who experience floods leave the affected zone during the flood event for a safer place and come back after several days or months. Since the area has already being ear marked as a flood zone, they become victims again when the next peak rainfall begins.

1.2 Problem Statement

Drainage systems in the sub – urban city, Kofrom has served the city in diverse ways carrying storm waters and dirty waters produced in the catchment areas to downstream for years. These runoffs end up in large drains and water bodies making the city free of all kinds of runoff. The drainage network in the city faces all kinds of problem as some drains are destroyed by heavy runoffs with others breaking down due to long periods of use without repairs. This has become a problem as there is the likelihood of these drains unable to take runoffs during peak rainfalls. This is due to increase in impervious areas within the catchment of primary drain. This is what usually result in heavy floods over parts of the sub - city during the rainy season. Drainage networks therefore needs to be modeled and maintained at a higher degree in order to have a sub - city full of good drainage system that meets demanding needs. Most foreign countries have drainage departments that are in constant operation of maintaining the drainage systems on regular basis. Kofrom within the Ashanti Region, Kumasi lacks this opportunity as the Roads and Highways department, Ghana Hydrological service are unable to maintain the roads and drains to the needed standard. They lack the constant maintenance required regularly to maintain the drainage systems. Once the drainage systems are in poor state, they do not have the ability to drain catchment runoffs downstream during high intensity rainfalls of longer durations. People living in flood prone areas or downstream of such drainage structures becomes the victims as they and their belongings are flooded. There is therefore the need to look at drainage networks and its effects on livelihoods as a result of good or bad drainage systems. The drainage networks may be correctly constructed but poor operation and maintenance can result in all kinds of floods. These floods results in the destruction of lives and properties worth Billions of US dollars and therefore the need to be managed participatory in order to save lives.

1.3 Justification

Good understanding of drainage engineering and construction of such is of utmost importance in the prevention of floods. Kofrom is harboring million tribes in the city resulting in the generation of all kinds of waste. Most of these wastes end up

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in the drains reducing the drain capacity and therefore unable to accumulate all the runoffs from the catchment area. This results in overland flows leading to floods of varied amounts within the city. Good drainage construction, operation and maintenance results in a city void of floods saving precious lives. City planners and managers needs to work collaboratively when it comes to the design, construction, operation and maintenance of drainage structures. Departments such as NADMO, Hydrological service department and Ghana Highways Authority needs to work hand in hand in order to maintain good roads and drainage systems. A lot of tools are also employed when it comes to the construction and maintenance of good drainage structures. These tools should be studied carefully based on the geographical location of the country and employed for good designing and construction of drainage networks. Most methods employed in one country when it comes to civil engineering works may not be applied in another country. Civil engineering works are usually designed based on a lot of factors such as geographical location, landscape, rainfall pattern etc. Designing drainage structures means a lot when it comes to the aesthetics of the sub – city and Kumasi is no exception. Most of the drains in Kofrom are open drains and not buried or underground hence the rate of waste wash into it is very high. This has detoriated the beauty of the city as compared to a city like Ajman in Dubai in the United Arab Emirates. The drainage network of the sub – city therefore needs to be taken into consideration and well modeled for future floods impact assessment.

1.4 Objectives of the study

The principal objective of this study is to look at flood risk management and surface water drainage in Kofrom – Kumasi in the Ashanti Region of Ghana. In order to meet the principal objective, the following specific objectives will be met. This includes;

- Determine all the tools employed in managing floods by inhabitants in Kofrom.
- Assess all the drainage areas contributing to flooding in the area.
- Evaluate future impacts of flooding in the study area.

2 Literature Review

2.1 Sustainable urban drainage system in the sub – city

The development of modern towns and cities has seen naturally vegetative areas which are pervious been replaced with impervious areas as the urbanization proceeds (Environment Agency, 2003). Most drainage engineer's highest priority is to get rid of storm water without considering the consequences. The book Urban Drainage by LaBranche et al (2007) describes archeological evidences which prove the Romans and other early civilizations to have drainage provided to specific buildings and certain urbanized areas. Czemiel Berndtsson (2004) continues the historical review by describing the development of transporting storm water away from the city to the recipients. The advantage of constructing such drainage structures is to move water from upstream to downstream using drainage structures. Most frequent

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problems or issues experienced are garbage's ending in open drains, clogging of the drainage system along the way and increasing sanitary problems. This was established in the 20th century and combined sewer system used to carry storm water and sewages downstream. The decision with combined pipes instead of a separate system for storm water and wastewater was in many cases economically oriented, since it was cheaper to connect the different sources of water to the same pipe, instead of the alternative, which was to construct more pipes (Berndtsson, 2004). It was monitored in the second half of the 20th century that praxis was changing towards separate systems for the different waters, which meant that the wastewater was transferred to wastewater treatment plants while the storm water was transferred directly to water bodies downstream. Though this solution was the primarily used one during the last half century, countries like England and France still have about 70% of their pipes as combined sewer-systems (Butler et. al., 2004). All storm water and sewages produced are carried by pipes of varied sizes. Leading the water through pipes means that the natural effects of nature like buffering, infiltration and evapotranspiration is bypassed (Falu Energi & Vatten AB et al., 2008). To cope with these problems, the concept of local management of storm water and open solutions won ground, and has been increasingly propagated in many countries during the last decades. More focus is put on possible treatment processes during the transport of the storm water, as well as the situation at the recipients (Persson et al., 2009).

2.2 Sustainable urban drainage systems concept

The idea with Sustainable Urban Development System (SUDS) is in the best possible way to regenerate the natural system of storm water handling, in order to reduce peak flows and provide treatment for the storm water on its way to the recipients. Urbanization and development of cities usually results in the development of impervious areas which results in no or less infiltration of water. This means that there is continuous overland runoff rather the infiltration into the soil since all the areas have being developed to become hard surfaces. The resultant consequences are high peak flows, which gathers quickly after the storms develops within the catchment area as seen in **Fig 1**. Most of the traditional pipe – systems in Kofrom have not being designed to handle high peak flows, as a result flooding is often obtained. When Sustainable Urban Drainage Systems are introduced, most of the water is delayed on its way downstream just like how nature handles storm water runoff (Environmental Agency, 2003).

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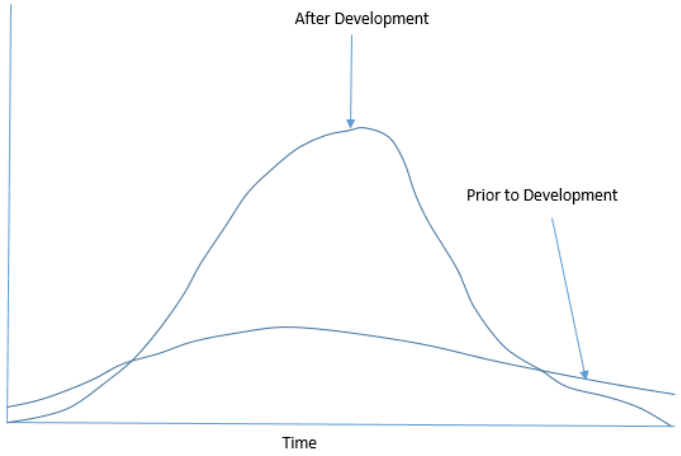

Fig 1: Impact of urbanization on runoff quantity

As depicted in **Fig 2**, the objectives with sustainable urban drainage are to minimize the effects of urbanization by improving the biodiversity and quality of the storm water on its way to the end user. Different techniques enjoy various potentials of pollutant removal, and elements like level of urbanization, climate and soil conditions play a vital role in deciding the most suitable SUDS-technique for a location (Falkirk Council, 2009).

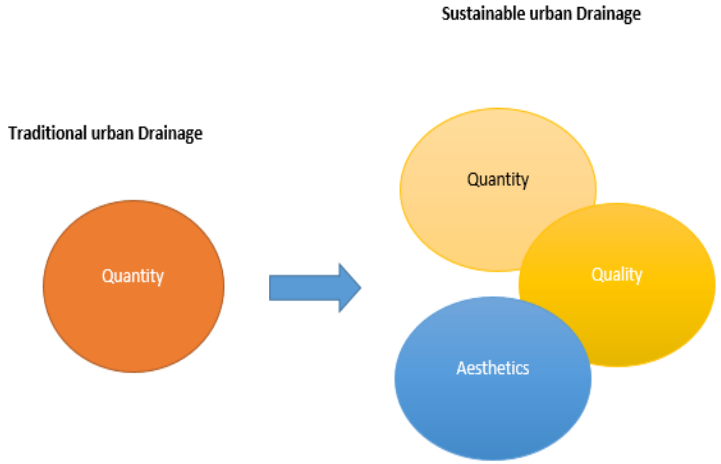

Fig 2: The Sustainable Urban Drainage approach of handling storm water (Jonsson, 2011).

The basic idea when it comes to sustainable urban development system is to handle the storm water as careful as possible and not just move them through pipes and sewers to end users. The solutions are flexible, and different measures can be taken depending on the characteristics in the area of implementation (NSWG, 2004). A number of different steps are involved when it comes to conveying storm water to end users. The main objective is to minimize the effects of reduced flow rates, flow volumes and achieve as possible reduced levels of pollutants in the storm water (NSWG, 2004). In order to

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achieve good results when it comes to the management of urban drainage systems, a series of sustainable drainage techniques are used together before the water reaches the end user (SEPA, 2011).

2.3 Permeable pavement in the Kofrom

Permeable paving is an alternative to the normal impermeable alternative, commonly used in urbanized areas. Infiltration and ensuring the quality of infiltrate is mainly conducted through the filtering process. Permeable paving is commonly used for low traffic roads, parking lots, driveways, pedestrian plazas and walkways (TRCA et al., 2010). According to Hinman (2005), high traffic roads such as highways in Dubai and Ajman have not been considered suitable for these solutions, much due to the heavy load these are subjects to. When constructing permeable paving, there is a wide range of solutions to choose from in order to obtain good results. The most commonly used pavers on the Kofrom roads in the Garden city are pervious concrete, permeable interlocking concrete pavers, plastic or concrete grid systems, and porous asphalt (Hinman, 2005). Compacted gravel is however not considered a permeable pavement (NCDENR, 2007c) as usually seen in remote places of Kofrom. Soil type conditions and the level of groundwater is what determines where to implement solution of creating proper drainage systems. The seasonally high groundwater level should be one meter below the base of the permeable paving according to TRCA et al (2010). Soil characteristics is very significant when it comes to soil infiltration rate determination as some soils have greater rate of infiltration than others. The United States Department of Agriculture – Natural Resources Conservation Service (USDA-NRCS) has defined that no finer texture than Loamy Very Fine Sand is acceptable beneath a permeable paving (NCDENR, 2007c). Pavement system in Kofrom of the Garden city is necessary as it helps to convey runoffs from the catchment area to drains located at downstream.

2.4 Inhibitors of good drainage system effectiveness in Kofrom

Good drainage system in a sub city like Kofrom is very necessary as it helps to drain all storm water from upstream of catchment area to downstream. Many activities in such areas turn to inhibit such process thereby resulting in all kinds of floods and associated problems. Kofrom is a busy sub city with all kinds of activities such as buying and selling hence increasing the rate of waste generation. Traders selling foodstuffs such as cassava, plantain, cocoyam, yam etc. and other vegetables turn to heap the waste produced close to drains. This the sanitation agency, Zoomlion tends not do on time. The refuse or waste finally finds themselves in the drains reducing the drain capacity and causing drain blockage. This stays in the drain for longer periods leading to rots and the bad odor it produces. It's an unbelievable situation to see some people or traders intentionally throwing rubbish or waste directly into drains in

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the study area. All this leads to blockage and reduced drain within the study area. Maintenance of drainage systems in the city and Ghana as a whole is a big problem as agencies or organization that are responsible are reluctant to take responsibility. What we usually experience or see is the highway authority working on potholes on our roads and not the drainage system. The hydrological service department which is also responsible rarely maintains and only works during flooding periods. This has resulted in a drainage system full of waste and reduced capacity hence the inability to withstand serious floods during peak rainfall seasons. Because most of the drains in Kofrom are open drains, the probability of getting filled with waste and dirt is at a higher rate. Sizing of drains by contractors is another problem as most drains are undersized or oversized. Undersized primary drains located down streams are therefore unable to take all the runoffs from secondary drains resulting in overland flow and finally floods. Drainage engineers and designers therefore needs to do serious step by step designs and proper consideration before siting them. The natural flowing slope for drains is also one of the problems experienced as most do not have this. The rate of siltation in the drains is very high with sand and other waste materials settling in the drains. Bad engineering works by contractors is a big problem especially during citing of new drains. The construct new drains and all sort of sands around the drains end up reducing the drain capacity. Such areas should have been covered with green grass vegetation but they leave them unattended resulting in the washing of sand and soils into the drains. Most drains are always silted and stocked with odour producing water. This finally becomes a breeding ground for mosquitoes yielding all kinds of diseases such as malaria. Furthermore, the unconcern nature of people in the Kofrom sub city is high. They do not care about what people do with the constructed drains within their vicinity. Some traders even has the ability to construct kiosk or structures on top of drains and throw refuse or rubbish into them. Literature shows that closed drains are better when it comes to the rate of waste accumulation. Because they are closed, what usually moves through them are water. The possibility of waste getting into them is very low as they are covered and this increases the aesthetics of the environment. With closed drains, the tendency to use screens at some vantage points to take away waste is possible and this reduces the level of waste getting stuck in drains and resultant blockages along pipe lines.

3 Methodology

The method employed for this study include critical studies of literature to understand the flooding situation at Kofrom in the Garden city. Flooding has been occurring in Kofrom over the years affecting lives and destroying properties worth Billions of US dollars. The drainage system of Kofrom was analyzed with the help of experts from Hydrological service department and Ghana Highway Authorities to know more about the current situation within the Municipality. This helped to determine all the areas contributing to flow within the study area. All the catchments which generates runoffs into the sub urban city

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were also determined and by that able to obtain the areas which contribute much to flooding in the city. Most of the primary drains downstream where in a poor state resulting in overland flows. Investigation gave the understanding that most of floods have been occurring in the flood prone zones because they fall within regions where the rate of saturation is very high. Consultation with NADMO was also done to determine all the tools employed in managing floods in Kumasi and hence the sub urban city Kofrom. There was further investigation to look at the effect of future floods. This was done by increasing and maintaining the drain capacity of current drains at the study area to see the effect of heavy torrential rainfalls. Once the drains capacity of current drains are maintained, heavy rainfall and greater runoffs from the catchment has the potential of causing future floods. If the drains capacity are increased, then there is the possibility of taking all the overland runoffs from the catchment during heavy pours in the future. Since the drains are of higher capacity, future floods are not likely to occur. The possibility of saving people in the future is therefore for sure as the drains and hydraulic structures will be able to take all the generated runoffs from the catchment.

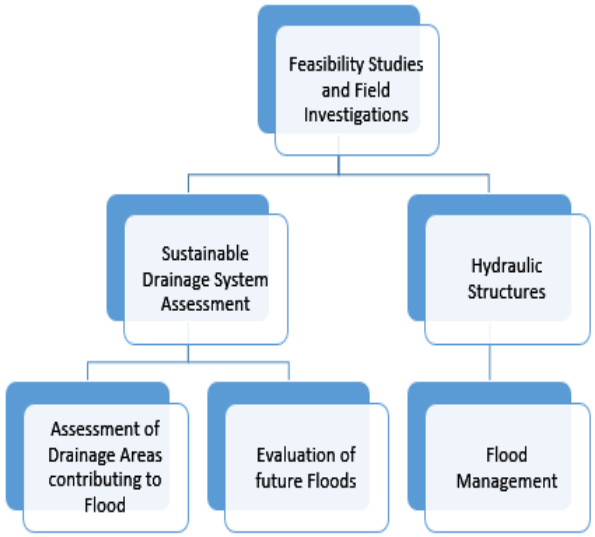

Fig. 3: Methodology employed for this study

4 RESULTS AND DISCUSSIONS

4.1 Tools employed in managing floods in the sub – city of Kofrom

4.1.1 Small hydraulic structures

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Most of the floods which does occur in Kofrom over the years have been brought under control through the construction of small hydraulic structures. These structures are usually constructed downstream of areas where there is always flooding to a greater extent during peak rainfall regimes. Most of the hydraulic structures were constructed years ago and as a result there is the need for repairs as they have been used over the years. Most were constructed with old engineering designs and as a result needs to be altered to meet modern climate change effects and impacts. Due to changes in the climate as the year proceeds, different rainfall regimes will be experienced and the resultant floods. City planners therefore needs to take such effects into consideration and work on current designs of hydraulic structures to combat the impacts likely to occur. If small hydraulic structures are well constructed and are able to drain all runoffs from secondary drains, then there is the possibility of avoiding floods in the study area. Hydraulic structures well designed and constructed are always able to meet the requirement and by that able to save flood victims when the need arises. Even though organizations like NADMO are in a position of saving floods victims and helping those in need, city planners should concentrate on flood mitigation measures. The government of Ghana should work through appropriate organization on the drainage system of the study area and rectify all possible situations before peak rainfall regimes. Hydraulic structures which have been built over the years should see good operation and maintenance before the rainy seasons so that all possible problems on them are rectified before the peak periods of the rainfall season.

4.2 Educating the people on the effects and impacts of floods

Most people have heard of floods and its impacts but still lacks the education on it. All said and done, people continue to experience the drastic impacts of floods as they live in flood prone areas day in day out. Even though some are informed especially those living down stream of huge hydraulic structures they continue to experience the impact. The interviewed in the study area indicated the occurrence of the flood is sudden so it usually meets them unprepared. This is true as most of the rainfall experienced within the study area happens at night meeting victims during sleep. Education and awareness creation within the study area is of utmost importance as it will prepare the minds of people living in flood prone areas. This can be done using information vans, briefing at social centers, through cards and posters and one on one talks. During the investigation, it was realized that some do not even know what floods are and their possible impacts likely to have on livelihood and living standards. On enquiring on the strategies employed by affected during flood periods, some said they move to higher lands. Others have to put up with family and friends for days for the flood waters to go down. They also talked about the drastic effect it results in as the loss of properties such as personal belongings worth Billions of US dollars. The most important things destroyed are electrical appliances, furniture, cloths and other personal belongings. Interviewed were asked whether they have monitored some of

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flood marks which gives a clear sign of the possibility of floods in the area. They replied affirmative but indicated obtaining accommodation in some areas are very expensive hence the reason of living in such areas. Once house owners knows the situation in that area, they are in a position of given the house to them at a lower cost. Some even said they were living in such areas for free of charge because they do not have the money to pay. The cost of living in the city is high and are not having good jobs, therefore have to manage such accommodations. Education should not only target adults but should include children as they are also victims. They are also good communicators to adults and therefore can be a tool of communication to disseminate flood issues. City planners and flood experts should pay regular attention to flood prone areas within the Kofrom area and allow for two – way communication. This will help flood victims to communicate their problems to city planners and city planners channeling the experiences and knowledge on floods to save them. Some victims said they do live within the food prone areas during the dry season and then move to higher lands or different areas within the city during the rainfall season. The interviewed indicated some of the people to save them do not have the affection and love for them. They are rather interested in the items and money to be given to the flood victims and even the flooded items. This they said is a serious problem and advised such people to desist from and concentrate on helping people. Some have lived with the floods for years and therefore unperturbed and therefore willing to experience it each year. The only problem they have has to do with the loss of properties and not the psychological impacts it has on their being. They are ready to relocate but the problem is the means as there is no source of living. Floods will continue to occur each year due to changes in the hydrological cycle and therefore the need for Kofrom to prepare especially those living the flood prone areas.

4.3 Modification of hydraulic structures

Waterway or floodplain modifications such as widening, deepening, realigning or cleaning rivers and flow paths can improve the transport of floodwaters downstream and reduce the likelihood of blockage, but can increase velocities and erosion and cause negative environmental impacts. The benefits of cleaning and clearing are only temporary unless these continue to be maintained. Once the size of hydraulic structures are increased, it result in secondary and primary drains having the ability to take huge quantities of floods. Runoffs from the catchment area are therefore able to move all the flood waters without causing any drastic effect to the populates. Development and building in water logged areas within the study results in the increase in urbanized areas and hence the rate of runoff generation. People are developing all kinds of areas for different kinds of purposes and city planners and drainage engineers need to critically work hand in hand with this people as it leaves the city in an unplanned manner. The development of vegetative covers and soils increases the rate of overland runoff making the rate infiltration very low.

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This puts pressure on the old hydraulic structures and drains capacity are unable to take all the runoffs from the catchment. Increasing the size of hydraulic structures therefore become very necessary in order to drain all flood waters from the catchment to a safer end. Other structures such as roads, railways and embankments also have an impact on flood risk management because they can alter flood flows and behavior. Most of the flood waters moves on roads looking for a drain to take the flood waters. Therefore, if roads are not constructed to meet modern standards, drains will not be able to take all the flood waters for recess to occur. Floods can be avoided if the rate of recession is very high. Floodgates can also be used to prevent backflow from river systems into drains.

4.4 Drainage areas contributing to floods in the study

Because most of the floods occurring in Kofrom is within the flood prone areas, the areas contributing to floods in the study area centered on the flood prone areas. These are areas which have a greater percentage when it comes to experiencing floods each year. The flood prone areas have been ear marked as areas which will always experience floods when precipitation of higher amounts are obtained. The flood prone areas were identified as low lying areas hence receive greater runoffs from the catchment area during rainfall. Because most of them are waterlogged areas, the rate of infiltration is very low as the soil is already saturated with water already. It takes shorter time for the soil to be filled with water with overland water developing at a faster rate. The very moment water from the catchment area adds up, flood development becomes very fast resulting in floods. Most of the drains carrying water from the catchment area are also in a poor state and as a result leaks most of the water to overland. This adds up to the flood water developed in flood prone areas leading to high peak water development resulting in floods. All the zones within the catchment area of the flood prone areas were seen as areas contributing to flooding in the study area. Because it's downstream of the catchment area all the drained water ends up there like a water body taking water from upstream. Drainage engineers should do critical investigations and calculations when it comes to analysis of areas contributing to flow. It was established during the study that most of the areas contributing to flow were not rightly determined hence under sizing of drainage structures. Runoffs from the catchment area therefore becomes greater than the maximum capacity of the constructed drain. This leads to overland flows in huge quantities leading to serious floods.

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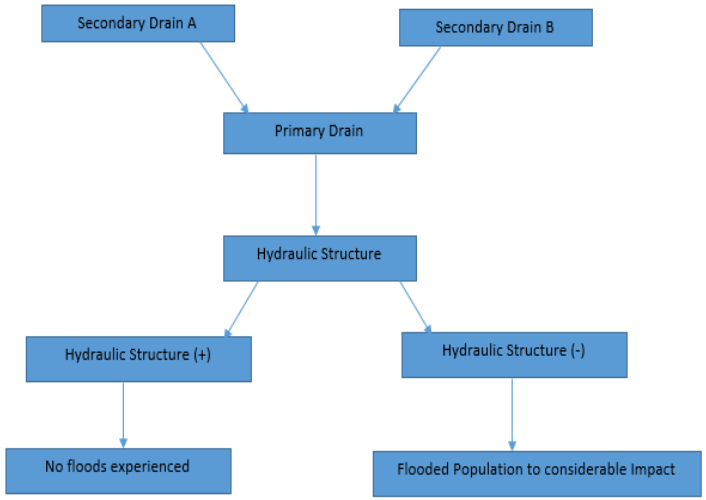

Fig 4: Drainage system resulting in floods in the study area

5 Conclusion

Since climate change is a continual phenomenon, floods will also be experienced in the study area once we enter the rainy season of the year. Future floods will see the flood prone areas being flooded with loss of lives and properties worth Billions of dollars. Lack of proper operation and maintenance of hydraulic structures and drainage system will see all runoffs ending at the flood prone zone. Urbanization and development of the Kofrom area will see vegetation covers and soil turned into pervious areas increasing runoff generation. City planners, Ghana highway Authority and the hydrological service department has to plan the city very well making room for peak rainfall season and the resultant runoffs generated. The possibility of determining the maximum rainfall likely to be experience within the year is very low hence the need for drainage engineers to ensure that drainage system are in good conditions and position to receive the overland runoff after good catchment area runoff determination. When this is not done, disaster as a result of serious floods will occur destroying precious lives and properties worth Billions of dollars. Future floods has the potential of increasing the affected zone as more pervious areas generates more runoffs. Once the flood prone areas are unable to accumulate the overland runoff generated, it will extend further to other areas increasing the affected areas. This means that if proper mitigation measures are not put in place, future floods will increase coverage destroying more buildings, factories, personal belongings and taking of human lives.

In the future, hydraulic structures should be increased in size and proper siting should be done in order to take all possible runoffs from the areas contributing to flow into the catchment area. By doing this, floods can be avoided and the possible disasters likely to happen avoided. Field investigations revealed that most newly constructed drains are left half filled with soils, bitumen and chippings after road constructions by road contractors. This need to be cleared from the drains to give drains full capacity to receive runoffs and move stormwater them downstream in flood prone areas. Furthermore, the government of Ghana and experts should work on acquiring

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knowledge on flood management and mitigation measures from other countries like United Kingdom, United States of America, Germany, U.A.E and other countries who are well vested when it comes to flood control. Participatory approach is the best way to control floods where all neighboring areas, cities or countries contribute their knowledge and time on how to control the flood.

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