

Drainage System Sustainability in Bodity Town, Southern Ethiopia

Wolaita Sodo University, Ethiopia

Wolaita Sodo University, Ethiopia

ABSTRACT

Urbanization is one of the key factors that contribute to urban flooding, which has caused major destruction to the environment, public and private buildings and disrupts public life. In particular, the increase in population and building density influence the change in hydrological characteristics in urban areas. This study assessed the approach to drainage system sustainability in Bodity town. To this end, households of the town and public sector officials were interviewed to obtain necessary information for the study. Inadequate coverage, poor quality and inappropriate provision of drainage infrastructure were problems identified in the study. Weak technical and institutional capacities associated with lack of finance, lack of integration among concerned bodies, lack of community participation and poor operation and maintenance are factors constraining proper drainage infrastructure provision and worsening the situation in the study area.

Keywords: Drainage system; Mitigation measures; Households; Bodity town

INTRODUCTION

Urbanization alters the natural process of storm water runoff [1]. Consequently, it increases storm water runoff quantity due to the increase of impervious area, such as roads, parking lots, and rooftops. On the other hand, it has also been well acknowledged that processes which continuously take place in urban development can negatively affect storm water runoff quality. Such issues are further reflected in the subsequent impact of water quality of natural receiving water bodies by altering physical, chemical and biological conditions of water [2]. With urbanization, impermeability increases because of the increase in impervious surfaces. This in turn changes the drainage pattern, increases overland flow resulting in flooding and related environmental problems. The impact of this is severe on spatial structures like road. This is because, flooding and its related environmental problems like sheet and gully erosion, surface inundation tends to affect road services and its life span. Given the significance not only in socioeconomic development, but also a path way for the location of other infrastructure, issues that affect its performance and longevity are critical areas of research [3].

In the last years, quite efforts have been taken to construct significant hydraulic structures in Boditi town to be used for drainage system. The urban drainage of these structures failed to serve for the intended purpose due to number of observed challenges. Some structures were blocked by sediments that emanate from the upland areas. On the other hand the existing drainage channels were found to be inadequate in their size to discharge the incoming

flow. The problem associated with foundation conditions within the vicinity of storm water drainage channels is also one of these issues. Presently, some of the problems that have been observed in the Boditi town are either under the category of engineering (i.e. hydraulic, hydrologic or structural) and management matters. Mainly, the management related problems are the results of lack of integration among stakeholders in the solid waste disposal mechanisms.

GENERAL OBJECTIVE

The main objective of this study was assessing the sustainability of existing condition of drainage infrastructure in the town.

SPECIFIC OBJECTIVES

- To identify the main problems in the provision of drainage infrastructure;
- To identify challenges associated with operation and maintenance of drainage system in the study area.
- To recommend some mitigation measures

LITERATURE REVIEW

Urban drainage is concerned with the collection and conveyance of wastewater and storm water from urban areas [4]. An important social aspect is to maintain public health and safety; hence an

*Corresponding to: Wondimu Elias Worajo, Wolaita Sodo University, Ethiopia, E-mail: wndmelias488@gmail.com

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efficient drainage of storm water and wastewater is essential to avoid impact of flooding on life and property. In addition, the current environmental awareness involves the protection of the receiving waters from the pollutants that may be dragged by water flowing in the surface during heavy rain events [5]. The urban drainage system was first challenged due to the interactions between human activities and the natural water cycle, where this cycle was interrupted due to either (a) abstraction of water for drinking purposes and generating a wastewater also (b) increasing the impervious surfaces that causing rainwater diversion from natural drainage system and generating a considerable runoff. Consequently, both types of water need immediate drainage [4].

Sustainable drainage systems (also known as SuDS), are a collection of water management practices that aim to align modern drainage systems with natural water processes. SuDS efforts make urban drainage systems more compatible with components of the natural water cycle such as storm surge overflows, soil percolation, and bio-filtration. These efforts hope to mitigate the effect human development has had or may have on the natural water cycle, particularly surface runoff and water pollution trends. SuDS have become popular in recent decades as our understanding of how urban development affects natural environments, as well as concern for climate change and sustainability, have increased. SuDS often use built components that mimic natural features in order to integrate urban drainage systems into the natural drainage systems or a site as efficiently and quickly as possible. SUDS infrastructure has become a large part of the Blue-Green Cities demonstration project in Newcastle-upon-Tyne [6].

According to Ethiopian Ministry of Urban Development, Construction and Housing Strategy after a road drainage study has been conducted along with road design, the quality of the road drainage that is built will determine the service-life of the infrastructure. Even though this task has been carried out by many Micro and Small Enterprises (MSE) in recent years and the enterprises have gotten encouraging results. Trainings and technical supports have to provide to these enterprises so as to enable them to conduct the construction of these road drainages and flood elimination systems with good quality. This will improve the quality of the constructions and it will also gradually lengthen their service life [7].

METHODOLOGY

Description of the study area

The study was conducted at Boditi Town which is located in Damot Gale Woreda, SNNPR regional state, Ethiopia, having a total area of 1368.115 ha. Geographically, it is located: 6°56'0" to 8°58'0" N Latitude and 37°50'0" to 37°53'0" E Longitude. The Town is at an altitude ranging from 1880 m to 2112 m. The Town is 365 km from Addis Ababa and 140 Km from Hawassa (Figure 1).

Both the primary and secondary data sources used to get the necessary data of the study. There are two sub cities named as Mesrak and Merab Sub Cities. There is a total of nine Kebeles under two Sub Cities and a total number of household in the town was 15,806. 200 sample households of the town were drawn systematically and 15 purposively selected key informants from public sector organizations and included in the study sample. Structured questionnaire were then distributed to these households while the public officials were interviewed to obtain all the necessary data. Both qualitative and quantitative data collected from the respondents were analyzed accordingly and presented by different ways.

RESULTS AND DISCUSSIONS

According to the town municipality data in 2020, the existing drainage network length of the town covers 68.6 km² which is not as much as the total built up area and the road network coverage in study area. Road infrastructure without appropriate drainage system become deteriorated by runoff and storm water. The majority of drainage systems of the town are open channels. There are three types of drainage in the town as indicated below in the Table 1 masonry drainage covers (81.75%), concrete (16.23%) and pipe drain (2.02%).

Concerning drainage infrastructure provision the main problems associated are like poor coordination and integration among stakeholders. Moreover, community participation is among the lowest in the study area. For example, 65% of respondents proved that there is no community participation in one way or another for drainage infrastructure provision. Therefore, government is the

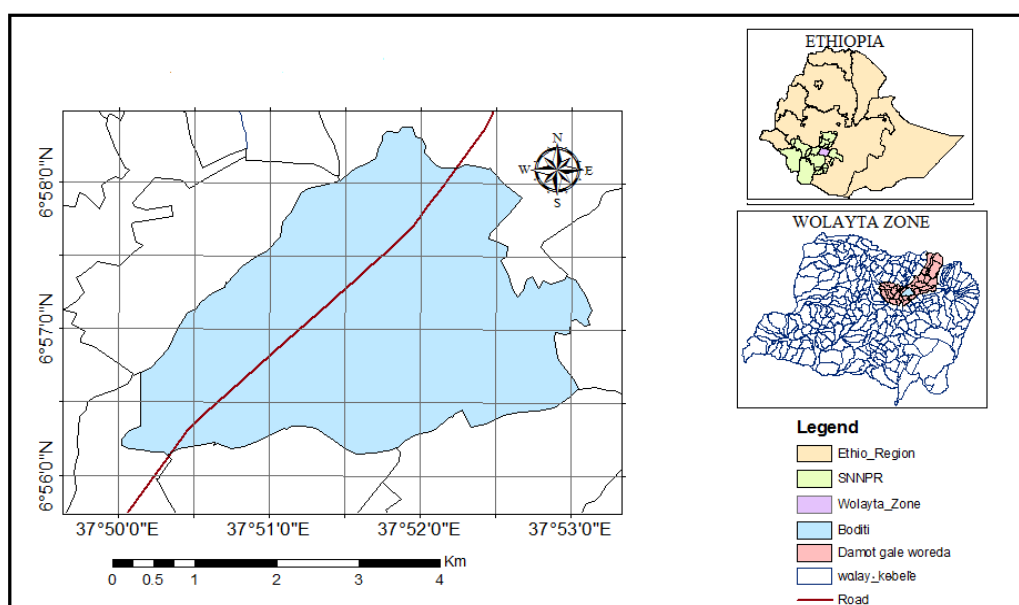


Figure 1: Location map of Boditi town.

Table 1: Drainage types in the study area.

Type of Drainage	Coverage (%)
Masonry Drainage	81.75
Concrete Drainage	16.23
Pipe Drainage	2.02
Total	100%

only body responsible for the provision of this service. Operation and maintenance of urban drainage infrastructure is a very challenging issue in the study area. Challenges that are encountered by community during the operation of drainage system were dumping solid waste, discharging of liquid waste and not cleaning the drainage system. Majority of respondents (75%) replied that all above mentioned challenges exist in the study area. Maintenance of drainage infrastructure is also a very challenging problem. Poor drainage infrastructure maintenance is the real obstacles to sustainability are the lack of adequate numbers of skilled personnel who are able to plan and implement urban drainage in a timely and holistic manner – coupled with the lack of funding needed to pay for the work. Community participation and coordination of private investors in the provision of drainage infrastructure is almost lacking in the study area although the government is not capable of providing and developing the service in sustainable manner. Participation in its approach is seen as a means of ensuring augmented social accountability with the involvement of the citizens in decision making as well as creating a close relationship between the “governed” and the “governing”. Concerning operation and maintenance of drainage system, operational problems caused by poor solid waste management are exacerbated by a lack of effective arrangements for drain cleaning. This tends to be related to a lack of resources and manpower, and inappropriate equipment. But, what makes the situation worse is the department responsible for solid waste management separate from that responsible for drain cleaning and coordination between different urban sectors is generally very poor. Public participation plays a key role by taking proper care of infrastructure and maintaining them with a feeling of ownership for a prolonged service life of infrastructure, in addition to its contribution in the form of finance and labor. Good maintenance requires a steady and reliable flow of funds. But in the study area, the capital budget allocated for the development as well as operation and maintenance of drainage infrastructure is inadequate. The study findings revealed that, the quality of drainage in the study area is poor and hence, the construction of drainage infrastructure has to be undertaken by skilled man power. With respect to quality, the role of municipality to improve the quality of drainage infrastructure is not convincing. In order to minimize the cost of the construction of the drainage system the construction is undertaken by micro and small scale enterprises and daily workers who do not have enough skill. Inadequacy of Sustainable urban drainage system leads to ill economy and poor environmental conditions. Due to the inadequacy of the drainage system, the low lying parts of the town, especially is hit frequently by splash flood. And this is mainly resulted because of the blockage of drainage system by the solid waste, poor maintenance practice of drainage system and lack strong integration among stakeholders in the provision of drainage infrastructure to ensure sustainability of drainage system causing pollution and a wide range of problems associated with the increased risk of waterborne disease. Poor quality drainage, inadequate coverage, low level community participation and weak integration of stakeholders are some of the

major problems drainage infrastructure and sustainability in the study area.

CONCLUSION

In the study area it is observed that drainage problem is a cause of flooding on pavement, congested traffic flow and difficulty on day to day activity of people. To investigate the cause of the problem, we try to assess the drainage system in the flood prone areas and site investigation was done by collecting direct field data to assess the storm drainage condition and operation management problem. The existing drainage system has extensive defects and requires immediate rehabilitation or reconstruction, and also maintaining major drainage works. Because, the construction of drainages were not undertaken by skilled personnel but by not dedicated contractors and micro and small scale enterprises. Therefore, there is inadequate and low coverage of drainage system coupled with poor physical condition and ineffectiveness of drainage system development in the town. Lack of skilled man power, poor integration of stakeholders, low level community participation, constraints of budget and absence of drainage network plan in the town were the main problems encountered in the provision of drainage in this study. Operation and maintenance works of drainage infrastructure is challenged by illegal dumping of solid waste, discharging of liquid waste in to drainage which leads health and environmental problems.

RECOMMENDATIONS AS MITIGATION MEASURES

Sustainable drainage system problem become major challenge for recently constructed road as it is observed in Bodity town. The following mitigation measures as recommendations have been drawn from this study.

1. Design of the structures

- All consideration, such as appropriate design method which depends on the catchment area, variability of climate, future settlement of people, expansion of urbanization and other factors shall be taken into account during the detail design of the drainage facilities so as the structures capacity shall accommodate the design flood.
- In case if the problem occurs and the town administration shall to take action to keep the serviceability of the road, the rehabilitation needs to be supplemented by the detail design to alleviate the problem permanently with low cost.
- Since the velocity of runoff is high in existing drainage channel, it is need to provide drop structure to decrease flow velocity.

2. Continuous Monitoring of the drainage facilities

- Continuous monitoring of the drainage facilities is required to take timely action where unexpected problem encounter that may create risk on the people, road and surrounding environment.
- Periodically, cleaning of the drainage facilities is also required to prevent of clogging of the drainage system.

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