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Assessing storm water drainage network in Sodo town, Ethiopia

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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. One way of minimizing urban flooding is to convey storm water to receiving waters through storm water drainage systems, which has been practiced in some parts of Sodo town. Despite development over the years, it remains a significant challenge to design sustainable and effective functioning of drainage system. This study assesses the storm water drainage network in Sodo 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.

Key words: Storm water, drainage, flood, Sodo town

Introduction

Urbanization alters the natural process of storm water runoff. 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 (Konard, C. P., and D. B. Booth., 2005). Storm water discharges are produced when the capacity of the land to retain precipitation is exceeded and runoff occurs. Runoff will be influenced by rainfall and intensity (millimeter of rainfall per hour) and duration, antecedent storms and a number of

watersheds, and land use characteristics such as slope, soil type, and impervious surfaces. Furthermore, the increases of peak flow, flow volume, flow velocity, as well as event frequency could deteriorate water quality in downstream areas (AASHTO, 1991).

Infrastructure is one of the indispensable elements in the process of urbanization and emergence and continuity of an urban growth. It is considered as motor/engine for economic development (World Bank, 2006). Infrastructure is important in eradicating poverty through various job creation opportunities and by so doing; it enables to speed up economic development and ultimately ensures improved quality of life (Wentzel.E, 2013)

The pattern of urbanization and modernization in Ethiopia has meant increase densification along with urban infrastructure development. This has led to deforestation, use of corrugated roofs and paved surfaces. The combined effect of this results in higher rain drop intensity and consequently accelerated and concentrated runoff. In Ethiopian context, where watersheds of many urban centers receive significant amount of annual rainfall and where rainfall intensity is generally high, control of runoff at source, flood protection, and safe disposal of excess water/runoff through proper drainage facilities becomes essential (Dagnachew.A, 2011).

Sodo town is like other town of Ethiopia has a lot of problems regarding drainage infrastructure including inadequacy and poor quality drainage infrastructure. Stemming from its location at the foot of Demota Mountain with absence of proper drainage line along roads in the town, seasonal floods and other environmental problems are most frequently occurring especially on downstream parts of the town. This has resulted in negative impacts on sustainable urban drainage system provision and management

Problem statement

In urban areas, impermeability increases with the increase of impervious surface, this in turn increases the overland flow resulting in flooding and related environmental problems (Abdu.B, 2019). In Sodo town, 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. Under the hydrological associated issues, the town is facing the problem of improper urban drainage design systems. The road side ditches already constructed along the asphalt road are poorly designed only considering discharging storm runoff from the asphalt road, however the fact is most of catchment storm water is conveyed by those existing ditches at study area. This made most ditches to be clogged with silt and urban effluent.

Therefore, this study was taken in this town to assess the existing storm water drainage network of the town.

General objective

The general objective of this study is to evaluate the existing storm water drainage system of Sodo town.

Specific objectives

- To identify the major challenges in storm water drainage management system
- To identify major flood prone areas in the town
- To identify major causes of flooding in the town
- To the existing condition of drainage infrastructure in the town;
- To make mitigation measures and recommendations on storm water drainage integration and their provision and management.

Significance of the Study

Managing urban storm water drainage system has a significant role for viable environmental management by keeping the service life of urban infrastructures such as roads, buildings, telephone lines, water supply lines and the existing rivers. This research is aimed at coming up with finding out reasons for inadequate provision of drainage system. The concerned body of Sodo town administrator may use it as a reference while they are preparing their annual plans for urban drainage system. And also it will be an alternative means of ensuring sustainable development in the town by strengthening the environmental and socioeconomic activities regarding to urban drainage system.

Literature Review

Urban drainage is concerned with the collection and conveyance of wastewater and storm water from urban areas. An important social aspect is to maintain public health and safety; hence an efficient drainage of storm water and wastewater is essential to avoid impact of flooding on life and property (NUPI, 1995). 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 (BULTER, D. & DAVIES, J., 2011).

Description of the study area

Sodo is a town and separate woreda in south-central Ethiopia. The administrative center of the Wolaita Zone of the Southern Nations, Nationalities, and Peoples Region, it has a latitude and longitude of 6°54′N 37°45′E with an elevation between 1,600 and 2,100 metres (5,200 and 6,900 feet) above sea level. It was part of the former Sodo woreda which included Sodo Zuria which completely surrounds it. Sodo is served by an airport. A 166-kilometre (103 mi) road connecting Sodo with Chida, whose construction had started in 1994, was completed by early 1999. Featuring an 80-metre (260 ft) Bailey bridge across the Omo river and five other bridges, this road cost 255 million Birr, and reduced the distance between the Regional capital at Awassa and Mizan Teferi to 400 kilometres (250 mi).[1] According to the SNNPR's Bureau of Finance and Economic Development, as of 2003 Sodo's amenities include digital and mobile telephone access, postal service, 24-hour electrical service, two banks, and a hospital. (https://en.wikipedia.org/wiki/Sodo).

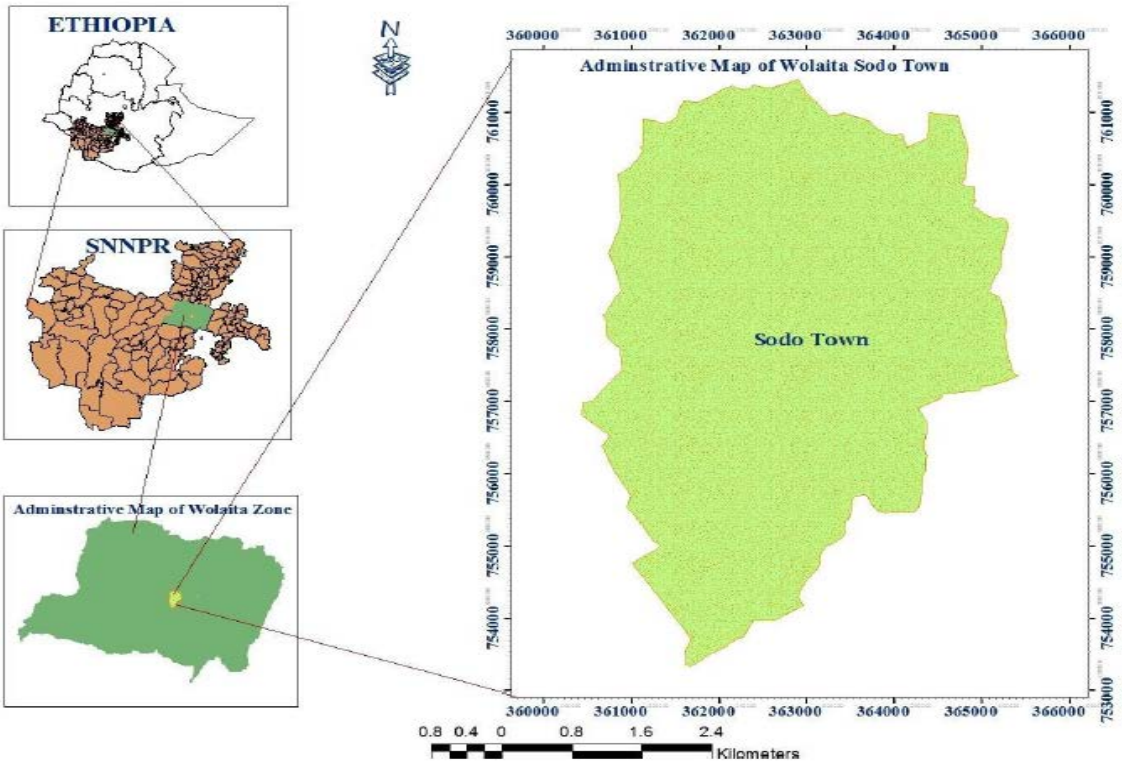

Figure 1: Locational map of Sodo town

Methods

The mixed research approach is used since it is useful to capture the best of both qualitative and quantitative approaches. 300 statistically determined households of the town were drawn systematically in addition to 6 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 overall respondents were analyzed accordingly and presented by using tables, percentages, figures, plates and narrative descriptions.

Results and discussions

As depicted in the following table, the major flood prone area in the town is Merkato sub city (36.7%) followed by Mehal Sub city (33.3%) and Arada Sub city (30%), which were evidenced from the respondents' response as well as field observation.

Table 1: Major flood prone areas in the town

Sub city	**Respondents**		**Ranking**
	Number	**Percentage**	
Merkato	110	36.7%	1
Arada	90	30%	3
Mehal	100	33.3%	2
Total	**300**	**100**	**-**

Sodo Municipality, in their 2015 report indicated that the existing drainage network length of the town covers 68,604.1m^2 (68.604 km2) which is not as much as the total built up area and the road network coverage in study area. 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: masonry drainage covers (68.7%), concrete (31.2%) and pipe drain (0.1%). Concerning drainage infrastructure provision the main problems associated are like poor coordination and integration among stakeholders. 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 (84.8%) 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.

Table 2: Drainage types in the town

Types of Drainage	Length (m)	Percentage (coverage)
Masonry drainage	47135	68.7%
Concrete drainage	21404	31.2%
Pipe drainage	65.1	0.1%
Total	**68,604.1**	**100**

Causes of flooding

As it was observed during field survey the majority of the storm drains are blocked by solid wastes of various types and many residents illegally connect their sewerage system in to the existing drains

Figure 2: Drainage line status in some areas

Table 3: The major causes of flooding

Major causes of flood	Respondents		Ranking
	Number	Percentage (%)	
Blockage of drains by solid wastes	173	57.7%	1
Inadequate drains	119	39.7%	2
Absence of drains	8	2.6%	3
Total	**300**	**100**	-

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. 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 hitted 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. 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. On the other hand, the provision of drainage system in the study area is characterized by absence city wide drainage network plan, shortage of capital and skilled manpower, lack of commitment on the side of contractors and micro and small scale enterprises. 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. 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.

Conclusions

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, it was tried 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. Accordingly, 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 dedicates 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

The following recommendations have been drawn from this study**.**

- ✓ Periodically, cleaning of the drainage facilities is required to prevent of clogging of the drainage system.
- ✓ 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.
- ✓ Integrated solid waste management.
- ✓ Encourage site infiltration through: Permeable pavements like porous concrete, coble stone, vegetated structures or grassing on road sides and vacant spaces/ gardens.
- ✓ To ensure sustainable urban drainage management, there should be an integrated urban storm water drainage management.
- ✓ 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.
- ✓ 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.

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