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Quantifying the Impacts of Poor Maintenance on Urban Infrastructures in Ethiopia: Drainage System as a Case Study

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Abstract:

In Ethiopia, poor drainage maintenance and lack of an integrated management of assets are among the challenges faced in the properly functioning of urban drainage system. Lack of proper maintenance of drainage and its structures is the potential factor that causes urban flooding in most cities/towns of Ethiopia. The purpose of this research was to evaluate and quantify the impacts of inadequate maintenance on the performance of urban drainage system and its structures. This study was descriptive, designed to obtain the potential impacts of poor maintenance on the performance of urban infrastructures. To fulfil the objective of the study, both primary and secondary data were used. Literature review, questionnaire survey and field observation were used to collect data for the study. Findings reveal that the impacts of poor maintenance are: blockage of drainage channels, urban flooding and pavement distress like potholes, edge failure, and sediment accumulation. It is recommended that institutional set up for effective operation and maintenance of drains should be strengthened, as the transportation of silt and sands to the drains is high during dry season, drains should be maintained before the rainy season and there should be a high degree of close communication and co-ordination between the urban authorities and town residents for operating and maintaining the various components *of the drainage network and sufficient funds in all annual budgets for carrying out routine maintenance program should be provided by the concerned bodies of the town.*

Key words: Blockage, Urban Drainage, Poor Maintenance, Drainage Performance

1. INTRODUCTION

When rainfalls on to undeveloped land, most of the water will soak into the topsoil and slowly percolate through the soil to the nearest watercourses or groundwater. A small proportion of the rainfall usually 15 to 20 % becomes direct surface runoff that usually drains into watercourses slowly because the ground surface is rough. So for removing water quickly from soil surface adequate drainage system is required. Drainage can be either natural or artificial. Many areas have some natural drainage which means the excess water flow to the lakes and rivers. Natural drainage, however, is often inadequate and artificial or man-made drainage is required. There are two types of artificial drainage: surface drainage and subsurface drainage.

According to Mc Robert J. et al. (2000), drainage is often described as the central and most important aspect of design, construction and maintenance of any road, including unsealed roads. Drainage of unsealed roads can be of even greater importance because lower quality design and construction standards and marginal materials are generally used, which are more permeable to water. Poor drainage will reduce the life of the pavement and have serious environmental impacts if left unchecked. There are many approaches to reducing erosion of exposed surfaces associated with unsealed roads, such as side drains, cut-off contour banks and batter slopes. Any road will readily concentrate runoff, so there is a need to design and construct roads to allow for frequent and safe discharge.

Rokade et. al. (2012) reported that inadequate drainage leads to major cause of pavement distresses due to large amount of costly repairs before reaching their design life. He found that pavement service life can be increased by 50% if water can be drained without delay. *GTZ-IS(2006)* reported that inadequate urban storm water drainage problems represent one of the most common sources of compliant from the citizens in many towns of Ethiopia and this problem is getting worse and worse with the ongoing high rate of urbanization in different parts of the country. *Dagnachew Adugna Belete (2011)* stated that due to poor drainage infrastructure provision, many areas are exposed to flooding problems in Addis Ababa. In other words, he concluded that urbanization and modernization in Ethiopia results in higher rainfall intensity and consequently accelerated and concentrated runoff in the urban areas. Kokeb Zena Besha et.al. (2016) stated that poor drainage integration between road and urban storm water drainage infrastructure and poor maintenance significant parts of Assosa town resulted in street flooding.

Recently Poor existing drains and their improper operation and management mainly cause severe flooding which creates damages and problems to the road pavement and road users at Assosa town. Generally, the overall problems of blocked water channels are one of deterioration in environmental quality, breeding points for mosquitoes among others. Efforts at properly understanding and appreciating the relevance of water ways are crucial to understanding the management techniques required to solve the problems. This indeed, constitutes the focus of investigation in this research work. The aim of this paper is to investigate the impacts of poor maintenance on the performance of drainage system in Assosa town with the set objective of suggesting remedial recommendations.

2. RUNOFF ESTIMATION

A storm drainage system is a system receiving, conveying, and controlling storm water runoff in response to precipitation and snowmelt. Such systems include: ditches, culverts, swales, subsurface interceptor drains, roadways, curb and gutters, catch basins, manholes, pipes, attenuation ponds and service lateral lines. It is designed to convey runoff from frequent storms (e.g., up to 2 or 5 year storms). The main purpose of this system is to minimize storm water ponding at intersections and pedestrian crossings which may cause inconvenience to both pedestrians and motorists so it is also called the convenience system. The major drainage system comprises the natural streams and valleys and man-made streets, channels and ponds. It is designed to accommodate runoff from less frequent storms (e.g., 100 years or the regional storms). The main purpose is to essentially eliminate the risk of loss of life and property damage due to flooding. There have been many methodologies developed earlier to estimate the total runoff volume, the peak rate runoff and the run off hydrograph from land surfaces under a variety of conditions like runoff curve number method, small storm hydrology method, infiltration model methods etc. for earlier stages and Rational method, SCS method, modified Rational method in present stages. The methodology followed here is based on Rational Method, which is adopted widely, however laborious effort are required to ensure that the few input data required for rational method is accurate.

The intensity of rainfall can be determined from rainfall records (Rational Method) or by assuming values found to be adequate from experience (empirical approach). The Rational approach to rainfall intensity is applicable where sufficient data in the form of rainfall records, giving frequencies and intensities of storms over a period of at least fifty years are available for a particular location. This approach is beyond the scope of this paper.

An empirical approach to rainfall intensity is based on the premise that for the drainage of paved areas, it is sufficiently accurate to take the following value for rainfall intensity:

I. Where the time of concentration is less than 10 minutes, assume a rainfall intensity (r) = 38mm/hr
II. Where the time of concentration is greater than 10 minutes, assume rainfall intensity (r) = 25mm/hr.

The time of concentration (tc) is obtained by adding together the time of entry (te) and the time of flow (t_f) for a particular length of pipe.

$$Tc = Te + T_f$$

To determine the quantity of run-off to be disposed off, the simplified rational formula is used.

$$\mathbf{Q = A \times i/360}$$

Where, Q = quantity of run-off (m^3/sec)
A = impermeable area to be drained (hectares)
i = rainfall intensity (mm/hr)

3. METHODOLOGY

The study would focus on the impacts of poor maintenance on the performance of urban infrastructure, drainage system as a case study in Ethiopia. Data for the research were collected from two sources: primary sources and secondary sources.

A. Primary Sources

These include questionnaires, Oral interview and field observation. Through these sources, data for the research were generated. Data gathered from primary sources are referred to as primary data.

Questionnaire Survey: To find out inherent causes of the environmental and social change due to improper drainage system in Assosa town and its associate impact on city life, questionnaire survey, informal interview and open discussion has been conducted with the authorities of different concerned organizations, experts and people living in the study area. The questionnaire was designed in such a way that it would track down the problem from the inception and the effect of the environmental and social change due to the unfit drainage system in the locality. The respondents were selected in different water logging prone area of the city with different professions.

Oral interview: road and drainage users were interviewed directly to obtain on the-spot-response from them. These users extend to the government bodies, as City administration officials, town water supply and sewerage authority, and regional road authority.

***Field Observation*:** This is the major data collection tool for this study. It was done in detail using base map, checklists, Satellite image and surveying instruments. The sizes of urban storm drains and roads have been measured and checked for their length, width, height and/or radius. It was also employed to identify the existing condition of urban storm water drainage infrastructure at the study area. Lots of photographs were also needed to illustrate the effect of drainage system, related obstacles into the smooth drainage of urban runoff and its effects on urban life. Some of these photographs have been collected directly from the field survey and some other from daily newspapers as well as from internet websites.

B. Secondary Sources

These include government reports, published and unpublished documents, manuals and books. Data collected from such types of sources are termed as secondary source of data.

Data Analysis and Presentation

All the data collected from different sources were analysed. Collected data has been analysed using some statistical computer software like, Microsoft Excel etc. Finally the analysed data have been integrated and presented as figures, tables, by photographs.

4. RESULTS AND DISCUSSION

4.1 Existing Drainage Facilities in the town

Open surface and buried/closed drains, which are inadequate achieve the storm water disposal to the town, and in most areas, there are no proper drainage arrangements. These run along the sides of the road and ultimately drain to natural drainage channels. There are about 68.9kms of various types of roads and around 38.3km different types of drains are available currently in the town.

Table 1: Road and surface water drainage integration at the study area

The integration of	*With rectangular*	*With trapezoidal*	*With circular*	*Total*	*% from total*
Asphalt Road	8,759.25	4,300	18,078	31,137.25	81.4
Cobble stone road	4,306.02	---	----	4,306.02	11.3
Earth road	2,656	----	-----	2,656	7.3
Total	***15,721.27***	***4,300***	***18,078***	***38,245.45***	***100***

Source: *Own data Analysis (August to November, 2016)*

Most of the houses have plastered drains by cement and they discharge sullage to the roads down below or allow it to soak in to the ground. The existing drains discharge their sullage and storm water into the nearest storm watercourse. These drains get stagnated during summer when the quantity of flow is less and then the drains get blocked due to poor maintenance. During storms, these blockages in the drains cause obstructions to the flow of storm water causing floods. Due to inadequate size and lack of proper design and maintenance, the existing drains in most of the places are not serving the purpose during flood season. This necessitates the design and construction of new storm water drains for town.

4.2 Impacts of Poor Maintenance on Road Performance

There is visibly very poor maintenance culture of the drains as majority of it are barely visible due to blockage by sediments, leaves, and other materials. Furthermore, the manholes on these existing drains are seen to be so poorly maintained and blocked by dirt and silt sand accumulation over time resulting in drain water to be retained on the pavement surface.

From the investigations conducted and as presented by photographs, reduction in service lifespan and it is evident in the deterioration of drainages and subsequent road pavement conditions which are visibly noticed in the form of edge failures of road pavements, formation of pot holes along the drive way of road pavements, and blockage of drainage channels such as culverts manholes and underground drainage networks. Also this poor maintenance culture results in open and closed drains blockage with dirt weed, silt sand accumulation over time and in the growth of vegetation inside and around the side drains which has resulted into total failure of the side drain and its structures.

To check these very poor conditions of drainages and road pavements, there is need to properly maintain them by empowering the local would be able to perform routine cleaning of dirt, weed and Silt sand accumulation over time that is visibly seen to have blocked these drainages (including underground drainage networks). The following pictures evidenced the existing condition of the drainage infrastructures due to poor drain maintenance at the study area.

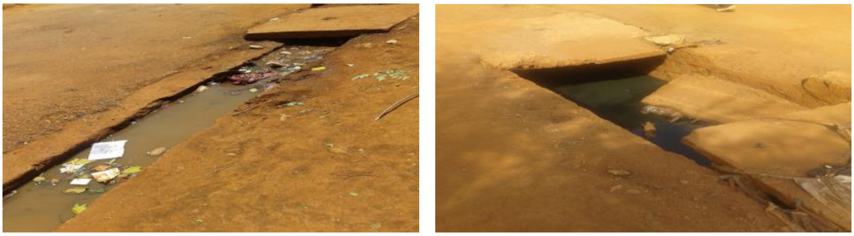

Figure 2: Poor Maintenance: resulted in pond of water inside the drains

Figure 3: Poor maintenance: - resulted in Potholes & Failed Manhole

Figure 4: Poor Maintenance: - resulted in Edge Failure & Sediment Accumulation

Figure 5: Poor Maintenance: resulted in eroded pavement & blockage

4.3 Environment Impacts of Poor Maintenance

4.3.1 Water Related Diseases

In urban areas of Ethiopia, the most adverse impact of water logging created by the blockage of drains is incidents and prevalence of various diseases. At the case study area, 81% of the respondent replied that stagnant storm water increases the diseases as it becomes polluted in different ways.

It is observed that in poorly drained areas, urban runoff mixes with sewage from overflowing latrines and sewers, causing pollution and a wide range of problems associated with waterborne diseases.

It is also observed that due to interruption of urban water supply, the urban poor people had to rely on shallow groundwater sources that are unprotected and polluted, as they don't have access to portable water during the period of monsoon. Malaria, respiratory problems, eye and skin disease are the worst impacts of drainage problem at the urban poor.

4.3.2 Breeding Site of Disease Transmitting Vectors

Poor drainage of rainwater leads to the creation of breeding sites for disease vectors. Solid waste blocks the drainage system and creates flooding in the streets resulting in increase mosquitoes, bad odour, and inconvenience. "Assosa town is suffering a lot from tremendous increase of mosquitoes and its associated diseases vectors, which is the ultimate result of water logging" opined by 88% of the interviewers.

4.3.3 Urban Area Pollutions: Indiscriminate dumping of solid waste culminates into negative effects on lives and the environment at large. Infiltration of polluted water into low pressure water-supply systems can contaminate drinking water, and is frequently a source of gastro-intestinal disease. In poorly drained areas, urban runoff mixes with sewage from overflowing latrines and sewers, causing pollution and a wide range of problems associated with waterborne diseases. In some areas, drains are capturing and holding polluted water for a long time; it creates bad smell, and polluted the surrounding areas as well.

5. CONCLUSION AND RECOMMENDATIONS

The main objective of this study was to evaluate and quantify the impacts of poor maintenance on the performance of drainage system. Drainage is an important feature in determining the ability of any road pavement to withstand the effects of environment and traffic. The study concludes that the impacts of poor maintenance are: blockage of drainage channels, urban flooding, and pavement distress like potholes, edge failure, and sediment accumulation. In other words, if properly maintained drainage systems are provided to road pavements, it will increase their life span, increase durability & strength, reduces pavement distress, and so on.

It is therefore recommended that institutional set up for effective operation and maintenance of drains should be strengthened, as the transportation of silt and sands to the drains is high during dry season, drains should be maintained before the rainy season at the study area, the concerned authority should ensure regular and careful maintenance of all the interconnected secondary and tertiary drains through proper monitoring program to secure its efficient operation, the inhabitants should be motivated for cooperation for maintenance of drainage system, there should be a high degree of close communication and co-ordination between the urban authorities and town residents for operating and maintaining the various components of the drainage network and sufficient funds in all annual budgets for carrying out routine maintenance program should be provided by the concerned bodies of the town.

REFERENCES

1. Cedegreen, H.R., Arman, J.A., and O'Brien, K.H. "Development of Guidelines for the Design of Subsurface drainage Systems for Highway Pavement Structural Sections." FHWA-RD-73-14, Federal Highway Administration, Washington, DC, (1973).
2. Dagnachew Adugna Belete. "Road and urban storm drainage network integration in Addis Ababa." Journal of Engineering and technology research. 3 (2011). 217-225.
3. GTZ-IS. "Urban drainage manual series on infrastructure," Addis Ababa, Ethiopia, (2006), 17-54.
4. Kokeb Zena Besha & Addisu Adamu Alemayehu "Assessment of Road and Surface Water Drainage Condition in Urban Ethiopia, with Special Reference of Assosa Town", EUROPEAN ACADEMIC RESEARCH - Vol. IV, Issue 2 / May 2016, Pp 1966 -1991.
5. Markow, M.J. "Simulating pavement performance under various moisture conditions." In Transportation Research Record 849, TRB, National Research Council, Washington, D.C., (1982), 24-29.
6. Mc Robert, J., Robinson, P., and Giummarra, G. "Environmental Best Practice for Outback Roads." Guidelines, (2000), SA RC 90165-4.
7. Rokade, S., Agarwal P.K. and Shrivastava R. "Study on drainage related performance of flexible highway pavements." International Journal of Advanced Engineering Technology, 3 (2012), 334-337.