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A Case Study of the Pollution Status of the Stream Flowing Within the Ethiopian Civil Service University Campus, Addis Ababa, Ethiopia

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Abstract

Urban rivers are more vulnerable due to the different urban processes which result in the degradation of the water ecosystem. Due to the constraints such as technology, implementation, financial viability etc. the adaptive measures are not so successful in developing nations such as Ethiopia. The Ethiopian Civil Service University, Addis Ababa, towards the environmental protection measures that are being taken up within the campus, was keen in studying the existing condition of the stream. In this particular case study type of research, an investigation study was carried out along the stream flowing within the university premises. It was aimed to assess the pollution status, to identify the potential sources and to suggest suitable remedial measures. The water samples collected at three locations on weekly basis were analyzed and field investigation was also conducted along the stream for a stretch of 1.5Kms. The experimental results indicated that the stream was highly polluted, due to the uncontrolled dumping and disposals activities that are taking place within the vicinity of the stream. For the restoration of the stream quality, the ECSU Administration had initiated measures to prevent the encroachments of the stream banks and to inhibit dumping of wastes into the streams. After the successful implementation and completion of the project, this will set a standing example and lays the foundation stone for many future projects pertaining to the restoration and rehabilitation of rivers in Ethiopia.

Key Words: **Pollution, Stream Fowling, Urban River**

1. Introduction

Rivers being an inseparable part of the ecosystem are mostly prone to the devastating effects of pollution due to their easy accessibility for waste disposals. The limited available fresh water sources are no longer pure and the situation is more severe in the urban areas. The urban water supplies across the world are facing challenges and ensuring proper usage of water is essential to

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minimize or avoid chance of water crisis. However, less attention has been given to the economical use and conservation of water sources, while a continuous monitoring of water quality is very essential to determine the state of pollution in rivers. The water quality indicates the composition of water samples and deals with the physical, chemical, and biological characteristics. In order to solve the water crises in urban areas and to prevent the degradation water quality of fresh water resources, there is a need to develop sustainable mechanisms and approaches (Mahesh 2012).

Urban rivers are the most vulnerable to different urban processes and activities that cause pollution and degradation of the water ecosystem. Restoring the health of rivers poses a huge challenge to governments and other actors in the public domain. The measures taken up by developed countries towards the rehabilitation and/or restoration of urban rivers, offers pathways to be followed by the other nations. The measures taken to clean up rivers are effective due to the adequate resources, strong public sector capacity and public institutions. Whereas the developing nations struggle to rehabilitate in the context of limited capacities, resources, absence of appropriate public institutions, legal framework and strong regulatory enforcement capacity (Frezgi 2017).

Ethiopia being one of the fastest developing countries in the African continent is facing severe deterioration of the urban rivers due to the rapid and tremendous urban transformations. Addis Ababa the capital city of Ethiopia has an estimated population of more than 3 Million or 25% of the total urban population with an annual growth rate of 8 %. According to the report of Central Statistics Authority (CSA), around 65% of the total industries in the country are found in Addis Ababa and more than 90% of them discharge their wastes without any form of treatment to nearby water bodies or open spaces. The common contaminants from these industries included solid wastes and wastewaters containing oils, detergents, solvents, and pesticides, other organic and inorganic contaminants. The wastes generated and disposed in the riverbanks pollute water and soil; thereby pose a major threat to public and animal health (CSA 2010).

The rapid urbanization, industrialization and population increase in the city of Addis Ababa, have brought the water supply and waste disposal challenges into existence. In addition, municipal waste collection systems are less efficient and the access to sanitation services is very low. The city is characterized by open dumping sites, drainage channels, rivers, valleys and streets; as a result it greatly contributes to the pollution of rivers since all wastes dumped in other places eventually end up to rivers during run offs. The present study area i.e, the stream flowing along the university campus had attracted the attention of the researchers and an effort was initiated to identify the existing condition of the stream and to propose adaptive remedial measures for preservation of the water sources such as rivers and streams. The main aim of this study was to lead restoration activities of the stream and the banks, so as to promote a culture of sustainable utilization and protection of water resources.

Study Area: Addis Ababa, the capital of Ethiopia and the African Union is located at 9^{0}48"N 38^{0}44'24"E and at an elevation of 2355m (7,726ft). It covers an area of 527 km2 .The climate is subtropical highland with complex mix of highland climate zones. Since the city is at the equator which means temperatures are very constant from month to month. The long-wet season is from June to mid-September and it is the major winter season of the country. Mid-November to January is a season for occasional rain. Average annual rainfall is 1165mm. The Ethiopian Civil Service University is located within the Yeka sub city, and the stream which is running in the campus is selected for the study. A field investigation was carried out along the stream starting from the Kotebe on the upstream to the Salte Mihiret church on the downstream. Water Samples

were collected at the three locations (Kotebe, ECSU Dormitory Complex and Salte Mihiret Church) and the water quality was analyzed by conducting experimentation.

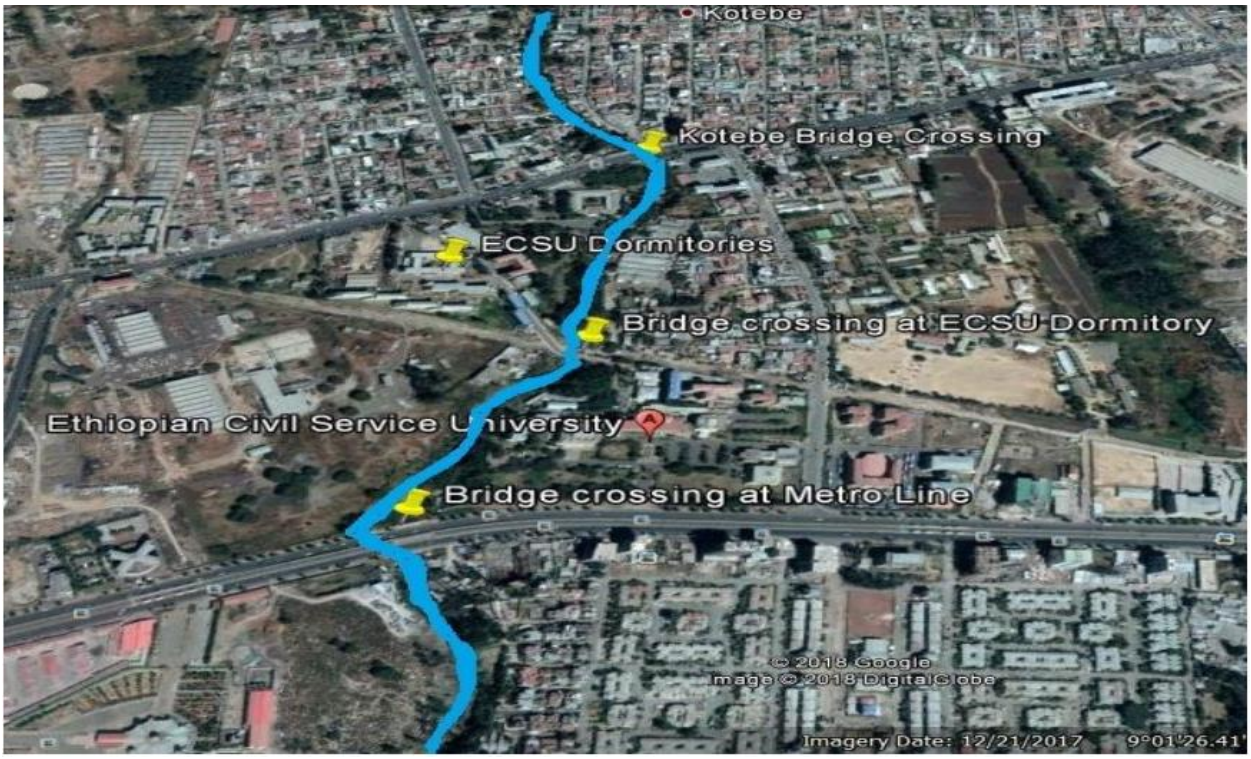

Fig 1: figure showing the stream stretching within the study area (source-Google maps)

Objectives of the Study: Promoting sustainable utilization and protection of water resources have been the main motto of this research. In this study, an attempt was made to investigate the condition of the stream running within the premises and to propose suitable remedial measures for restoring the health condition of the stream. The objectives of the study include; To examine the pollution status of the stream

- To inspect the existing conditions of the banks and to identify the sources of pollution
- To identify the remedial measures needed for improvising the condition.
- To set up an model for upcoming restoration and rehabilitation of river projects in Ethiopia

Scope and limitations of the Study: It is important that the restoration and rehabilitation activities of water bodies, needs a wide coverage of study all over the stretch of the streams and rivers and in this case it has to consider the whole catchment of the stream in Addis Ababa, Ethiopia. Due to the limitations of area, finance and time, the study is limited only to the stream stretching within the university premises only. In this attempt, only the physical pollution will be addressed and measures to be taken will be evaluated. The aim of this effort is to set up a pilot study project so as to set a standing example for the rehabilitation and restoration project of the various sustainable management measures of rivers that might occur in the future. This is to create awareness among the general public and educate them towards the protection of water resources.

2. Data Collection and Methodology

Currently extensive studies are being carried out in this field for tackling the scarcity of water, to identify the state of water sources and to identify suitable measures for mitigating the water challenges. Exploring sustainable management practices and advocating conservation of water resources have been the driving motive for the research. For this, water samples were collected at three sampling locations, on a weekly basis for three times and were analyzed as per the standard procedures of EPA. The water quality parameters such as pH, Temperature, Total Solids, Suspended solids, Settleable solids, BOD, COD, Total Nitrogen and Total Phosphorous were monitored. During the field investigations, a walk through survey was made along the stream for a 1.5Km stretch, to identify the existing bank conditions and the sources of pollution. Among the Qualitative and Quantitative research methods, viz., Interviews and Focus group discussions were also adopted.

The experimental results of the water quality analysis for the samples collected during the study period backed the primary data sources for estimating the pollution status of the river. During the physical field investigation, detailed investigation was carried out about the existing condition; every minute detail which is more specific to the research objectives was noted and photographed all along the stretch. During the social survey, interviews were held with the Students, Staff, Residents, Shepherds, Rag pickers and others. In total a 100Nos of respondents were approached for obtaining the social survey data, these included Students, Staff, Residents, Shepherds, Rag pickers and others. The information obtained from them was very useful and are critical for arriving at the awareness levels and attitudes of the respondents.

3. Results and Discussions

Experimental Study: During the study period, the water samples were collected during the day time (10.00AM to 4.00PM) in a 5 Ltrs sterilized plastic containers from the stream at a sufficient depth from the water surface at the designated sampling points. The collected samples were shifted immediately to the laboratory, where the samples were preserved and the experimental work was carried out. The sample collection and conducting experiments were done with the support of staff of EPA and in accordance with the standard procedures of the EPA. The results of the experimental study indicating the concentrations of few water quality parameters are presented in the Table below.

Table: 1 – Experimental results of the selected parameters.

Parameter	Units	Location -1			Location -2			Location -3		
		S-1	S-2	S-3	S-1	S-2	S-3	S-1	S-2	S-3
Total solids	mg/L	925	895	970	930	900	980	930	920	980
Suspended solids	mg/L	250	290	300	280	275	295	300	300	320
Settleable Solids	mg/L	18	20	19	18	19	18.5	19.5	20	20
BOD	mg/L	350	340	355	360	350	370	380	370	390
COD	mg/L	800	850	820	850	830	850	850	870	820
Total Nitrogen	mg/L	70	73	76	70	75	78	80	76	80
Total Phosphorus	mg/L	10	12	10	12	10	12	12	12	11

** S: Sampling Day, ** L: Location

Table: 2 – Comparison of the Parameter concentrations with permissible limits

Parameter	Units	Average concentrations at various locations			Municipal Domestic waste limits		
		L: 1	L: 2	L: 3	Weak	Medium	Strong
Total solids	mg/L	930.0	936.7	943.3	350	720	1200
Suspended solids	mg/L	280.0	283.3	306.7	100	220	350
Settleable Solids	mg/L	19.0	18.5	19.8	5	10	20
BOD	mg/L	348.3	360.0	380.0	110	220	400
COD	mg/L	823.3	843.3	846.7	250	500	1000
Total Nitrogen	mg/L	73.0	74.3	78.7	20	40	85
Total Phosphorus	mg/L	10.7	11.3	11.7	4	8	15

From the concentrations tabulated above, it was identified that the concentrations of all the parameters are above the standard permissible values and they indicated a strong graded wastewater standards of the domestic municipal waste water characteristics. This is because the domestic liquid and solid wastes within the vicinity of the stream find their way into the stream. The lean flow at times contributes to an increase in these levels and thereby contributing to odour nuisance and degraded color of the stream. However, during heavy rainfall, the huge quantum of runoff from the upstream washes away these polluted waters onto the downstream, thereby preventing too much increase in concentrations of pollutants. Finally, it might be concluded that, the stream is highly polluted with the domestic and municipal wastes coming out from the residences within the stream catchment.

Facts from Interviews and Focus Group Discussions

According to the information obtained from the interviews and focus group discussion held with the Students, Staff, Residents, Shepherds, Rag pickers and others, key points gathered and they are furnished below:

- Regular water quality monitoring of rivers is not being attended and there is a lack of sufficient reliable data with the Environmental Protection Agency, Ethiopia
- The Little Akaki is severely polluted and most of the respondents during the social survey were not aware of water quality standards or water quality indices.
- The main pushing factor for the pollution includes, improper industrial waste disposal without proper treatment, poor waste collection and management mechanisms, lack of social awareness and lack of skilled labor.
- Odour nuisance is quiet common, and the persons crossing the bridge across the stream are at risk for health related problems.

Field Investigation

Water quality of stream: The physical characteristics of the stream water such as color, odour, turbidity, solids etc. were practically witnessed. It was found that the water was dark coloured, filled with large amounts of foams and oils which were due to washing and vehicle servicing activities that are being done on the upstream. It was observed that liquid wastes are directly disposed into the stream, several floating matters such as dead animal carcasses, plastics, clothes etc. created an unhygienic and unaesthetic appearance. During non-rainy days the concentrations were higher and causing nuisance, but due to heavy runoff from the upstream on rainy days dilution are taking place.

Existing condition of banks and stream widths: Though large land widths were available, the width of the stream is not uniform and narrowed with heaps of debris deposited. The close proximity with the residential, commercial, educational establishment and due to absence for proper waste disposal mechanism, huge quantities of debris are dumped onto to the bank, leading to encroachment and narrowing of stream width. Due to the easy accessibility, the remains of animal slaughter and other wastes are mostly dumped are found along with huge amounts of plastics, cardboard, and other wastes. The liquid waste emerging from the vehicle service stations, urinals of workshops and residences along the stream bank, find their way directly into the stream.

Threat to the existence of wildlife: Due to the rapid urbanization and various developmental activities taking place in the Addis Ababa, there always exists a conflict between the wildlife and human. Tremendous construction activities convert the natural habitat into thick concrete jungle, whereby the animals have to vacate or adjust with the changes. These create a threat to the existence of species and may also wipe out them the earth. This portion is found to have a natural scenic beauty which may hosts wildlife, so the present study also considered in obtaining the facts of the wildlife. This stretch being the buffer zone between the major roads occupied with heavy vehicular traffic and human thorough fare, mostly the hyenas find their way along this stream to eat the carcasses of the slaughtered animals and food wastes disposed within the stream premises. Sheep and goat herders, mobilize their cattle through this stretch for safety reasons and for drinking purposes. It was found that the animals are drinking these polluted waters while grazing on the banks. This is a miserable scene to be seen, as it reveals the critical situation for the scarcity of water and it questions the health of the meat consumers. Among the endemic and endangered bird species of Ethiopia, birds such as Wattled Ibis (Bostrychia carunculata), Rouget's Rail (Ralbus rougetii), White-collared Pigeon (Columba albitorques), White tailed swallow (Hirundo megaensis), White winged cliff chat (Myrmecocichla semirufa), Abyssinian cat bird (Parophasma galinieri), Black-winged Lovebird (Agapornis taranta), Abyssinian Owl Asio abyssinicus, Abyssinian Woodpecker Dendropicos abyssinicus etc are found in the surrounding areas and the big trees in this stream stretch provides shelter to them.

4. Conclusions

From the above findings it might be concluded that the stream flowing within the premises of the Ethiopian Civil Service University is highly polluted due to the domestic municipal waste that are draining from the residential occupations, educational institutions, Workshops and others, which are in close proximity to the stream. The stream width is narrowed due to the encroachments and depositions of wastes onto the banks. The carcass thrown in this reach are fed

by scavenger animals and mostly the shepherds mobilize their cattle through this stretch, as such the animals drink these polluted waters and pose threat to the meat consumers. The big trees on the bank backed up with the compound walls of ECSU, National Meteorological Organizations etc. provide shelter to many birds. There is a need to take up measure to protect the stream and to prevent the available land widths from encroachments and misuse.

5. Recommendations

In this limited cross sectional case study; rigorous investigation, experimental and social survey studies were extensively attended. For ensuring proper rehabilitation and restoration activities for a river or stream, the whole system comprising of the catchment area and other functional elements must be well addressed. Any interventions for restoring the stream at selected reaches might not completely arrest the pollution or improve the water quality. However, in a developing nation such as Ethiopia, the sustainable measures and approaches must have an initiation with limited scope and in the near future these small attempts will address the various environmental friendly and sustainable approaches that would be taken in the upcoming years.

The Ethiopian civil service university is a premier educational organization in Ethiopia, committed for addressing the environmental protection measures and activities. As such the findings of this limited case study was brought to the notice of the to the ECSU administration. The higher authorities have made a positive approach and ensured to take suitable measures for preventing the degradation of the stream quality, prevent encroachments,stop waste disposal and other related issues. It was decided to consider the stretch within the campus limits and in this approach the control of physical pollution would be aimed, to prevent the debris from entering into the stream, Screens would be provided at the entrance of the stream into the campus premises. The intended total stretch will be cleared from the debris and wastes deposited on the banks, the widths of the stream will be restored and beautification activities will be addressed.

This will set an example by improving the conditions of stream surroundings, by creating awareness among the people and also contribute to enhancement of urban green space allowing the residents to appreciate and recognize the value of nature. Similar activities must be attended in large numbers for creating awareness among the people and for protecting the limited available fresh water sources and these will contribute for the sustainable utilization of resources and protect the rivers/streams.

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