Causes of Water Pollution in Chiro River Eastern Oromia, Ethiopia

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Abstract- The world's most valuable natural resource is water, and one of the most pressing global environmental issues is the contamination of water resources. The UN 2030 Agenda for Sustainable Development declares the importance of water by Sustainable Development Goal 6 (SDG 6) establishes a commitment to 'Ensure availability and sustainable management of water and sanitation for all'. SDG 6 target 6.3 state that 'improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, having the proportion of untreated wastewater, and substantially increasing recycling and safe reuse globally'. Water pollution is any chemical, biological, or physical change in water quality that has harmful effects on living organisms or that makes water unsuitable for desired uses. The main Source of pollution is domestic wastewater and solid waste. In Ethiopia, like many developing countries, the management of river water quality is a major environmental challenge. This study focuses on the main causes of Chiro River water pollution.

The study employed both primary and secondary data, including primary data from field survey questionnaires, interviews, and field observations, as well as secondary data from published publications, published and unpublished Government and Non-Governmental Organization reports. To establish the specificity relevance of spatial differences to accomplish the goal of this study, descriptive statistics (frequency, mean, standard deviation, and proportion) were run on the data acquired from both primary and secondary sources using SPSS software and MS-Office excel.

According to this study, municipal liquid waste and municipal solid waste, which release a lot of nutrients into the river, were the main causes of water pollution in the chiro river. Another source of pollution was rapid urbanization and lack of infrastructure for both solid and liquid waste disposal that had caused the deterioration of water quality of chiro river. According to the study's findings, the river was polluted, unsuited for domestic use, and seriously harmful to the health of individuals who live nearby. The study suggests that sustainable management of wastewater and solid waste is essential for the prevention, control, and reduction of pollution in the studied area.

Index Terms- Cause of pollution, Chiro River, Ethiopia

I. Introduction

The world's most valuable natural resource is water, and one of the most pressing global environmental issues is the contamination of water resources. The UN 2030 Agenda for Sustainable Development declares the importance of water by SDG 6 establishes a commitment to 'Ensure availability and sustainable management of water and sanitation for all'. SDG 6 has a targets which are directly linked to water pollution: Target 6.1: 'achieve access to save and affordable drinking water'; Target 6.2: 'achieve access to adequate and equitable sanitation and hygiene for all, and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations'; Target 6.3: 'improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, having the proportion of untreated wastewater, and substantially increasing recycling and safe reuse globally'. Goal 6 goes beyond drinking water, sanitation and hygiene to also address the quality and sustainability of water resources. Agenda 2030 recognizes the centrality of water resources for sustainable development and the vital role that improved drinking water, sanitation and hygiene play in progress in other areas, including health, education and poverty reduction (UNEP, 2016). Sustainable sanitation and wastewater management is influential within many of the SDGs (Water, 2021a).

Source: Adapted from UN-Water (Water, 2021b)
Figure 1. 1 Sustainable Development Goal (SDG 6)

Water is one of the main necessities to live on planet earth (Gbadegesin and Akintola, 2020; Goncharuk, 2013; Ukpaka and Ukpaka, 2016). Water quality is intrinsically connected to human health, food production, gender equality, reduction of poverty, ecosystem livelihoods, economic development, and social growth in our communities (Jha et al., 2020). It is not necessary to exaggerate the value of water for life support (Biggs et al., 2015; Xie et al., 2021). Furthermore, an increase in urbanization, construction, agricultural activities, industrial applications, and natural processes has adversely impacted the quality of surface water and groundwater, and its effects on human health throughout the world (Akhtar et al., 2020). Since entering the Anthropocene, the impact of human activities on the global ecological environment has become increasingly prominent (Clemente, 2020; Li et al., 2022). In Southeast Asia, poorly managed aquacultural and agricultural activities are one of the most prominent sources of water pollution (Schneider and Asch, 2020; Thu Minh et al., 2020; Thu Minh et al., 2022). Pollution of river water is one of the biggest environmental problems, particularly in developing and underdeveloped countries. Through their self-purification processes, rivers are efficient means of supplying source of water for drinking and for domestic, agricultural, commercial, industrial and recreation uses, both in terms of quality and quantity (Zając et al., 2021). Therefore, effective and accurate assessing of river water quality (and quantity) is a necessary for the comprehensive management of different types of landscape: urban, agricultural, and forested, including the high-mountain regions (Zając et al., 2021).

Water pollution is any chemical, biological, or physical change in water quality that has harmful effects on living organisms or that makes water unsuitable for desired uses. The main Source of pollution is domestic wastewater, industrial wastewater, agricultural runoff, and solid waste. Changes in physical outline of rivers and lakes, addition of anthropologic pollutants and introduction of invasive species create a poor water quality and has a huge impact on the life quality of those using the water(UN, 2018). Disposal of untreated solid waste, stormwater and agricultural runoff, along with municipal and industrial wastewater, into the river is the main cause of physical, chemical (nutrients, metals, organic matters, nanomaterials, etc.) and microbial contamination of river water (Anawar et al., 2000; Darwich et al., 2018; Md Anawar and Chowdhury, 2020). Sources of these wastes include industrial production, sewage, domestic waste, municipal waste, shopping markets, restaurants, agricultural waste, etc. (Anawar and Strezov, 2019; Md Anawar and Chowdhury, 2020). Stormwater runoff is another major contamination transport route, which brings treated and untreated sewage, industrial waste, petroleum hydro-chemicals and road dust into the river water (Jamwal, 2018; Md Anawar and Chowdhury, 2020).

Water pollution resulting from human activities has become a matter of global concern in almost all rivers in Africa, Asia, and Latin America since the 1990s (Chen et al., 2022; UNEP, 2016). River water bodies are widely used as disposal sites of solid and liquid waste in the world (Alie, 2019; Cheng et al., 2018; Xiao et al., 2022). Discharges of pollutants to the fresh water ecosystem results in a consequent reduction of aquatic life (Shapoori et al., 2022; Shi et al., 2017). Ambient water pollution has human health impacts in these settings (Do et al., 2018; Greenstone et al., 2021). Poor water quality may also reduce agricultural output, educational outcomes, and labor productivity (Greenstone et al., 2021; Hagerty, 2018; Meeks, 2017). Damages to recreational opportunities and other ecosystem services in polluted surface water in developing countries have also been monetized (Mishra, 2017; Olmstead and Zheng, 2019). Water quality management depends on the strict policy controls for discharge of solid waste, wastewater, stormwater and standards of treated or untreated wastewater, which requires cost and time for successful execution (Md Anawar and Chowdhury, 2020). Nutrient loadings affect water quality throughout the world and have resulted in the eutrophication of many fresh water lakes (Assegide et al., 2022). The release of nutrients from agricultural land to the surface water resources promotes eutrophication which ultimately depletes the dissolved oxygen concentration (Angello et al., 2021; Mekonnen et al., 2020; Waseem et al., 2018). The dissolved oxygen reveals the changes due to aerobic and anaerobic phenomena in the biological parameters and demonstrates the state of water for the purposes of both aquatic and human life (Papajová et al., 2022; Payment et al., 2003).

There are several previous studies on river water quality in Ethiopia Addis Ababa focused on ecological status of major river systems by evaluating physio-chemical parameters and bioindicators (Awoke et al., 2016; Chen et al., 2022). Wastewater from households and human excreta and feces wash-outs from open fields contribute a large quantity of waste load to the Little Akaki River (Abebe and Tucho, 2020; Angello et al., 2021). The physio-chemical parameters showed a deterioration of water quality in surface water in the rivers compared to non-impacted sites, and the study concluded that the river water pollution in Ethiopia is increasing. The Ethiopian Public Health Institute similarly pointed out, as a result of their study of microbiological, bacteriological and chemical parameters, that the river quality in Addis Ababa is being highly affected by anthropogenic pollution (Mengesha et al., 2021; Mengesha et al., 2017). The conclusion of all studies is that the levels are higher than what is recommended by the WHO, and the water is not safe to use as an irrigation source (Mengesha et al., 2021; Mengesha et al., 2017)

In Ethiopia, like many developing countries, the management of river water quality is a major environmental challenge. There is a lack of sufficient funding and expertise to implement and maintain water quality monitoring programs on rivers and streams. Monitoring different sources of pollutant load contribution to the river is quite a difficult, laborious and expensive process. Many people live in the river catchment, and use the river water for irrigation and domestic purposes, but the quality of this water is not routinely monitored. knowing vital role of the river many scholars and different organizations have an interest to know about the quality of the river water.

Chiro River is originated from Chiro Kela, and Jello Mountain and flow through the Chiro city and it is the major source of irrigation for upstream and downstream societies and also used for drinking, cooking, and washing as the main source of water for the downstream societies. According to chiro town environmental protection authority reports of 2022, the river is highly polluted due to existing poor sanitation, luck of landfill for solid waste disposal, and luck of infrastructure for liquid waste disposal of the city. Urban farmers in Chiro Town have been growing chat and vegetables for the last 70 years, using the Chiro River as the main source of irrigation water. Today around 65% of the towns chat and vegetables are irrigated by polluted chiro river water.

There was no research conducted on water pollution of the Chiro River in Eastern Ethiopia. Therefore, this study was conducted to cover the research gap of the river water pollution in the study area. To establish sustainable conditions in the surface water and reduce human health risks, addressing the pollution problem and start mitigation processes is highly needed. Environmental studies as well as establishment of management systems were necessary. Research objective was to analyze the main cause of water pollutions of the Chiro Rivers. Research question was What was the main cause of water pollutions of Chiro Rivers?

II. Research Methodology

Description of the Study Area

Chiro Town is one of the 20 districts of west Hararghe Zone of Oromia Regional State, Eastern Ethiopia. Since its founding in 1923, Chiro Town has served as both the administrative center and the capital of the West Hararghe Zone. It is one of the largest metropolitan areas in eastern Ethiopia, located 326 kilometers from Addis Ababa, the country's capital. Its total area is 3,682 hectares. Its subtropical (mid-land) climate, which is healthy and appealing, makes it a good place to live. The current location of Chiro was previously heavily forested and used for farming before being established as an urban center. Astronomically, the settlement is situated between latitudes of 9º0’0” and 9º7’30” N and longitudes of “$40^0$49’30’’ and $40^0$55’30’’E. The town's elevation ranged from 1,548 meters above sea level in the northern parts to 2,352 meters above sea level in the southern part. As a result, the town was situated at a typical elevation of 1,950 meters above sea level.

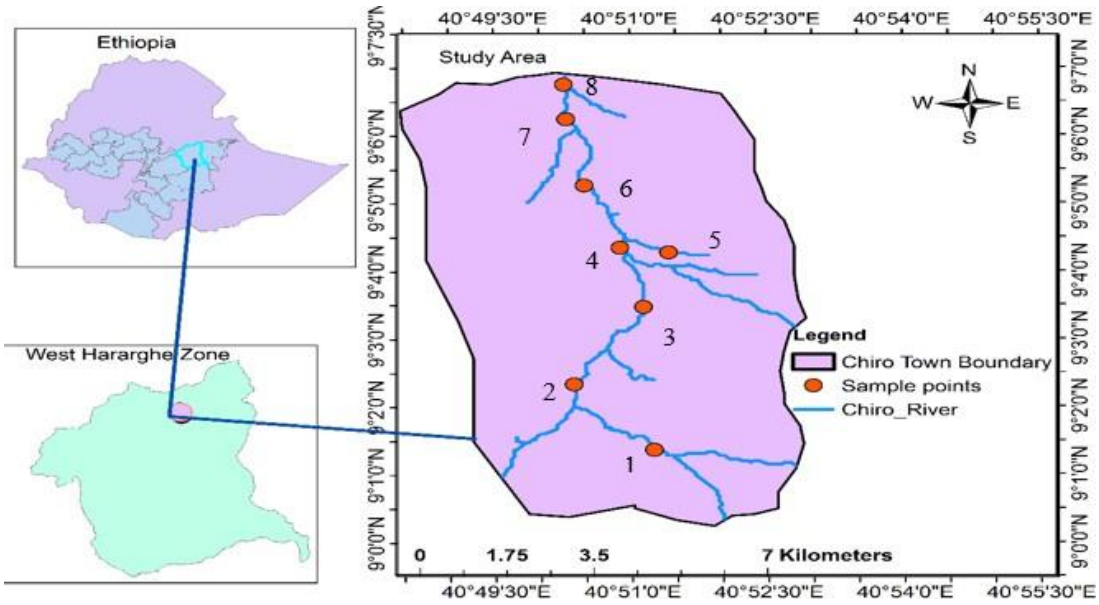
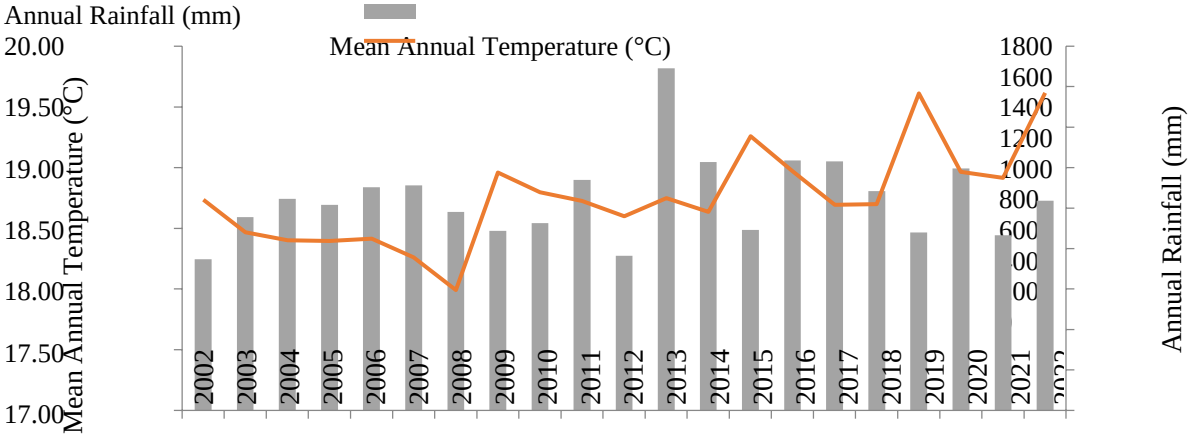


Figure 3. 1 Location map of the study area

The distribution of rainfall is bimodal, with the long rainy season lasting from June to September and the short-wet season lasting from March to May. The last 20 years of annual rainfall and mean annual temperature was shown below in (Figure 3.2).



Source: Computation based on grid meteorological raw data from NMA (2022) Figure 3. 2 Mean annual temperature and annual rainfall of the town from 2002 to 2022

There are currently 131,680 people living in Chiro Town (Source: Chiro Municipality data from 2022). The town of Chiro is surrounded by two parallel mountain chains on its western and eastern sides. Geography of the town and its surroundings is typically described as having rough, steep, and related undulating dissected parts, as well as river gorges. The main river that drains the town from southeast to northwest is the Chiro River and the town's cores were being crossed by it. WHZFEDO (2017) reports that during the period before urbanization, this river occasionally overflowed. However, due to the high levels of contamination and pollution caused by various elements in the river, ground water is the primary source of water supply.

III. Methods

The researcher used a mixed-methods research design in order to achieve the study's objective. Information was gathered from both primary and secondary sources for both qualitative and quantitative study. The primarily information were gathered from household survey and key informant interviews by using questionnaires as well as from field observation during data collection. Secondary data for review of literatures were gathered from a scientific research, UN Water, WHO, UNEP, published and unpublished documents related to sustainable water, sanitation, and hygiene. Secondary information pertinent to the study was gathered from a variety of sources, including the Chiro town

and zonal Environmental Protection authority Office, the water resource and liquid waste Office, the Chiro town Municipal Office and administration/Mayor/Office, published and unpublished documents, and other sources thought to contain pertinent data for this particular study. The secondary data gathered from various sources was used to identify gaps in current practice, as well as to improve understanding of the issues with water, sanitation, and hygiene in managing and treating human waste and other liquid wastes. The material accessed covers a wide range of socioeconomic and environmental challenges related to sustainable water, sanitation, and hygiene.
With the use of SPSS software and MS Office Excel, descriptive statistics (frequency, mean, standard deviation, and proportion) were run on the data gathered from both primary and secondary sources to determine the specificity relevance of spatial differences to achieve the objective of this study. Figure and tabular forms were used to present the data that was examined using descriptive statistics.

IV. Results and Discussion

Causes of Water Pollution of Chiro River

Municipal Liquid Waste Disposal

Liquid waste was defined as waste produced by washing clothing, dishes, and floors as well as leftover coffee, and is claimed to be stored before discharge in readily available material. This classification was supported by key informant interviews. The key informant interview revealed that there was no wastewater treatment plant, sewage connections, or any other facilities for disposing of liquid waste in the community. The survey's findings indicate that 41% of liquid waste is dumped in an open field, 35% is dumped in an open ditch, 20% is dumped straight into a river, and only 4% is dumped in a septic tank (Figure 4.10). Sewage, surface runoff, human waste, and other residential wastewaters make up the municipal liquid waste. The cleaning of clothes and dishes as well as human waste are examples of domestic pollution sources.

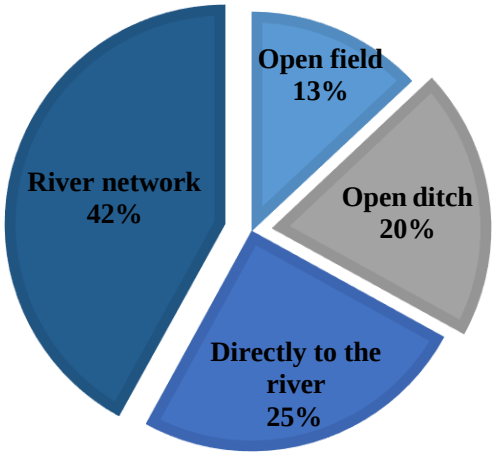


Figure 3. 1 Disposal of municipal liquid waste

Municipal Solid Waste Disposal

The common disposal places used by the respondents were road side (16%), open ditch (10%), river network (40%), and directly to the river bank (34%). All of the disposal locations were illegal. These indicate that the community lacked a hygienic landfill and effective solid waste management. According to chiro town environmental protection authority reports of 2022, one of the biggest contributors to water contamination in Chiro town is improper solid waste management. The community lacks facilities for properly disposing of solid garbage. The Chiro River primarily flows through the town's central residential and business districts. Because of this, practically every home dumped their solid wastes into the river, which contaminates the river's water.

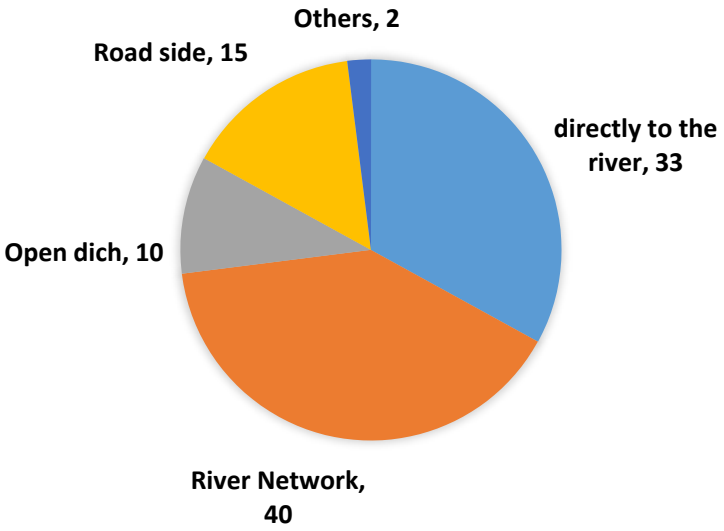


Figure 4. 1 Municipal solid waste disposal

Municipal Solid Waste Generation Rate
Waste generation is measured as the total volume of waste produced by various sources at a certain time and location. The generation rate of municipal solid trash in Chiro Town is 0.42 kg per capita per day (Chiro Town reports of 2022). Each source produced a different amount of garbage. Households make up 72% of Chiro Town's total generation of municipal solid garbage, followed by businesses (12%), hotels (4%), hospitals (1%), street sweepings (10%), and other sources (1%). This demonstrates that households generate the majority of municipal solid garbage.

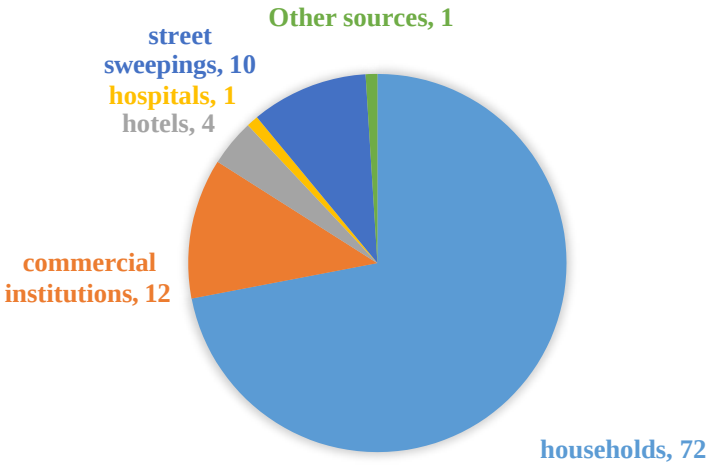


Figure 4. 2 Municipal Solid waste generation rate

Households Sanitation Access
According to the survey's findings, 63% of households had access to traditional pit latrines, 20% to flush latrines, 6% to ventilated improved pits (VIP), and 11 to open defecation or no latrine facilities (Figure 4.13). During the field observation, open defecation was observed in large areas of the river network and bank. The community did not have any built public
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bathrooms.

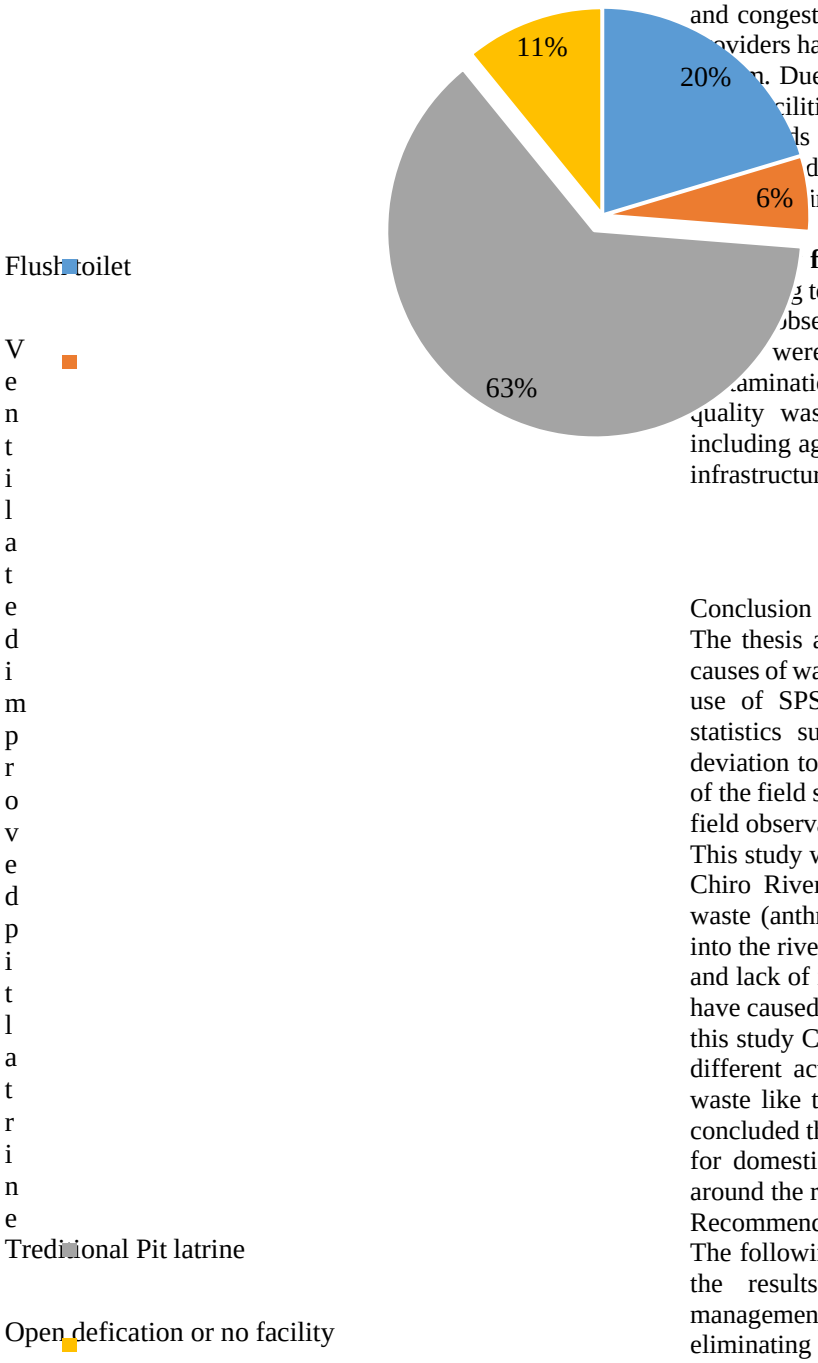

Figure 4. 3 Household sanitation system distribution

As a result, sanitation calls for both uniform access to toilets and the proper management of all excreta along the whole sanitation supply chain. Only 19% of respondents indicated they had ever filled a pit or tank, while 81% of families said they had never filled a toilet. That means they were releasing their toilet into the river and river network. Open sludge dumping and direct discharge to drainage systems are supposedly frequent in the town. The majority of the town's on-site sanitary facilities, it appears from the main informants' interview, are not waterproof and never get finished. As facilities fill up, some overflow, while others are covered, and a new pit is dug nearby. Access for vacuum tankers to on-site facilities may also be hampered by bad road conditions and congested lines. While they are there, households or service oviders have a tendency to release the FS into the local drainage m. Due to the severe lack of pit emptying services, 50% of cilities had a direct connection to a river. The majority of ds connect the outflow of their pit latrines to the nearby d storm drainage facilities for amenities, further ing the water.

for the main cause of Chiro River water Pollution:

g to a field survey, key informant interviews, and on-the-bservations, municipal liquid waste and municipal solid were the main contributors to Chiro River water amination. The decline of the chiro River's surface water quality was also brought on by other sources of pollution, including agricultural runoff, growing urbanization, and a lack of infrastructure for the disposal of both solid and liquid waste.

V. Conclusion and Recommendation

Conclusion

The thesis aimed to perform a brief description about the main causes of water pollution of Chiro River eastern Ethiopia. With the use of SPSS and MS-Excel, the researcher used descriptive statistics such as frequency, percentage, mean, and standard deviation to examine the study's findings. The study revealed all of the field survey findings, key informant interview findings, and field observation findings that were carried out in this study.

This study was showed that the main causes of water pollution of Chiro River were municipal liquid waste and municipal solid waste (anthropogenic origin) which a large number of nutrients into the river. Another source of pollution was rapid urbanization, and lack of infrastructure for both solid and liquid waste disposal have caused the deterioration of water quality of chiro river. From this study Chiro River can be described as highly polluted due to different activities like domestic wastes solid waste and liquid waste like toilets directly discharge from homes. It is therefore concluded that Chiro River in the study area is polluted and not fit for domestic use and has high effect on health of people live around the river.

Recommendation

The following recommendations were made from the analysis of the results and discussions to improve the sustainable managements of this river's water quality by reducing pollution, eliminating dumping and minimizing release of wastewater.

i. The sustainable environmental protection policy, rules and regulation must be implemented by the government,
ii. The government should construct landfill for the managements of solid waste disposal,
iii. The government should construct wastewater treatment plant for controlling the release of wastewater into the river and river network,

iv. Construction of public latrines to end open defecation to reduce the pollution load from the river,

v. Awareness creation among citizens, increasing the knowledge about health risks they are exposed to and how they contribute to pollution.

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