Civil and Environmental Research
ISSN 2224-5790 (Paper) ISSN 2225-0514 (Online)
Vol.10, No.9, 2018

Overview of Existing Wastewater Management System in Case of Debre Markos Town, Ethiopia

Temesgen Mekuriaw Manderso
department of Civil engineering, Near East University, Cyprus Mersin 10 Turkey ,
lecturer in debre tabor university, debre tabor, ethiopa

Abstract
The study is conducted in Debre Markos Town which is the capital of East Gojjam Administrative Zone. The study aims at assessing the waste management system practice, challenges and impacts on environment. The existing household wastewater management in the Town is very poor and creates adverse impact on environment like health problem, river and air pollution. These are due to lack of ownership in the town, shortage of vacuum trucks to empty toilet, absence of well planned central sewer system, improper use of drainage systems for household wastewater, low income and lack of awareness of the community to manage household wastewater are the common problems in the Town. As the result, the community discharges household wastewater in to open space, river and streams. The existing household wastewater (liquid and/or solid) management services was inadequate, health problem, environmental pollution and social impacts of improper management are due to insufficient infrastructure, lack of coordination between institutions, inadequate participation of stakeholders and lack of community awareness are challenges to manage household wastewater in the Town. Generally, increase inaccessibility of household wastewater management facilities, creating awareness to community, coordination and integration among institutions, participation of stakeholders and provide sewerage system are the recommendations forwarded in order to promote proper household wastewater management system in the Town.
Keywords: challenges, sustainable sanitation system, household, stakeholder, wastewater

1. INTRODUCTION

The history of modern water and wastewater handling started with the health challenges in large cities and towns. To provide safe water supply when the local sources ran dry or became polluted, water was piped from reservoirs outside the city. To transport wastewater out of the city, large collection and drainage systems were constructed. About 150 years ago, the flush toilet was introduced and human excreta were flushed out through the sewers into receiving water bodies. The discharge of untreated wastewater resulted in a local and often regional deterioration of water quality. However, it took almost a century before wastewater treatment became standard practice in rich countries and still 90% of the world's wastewater is discharged untreated (Corcoran et al. 2010). Water and waste water management are still laking in many countries. Whereas in most industrialized countries safe water is supplied to the population and wastewater polution control has progerassed substantially, in low and middle income countries the situation is different, withlower coverage of both water suppply system and sanitation serrvices. Still, water supply coverage is usually higher than the sanitation coverage. In developing countries,for example 85% of the population has access to safe drinking water , whereas only 32% has access to sanitation services (UNEP/GPA, 2000). Recent reports indicate that worldwide more than half of the population of less developed countries does not have access to sanitation and more than 80% of the waste water generated is directly discharged into surface and ground water bodies.

In Ethiopia, the sanitation facility coverage gap remains unacceptably large and collection and emptying mechanisms are one of the challenges. The habit of open field disposal of liquid waste is one of the main causes of soil and water contamination and consequently a cause of many communicable diseases.

The management of liquid waste at household level is very poor. About half of the households handle grey water (household liquid waste) by openly discharging into any accessible public properties, such as streets, drainage lines and nearby open space. Sewer line application is not that much familiar in the country except Addis Ababa.

The 2014 Ethiopia Mini Demographic and Health Survey (EMDHS) and (CSA) in Ethiopia in 2014 showed that only 4.5% Percentage of the population with access to flush toilet, ventilated improved pit latrine, traditional pit latrine with a slab, or composting toilet and does not share this facility with other households.

Debre Markos Town is one of the Administrative Zone of Amhara Regional state, which has the degradation of urban environment becomes one of the major problems that we are facing today. Because, most of the households are directly discharging their wastewater into the environment through drainage line, from overflowing and seeping pit latrines, septic tanks, public toilets, open ground excreta defection and grey water from kitchens and bathrooms flow through drainage lines that connect to river and open spaces near to them without any treatment . Therefore, the discharging of untreated household wastewater on the environment such as air, rivers, streams and open space are adverse environmental impacts on the human health by unpleasant odor and diseases like typhoid and diarrhea. Due to this, proper waste water management is fundamental for

maintaining public health and protecting the quality of the environment.

1.1. Statements of the problem

Wastewater results from human and animal activities that are unwanted or hazardous. Human pollute their environment with industrial and domestic wastes. In this case, when people do their daily activity, they bring negative effects on the environmental, environmental pollution increase as the density of people increase. Unsanitary environment are favorable for the outbreak and spread of different type of communicable diseases. Most of the disease causing agents that contaminate water and food come from human and animal wastes. Without proper management they result in communicable diseases and around the city create bad odor and breading sites for different insects. Many diarrhea diseases such as cholera, typhoid and hepatitis caused by poor sanitation conditions are serious threats (damage) to life, particularly childhood diarrhea, which is a leading cause of morbidity and mortality in children under five years. The high prevalence of intestinal parasites among the population, especially worm burden in children is the direct results of fecal contamination of food and water.

1.2. Objective

The overall objective of the assessment was to review and analyze the intention of the town on sanitation and waste management; assess availability and enforcement of regulations, institutional capacities, and describe the current sanitation and waste management knowledge, perspectives, and practices among the communities. The specific objectives were:

i. Assess the sanitation and waste management services profile of the town and identify key challenges, needs, and good practices for proper waste management and sanitation.
ii. To suggest suitable remedial measures for strategic planning of wastewater management,
iii. To suggest appropriate and effective measure of liquid waste and solid waste disposal in the vicinity.
iv. To recommend appropriate waste handling and disposal measures/routings in accordance with the current legislative and administrative requirements;
v. Describe the current sanitation and waste management knowledge, perspectives, and practices of the communities, particularly regarding household latrines, solid and liquid waste management, and associated problems.
vi. Analyze the liquid waste generation rate at the household level.
vii. Assess existing practices and opportunities for private sector involvement in waste management and urban sanitation.

1.3. Research Design and Data sources

1.3.1. Research Design

Descriptive type of research helps in describing the existing condition of household wastewater management and its impact on the environment. It also enables to describe the situations like access to toilets, type of toilets, toilet ownerships and disposal system of wastewater, their impact on environment and challenges of household wastewater management in the study area.

Generally this study can be seen as a descriptive cross-sectional study with a central task of the analysis of the existing waste water and solid waste collection, treatment and disposal. The study used a mixed approach with a central premise of; the use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone. Hence, the mixed approach that is used in this research employs strategies of inquiry that involve collection of qualitative and quantitative data simultaneously to best understand the research problem under investigation. The study was guided by the principles of multiple sources and subsequent crosschecking of information as well as by applying various data collection instrument and analysis techniques- both quantitative and qualitative.

1.3.2. Data Sources

A combination of both quantitative and qualitative data from both primary and secondary sources was generated. The primary data was collected from Debre Markos water supply and sewerage service authority. In an effort to supplement the primary data and make this research work more valid and worthy, relevant secondary sources pertinent to the study were consulted. Accordingly, official statistics and reports available in WASH project implementing agencies' offices were the major sources of secondary data for this study. Moreover, different written documents both published and unpublished- books, CSA, government, non government documents, journals and research works in relation to the issue under consideration; government policy and strategy were reviewed to supplement the study as well as to review the overall sanitation situation in the study area .

2. LITERATURE REVIEW

2.1. General overview

Williams (1998) stated that waste is an unavoidable by-product of human activities. Economic development,

urbanization and improved living standards in cities are the major reasons behind have led increase in the quantity and complexity of generated wastes. Waste management has become one of a major concern in environmental issues (Mazzanti & Zoboli, 2008). This is particularly true to urban areas where population is rapidly growing and amount of waste generated is increasing like never before (Kathiravale & Mohd Yunus, 2008). Current earth's population is 7.46 billion and it is estimated that almost half of this population lives in urban areas. Waste generation increase proportionally to this population number and income, creating the needs of effective management (Mazzanti & Zoboli, 2008). Urbanization and industrialization leads to new lifestyles and behavior which also affects waste composition from mainly organic to synthetic material that last longer such as plastics and other packaging material (Idris et al., 2004).

The management of waste become complex and the facilities provided cannot face and deal with responsibilities with the increasing demand and needs. Therefore, best approach need to be implemented immediately while considering environmental, social and economic aspects (Aye & Widjaya, 2006). The drivers of sustainable waste management were clarified by Agamuthu et al. (2009), which include human, economic, institutional and environment aspect. The study suggests that each driving group should be considered in local context as managing solid waste for a particular society may differ from the others.

For example, waste managers in Africa need to tackle some issues including, lack of data, insignificant financial resources, vast different of amount and waste types between urban and rural area, lack of technical and human resources, low level of awareness and cultural aversion towards waste (Couth & Trois, 2010). On the other hand, problems faced among Asian countries differ with two distinct groups; developed and developing countries. While some of the countries are having specific national policy on waste management, some others experience problems such as increasing urban population, scarcity of land, services coverage area, inadequate resources and technology, and so on (Shekdar, 2009).

Integrated Sustainable Waste Management system was then introduced in 1995 to improve earlier system that neglect unique characteristics of a given society, economy and environment (van de Klundert, 1999). For example, European countries had applied various system assessment tools and engineering models to create sustainable communities, manage resources efficiently, tapping innovation potential of the economy, ensuring prosperity, environmental protection and social cohesion in their waste management system (Pires et al., 2011). Asian countries had also given attention in building the national legal frameworks, managing institutional, technology, operational and financial aspects, and creating public awareness and participation (Shekdar, 2009).

The waste management system should be dynamic and continuous based on new insights and experiences (van de Klundert, 1999). For example, continuous assessment of current policy and regulatory framework of Ethiopia indicated the lack of policies coordination, hazardous waste management, consistency, incentives and markets for recycled material, and cleaner production effort (Maru Abebaw, 2014). Thus, the improvement in policy is needed while it will also benefit the country.

A lot of literature has discussed current practices, challenges and future solutions on waste management such as those for India (Hazra & Goel, 2009), Portugal (Magrinho et al., 2006), Canada (Wagner & Arnold, 2008), Malaysia (Agamuthu et al., 2009) and Ethiopia (2014). These studies allow comparison to adopt the best practice wherever applicable.

Waste generation is the most important aspect to look at in order to have effective solid waste management system. The generation of waste varies considerably between countries based on the culture, public awareness and management (Hazra & Goel, 2009; Wagner & Arnold, 2008; Magrinho et al., 2006).

Generally, developed countries generate more waste than developing countries (Kathiravale & Mohd Yunus, 2008). Countries in Asian and African region produce waste in the range of 0.21-0.37 tons/ capita/ year, while European countries generate higher amount of waste with 0.38-0.64 tons/ capita/ year (Intergovernmental Panel on Climate Change [IPCC], 2006).

Developed countries are experiencing high waste generation while developing countries always have problems with the implementation of the management system (Hazra & Goel, 2009; Bai & Sutanto, 2002). This includes weak enforcement, lack of technology and ineffective policy implementation (Agamuthu et al., 2009). In detail, these countries experience low and irregular collection of waste, uncontrolled of air and water pollution in open dumping area, the breeding of flies and vermin, and the mismanagement of scavenging activities (Latifah et al., 2009).

Looking at the waste generation trend of developed country, it is believed that other transition and developing countries will experienced the same. Until recently, the generation of waste is increasing and it is believed to continue rising. This is an issue of concern for authorities all over the world. It is believed that the amount of waste will continue to pile up the landfill and someday the land will not be able to receive anymore waste.

Information on waste generation is important to determine the most suitable waste disposal options. Improper waste disposal may cause pollution. The main purpose in implementing best practice for liquid and solid waste management is to prevent pollution. Pollution is a threat to human and other living organism (Morra

et al., 2009; Liu & Morton, 1998). It may also damage the ecosystem and disrupt the natural cycle and climate on earth (Raga et al., 2001). There are many disposal options available to suit the nature of waste and a country's preference and interest.

Economics and environmental aspects of waste disposal option are always the main issue in choosing the right technology (Aye & Widjaya, 2006; Daskalopoulos et al., 1997).

2.2. Current Status Of Waste Water Management in Ethiopia

There are efforts exerted by various governmental and non-governmental organizations including the private sector towards improving the sanitation sub-sector. These include: Ministries of Health, MoWIE, Urban Development and Construction, Education, and Agriculture, as well as the Federal and Regional EPA Authorities/ Bureaus, Municipalities, NGOs, Academic Institutions, private sector sanitary suppliers and donors. Efforts are made in the areas such as policy and strategy formulation, planning, co-ordination, infrastructure provision, monitoring and evaluation. Urban wastewater management activity in the country in a planned manner is limited to Addis Ababa and few other cities (MoWIE- Ethiopia, 2015).

3. DESCRIPTION OF THE STUDY AREA

3.1. Introduction

Urban growth is a worldwide phenomenon. It is a process which takes place rapidly to occupy the adjacent land of an area and changes in land use pattern, demographic features and transforms the economic activities of the people. Over the years, Ethiopian cities have experienced massive expansion which generates a great concern for urban planners.

Debre Markos town was founded in 1852 by Dejazmach Tedla Gualu who was the then administrator of the town. Its name was initially called Menkorer. The name of the town was changed to Debre Markos when due to the establishment of Saint Markos church, King Teklehaimanot who came to power in 1879 proclaimed that the town shall be named Debre Markos instead of Menkorer. Until 1995, the town was the capital city of the province of Gojjam and currently served as the capital city of East Gojjam zone. Debre Markos is one of the reform towns in the region and has a town administration, municipality and 7 kebeles. The town has a structure plan which was prepared in 2009.

3.2. Location

Debre Markos, the capital of East Gojjam Administrative Zone is located in the North- west of the capital city of the Federal Democratic Republic of Ethiopia, Addis Ababa at a distance of 300 Km and 265 km to the capital of Amhara Nation Regional State Bahir Dar. Specifically it is located in the Amhara regional state, East Gojjam zone. The geographical location of the study area is located between 10°17′00″ to 10°21′30″ N Latitudes and 37°42′00″ to 37°45′30″ E longitudes and its elevation ranges in altitude from 2350-2500 meters above the sea level.

3.3. Topography

The main natural constraints for the physical expansion of the Debre Markos town are hills, swamps, rivers and forests; while the manmade constraints are illegal settlements and urban rural boundary conflicts.

3.4. Climate

The town has 1380 mm average annual rainfall and minimum and maximum temperatures of 15^0C and 22^0C respectively (Debre Markos Town Administration, 2011). The weather condition of Debre Markos town is Woynadega.

3.5. Demography Condition of the Town

According to Central Statistics Agency (2007), the population of the town was 62,497. Out of this 29,921 (47.87%) were males and 32,576 (52.1%) were females; 16,325 (26.14%) were within the age group of 0-15 years, 42,185 (67.49%) 16-60 years, and 3,987 (6.37%) 61 years and above. The population growth rate at low variant was 2.4%, while household size in the town is calculated to be 3.2. The majority of the urbanites worshiped Ethiopian Orthodox Tewahido church. 97% of the inhabitants are speakers of Amharic language. The remaining 3% of the inhabitants are speakers of Tigrigna, Agew and Afaan Oromo. According to Central Statistic Agency (2013), the population projection figure of the town had been estimated 38291 male and 41689 female inhabitants which is a total of 79980 populations. Area of the town is expected to be 1214.9 sq. Km and 65.82 km/square density.

3.6. Socio-Economic Activity of the Town

3.6.1. Basic Social Services

Education

There are 16 private kindergartens; 15 government and 8 private primary schools; 2 government senior secondary schools (9-10), 1 preparatory school; 1 TVET; 1 university; 3 government and 5 private colleges in Debre Markos town.

Health

Regarding health services in town there are one referral hospital, 7 health posts, 3 government health centers and 14 private clinics and 5 government clinics. There are 3 ambulances that give service for emergency cases.

Municipal services

Debre Markos has one public meeting hall, an abattoir; a general market meeting every day except Sundays, daily markets in 3 places and 2 cattle markets meeting twice a week on Fridays and Saturdays. There are two public toilets in the town, and liquid waste is collected by vacuum truck and disposed in the prepared site. There is a green recreation area covering 1115 ha, forest area covering 160 ha and street trees are also planted along 3Km of streets in the town. There are four parks, one public library and a town hall, two stadium and seven playgrounds, more than 15 semi standard hotels in the town. Regarding religious services there are eleven churches for Orthodox Christians, one church for Protestants and two mosques in the town.

3.6.2. Development Situation

Majority of the houses in this town are traditional made of plastered mud, wood and corrugated iron roof etc. Due to this, the administration is making effort to change the housing situation and house problem of the town. Road construction and other important institutional sectors and small industries will be under go.

3.7. Infrastructure, Housing and Service

3.7.1. Infrastructure

Regarding infrastructure the town has asphalt and gravel roads connecting it to different Wereda in the zone, surrounding zones, towns in the region and Addis Ababa. In the town there are 6 main roads, 118.9 km gravel, 16.97km asphalt, 6km cobble stone, and 21 km compacted earth roads. The town gets 24 hours electric supply from the national grid, and has wireless, mobile and fixed telephone lines, internet services, and a postal service with 1000 boxes.

3.7.2. Houses

There are 18479 houses in the town. The housing backlog in the town is estimated to be 7000 housing units. Houses were dominantly built of wood and mud walls, Corrugated Iron Sheet (CIS) roof, cement flooring, nylon and chip wood ceiling. Available construction materials in the town are wood, stone, sand, Hollow Concrete Block and mud.

3.8. Existing water supply and sanitation system

3.8.1. Existing Water Supply system

Debre Markos water supply scheme was constructed in 1979 funded by German development bank. The source of water supply for the town is groundwater. In 1979 seven boreholes in Sentera well field were drilled to the west and southwest about 12 km of from the town. Currently only five of them are giving service and current yield of these wells is 1342.80 m^3/day. In 2010 additional ten boreholes were drilled in the southwest of the town and out of these seven boreholes are giving service and current yield of these wells is about 1440 m^3/day.

The main water supply source of the town is ground water distributed through piped network and 64 public taps. There are four concrete reservoirs in the distribution system located at three places. The two circular concrete reservoirs are located in Abma Mariam church at an elevation of 2480 m.a.s.l in one place with a capacity of 500m^3 operated by a common valve chamber and each are erected side by side and water from the treatment plant is directly distrusted to the distribution network by booster pumps. The third palace reservoir locates in Bete-mengest (R_3) and its capacity is 200 m^3 concrete reservoir place at an elevation of 2472 meter. The fourth reservoir (R_4) located in Abma Teklehaimanot its capacity is 1500 m^3 concrete reservoir at an elevation of 2499 meter. Treated water from these reservoir flows to the distribution system by gravity flows.

The existing water supply network includes the Sentera D250/ D200 pipe transmission mains; DN50/150 distribution main and DN 15/32 service connection. An addition new water supply network in the Western D250//D500 transmission mains , DN50/450 distribution main and DN 15/32 service connection and the total of four concrete service reservoirs placed throughout the town. The total length of distribution pipelines installed by the town water supply system was 57.72 Kilometer up to date.

3.8.2. Existing sanitation system

The Debre-Markos water supply and sewerage service is a public institution in the town that is responsible for supplying of portable water and collection ,treatment and disposal of water and sludge for town, yet the disposal of sludge at present is being done by the municipality.

In light of the fact that, Debre Markos Town has shown speedy growth in every direction, the present installation of modern sewerage infrastructure i.e. sewerage line have been covering limited area of the town and only serving 8% of town`s residents from the total. As the result, the current sewerage disposal work has been mainly undertaken through sewerage cars (Debre Markos Town Water and Sewerage office, 2011).

Due to shortages of sewerage infrastructure management of household wastewater in Debre Markos, that has created environmental problems like water pollution, human health problem and air pollution. Wastes are most often discharged into the receiving water bodies with little or no regard to their assimilative capacities. One of the major problems facing urban areas today is the contamination of soil, groundwater, surface water and air with wastewater discharged from households. It also affect the quality of the environment through reduce aesthetic value of the town due to creating unpleasant odour by the stagnant of the wastewater on themselves drainage and the open spaces.

Debre Markos town, with high population number, it is very difficult for collection of pit latrines and septic tank sludge and services running at very slow capacity. Overflowing pit latrines and septic tanks are in many parts of the town, which is common and are aggravated via road inaccessibility, insufficient management of household wastewater, increase population and lack of community awareness, most of the existing households has low incomes and live in slum areas and most of the toilets are left unattended for many years. Due to this, it is difficult to provide proper household wastewater disposal infrastructures such as toilets and sewerages.

The household wastewater is discharged into the environment through drainage canal, from overflowing and seeping pit latrines and septic tanks. In addition to these, open ground excreta defection and grey water from kitchens and washing cloth flow through drainage canals that connected to river and streams in the town. Those rivers are will used as sources of washing cloths and bathing for the communities who are lived near and around to the river.

Generally pollution sources that pose threats to water are open field defecations, animal wastes, plant residues, economic activities (agricultural and other businesses) and even wastes from residential areas as well as transportation systems. Natural and artificial/manmade factors are responsible for the pollution of Chemoga, Weteren and Wuseta river water. Human waste is often disposed of in the river water in which people use water for convenience.

3.8.3. Solid Waste Management System of the Town

According to the investigation improper management of solid waste is one of the main causes of water pollution in Debre Markos town, particularly Weteren and Wuseta River. The town lacks solid waste regulations and proper disposal facilities, including for harmful waste. Such waste may be infectious, toxic or radioactive and they are released into the river.

Household solid waste generation varied by components. The majority of households had floor sweepings. Leftover food, paper, and ash were also common types of waste. Frequent collection of household waste is practice in a poor and unwise manner. The various forms of solid waste collection from households were door-to-door; block collection; and container service. Generally, some of the households used municipal containers but the municipal container in the community is not timely served for a week or months. This created health problems in the community. Because of the demand for containers, urban mothers complained, there are inadequate supplies properly located containers and services are delayed.

Micro-enterprises provided solid waste collection for 71% of households. Eighty-eight % of the households stored solid waste in a sack (“madaberia”) until collection or a household member disposed the waste in a municipal container. Females in 87% of households are responsible for solid waste.

However, most of the households in slum areas might not get service because they cannot pay for it. In addition, households not served by microenterprises dump solid waste in open fields and public places, and in rainy season floods the waste resurfaces.

Municipal containers were the destination of micro-enterprise primary collection services, which used manually operated and donkey-driven carts. Municipal containers are lifted by refuse trucks for transport to final disposal sites. The efficiency of public container service, however, was found to be very low. Lift trucks are specifically designed to serve the containers. However, dump trucks served the collection of solid waste, even though dump trucks are non-specific to solid waste collection and are meant to be used when there are space shortages in standard refuse trucks. Generally existing solid waste disposal sites do not satisfy sanitary landfill requirements.

4. QUANTITY ESTIMATION OF SEWAGE

4.1. INTRODUCTION

The sewage collected from the municipal area consists of wastewater generated from the residences, commercial centers, recreational activities, institutions and industrial wastewaters discharge in to sewer network from the permissible (allowable) industries located within the city limits. Before designing the sewer and wastewater treatment plant, it is necessary to know the discharge i.e., quantity of sewage, which will flow in it after

completion of the project.

Accurate estimation of sewage discharge is necessary for hydraulic design of the sewers. Far lower estimation than reality will soon lead to inadequate sewer size after commissioning of the scheme or the sewers may not remain adequate for the entire design period. Similarly, very high discharge estimated will lead to larger sewer size affecting economy of the sewerage scheme, and the lower discharge actually flowing in the sewer may not meet the criteria of the self-cleansing velocity and hence leading to deposition in the sewers.

The concept of domestic flow encompasses the sewage originating from homes, as well as commercial activities and institutions that are normally components of the locality. More expressive values originating from significant point sources must be computed separately and added to the global values.

Normally domestic sewage flow is calculated based on the water consumption in the perspective locality. The water consumption is usually calculated as a function of the design population and of a value attributed for the average daily per capita water consumption.

It is important to observe that for the design and operation of the sewage treatment works it is not sufficient to consider only the average flow it is also necessary to quantify the minimum and maximum flow rates, because of hydraulic and process reasons.

4.2. Discharge of Sanitary Sewage

The total quantity of sewage generated per day is estimated as product of forecasted population at the end of design period considering per capita sewage generation and appropriate peak factor. The per capita sewage generation can be considered as 75 to 80% of the per capita water supplied per day. The increase in population also result in increase in per capita water demand and hence, per capita production of sewage. This increase in water demand occurs due to increase in living standards, betterment in economical condition, changes in habit of people, and enhanced demand for public utilities.

Average sewage flow

In general, the production of sewage corresponds approximately to the water consumption. However, the fraction of the sewage that enters the sewerage system can be different, due to the fact that part of the water consumed could be incorporated into the storm water system or infiltrate. The fraction of the supplied water that enters the sewerage system in the form of sewage is called Return Coefficient (R = sewage flow/water flow). Typical values vary between 60% and 100%, and a value of 80% (R = 0.8) is usually adopted (Marcos Von Sterling, 2007).

Table 1Waste water generated

description	unit	2015	2018	2023	2028	2033	2038	2040
projected PHWD	m^3/d	7309	7876	10844	14112	17512	21321	23242
quantity of WW	m^3/d	5847	6300	8675	11290	14010	17057	18594

Maximum and minimum flow

Figure 1 represents a typical hourly wastewater flow rate variation into generated from the town in one day. Two main peaks can be observed: a peak at the beginning of the morning and a peak at the beginning of the evening. The average daily flow corresponds to the line that separates equal areas, below and above the line.

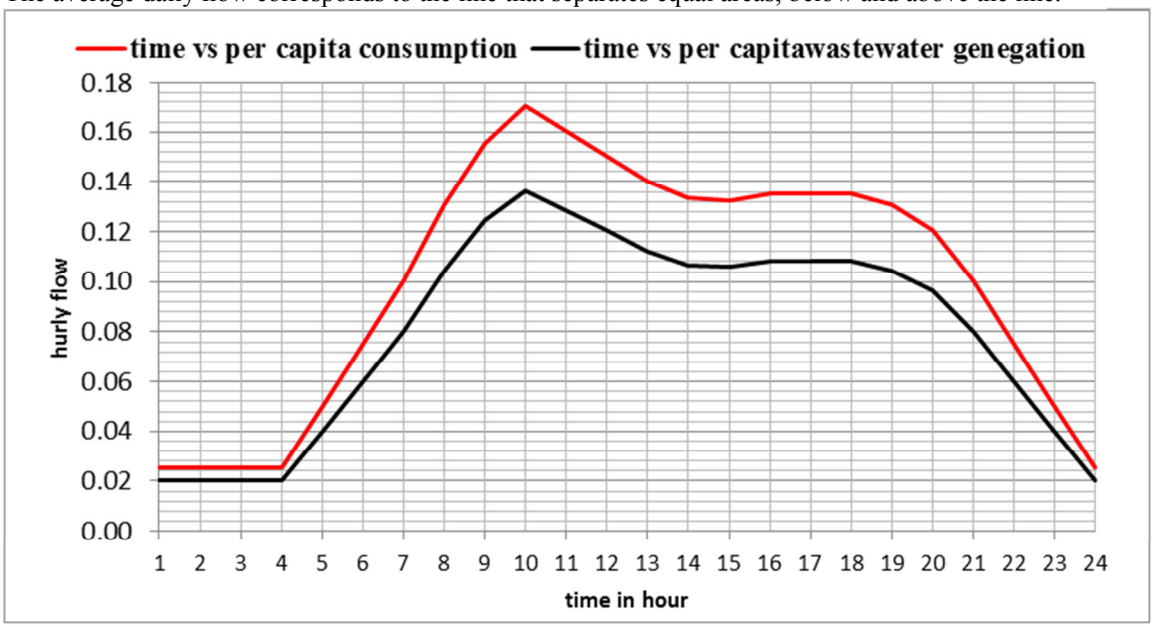

Figure 1 hourly fluctuation per capita consumption and wastewater genaration

5. WASTEWATER COLLECTION TREATMENT AND DISPOSAL IN THE TOWN

5.1. Introduction

Wastewater management is comprised of wastewater collection, treatment, and reuse or disposal of effluent and sludge (Crites and Tchobanoglous, 1998). It is essential for several reasons: (1) protecting public health and the well-being of the communities; (2) protecting the water resources and the environment; and (3) in water-scarce regions for reuse purposes in order to reduce the pressure from the potable resources (Bakir, 2001; Friedler, 2001). Some note that even in regions with abundant water, reuse of water and nutrients is essential for a sustainable use of these resources (Hedberg, 1999). Nevertheless, wastewater management, and especially treatment and safe disposal, is neglected in many countries.

Developing country governments and their regulatory agencies, as well as local authorities (which may be city or town councils, or specific wastewater treatment authorities, or more generally water and sewerage authorities), need to understand that domestic and other wastewaters require treatment before discharge or, preferably, re-use in agriculture and/or aquaculture. They also need to act, but first they need to decide where, when and how much to invest in wastewater treatment (Marino and Boland, 1999).

5.2. Domestic Wastewater Management Systems in the city

5.2.1. Sources of Household Wastewater

The investigation of the study shows as, Debre Markos town, gray water and black water are the two types of wastewaters which are generated at household level. Similarly, the main sources of wastewater in the households are: from cloth washing, kitchen, bathroom and toilet services. Hence, the result indicated that, from the major sources in the town, household wastewater was generated from washing clothes and materials. In relation to this, Duncan (2004) explored that, household wastewater sources are black water (toilets) and gray water (sludge), which are wastewaters resulting from personal washing, laundry, food preparation and the cleaning of kitchen utensils. Similarly the result of the study revealed as, washing clothes, kitchen, and bathroom and toilet services are main sources of household wastewater in the study area.

5.2.2. Means of Discharging Household Wastewater

The finding of the study shown as, household wastewater produced in the sub city is discharged at drainage canal, open space, river and septic tank. Majority of households discharged in to drainage canal that was prepared for storm water drainage.

In support of finding, Rosenthal (2005), said that, most of the household wastewater generated in developing countries, including Ethiopia, is discharged in to the environment such as river and open space without treatment, which contaminating downstream water supplies used for drinking water, irrigation, and recreational activities. Similarly according to the data, from health office officials even if the majority of household discharged their wastewater to drainage canal, the canal was built long time, opened and majority of existing drainage canal was blocked by solid wastes, it does not give proper function to the community. Therefore, the study shows that, wastewater discharged in to the environment such as open spaces, river and streams without any treatment systems, which polluted river and air and also create health problem on community like diarrhoea and upper respiratory diseases in the study area.

Access to Toilet

Access to toilet is the main to manage household wastewater. In the world around 300 million urban residents have no access to sanitation and they are mainly low-income urban dwellers that are affected by lack of household wastewater discharging infrastructure (Walid et al., 2008). $1/4^{th}$ of the population in Debre Markos has no toilet facility, who are defecated on open ground in any open spaces especially river bank. Plus to this, the town is one of town which has high density of population and lives in crowded homes. Hence, the management of household wastewater is very poor and some of the populations have no access to toilet and used river banks and open space for defecation. As a result, it created health problem, pollution of air, river and steams.

Types of Toilets and Emptying Condition

The degree of household wastewater management varies in most developing countries. Hence, household wastewater is discharged to offsite (centralized plants) and on site (pit latrines, septic systems) or disposed of in unmanaged drainage canal or waterways that can open or closed sewers. In urban area of Ethiopia, the most common used for the management of household wastewater is onsite wastewater disposal method. This is because its cost for construction and management is easy as compared to off-site disposal method. Similarly, the findings of the study indicated as, like any other Ethiopian urban cities, in Debre Markos town the common type of household wastewater management is onsite systems (pit latrine, septic tank and ventilated pit latrine). In addition, Debre Markos town has no off-site (sewerage line) system; instead canal system that covers a small part of the city, only 8% of the population is connected to channel line (Debre Markos Town Water and Sewerage office, 2011). In contrast to this, according to report, from the town water and sewerage office official off-site wastewater management is absent in the sub city due to it takes large amount of resources to construct and maintain and majority of community who lived the town are low income and lives in slum homes, hence,

they have no a capacity to build off site wastewater management system. The most common type of toilet used by the community in the town is pit latrine and used as shared with each other.

On the other hand, empting of onsite facilities is often neglected and wastewater overflows from the pits to the roads or gardens, and often disposed without treatment into open streams and rivers near the town (Kebede, 2004) that creates a negative effect on urban environment. This is also, the result shows, to some extent common in Debre Markos town, residents who have access to toilet 23.3% are not emptying. According to Maru Abebaw (2014), households did not get trucks from town water and sewerage office to emptying their latrine; because some pit latrines are not accessible for transportation to pick wastewater and some communities have financial problems to emptying the latrine. Therefore, it is difficult to access truck for the community in the required time; as a result, the latrine could not empty on time.

The sub city water and sewerage branch office give emptying service and charged 69 Birr per truck at household level. Some communities are connected their toilets directly to river and drainage canal at rainy season. As a result, its consequence of the problem resulted in pollution of river and stream water in the study area.

5.3. Impacts of Household Wastewater on the Environment

Proper liquid and solid waste management is considered one of the challenging environmental problems in Ethiopia as well as in Amhara Region. The waste genetareted from different area increased significantly due to rapid population growth and fast urbanization, change in lifestyles and consumption patterns. Major problem associated with waste management are poor collection rates, open dumping, and improper recycling that pose environmental damages**.**

Improper management of household wastewater has various impacts on environment. The result of the study shown as, the impacts of improper household wastewater management are observed and these impacts are grouped in to health problem, water and air pollution.

5.3.1. Social impacts

Household wastewater is the principal vector by which a large number of communicable diseases are transmitted and spread in urban areas (Sien, 2001). According to Maru Abebaw (2014) study, 94.4% of town households source of wastewater were gray water, 16.6% of the population have no access to toilets and 23.3% those have access to toilet but not empting in truck who disposed their wastewater either or both in open space, in river and drainage channels. As a result, it creates environmental problems. In relation to these, according to Debre Markos Town Health Centre Annual Report (2013) the mostly occurred top diseases were: upper respiratory disease and diarrhea 35% and 9.8% respectively, which are resulted from, the town households were discharging there wastewater in to the environment without any treating mechanisms. Therefore, these methods of wastewater management have a negative consequence on health status of the community in the sub city and it also has health cost, needs additional cost and reduce the productivity of the community. A losing of a working day to health problems related to poor household wastewater management has an economic cost, which brings a reduction of household income and the productivity of local and national economy and conflicts between neighborhoods due to improper disposal of waste water in the study area.

5.3.2. River Pollution

Improper management of household wastewater has great impacts on the quality of water. Hence, the finding of the study indicates in the study area, household wastewater is directly discharged to the river and streams, which pollutes the water. The river and stream which were found in the town are used as washing cloth and bathing for those low income communities lived near and around the river and streams.

Results from field observation when I was in Debre Markos shows people of different communities released their wastewater directly to the Wuseta and Wutren River. This river was also used as washing cloth and recreational activity for low income groups live around and downstream of the river. In addition, report from Wereda health office, the community who uses the river and stream for washing cloth and bathing are affected by different diseases like skin infection. In relation to these data from Debre Markos Town Socio Economic Annual Report (2013) explained that, 6.2 % of the diagnoses in the town were skin infection disease.

5.3.3. Air Pollution

Air pollution occurred due to improper management of household wastewater in town. Wastewater discharged from household overflowing on road, and stagnant at drainage canal and open space that decays create bad smell that hinders the aesthetic value of the town.

Stagnant of wastewaters that discharged from households at road side and drainage canal are not mostly flow in to the river or stream. This creates bad smell and reduces the aesthetic value of the sub city. Similarly, according to the data from health offices, the wastewater which are generated from the household are not discharge properly; majority of the drainage canal in the town are work for long year, opened and outdated. Households also openly had thrown solid wastes on and around drainage canal which restricts the flowing of wastewater, which resulted in stagnant of household wastewaters on canals. Due to this, wastewater is not flow

and stay long time cause to create offensive odder and the community easy to catch with common cold and the cause of disease of those asthmatic patients**.**

5.4. Challenges of Household Wastewater Management Systems

Many cities in developing countries have problem in managing the household wastewater, especially in big and densely populated cities. Debre Markos town is one of most densely populated and business area; such massive person needs adequate sanitation infrastructure services, and fulfilling these needs was the challenges faced by the town.

Hence, the result of findings from different literatures and reports some of the main constraints are; shortage of household wastewater management infrastructures, lack of awareness and sense of ownership on the communities, lack of policy and strategy on the safe use of wastewater in agriculture, poor water use efficiency, and lack of skilled technicians for promoting and training urban agriculture skills, Poor sanitation coverage/low level of awareness on waste management, weak enforcement mechanisms on pollution prevention and control and low level of income of the city, inadequate participation of private sectors, NGOs and inadequate coordination between institutions were the main challenges of household wastewater management in the study area.

5.4.1. Shortage of Household Wastewater Related Infrastructures

Infrastructure accessibility and sufficient services is the base for urban development. In Debre Markos town, some of the communities were in accessed with basic sanitation infrastructures like toilets and drainage canals as the result, used open space, street road, river bank and streams defecation and discharging mechanism. Similarly, due to shortage of trucks to collect the wastewater, some of the communities are also discharging their wastewater through direct connect to river and drainage canals.

In relation to this, according to About Briscoe (1993), one- sixth of the world's population lives in urban area with inadequate sanitation infrastructure like; toilet, septic tank, drainage canal and wastewater treatment plants.

In Debre Markos town, currently to collect wastewater only one truck is available. According to Debre Markos Town Water and Sewerage office (2011).Therefore, due to shortage of the trucks, some community has no access to get truck to emptying their toilet, and prefers to discharge their toilet illegally through directly connecting in to the river and drainage canal at rainy season. Hence, from the findings it can summarized that, shortage of infrastructures, produced household wastewaters are not managed properly, and discharging in to river and stream, street road, open space and open defecation creates an adverse impacts on health problems of the communities, air, river and stream pollutions in the study area.

5.4.2. Lack of Coordination between Institutions

The provision of effective and efficient household wastewater management service is not possible alone; rather coordination of other sector is important to provide adequate services to the community. In Debre Markos town, as the result of inadequate coordination, the management of household wastewater is very poor. Similarly, according my observation the coordination between Debre Markos town water and sewerage service office, the town solid waste management office, health and land and planning administration office was poor on proper management of household wastewater in the town. In addition due to the lack of coordination among the concerned sector, some of the communities were dumping their solid waste into drainage canals and open spaces. Due to the absence of timely maintenance, the existing drainage canals are old and open on which the community dispose wastewater. As a result, due to the lack of coordination and integration between institutions this fuels the environmental problems like river and air pollution and health problems on the community in the study area.

5.4.3. Inadequate Participation of Stakeholders

Household wastewater management is not government task only, but NGOs and private sectors should also participate. In Debre Markos town the participation of stakeholder was very limited. According to Debre Markos Town Water and Sewerage office (2011), there is no any private sector that participates in collecting and transporting wastewaters in to disposal site in Debre Markos. Similarly previous findings indicated that, not only small private sectors small participation but also are not covered whole parts of the town. Hence, due to the private sectors are small, they are no providing services to the community, charged high price and select the nearest areas that accessible to transportation as compared to the government sectors. Therefore, it can be generalized that in adequate participation of concerned private sector was the challenge for household wastewater management in the study area.

5.4.4. Lack of Awareness and Sense of Ownership on the Community

Increasing public understanding and know how on the value of proper household wastewater management is critical. Household wastewater management is the most important basic function for protecting public health, wellness and the environment. In Debre Markos town, due to lack of awareness and sense of ownership of the communities, the management of household wastewater is very poor. According to the report from Wereda

health office, some of households are damping solid wastes produced at home in to drainage canal, directly connect their toilet and gray water with drainage canal, river and streams at rainy season. Therefore, it can generalized that, due to the absence of awareness and sense of ownership of local communities, the dispose their wastewaters in to the environment without treatment which causes a health problem of the community, air, rive and stream pollution in the sub city.

5.5. Strategies to Improve Household Wastewater Management

The creation of suitable and favorable environment requires the proper management and disposal of household wastewaters through involving concerning stakeholders like government sectors, private companies, NGOs, local communities, CBOs, and associations by involving them from planning to implementations.

In addition the involvement of major stakeholders by itself do nothing without continuous monitoring and evaluation and undertaking remedial measures for the identified gaps and problems in relation to household wastewater management. The findings of the study also revealed that, government sectors to properly mange household wastewaters, design mechanisms that are cost, time and effort effective in order to minimize the costs of the tasks accomplishments in the study area.

Similarly, local communities can be encouraged to participate; to contribute indigenous, valid ideas, have strong sense of ownership by members of the community. It is also very important to engage 'gate keepers or influential community leaders and existing community in to maintenance and cleaning of wastewater related activities in the study area.

Some Strategic measures which should be taken to improve household wastewater management system:

Strengthen existing policies and strategies

- Harmonize and implement national and regional policies, strategies, and guidelines on the society and waste management services to avoid duplication of efforts, overlap, and unclear roles among various stakeholders in local level.
- Strengthen the links and support between national, regional, and local Urban Sanitation and Waste Management sectors.
- Revise the Implementation Manual for Urban Health Extension Program to strengthen and intensify the USWM Focus the coming HSDP strategic action plan on town sanitation and waste management.
- Translate the national policies, proclamations, and regulations into action at regional and local levels.
- Develop Urban Sanitation and Waste Management strategy to promote intersectoral collaboration.
- Avoid overlaps in roles and responsibilities within USWM operational units and other government sectors. Formulate national and regional Urban Sanitation and Waste Management implementation strategies and create city-wide platforms to monitor and evaluate performance.

Strengthen advocacy and promotion

- Provide health/hygiene/sanitation promotion and advocacy to improve community knowledge and attitudes.
- Implement WASH forum at the local level.
- Advocate and strengthen public private partnerships

Strengthen partnership

- Strengthen partnerships between stakeholders engaged in sanitation and waste management services from need assessment to the final implementation of common objectives.
- Outsource and strengthen primary and secondary waste collection services to private microenterprises.
- Develop and implement legal framework to delineate Urban Sanitation and Waste Management responsibilities and accountability for sectoral offices.
- Encourage informal waste collectors to organize as formal waste collectors.

Capacity Building

- Provide budget, skilled human resources, machinery, and other relevant facilities for sanitation and waste management services.
- Organize and facilitate credit services for private micro-enterprises participating in sanitation and waste management services.
- Design and implement motivation schemes like technical support, capacity building, and incentives for private microenterprises engaged in sanitation and waste management services.
- Strengthen UHEP to improve coverage and utilization of sanitation and waste management services.

Improve interventions and service delivery

- Improve traditional pit latrines into a technology option that suits urban community needs. Such technology options include VIPs and flushing facilities that can be promoted through education and demonstration.
- Improve design of local facilities to handle daily generation of grey water, using standard design and enforcement.

- Improve access to pit-emptying services based on urban needs assessment.
- Develop and implement sustainable technology of hand washing facilities in the urban environment. Such needs must satisfy the needs of households residing in slum areas.
- Increase access to municipal solid waste containers and lift trucks based on based on urban needs assessment.
- Municipalities should subsidize the services of Urban Sanitation and Waste Management to assist the urban poor.
- Design and construct proper final solid and liquid waste disposal and treatment sites.

Strengthen research, monitoring, and evaluation

- Strengthen the assessment of the outputs associated with national and regional policies.
- Develop and promote options for waste recycling and reuse.

6. CONCLUSION

The degree of household wastewater management varies in most developing countries. Thus: Household wastewater management, among other urban problems, has currently become a concern of local government of developing countries including the public at large. Hence household wastewater is discharged in off-site and onsite sanitation systems. In most cities particularly Ethiopian cities, the management of household wastewater is commonly used to onsite discharged systems. Like other cities of Ethiopia, Debre Markos town was the town which has no off-site system; only 8% of the population is connected to sewer line. Hence, the study finds that, the town used to manage the wastewater by using onsite sanitation system like septic tank, pit latrine and ventilated pit latrine. Among these, majority of households in the town used pit latrine and they utilized by sharing, few of the household used ventilated pit latrine and a very few used septic tank.

In the study area, the management of household wastewater is not in proper way and some of the households have no access to toilets. As a result, majority of households discharged their wastewater in to the environment like to river and stream, drainage channel, road side and open space.

Consequently, it results a serious water contamination, over flow toilet and stagnant of wastewater in to the road side in the town and particularly in the overcrowded low-income neighborhoods. These exposed the community to disease such as, diarrhea, skin infection, upper respiratory diseases like influenza and common cold, and also reduce an aesthetic value of the town. These problems are aggravated due to shortage of household wastewater management infrastructures provision, lack of awareness and sense of ownership on the communities, inadequate participation of private sectors, NGOs and inadequate coordination between institutions in the study area.

7. RECOMMENDATIONS

The points discussed below are forwarded for improvement of household wastewater management system in Debre Markos town. The provision of household wastewater management at present is not as such properly. So, in order to create proper management of household wastewater in the town the following recommendations are in line with the provisions of the national one WASH Program developed in 2013 and Urban Wastewater Management Strategy 2017.

Increase Accessibility of Household Wastewater Management Facilities: The management of household wastewater in the town is poor due to less accessibility facilities like less access to toilet, lack and poor drainage canal and shortage of truck to collect wastewater. Hence, to mitigate the current toilet access problem, the municipality should construct additional public latrines on areas that problems are commonly observed and areas that open space and river bank defecated. The municipality should also, maintain the existing drainage canal and construct drainage canals in areas that drainage canal were not available by participating communities to support money. In addition, Debre Markos water and sewerage office should buy additional emptying trucks. Therefore, as all this needs high cost, the municipality should operate in cooperation with concerning bodies like the town land administration office, the town road authority, Debre Markos town water and sewerage office, involving NGOs and donors by preparing proposals related to inadequate management of household wastewater management infrastructures.

Creating Awareness to Communities: Findings indicates that majority of households discharge their household wastewater in to the environment like open space, river and streams without any treatments, thus awareness for all required. Solid waste disposed of illegally in drainage canal, connecting their toilets in the river, open space and drainage canal at rainy season are not only because of lack of solid waste disposal container and other services like truck for empted toilet to discharge wastewater but also lack of awareness of the consequences of mismanagement of wastewater in the sub city. The concerned bodies such as the health office, solid waste office, water and sewerage office should be raise public awareness about proper household wastewater management and its impacts on the environment and how to maintain and use household wastewater management facilities and participate in construction of drainage canal and toilet by using techniques like mass media, pamphlet and

demonstration of best experience community to community. Furthermore the town health extension workers should work to bring continues behavioral change though communication to improve the awareness and attitude of the community concerning household wastewater management in the town.

Make strong coordination and Integration among Institutions: A single institution cannot perform the required service being alone; the coordination of other institution seems to the crucial. The municipality should promote institutional coordination among different sectors like water and sewerage office, health offices, land administration office, road authority and solid waste management office in order to proper management of household wastewater in the town. The municipality should be also participation of community and CBOs like Edir in different components of household wastewater management services such as construction of toilets, maintaining and building of drainage canal in the town.

Participation of Stakeholder: Household wastewater management is not only the task of government. NGOs, stakeholders and private sector should involve in household wastewater management services in various motivational activities like tax fee imported truck, spare parts and other relevant materials, and the municipality should be a favorable condition for NGOs participation to promote and support on activities like, facilitation of credit provision; providing supporting skills, management, financial and training.

Expand Sewerage System: Debre Markos town like other town has no sewerage line, due to the presence of slum areas and low income households living in the area which restricts the development of sewerage lines. Therefore, the municipality should give attentions and renew the slum areas for the future to provide sewerage line in the town by giving kebele houses with minimum fee, providing condominium houses and creating job opportunities to the communities to afford the house.

REFERENCE

[1] Abebaw Andarge. (April, 2017). Monitoring the urban growth of Debre Markos Town (1984-2012), Ethiopia: Using satellite images and GPS. Journal of Geography and Regional Planning. 10 (4), p 69-76.
[2] Central Statistical Authority Administrative Report, Ethiopian - Population and Housing Census Of 2007
[3] Debre Markos Town Socio Economic Annual Report, 2013. Unpublished.
[4] Federal Democratıc Republıc Of Ethıopıa Mınıstry Of Water Irrıgatıon And Electrıcıty Urban Wastewater Management Strategy: Addıs Ababa May, 2017
[5] Federal Democratic Republic of Ethiopia Ministry Of Water, Irrigation And Electricity Urban Water Supply And Sanitation Project-II; November, 2016, Addis Ababa, Ethiopia
[6] Fesseha Hailu Mekonnen. (2012). Liquid waste management: The case of Bahir Dar, Ethiopia. Ethiopian journal of health department. 26 (1), p 49-53.
[7] Getahun Workup and Adinew Adam. (1999). wastewater management in Addis Ababa, Ethiopia. Integrated development for water supply and sanitation. 25th conference (3), p 32-34.https://en.wikipedia.org/wiki/Debre_Markos
[8] Kartikey Tiwari and SC Tiwari.(2012).An overview of Solid Waste Management System in Debre Markos Town of Ethiopia, Global Journal of Current Research Vol. 1 (1). Pp. 1-8
[9] Maru Abebaw. (2014). Impacts of Household Wastewater on the Environment: The Case of Debre Markos Town, Amhara Regional State, Ethiopia. Asian Journal of Social Sciences and Management Studies. Vol. 1 (3), p87-93.
[10] Melaku Abebaw. Assessment of Water Loss in Water Supply Networks (A Case of Debre Markos Town)**,** A thesis Submitted to the School of Civil and Environmental Engineering July,2015
[11] MoWIE- Ethiopia Urban Wastewater Management Strategy ;Februry 2015.
[12] Population And Housing Census Of Ethiopia Administrative Report Central Statistical Authority Addis Ababa: April 2012
[13] Sharon Hophmayer-Tokich:Wastewater Management Strategy: centralized v. Decentralized technologies for small communities;
[14] Situational Analysis of Urban Sanitation and Waste Management, Strengthening Ethiopia's Urban Health Program (SEUHP) John Snow Inc. Addis Ababa, Ethiopia: march 2015.
[15] Urban Sanitation Universal Access Plan (USANUAP) part-IV, December 2011, Addis Ababa
[16] Urban Water Supply Universal Access Plan (UWSPUAP) Part-III 2011-2015, December 2011, Addis Ababa