

Challenges and Resolutions for Sustainable Domestic Wastewater Management in Kabul City, Afghanistan



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Abstract: *There is an extreme lack of statistics about Kabul city wastewater management. Therefore, the objectives of this study were to investigate and address the current circumstances and key challenges of domestic wastewater management in residential areas. In addition, to recommend sustainable solutions. The methodology adopted includes the use of questionnaires, field observation and review relevant documents from related stakeholders. The result indicated that more than 50% of households do not have improved toilets. There are no proper wastewater treatment plants except Macroyans' wastewater treatment facilities that are not worked properly. Furthermore, there is no proper drainage system. Approximately 100 % of domestic wastewater is discharged to the environment without appropriate treatment that creates severe health and environmental problems such as groundwater pollution, bad odors, and effects on biodiversity. The major diseases are diarrhea, malaria, cholera, and typhoid. The key challenges of domestic wastewater management include; absence of improved sanitation facilities, lack of proper wastewater treatment plants and drainages system, poor government responsibilities, deficiency of public participation and unsolid of sustainable wastewater management framework. According to the current circumstances and challenges of domestic wastewater management: decentralized wastewater treatment technologies, enforcement of legislation, decentralization of planning and budgeting to local institutions, involving public, planners and policy-makers at all level and forming of a sustainable wastewater management framework are the main elements which can contribute with wastewater management sustainability in Kabul city*

Keywords: *Domestic wastewater, Sustainable wastewater management, decentralized system, Circular economy*

I. INTRODUCTION

Wastewater that comes from residential sources such as toilets, bath, laundry, food preparation and the cleaning of the kitchen is called domestic wastewater. In other words, wastewater that is, produce due to human activities in households is called domestic wastewater. It consists of a massive amount of suspended and floating solids, such as

feces, paper, vegetable peels and hazardous pollutants such as pathogenic microorganisms (Mara, 2004).

Microbiological components of untreated domestic wastewater are bacteria, protozoa, and viruses. There are two types of bacteria in untreated domestic wastewater beneficial and harmful. Beneficial bacteria which, degrade the waste products and they are used in wastewater treatment plants. Harmful or pathogenic bacteria cause several types of diseases in a human being such as typhoid fever, bacillary dysentery, and tetanus. Researchers have found that 10,000-100,000 transferrable particles of viruses are emitted per gram of feces from people diseased with hepatitis (Arcadio and Gregoria, 2003).

Generally, domestic wastewater has two types; Domestic wastewater that is collected from the bathroom, showers, bathtubs, dishwashing, and clothes washing or any water used at home except, water from toilets is called greywater. Greywater usually contains shampoo, toothpaste, soaps, oil, and food particles.

Greywater can be directly reused for irrigation, toilet flushing, and domestic heating. The wastewater, which, is collected from toilets, is called black water. In general, black water consists of brown water (human feces and flush water) and yellow water (urine) (Andersson et al., 2016a). There is 13 % of nitrogen and 28 % of phosphorus in brown water (human feces) composition. Whereas urine compromise of 69% of total nitrogen and 40% of total phosphorous. Phosphorous fertilizers are produced from non-renewable sources and lack of phosphorous nourishments effects on agricultural productions. However, approximately 22% of existing phosphorous nutrition requirements can be fulfilled if all phosphorous from the black water returned to agricultural land (Mulec et al., 2017).

Untreated domestic wastewater causes numerous types of economic threats; for example, a declines in agricultural and industrial production and increases the financial burden on health care. Decreases prices of properties near contaminated water bodies and tourism can be, impacted by water quality degradation because tourists demand clean water. In addition, untreated domestic wastewater causes damage to environmental beauty, effects on recreational values and

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creates bad odors and other ecological problems (Sancho et al., 2015). Untreated domestic wastewater is the biggest threat to sustainable water and creates both short and long-term environmental, economic and health problems. Researchers discovered that domestic wastewater contains pathogenic microorganisms, which can cause various diseases, including bacteria, protozoa, viruses, fungi, and parasitic worms (Edokpayi et al., 2017). Untreated domestic wastewater creates serious environmental problems such as eutrophication and Greenhouse Gas (GHG) emissions in the form of CH₄ (methane) and N₂O (nitrous oxide) (Libardi et al., 2019). Untreated domestic wastewater causes 1.5 million child deaths every year. According to the World Bank, an estimation indicated that globally each year 260 billion dollars is lost due to untreated domestic wastewater (Cheng et al., 2018).

The sustainable development Goal 6 especially targets 6.2 and 6.3 on hygiene and water quality, and Goal 3 on good health are mainly related to sanitation. Wastewater management is essential for reaching other sustainable development goals, such as poverty, economic growth, education, gender equality, and sustainable cities (WHO, 2018).

Water plays a significant role in the circular economy because it is the most important and vital source for production. Therefore, in the circular economy wastewater treatment is an important element of water resources management. Water must preserve full value after each use in a circular economy. The advantages of domestic wastewater reuse are; improvement of productivity in agriculture and rising productions (Flores et al., 2018). Reusing of domestic wastewater can contribute to societies to find valuable and vital solutions to safe water resources availability challenges (Moretti et al., 2019). Recovering of raw materials and energy has an essential role in the circular economy. Human feces and urine are nutrient-rich biomasses and could be used as agricultural fertilizer. Such kind usage of urine and feces protects the natural water sources from eutrophication and contamination (Malila et al., 2019).

There is a general realization that there are not enough alternative sources of water to provide a safe water supply. As population increases, and with urbanization and industrialization, water is becoming increasingly scarce, making potable reused water a more likely resource to augment drinking water supplies (Tortajada and Nambiar, 2019). Bioplastic, cellulose, phosphate, alginate-like and biomass can be, recuperated from wastewater. The recovery of energy and raw material from wastewater improves water quality and supports the circular economy. For example, the Netherlands each year get 230 million revenues from wastewater-recovered resources (Leeuwen et al., 2018).

Kabul city is the capital of Afghanistan, and one of the fastest-growing city in the world, with an estimated 4 million populations in 2012 (Ahmadi and Kajita, 2016). Kabul city is one of the most miserable city-related access to clean water deliveries and proper hygiene services in the world. The

residents of Kabul city do not have access to any general wastewater treatment system. Surface water and groundwater resources in Kabul city are at risk due to unsustainable and uncontrolled groundwater abstractions and surface and groundwater polluted biologically and chemically by several types of sources. Microbiological analyses found that around 58 to 70 % of the city deep wells water is polluted with fecal (coliform) bacteria (Zaryab et al., 2017).

II. LITERATURE REVIEW: SUSTAINABLE WASTEWATER MANAGEMENT SYSTEM

A sustainable wastewater management system has a proper wastewater collection system, sustainable treatment, and energy-saving facilities, an appropriate raw material recovering system and suitable legislative and financial structures (Laugesen, 2010). Any system can be sustainable which protects public health, economically affordable, technically and institutionally consistent, environmentally protective and acceptable to the public. It is necessary that a sustainable wastewater treatment system must guarantee environmental quality protection, reutilizing of nutrient and preservation of natural resources (Capodaglio et al., 2016). A sustainable wastewater management system contributes significantly to protect society, economy, and environment from the negative impacts of wastewater. Besides, sustainable wastewater treatment technologies contemplate the impacts of their actions on public health and the environment (Popovic and Kraslawski, 2018).

Sustainable wastewater management systems can improve soil quality, agricultural productivity and more effectively protecting ecosystems. As well, reduce health care costs, creates new job opportunities and business. The achievement of SDG goals is impossible without a sustainable wastewater management system (Andersson et al., 2016b). Sustainable wastewater treatment systems have an essential role in contributing to declining water pollution and greenhouse gases. Sustainable wastewater management systems, which produce energy whereas decreasing water contamination, air pollution and greenhouse gases (Sanabria et al., 2018).

The key challenges for a sustainable wastewater treatment system are lack of public participation and awareness, community resistance to pay, difficulty in availability of land, lack of suitability of technology adaptation, absence of private –owned business involvement and government's role and commitments (Wirawan et al., 2018). Often due to an unsupportive governance framework, wastewater management systems fall into poor condition and disorder. Therefore, to achieve sustained and constant growth in wastewater management it can be more useful to invest in institutional capacity compared to direct investment in physical structure (Kjellén, 2018).

III. METHODOLOGY

The data collected from primary and secondary sources. Primary data sources include field observation and questionnaires. Secondary data attained from books, journals, reports, maps, and conference proceedings. In addition, from governmental and non-governmental organizations (NGOs) in Kabul city. The questionnaire used in this study was adopted from Ehsas (2013). The questionnaire had closed-ended questions, and it was distributed to 151 respondents. The participants of the survey were compromised the individuals or family members who live in residential areas of Kabul city. The questionnaire was reliable and consistent; therefore, every survey participant answered precisely similar questions. A comprehensive field study conducted in order to collect information about current domestic wastewater management such as wastewater drainage, sanitation facilities, domestic wastewater disposal, water sources and conditions where wastewater related hazards threats public health and environment. Public health Directorate of Kabul city visited on the cases of diseases related to water contamination. The method of data analysis was the frequency percentage method.

IV. RESULT AND DISCUSSION

The questionnaire was divided into sections relating to sanitation facilities, wastewater management systems, wastewater disposal, reform of planning, water-related health and environmental problems, drinking water resources, people’s contribution and cost reclamation and bills issues, wastewater reuse possibilities, the factors, which caused of current situations domestic wastewater management. The following table 1 indicates the findings of the questionnaire.

Table -I: Summary of Questionnaire Results

Questions	Parameters	Survey participants responses	
		Frequency	Percentage
Respondents education level	Illiterate	36	23.8
	Secondary school	20	13.2
	Under graduated	44	29.1
	Graduated	44	29.1
	Post graduated	7	4.6
	Total	151	100.0
Types of Toilets	Simple pet latrine	82	54.4
	Pour-flush latrine	11	7.3
	Pit latrine with flush	44	29.1
	Conventional flush toilet	14	9.2
	Total	151	100.0
Wastewater Treatment Facilities	Septic tank	41	27.2
	Cesspool	110	72.8
	Central municipal sewerage	151	100.0
	Total	151	100.0
Wastewater disposal	Directly to drainage	10	6.6
	First Septic tank		

Questions	Parameters	Survey participants responses	
		Frequency	Percentage
	then drainage	42	27.8
	To canal	5	3.3
	To open field	54	35.8
	To stream	40	26.5
	Total	151	100
Government current Improving projects	Yes	29	19.2
	No	122	80.8
	Total	151	100.0
Types of diseases	Typhoid	23	15.2
	Malaria	34	22.5
	Diarrhea	78	51.7
	Cholera	16	10.6
	Total	151	100.0
Environmental problems	Mosquitoes	17	11.3
	Flies	16	10.6
	Bad Odor	24	15.9
	Effects on environmental beauty	20	13.2
	Effects on drinking water quality	13	8.5
	61	39.8	
	All of them	151	100.0
Drinking water sources	Private tanker supply	24	15.9
	Municipality water supply	42	27.8
	85	56.3	
	Individual well	151	100
	Total		
Domestic Wastewater reuse possibilities	Yes	54	35.8
	No	97	64.2
	Total	151	100.0
Non-financial Contributions	Labor for repairs	46	30.5
	Labor for building	66	43.7
	I do not know	39	25.8
	Total	151	100.0
Amounts of affordable payments for services	(1USD = 70 AFNs) 2019	17	11.3
	450-1000 AFNs	14	9.3
	350-449 AFNs	52	34.4
	200-349 AFNs	67	44.4
	100-199 AFNs	1	0.6
	Could not pay	151	100.0
	Total		
Causes of current situations	Lack of suitable land.	38	25.1
	Low government responsibilities.	75	49.7
	Lack of community participation.	32	21.2
	6	4.0	
	I do not know.	151	100.0
Total			

A. Current Situations of Domestic Wastewater Management in Kabul City

Currently, households in residential areas of Kabul city use different types of toilets such as simple pit latrines, pit latrine with a flush; pour-flush latrines and conventional flush latrines. It was observed during field study that yellow wastewater from toilets discharged to the streets, which causes severe health and environmental problems. The house owners build the pit latrines unprofessionally. In addition, the pit latrines are not built from durable materials such as concrete, bricks, fiberglass, and stainless steel. Pit latrines without platforms or which, are not built from durable materials and not easy to clean, are not improved sanitation facilities (UNICEF and WHO, 2018). Accordingly, more than 50 % of households in residential areas of Kabul still do not have improved toilets. According to Graham and Polizzotto (2013), pit latrines causes of health and ecological problems such as microbiological and chemical pollution of groundwater. Scholars frequently found that the travel distances from pit latrines of up to 25 m, 26 m, and 50 m for unsafe concentrations of chemicals, Bacteria and viruses.

The survey findings indicate that more than 70% of the households in residential areas use cesspool systems and 27.2 % septic tanks. Cesspools are one of the main sources of groundwater contamination in Kabul city because house owners usually build them inadequately. In addition, most often, cesspools are not protected which allows the infiltration of wastewater that causes diseases. According to the Ministry of Rural Rehabilitation and Development (2015), deep wells are polluted biologically and chemically in Kabul city. Besides, the report findings indicated that in some areas deep wells water is not drinkable. Cesspool system is used for black water treatment. Generally, the effluent that is produced in cesspools has poor quality and usually leaches into the surrounding soil, in result causes groundwater contamination (Surinkul et al., 2017).

The above analysis in table (1) indicates that households in residential areas do not have access to proper wastewater treatment systems and around 100 % of residential areas domestic wastewater discharges to the environment without any appropriate treatment. There is no wastewater treatment plant in residential areas of Kabul city except Macroyans, a wastewater treatment plant that receives only 5 % of wastewater from the whole city. There are no chemical and biological treatment processes in Macroyans, wastewater treatment plant. After the physical treatment process, the wastewater is directly discharged to the Kabul River. In addition, there is no proper drainage system; therefore, wastewater accumulated and clogged in streams or directly discharges to the Kabul River. The following figure (1) shows the overall current situations of domestic wastewater management and the lack of proper drainage systems in Kabul city.



Figure 1: Current situations of domestic wastewater management in Kabul city.

As the analysis in the above table (1) indicates, the majority of families have diarrhea, malaria, typhoid, and cholera. According to Kabul City Directorate of Public Health (2018) in the first quarter of the solar year (Spring season in Afghanistan), 31350 cases of diarrhea in under five years' children and 768 cases of Malaria were registered only in public hospitals of Kabul city. Besides, wastewater is caused by several types of environmental problems in Kabul city such as surface and groundwater pollution, bad odor, flies, mosquitoes and effects on environmental beauty.

In Kabul city, 100% of drinking water comes from groundwater sources. Wastewater is not reused; that is why groundwater is used for all domestic purposes including agriculture in Kabul city. More than 60 % of the residents still did not know that recycled wastewater could be used for agriculture and other indoor purposes such as toilet flushing

The findings of the present survey indicate that the households in residential areas are satisfied to contribute financially and non-financially (such as labor for building and labor for repair) with domestic wastewater management projects. The amount of affordable money depends on households' monthly incomes the families with high incomes afford high amounts and families with low incomes delighted to pay less amount of money for services. The analysis of the survey illustrates that the main reason for current domestic conditions is low government responsibilities, lack of suitable land and lack of community participation. Responsibility is an extraordinary form of incentive that drives society and organizations in the right way. Responsibility is essential to embrace international associations, government organizations, and service suppliers to provide sustainable sanitation services and water supply. One pleasant and helpful approach for improving responsibility in wastewater management is the decentralization of planning and budgeting to local societies and associations. Decentralizing of planning and budgeting increases the power of public over policy and decision-makers, through social rules, community judgment and votes (UN Millennium Project, 2005). According to Naughton and Hynds (2014), public awareness has a vital role to involve society successfully in wastewater management. Community awareness about the threat posed by wastewater to drinking water and the environment could improve public commitment.

B. The key challenges of domestic wastewater management in Kabul city

The key challenges of domestic wastewater management in Kabul city are; absence of improved toilets, lack of proper wastewater treatment plants and poor drainage systems, Poor government responsibilities and deficiency of public participation and Unsolid of a sustainable wastewater management framework. The following table 2 indicates the key challenges, causes, and proposed solutions.

Table- II: The key challenges of domestic wastewater management in Kabul city

<i>Key Challenges</i>	<i>Causes</i>	<i>Proposed solutions</i>
The absence of improved toilets.	1- Informal settlements 2- Lack of public awareness 3- Public low incomes	Composting toilets: Economically and socially affordable, more sustainable, environmentally friendly, no need for water and electricity.
Lack of proper wastewater treatment plants and inadequate drainage systems.	1-Rapid urbanization and population growth, 2-Economical and institutional issues. 3- Water and electricity scarcity. 4- Lack of suitable land. 5- Lack of technical experts	1-Installation of decentralized systems. 2- Monitoring and enforcement of the legislation related to wastewater management. 3-Involvement of private sectors. 4- Management of water supply and sewerage systems, waterways, drainage, storm, and recycled water.
Poor government responsibilities and deficiency of public participation.	1- Low public awareness. 2- Low level of education. 3- Low government regulations enforcement.	1-Establishing systems for providing data and guidelines to the public, which includes environmental reports, law and policy documents, and

<i>Key Challenges</i>	<i>Causes</i>	<i>Proposed solutions</i>
	4- Lack of government priority to wastewater management.	wastewater related pollutants 2-Decentralization of planning and budgeting to local societies and associations. 3- Involving public, Planners, and policy-makers at all levels. 4- Establishing a research center. 5- Providing the procedural rules regarding public participation that can be central in monitoring. 6-Improving regulatory system effectiveness and the enforcement of environmental law.

Key Challenges	Causes	Proposed solutions
Unsolid of a sustainable wastewater management framework	1- Problems in policies and regulations related to wastewater 2- Lack of experts 3- Lack of initiatives	1- Forming a comprehensive framework of procedural rules for local communities and authorities to reuse the wastewater effectively and recover the raw materials. 2- Improvement of regulations and policies. 3- The government must collect wastewater and decide upon the best ways and initiatives to treat it. 4- Provide opportunities to public and private sectors based on the circular economy.

C. Resolutions

As indicated in Table (1) that more than 50% of residents of Kabul city do not have access to improved sanitation facilities. Most of them use pit latrines, which are not built from durable materials such as concrete, bricks, fiberglass, and stainless steel in result cause underground water contamination. So one of the suitable and sustainable solutions for this challenge is composting toilets. Because composting toilets are economically and socially affordable, more sustainable, environmentally friendly, no need for water and electricity. Composting toilets have the potential to provide a low-cost solution to improved agricultural productivity, alongside increased nutrition and the reduction of health and environmental impacts from open evacuation (WWAP, 2017). Besides, waterless composting toilets are an alternative for areas where a centralized wastewater system network cannot also be provided for that location where there is a lack of standard urban infrastructure, water supply, and electricity (Nasri et al., 2019). Composting toilets also protect public health and decrease environmental pollution. A study conducted by Balamurugan et al. (2017) has found that E.

coli and Salmonella are absent throughout the composting process because of the alkaline condition.

The finding of the current survey showed that lack of proper wastewater treatment plants and inadequate drainage systems are one of the mean challenges of domestic wastewater management in Kabul city. The mean causes of this problem are; rapid urbanization and population growth, economic and institutional issues — furthermore lack of technical experts, water and electricity scarcity. Therefore, the implementation and application of a decentralized wastewater system are one of the appropriate and sustainable solutions for domestic wastewater management in Kabul city. Because in several developing countries in Asia, centralized systems have failed in many circumstances, due to the high cost. It is, firmly believed that a decentralized wastewater management system is a proper and suitable alternative for the centralized system in numerous Asian countries (8th World Water Forum, 2018).

As illustrated in table (2), the third challenge for domestic wastewater management in Kabul city is Poor government responsibilities and deficiency of public participation. Because responsibility is an extraordinary form of incentive that drives societies and organizations in the right way. Responsibility is essential to embrace international associations, government organizations, and service suppliers to provide sustainable sanitation services and water supply. One favorable and helpful approach for improving responsibility in wastewater management is the decentralization of planning and budgeting to local societies and associations. Decentralizing of planning and budgeting increases the power of public over policy and decision-makers, through social rules, community judgment and votes (UN Millennium Project, 2005).

Public participation and access to information are the significant elements of a legal framework related to wastewater management. The UNICEF Convention on Access to information, public participation in Decision-making and Access to Justice in Environment Matters, (the Aarhus convention), and its Protocol on Pollutant Release and Transfer Registers (PRTRs) provides a comprehensive framework of procedural rules for governments to engage the public efficiently in sustainable development. Public participation has an essential role in the improvement and enforcement of environmental law. Also, access to statistics is essential for active public participation in decision making and pollution warnings (United Nations Environment Program, 2015).

As in table (2), showed that the unsolid sustainable wastewater management framework is also one of the biggest challenges for domestic wastewater management in Kabul city. Because The existing WASH policy, which was formulated for the period 2010 to 2020, updated in 2015 policy does not provide a specific and relevant domestic



wastewater treatment framework. So the implementation of a sustainable domestic wastewater management framework and wastewater management initiative is essential and vital for domestic wastewater management in Kabul city. According to current situations and challenges of domestic wastewater management Uganda “Waste to Wealth” initiative framework is one of the appropriate and suitable solutions for Afghanistan domestic wastewater management especially for Kabul city. Uganda “Waste to Wealth” initiative through a framework, which harnesses potential post-treatment revenue, and contributes to decreasing human waste` environmental pollution. Digesting of domestic wastewater through the anaerobic process can produce vital resources that would otherwise pollute the environment, and degrade ecosystem services, such as fisheries. Currently via anaerobic digestion of human and solid waste creates by-products in Uganda from which then produce biogas and agricultural fertilizers that have higher values compared to traditional sludge (UNU-INWEH, 2013). Kampala, the capital of Uganda, as an African pioneer has received global recognition in integrated water management. Kampala is taking a comprehensive, citywide framework to increase the treatment and reuse of wastewater and fecal sludge, on the path towards a circular economy. Kampala Sanitation project includes the implementation of the wastewater treatment plant and the restoration of the sewer network. In addition, biogas production and electricity generation will be used to power the treatment plant and any surplus will be sent back to the grid. The National Water and Sewerage Corporation and Kampala Capital City Authority work together to accelerate Kampala’s transition towards sustainable wastewater management. These two organizations have actively involved a range of additional city-based stakeholders, including citizens, in providing solutions. A fundamental pillar of this approach is the formation of call centers for septic tank emptying and setting up decentralized wastewater treatment systems (Wastewater Report, 2018).

V. CONCLUSION

Currently, more than 50 % of households in residential areas of Kabul city do not have improved toilets. There is no centralized or decentralized system in residential areas of Kabul City. As a result, around 100 % of domestic wastewater discharges to the environment without proper treatment. Health problems are rising in Kabul city, particularly illnesses such as diarrhea, malaria, typhoid, and cholera. In addition, wastewater caused environmental problems such as surface and groundwater pollution, bad odor, flies, mosquitoes and effected on environmental beauty. The key challenges are including the absence of proper sanitation facilities, Lack of wastewater treatment plants and inadequate drainage systems, poor government responsibilities and deficiency of public participation and unsolid of a sustainable wastewater management framework. According to the current circumstances and challenges of

domestic wastewater management; composting toilets and decentralized wastewater treatment technologies are the most appropriate and sustainable solutions for wastewater management in Kabul city. In addition, enforcement of legislation, providing data and guidelines to the public, decentralization of planning and budgeting to local institutions, establishing a research center, Involving public, planners and policy-makers at all level and forming of a sustainable wastewater management framework are the main elements which can contribute with wastewater management sustainability in Kabul city.

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