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The Somali Raw Sewage Management: Environmental Issues and Alternative Solutions

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Abstract

The use of pit latrines in Somali communities poses significant environmental challenges due to the release of harmful contaminants into the water table and methane gas into the atmosphere. This article discusses the potential of harnessing biogas energy from raw sewage as an alternative solution to the environmental challenges posed by pit latrines in Somali communities. The study finds that biogas production from human waste has far-reaching economic benefits for society, including the creation of a new industry that produces biogas and generates employment opportunities for young people. Biogas production for cooking serves as a viable alternative energy source that can effectively replace charcoal, which in turn helps conserve the environment by reducing deforestation activities. The study

recommends the adoption of publicly managed urban sewage systems and investment in the infrastructure needed to facilitate biogas production to promote sustainable waste management and promote public awareness of the benefits of renewable energy sources in Somalia. Further research is needed to assess the feasibility and sustainability of biogas production in Somali communities.

Keywords: Environmental pollution; Sewage Processing; Biogas Energy; Economic Viability.

Introduction:

Somalia does not have a sewage treatment system; instead, every household and building, private or public has its own pit latrine or septic container to store and manage its raw-sewage. Waste drainage is an unregulated system that citizens are left on their own to deal with their sewerage predicaments, where by the mitigation options of this problem are based on the urban geographical location of the residents and their financial status.

E.g. while village and small-town inhabitants use simple pit latrines, city dwellers use a slightly more advanced septic tanks built underground and re-enforced with cement or concrete, depending on the financial status of the individual households; that is, upscale quarters of the major cities have can afford to spend on concrete septic tanks.

However, the problem with pit latrines and underground-built septic tanks or septic containers is that they leak contaminants to the groundwater or release methane gas to the air. Thus as major contaminants, the city of Mogadishu with the population of 3 million, the rate of environmental pollutants generated by this city is quite enormous. Conversely, the amount of methane energy the city sewage generates as biogas, had it been utilized, is potentially massive. Hence this document explores a method that this pollution is mitigated and reversed as an opportunity which is environmentally friendly and economically beneficial. This article does not intend to instruct on sewage treatment and biogas production. Its main objective is to highlight the crucial importance of these systems as practical alternatives to conventional pit latrines.

Sewage treatment system:

Most modern sewage treatment systems are mechanized systems that treat urban raw sewage and separate them into harmless and odorless water and solids reusable as solid fertilizers and safe water. In this preplanned urban treatment system, every household's raw sewage is drained into a preset industrialized structure, which is managed by the local city municipality. Sewage systems largely contribute to the public health and hygiene of the cities and protect the environment from the water and air pollutants inherent in untreated human raw waste.

Moreover, the environmental pollution that resulted from the inadequately managed sewage waste has compounded with the already fragile environment devastated by deforestation. In Somalia, hundreds of thousands of trees are felled daily for the consumption of firewood and charcoal production. If this trend continues for another decade without mitigation, the slim chance we currently have to alleviate deforestation may stay strong. The opportunity to tackle deforestation in this country will be forever lost.

Environmental Problems of the pit latrines and available alternatives

(1) Groundwater contamination occurs when pit latrines leak into the water table.

(2) Methane gas is released into the atmosphere, causing air pollution. However, by using methane as a biogas cooking fuel, forests can be preserved.

(3) Harvesting methane gas for cooking can reduce dependence on charcoal.

(4) The creation of a methane gas production industry can help reduce unemployment. By addressing these issues, we can minimize groundwater and air pollution, as well as the need to cut down trees for firewood or charcoal.

Thus it's important to note that groundwater contamination can be a serious problem, especially when pit latrines leak into the

water table. On top of that, methane gas can have a significant impact on air pollution. However, it's worth considering the benefits of using methane as a biogas cooking fuel.

For example, this type of fuel can help preserve forests and reduce dependence on charcoal. In fact, harvesting methane gas for cooking purposes could potentially lead to the creation of a new industry, which might help reduce unemployment rates. Ultimately, by addressing these issues, we can help minimize groundwater and air pollution, as well as the need to cut down trees for firewood or charcoal.

Expected Outcomes

The mitigation of the abovementioned sewage pollution problem could result in the following:

1. Sewage-generated contaminants in the groundwater can be avoided;
2. Release of methane gas to the atmosphere as air pollution can be reduced;
3. Due to methane gas harvesting for cooking, charcoal dependence can be reduced;
4. Unemployment can be reduced by creating an industry of methane gas production;

Problem statement

Septic tanks and pit latrines are commonly used for human waste disposal in many parts of the world. However, these

methods can lead to groundwater contamination and air pollution, posing a significant threat to public health and the environment. Additionally, the inefficient and unsustainable use of methane gas generated from sewage contributes to deforestation, resulting in increased greenhouse gas emissions and climate change. Therefore, there is an urgent need to identify practical solutions to address these challenges.

Significance of the study

This study is significant as it addresses two critical issues that have far-reaching implications for our environment and future. Firstly, identifying and implementing alternatives to septic tanks and pit latrines can help reduce groundwater contamination and air pollution. Secondly, finding more efficient and sustainable ways of harnessing methane gas from sewage can reduce dependence on charcoal and firewood, safeguard forests, and mitigate climate change. By providing practical solutions to these problems, this study can contribute towards a more sustainable and healthy future for our planet.

Objectives

1. To identify and evaluate alternatives to septic tanks and pit latrines that can reduce groundwater contamination and air pollution.
2. To investigate and develop more efficient and sustainable methods of harnessing methane gas generated from sewage to

reduce dependence on charcoal and firewood and safeguard forests.

Research questions

1. What alternatives to septic tanks and pit latrines could be identified and implemented to reduce groundwater contamination and air pollution?
2. How can methane gas generated from sewage be harnessed in a more efficient and sustainable way to reduce dependence on charcoal and firewood, and safeguard forests?

Related work

According to the paper's results for Min et al.,(2017), the most economically and environmentally sustainable method for energy recovery from sewage sludge is to create a solid fuel to replace coal, followed by using the pyrolysis configuration. On the other hand, producing bio-methane for grid injection was found to have the worst environmental impact among all the scenarios, despite being financially attractive. The study emphasizes the possibility of further energy recovery from sludge through the use of innovative processes and technologies (Min et al., 2017).

Lyng et al., (2018) conducted a study on the life cycle assessment (LCA) methodology to compare the environmental performance of biogas as a fuel for bus transport with natural gas, electricity-fueled buses, biodiesel, and fossil diesel. The findings

indicate that biogas has a relatively minor impact on the assessed environmental categories. However, greenhouse gas emissions are influenced by factors such as system boundaries, transport distances, and methane leaks. Although biodiesel was not included in the study, a European investigation concluded that generating biogas, particularly from waste materials, results in minimal greenhouse gas emissions. Although the study focuses on Norway, the results are likely to be applicable to other European countries (Lyng et al., 2018).

The focus of the studies of Paolini et al., (2019) was on the environmental impact and potential health risks of biogas technology. It provided estimates of greenhouse gas and gaseous pollutant emission rates and stresses the importance of appropriate storage systems for biomass and digestate. Additionally, the study critically examined the environmental consequences of using digestate. (Paolini et al., 2019).

The Tamar et al., (2019) paper's principal discoveries indicate that anaerobic digestion was successful in diminishing the quantity of sludge and generating pure biogas from municipal wastewater in the Zakho district of the Kurdistan region in Iraq. Furthermore, the study emphasizes the obstacles of wastewater treatment in the area caused by inadequate infrastructure (Tamar et al., 2019).

The paper's results of Kiselev et al., (2020) indicate that anaerobic digestion is a viable approach for reclaiming energy

from sewage sludge, and that in the case study of Ekaterinburg, generating biogas through cogeneration of electrical and thermal energy (option B-H) is a more desirable alternative to producing biomethane for use in transportation. However, additional research is required to resolve the remaining technical and economic issues involved in implementing the biogas/biomethane energy conversion system at the Ekaterinburg WWTP (Kiselev et al., 2020).

The study of Khan et al., (2021) offered a thorough examination of the shortcomings of current biogas upgrading technologies, as well as recent developments in physical, chemical, and biological biogas upgrading methods. Additionally, the study explores potential solutions for the future, including hybrid systems. Comparative analyses of process complexities and economic considerations are also presented, and the report considers prospects for future research into sustainable biogas upgrading technologies, with a specific focus on cryogenic separation, innovative biological techniques, biochar-based upgrading, and hybrid technologies that seamlessly integrate two or more different methods (Khan et al., 2021).

The primary outcome of the study of Sikorska et al., (2021) suggests that solidified CO2 can serve as a useful technique for conditioning, sanitizing, and dewatering sludge, as well as a pre-treatment approach to enhance methane digestion and fermentative hydrogen production. Additionally, it can be

integrated into a closed CO2 cycle of biogas production, biogas upgrading, solidified CO2 production, sludge disintegration, digestion, and biogas production, which may help decrease atmospheric CO2 emissions (Sikorska et al., 2021).

Gustafsson et al., (2021) examined the requirements, challenges, and consequences of increasing biogas production from anaerobic digestion in Sweden. The paper proposes a decentralized structure of small biogas plants to facilitate the logistics of agricultural substrates and biofertilizers. The report suggests that new and increased production subsidies, as well as a growing demand for renewable energy, could encourage new production capacity. The study concludes that public and private actors must work together to overcome the various challenges involved (Gustafsson et al., 2021).

Musmarra et al. (2021) discovered that using waste from the agro-food industry and agriculture as a raw material for biogas production has a positive environmental effect, particularly in the areas of human health and resource utilization. The study determined that pollutant emissions associated with substrate acquisition have a significant impact on the environmental effect. The substitution of coal with biogas, regardless of the feedstock used, has a favorable environmental impact Musmarra, etal.,2021).

Since Somalia is not industrialized, untreated sewage is responsible for most of the Somali environmental pollution, and

finding a solution to this problem would have been a significant environmental achievement. And this solution may provide the dual benefit of reducing potential risks of environmental pollution and producing methane gas energy with the prospect of business opportunities and job creation. Hence in the next segment, we discuss the first objective of the writing about the availability of an alternative to the pit latrine.

Environmentally Alternative Solutions

Bio-toilets

The bio-toilet system is a great way to conserve water, promote hygiene, and maintain sanitation. It has been designed to protect the environment and benefit the community, aligning perfectly with SDG 6, which aims to provide clean water and sanitation for people.

Five strains of aerobic bacteria can break down human solid waste into water, carbon dioxide, and biogas. The amount of carbon dioxide produced is relatively negligible, but the amount of water converted from solid waste to water is enormous. This water is odorless and can be reused for garden irrigation or recycled for multiple purposes. However, the main objective of the bio-toilet is to produce biogas for cooking, which also can be utilized in different forms of energy.

Moreover, using bio-toilets protects the planet by trapping pollutants like methane gas and carbon dioxide and recycling human waste before contaminating groundwater.

By definition, "Bio-toilet is a decomposition mechanized toilet system which decomposes human excretory waste in the digester tank using specific high graded bacteria (aerobic or anaerobic) further converting it into methane gas, Carbon dioxide gas and water," (Jagranjosh, 2018).

A bio-toilet is an innovative and highly efficient system designed to decompose human waste. This process is made possible through specialized bacteria that facilitate waste conversion into methane gas, carbon dioxide, and water. Such technology has proven to be an effective and sustainable way of managing human waste, with the added benefit of producing renewable energy sources. Its efficient and eco-friendly design makes it a promising solution for communities seeking to improve waste management and promote a more sustainable future.

Importance bio-toilet

Bio toilet is important, specifically for the developing countries like Somalia for the following reasons:

It mitigates the hazardous result of untreated raw sewage from pit latrines. "This activity is introducing a bio-toilet system which disposes human waste and saves energy, conserves water and produces energy in the form of biogas. These bio-toilet systems meet the need for a basic, easy-to-install and hygienic human waste disposal mechanism in areas with no infrastructural facilities, such as sewage treatment plants. It also addresses the

need for a cheaper and easy-to-operate alternative to the traditional waste disposal system. The sanitation systems can be installed in places where conventional toilets facilities cannot be made available," (Jagranjosh, 2018).

In the realm of environmental protection, bio-toilets have emerged as a critical player. Not only do they serve the basic function of human waste disposal, but they also capture harmful substances like methane gas and carbon dioxide. Furthermore, bio-toilets are designed to treat human waste in a way that prevents groundwater contamination, making them a safe and sustainable option for a variety of settings. Additionally, bio-toilets play an important role in environmental protection by capturing harmful substances such as methane gas and carbon dioxide, and treating human waste to prevent groundwater contamination.

Methane Gas Use and production

Methane gas is a highly combustible hydrocarbon that occurs naturally. It is made up of one carbon atom and four hydrogen atoms and has the chemical formula (CH4). Natural gas, which is familiar to most people, contains up to 90% methane gas. Unfortunately, methane is also a greenhouse gas that contributes significantly to air pollution and climate change. However, methane can be harvested and used as cooking gas, transportation fuel, and lighting energy, making it a valuable resource. According to Prof. Daudi M. Nyaanga, "Biogas is a flammable

gas which burn at 60% of what a pure gas will do and can be used for cooking, lighting, and electricity generation and all other purposes…" (Nayaanga, 2015).

Methane gas harvesting

In the Somali context, there exist two distinct methods for the harvesting and utilization of methane gas as a bio-fuel energy source. These methods involve the implementation of pit-lanterns and septic tanks, which are designed to facilitate the extraction and storage of methane gas. Once extracted, this gas can be utilized in a number of different ways, including as a replacement for charcoal in cooking. By leveraging the power of methane gas, communities in Somalia can reduce their reliance on traditional forms of cooking fuels and move towards a more sustainable and environmentally-friendly future.

Producing biogas is a sustainable way to generate energy using natural or organic waste such as manure, fruits, and food leftovers. The process involves decomposing the waste in a series of septic tanks. The first tank is an anaerobic digester, which is a sealed container that breaks down the waste in the absence of oxygen. During this process, microorganisms in the waste break down the organic matter and produce biogas, which is mainly composed of methane and carbon dioxide.

In pit latrines, the untreated human excrement consists of organic compounds like lipids, proteins, carbohydrates, and fibers. Each of these compounds must be biologically processed

to gain a biogas product; hence different bacteria digest and biologically biodegrade these different elements to produce the intended results of biogas. These bacteria hence release specific enzymes to digest or degrade each target compound and produce biogas.

The final tank is a gas holder that stores the biogas until it is ready to be used. The leftover sludge from the first tank is a nutrient-rich fertilizer that can be used to improve soil quality.

Biogas has several uses, including cooking, heating, and producing electricity. However, to use it as a fuel for cars and other machines, the motor needs to be modified to adopt gas as fuel energy. This is because biogas has a lower energy density than gasoline, which means that it requires more refining to produce the same amount of energy. This involves removing impurities such as water, hydrogen sulfide, and carbon dioxide to increase the concentration of methane. The purified biogas can then be used as a substitute for natural gas in engines and other applications. Thus producing biogas from natural or organic waste is an environmentally-friendly and cost-effective way to generate energy. It reduces waste and greenhouse gas emissions and provides a renewable source of energy that can be used in various applications. This method can save families money and reduce the need to burn trees for charcoal.

Biogas production construction methods

Constructing a biogas production system from pit latrines or septic tanks can be a practical and cost-effective option for families. By investing an initial amount of money, families can set up a system that will produce enough biogas to meet their cooking needs. The process involves capturing and processing the methane gas released from the decomposition of organic waste in the latrine or tank. This biogas can then be used as fuel for cooking, lighting, or heating. Additionally, in some cases, families can even generate excess gas that they can sell to their neighbors, providing a sustainable source of income.

Creating a biogas production system is a smart investment for families looking to save money on energy costs while also promoting environmental sustainability. We have provided below an online manual for constructing a biogas system to help individuals interested in building one; however, users must adhere to the guidelines established by the website's owners.

https://www.homebiogas.com/wp-content/uploads/2021/04/BT1120_0421_4.pdf

Fiberglass septic tank

The bio-digester tanks used for biogas production are varied according to the budget the customer is willing to spend, the quality of the tank, and the design chosen. The bio-digester is the methane (biogas) producer, and the most important unit of the septic tank system. This unit is the reactor system which converts

the organic waste into a useful biochemical compounds. However, due to the affordability and durability, fiberglass septic tanks are our suggestion for replacing the current pit latrines and the underground cement or concrete septic containers. Moreover, fiberglass is light and easily manageable to repair or replace.

Likewise, the required fiberglass septic tanks to replace pit latrines are corrosion and leak-proof and are the primary treatment system for household sewage processing. The digester tank has three chambers, where the first chamber is the waste collector, and the biodegradation reaction settles the anaerobic sludge at the bottom and sends the semi-treated waste to the second-stage anaerobic digester, which releases the methane gas to the third-stage clarifier chamber. This final chamber has an outlet to release the gas for use or storage.

Target communities

Prior to introducing this program to the general public, it would be prudent to first introduce it to specific communities and institutions that are more likely to benefit from implementing biogas harvesting. “Waste generation is an intrinsic part of human existence. Waste materials are usually characterized by their nature, components and quality. Variations in quality, quantity and composition of solid waste can be linked to various factors such as cultural, economic, social and financial status of inhabitants of the particular space being studied. These distinct factors will also determine the best waste management practice to

adopt," (Coker et al., 2015). These particular inhabitants possess unique attributes that make them ideal candidates for adopting this innovative technology. The following are some of these groups and institutions:

1. Gated Communities;
2. Refugee resettlement institutions;
3. Middle-income communities;
4. Public and private institutions;

The institutions and communities that would be most receptive to this technology are those that are highly adaptable in terms of their financial, philosophical, and professional goals. These entities are more open-minded and receptive to embracing new technical innovations. For instance, refugee resettlement programs are focused on creating environmentally-friendly communities that promote sustainable livelihoods, which makes them eager to adopt new sustainable technologies. Similarly, gated communities, middle-income households, and public and private institutions are constantly seeking out cost-effective innovations that can help reduce energy costs and maximize savings. These entities are highly motivated to explore new solutions that can help them meet their financial goals while simultaneously reducing their carbon footprint.

Biogas Technology Training

In order to successfully generate and utilize biogas, it is of utmost importance to possess the necessary equipment and technical expertise. With this in mind, the ultimate goal is to train various teams of biogas workers for the production process and technical repairs, and provide employment training to individuals who may be currently unemployed, regardless of their educational background.

At the Institute of Peace, Water, and Environment at Mogadishu University, there is availability to facilitate obtaining all the necessary training equipment and modules to produce skilled biogas workers capable of producing high-quality biogas. One of the key factors to consider when producing biogas is the cost of production. In order to make it more affordable, it is essential to have access to locally produced fiberglass tanks in Somalia. Fortunately, local companies can produce septic tanks, as they have the necessary materials and production capacity, having already produced fiberglass water tanks and fishing boats. The availability of such local fiberglass production is crucial to biogas production's success in Somalia.

Youth employment

In Somalia, the issue of high rates of youth unemployment is a pressing concern that requires immediate attention. In order to address this challenge, job creation projects are essential. This project aims to provide diverse employment opportunities across

different levels, including manufacturing, management, distribution, sales, and marketing. Establishing the biogas industry in the country will create numerous job opportunities, thereby boosting the economy. Additionally, this business venture will positively impact the environment, as it involves the production of both tanks and gas. Indeed, this project can help address the issue of youth unemployment while also promoting sustainable development in Somalia.

Conclusion

Somali cities and towns require publicly managed urban sewage systems to replace the current practice of individual households managing their human waste, which poses a threat to citizens' health and the environment due to contamination. However, sewage can be utilized as household energy, transforming a hazardous issue into a benefit. Technically, issues such as groundwater sewage contamination and greenhouse methane gas release are preventable. Additionally, methane gas is a low-cost and eco-friendly alternative to charcoal that can save trees and create job opportunities for unemployed youth. Biogas production from human solid waste is a crucial renewable energy source that can lower greenhouse gas emissions, enhance waste management sustainability, and create a renewable energy industry that can contribute to the national economy.

Recommendations

To promote sustainable waste management, it is recommended that Somali cities and towns adopt publicly managed urban sewage systems. Additionally, there is a need to harness the potential of biogas energy from human solid waste as a renewable energy source. This will help reduce greenhouse gas emissions and improve the sustainability of waste management systems while creating a wholly renewable energy industry that can contribute to the national economy. Moreover, biogas production from human waste will save trees by reducing the dependence on charcoal and create jobs for unemployed youth. The government should prioritize investing in the infrastructure needed to facilitate biogas production and promote public awareness of the benefits of renewable energy sources. Furthermore, there is a need for further research on the feasibility and sustainability of biogas production as a means of waste management and renewable energy production in Somalia.

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