Sludge management in Lebanon

Sludge: Definition and challenges

Sewage sludge is the main by-product of a treatment plant that processes wastewater conveyed through networks. Faecal sludge is the residue extracted from non-collective sanitation systems, such as septic tanks.

Sludge management poses increasing challenges for countries around the world.

Widespread use of liquid sanitation systems, and improvement in treatment processes and performance, are beneficial for the preservation of the environments receiving treated wastewater. However, they also result in growing quantities of sewage sludge. In the case of collective sanitation, the cost of sludge treatment accounts for a significant share of the total cost of wastewater treatment. Sewage sludge management therefore plays a key role in liquid sanitation management.

While sludge may be perceived as a waste product, the management of which represents a technical and financial constraint, there are solutions for its valorization, turning it into an environmental and financial opportunity. The health and environmental risks associated with the management of sewage sludge have raised controversy and even conflict among citizens, politicians, and scientists. Yet sludge is rich in nutrients such as nitrogen and phosphorus, and contains valuable organic matter, useful when soils are depleted or subject to erosion. It also has the potential to produce energy through methanization.

This note summarizes the various possible valorization methods and provides an overview of the sludge management situation in Lebanon.

Final disposal methods

Spreading: *Reusing on agricultural land or rehabilitating degraded soils*

The spreading of sludge produced by wastewater treatment plants on neighboring agricultural land is a virtuous valorization method, provided that it ensures:

- ✓ Compatibility with the needs of the agricultural sector: agronomic benefits for crops, consideration of soil absorption capacities, and adherence to suitable spreading periods.
- ✓ Absence of health risks: ensuring their harmlessness to humans, fauna, flora, and the environment; and their traceability from production to the spreading site.

Wastewater sludge can also be used for the restoration of degraded soils, such as desert lands and industrial wastelands.

Composting: *Hygienization before agricultural valorization*

Composting is a treatment process through aerobic fermentation (presence of oxygen), producing a stabilized fertilizing material rich in humic compounds — compost — which can be used as an organic amendment to improve soil structure and fertility.

Due to its high water content and low carbon/nitrogen ratio, sludge cannot be composted on its own. At composting facilities, it is therefore mixed with green waste or household/industrial biowaste.

Methanization: *Energetic and agricultural valorization*

Methanization is the process of creating favorable conditions for anaerobic degradation (in the absence of oxygen) by micro-organisms in a reactor called a digester, producing digestate (a wet product, rich in partially stabilized organic matter) and biogas (a water-saturated gas mixture).

- ✓ Digestate can be used as an agricultural amendment after additional hygienization and stabilization treatment.
- ✓ Biogas can be used for electricity and/or heat generation, biofuel production, or injection into a biogas network. Cogeneration, involving the simultaneous production of electricity and heat, offers optimal efficiency. Depending on the valorization type, biogas may require varying degrees of purification treatment, including desulfurization.

Incineration: *Destruction for energy valorization*

Incineration refers to oxidation through combustion, producing a mineral residue free from organic and toxic constituents, which can be reused in agriculture but is often landfilled (reduced volume by 90%). It also produces energy in the form of heat and emissions containing pollutants (gas or fine particles). *

Despite these opportunities, as mentioned in the introduction, sludge is often regarded as an undesirable by-product generated by wastewater treatment processes. Even if sludge is considered as waste and sent to landfills, it must be dewatered to limit the environmental impact of its storage (runoff, infiltration).

Regardless of the chosen disposal/valorization solution, it is preferable for landfill disposal to remain a backup solution in case difficulties arise with the preferred disposal method.

Landfilling sludge does not allow its agronomic and energy potential to be exploited.

The situation in Lebanon

Before even considering the reuse of treated wastewater and sanitation by-products, it is important to note that the sanitation sector is still at a limited stage of development in Lebanon. Numerous wastewater treatment plant projects struggle to materialize, and existing infrastructures are not all functional. Only 60% of users are connected to a sanitation network, and less than 10% of wastewater is currently treated.

As a result, few treatment plants are operational and produce activated sludge that can be valorized after further processing. However, partially functional plants generate by-products that are difficult to characterize: wastewater that has only been pre-treated, and highly liquid sludge that is harmful to the environment and difficult to recycle.

In addition, there are several local non-collective sanitation initiatives that produce faecal sludge, which can then be treated and recycled.

Regulations for sludge use still under construction

There is no existing national regulation or standard for the control and quality of wastewater discharged from treatment plants, nor for the use of sewage sludge.

In 2010, as part of the project UTF/LEB/019/LEB "Reuse of Treated Effluent and Sludge," the United Nations Food and Agriculture Organization (FAO) contributed to the attempt to develop guidelines for the agricultural use of sludge generated by wastewater treatment plants. However, since most treatment plants were not operational, this attempt was aborted due to implementation difficulties.

Since 2019, the Lebanese Standards Institution (LIBNOR), the Lebanese Agricultural Research Institute (LARI), and several other public administrations (Ministry of Energy and Water, Ministry of Agriculture, Ministry of Environment) have established a committee to work on the formulation of official standards for the reuse of water and sludge, based on the recommendations issued by FAO in 2010. In the meantime, international ISO standards (issued by the International Organization for Standardization) are applied in Lebanon, particularly ISO 19698:2020 on sludge recovery, recycling, treatment, and disposal. However, sludge reuse still requires case-by-case approval from the Ministry of Agriculture, a validation process that can take up to two years. So far, the technical and institutional challenges have not been fully addressed to enable the use of sludge in agriculture.

Moreover, to date, there is no wastewater treatment plant with an effective sludge management system, encompassing treatment, disposal, landfilling, and possibly valorization. Local sludge is evacuated and discharged without control, posing a risk of environmental contamination.

In the updated National Water Sector Energy Strategy, sludge management is recognized as an important issue, and the agricultural use of sludge is recommended. However, operational details and possibilities are not specified.

Sludge management studies and projects in Lebanon

Study: "Energy from Wastewater Sewage Sludge in Lebanon; Transforming a Waste Disposal Problem into an Opportunity," as part of the Country Entrepreneurship for Distributed Renewables Opportunities (CEDRO) project supported by the United Nations Development Programme (UNDP), 2013[1]

[1] UNDP (2013)
Energy from Wastewater Sewage Sludge in Lebanon; 'Transforming a Waste Disposal Problem into an Opportunity_2013' (pseau.org)

In 2013, at the request of the Ministry of Energy and Water (MoEW) and the Council for Development and Reconstruction (CDR), UNDP conducted a study under the CEDRO project aimed at creating favorable conditions for investing in energy production from sewage sludge through anaerobic digestion. The initial objective of the study was to assess the energy potential of sludge production for the ten largest treatment plants in Lebanon.

However, after an initial phase, the objective of the study was modified based on the observation that only a few plants were ready to operate, while most were still waiting to be connected to the sewage network. This made it difficult to assess the energy potential of sludge. As a result, the scope of the study was redefined with a new objective: to first identify plants meeting the conditions for implementing an anaerobic sludge digestion system. The collected data identified five treatment plants meeting the necessary conditions, namely Sour, Aabde, Sarafand, Saida, and Majdal Anjar. Such a system has already been set up in Tripoli. In total, it is estimated that anaerobic digestion systems at these six treatment plants could produce 143,000 MWh.

Study: "Assessing the quality of sewage sludge as an agricultural soil amendment in Mediterranean habitats" – LIRE, 2019[2]

This study was conducted in 2019 and published in the *International Journal of Recycling of Organic Waste in Agriculture*.

The objective of the study was to characterize the physicochemical and microbiological quality of sewage sludge generated by three wastewater treatment plants located in the Bekaa Valley in Lebanon, with the aim of evaluating its suitability as an agricultural amendment.

The results indicate that sewage sludge has high fertilizing values but is contaminated with *E. Coli*, *Staphylococcus aureus*, and *Acinetobacter* spp. As a result, this sludge cannot be spread on soil as an agricultural amendment without undergoing additional treatment to reduce pathogens. Regarding heavy metals, all levels were below the limits set by Lebanese guidelines for sludge reuse in Lebanon (FAO, 2010). Microbiological activity in all samples affected sludge stability, limiting its use in agriculture.

Further research is needed to explore the impact of local sludge use on soil and crops.

The WAMA project led by GIZ: Sludge management in Tebnine (South Lebanon)

As part of the WAMA project (Enhancing Water Resource Management) led by GIZ to improve water resource management in Lebanon — wastewater management being a significant component — a feasibility study was carried out to optimize the management of dewatered and limed sludge from the Tebnine wastewater treatment plant (Sultaniye region, Nabatiyeh governorate). Conducted by the Bureau Technique pour le Développement (BTD), this study explored various scenarios for managing the sludge produced by this plant. For each scenario, it assessed the economic implications in terms of investment (CAPEX: capital expenditure) and

[2] Assessing the quality of sewage sludge as an agricultural soil amendment in Mediterranean habitats (researchgate.net)

operation (OPEX: operating expenditure), environmental impacts, and regulatory requirements. The characterization of sludge quality was also considered.

The study thus provides a basis for informed decision-making aimed at long-term improvements in wastewater management in Lebanon.

The study identifies four options for sludge disposal:

- Spreading on agricultural land as a fertilizer;
- Spreading for land reclamation purposes (e.g., rehabilitation of mining sites, restoration of roads and terraces (forestry), disturbed sites, etc.);
- Energy recovery through incineration in combustion units for electricity production; incineration as fuel in cement kilns; or biogas production for electricity generation;
- Landfilling.

The study concludes that the most favorable option for the management and treatment of sludge from the Tebnine plant is co-composting the sludge with municipal green waste and applying the produced compost as fertilizer for agricultural lands.

UNICEF: Low-tech omniprocessor pilot project in refugee camps in Iaat (Baalbek)

Since July 2023, UNICEF in Lebanon has been piloting a low-tech omniprocessor project to receive and treat faecal sludge from informal housing in the municipality of Iaat (Baalbek region). Faecal sludge is collected at the Iaat site and dried there.

With the support of CubeX, UNICEF is currently conducting a study to assess the type of valorization solution that could be chosen for the treated sludge generated by the omniprocessor (several solutions are possible: compost, fuel, construction materials, etc.). In particular, the study is looking into the possibility of producing compost from the sludge generated by the omniprocessor, so that it can then be distributed to farmers in the municipality of Iaat, and even in other municipalities in the region.

The responsibility for operating this omniprocessor treatment system is expected to be transferred to the Ministry of Environment.

The Iaat community has been actively involved throughout the project and now has a good understanding of the potential of sludge reuse. Technicians currently assigned by UNICEFF to operate the omniprocessor are members of the community. The experience of the Laat municipality underscores the importance of community involvement in ensuring the sustainability of the faecal sludge treatment and valorization solution.

Al-Shouf Cedar Society (ACS): "Wastewater treatment and sludge management in the Barouk river watershed and its tributaries" pilot project

Al-Shouf Cedar Society (ACS) is the NGO in charge of the Shouf Biosphere Reserve (SBR) and focuses on preserving its biodiversity and natural resources. Since October 2022, these organizations have received funding from the United States Agency for International Development (USAID) for the "Wastewater treatment and sludge management in the Barouk river watershed and its tributaries" pilot project implemented in collaboration with Development Agency International (DAI) and with technical support from the firm MORES.

The sludge produced by the wastewater treatment plants in the Barouk river watershed is currently evacuated untreated and uncontrolled, posing environmental risks for the reserve. The project aims to establish a management system for this sewage sludge, incorporating a treatment and valorization process. There are 14 partially operational wastewater treatment plants in the valley. The project targets the Jdeidet al Shouf plant.

The chosen treatment and valorization process includes:

- Sludge treatment through thickening, dehydration (belt press), and drying.

The produced sludge is analyzed to ensure compliance with international ISO standards mentioned earlier.

- A composting unit (located in the village of Maasser al Shouf) mixed with crushed organic matter, by-products of various agricultural activities in the surrounding areas.

Various outlets are considered for this compost: rehabilitation of degraded soils (former quarries, landfills), amendment for public green spaces (roadsides, public gardens), and for agricultural use. The latter option involves consultation with local farmers.

The project aims to mitigate the negative environmental impact of current management practices regarding sludge generated by wastewater treatment plants, and to contribute to the proper management of waste resulting from forestry and other agricultural activities. It will also help reduce the risk of wildfires.

Resources

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