



Feasibility Assessment of Fecal Sludge Treatment in Refugee settings in Jordan and Lebanon

Jordan and Lebanon

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Mission statement (Bill&Melinda Gates Foundation)

« Because the innovations we support can be most immediately valuable in densely populated areas, our main focus is on urban sanitation. Our priorities include developing non-sewered sanitation approaches, identifying new delivery models, and advocating for public policies that support improved sanitation in densely populated areas.»

<http://www.gatesfoundation.org/What-We-Do/Global-Development/Water-Sanitation-and-Hygiene>

Scope of work

1. Investigate and report on state of faecal sludge treatment in Lebanon and Jordan related to mainly Syrian refugee settings,
2. establishing contact to relevant institutions and organizations,
3. working on these topics in both countries,
4. analysing reports and literature,
5. in-country missions prepared logistically in partnership with a local partner,
6. develop innovative methods and techniques to reduce, recycle and re-use the sanitation waste, to protect the aquifers and to reduce the land footprint.

Macro strategy: Criteria

Line ministries, local partner, NGO and municipalities, national policy and plan, urgency

Pre-selection criteria are:

- » Large number of refugees - in relation to local population,
- » Degree of sanitation crisis with readiness to change,
- » Proud to be selected and to become a project partner,
- » Already a host for a BMGF intervention through institutional partners/ grantees.

Part II :

Field investigation on site and locations with high refugee presence, to investigate and assess the potential of preparing and apply innovative solutions, followed by a description of innovative partnership projects and related key technical solutions

JORDAN

Set criteria for the assessment and investigation phase

- 1) Application of Innovative Fecal Sludge Technology**
- 2) Economical & ecological dimension (*« low environmental foot print »*)
- 3) Refugee context**
- 4) SDG values (climate, social, health, pollution)
- 5) Renewable energy surplus
- 6) Circular economy promotion
- 7) Advocating for public policies
- 8) Replicability and up-scaling**
- 9) High impact with lowest input (*« Lowest hanging fruits »*)
- 10) Private business involvement**
- 11) High(est) demand
- 12) Potential for **co-financing** by other institutions

Part II :

Proposal 1: Innovative partnership for the completion of the Al Khaider Sludge Treatment Plant with Valorisation of remaining pre-thickened sludge

No.	Criteria	High relevance
1.	Innovative technology or concept	Based on former BMGF concept developments
2.	Syrian Refugee context	Yes, sewage sludge from 30 municipalities plus refugee camps
3.	SDG values (climate, social, health, pollution)	Yes
4.	Renewable energy surplus	Yes: biogas, electricity
5.	Circular economy promotion	Yes
6.	Advocating for public policies	Integrated regional waste management concept
7.	Replicability and upscaling	Yes, for other Governorates
8.	Greatest impact with lowest input	Technologies are already developed and piloted in other countries
9.	Private business involvement	Entire operation could completely "privatised"
10.	Highest demand	Yes
11.	Potential co-financing	Yes, JICA, KFW

9 waste streams received at Al Khaider site

During a typical day, between 50 and 100 tanker are discharging the following major categories of wastewater:

1. Textile wastewater
2. Paper sludge
3. Faecal sludge from "Septic Tanks"
4. Poultry droppings
5. Treatment Plant Sewage Sludge
6. Olive (Zibar) (OMW - Olive Mill Wastewater)
7. Kamkha (Marble cutting wastewater)
8. Dairy wastewater
9. Slaughterhouse wastewater

Key technical solution, practical technologies



- Installation of a central biogas co-fermentation system for treatment of the delivered sludge, offering services for specific pre-treating. Recommended capacity is 2000 t/d.
- Digestate can be dried and pasteurized as bio-solids and reused as soil improver and fertilizer in agriculture and fruit orchards.
- Biogas produced could fuel a 3 MW CHP during 15 h/d with opportunity to see bioelectricity to the national grid (equivalent daily electricity for 45000 refugee shelters).



Proposal 2: Innovative partnership proposals for the completion of the Azraq Wastewater Treatment Plant with Valorisation of sorted organic solid waste and remaining pre-thickened sludge

No.	Criteria	High relevance
1.	Innovative technology or concept	Based on former BMGF concept developments
2.	Syrian Refugee context	Yes, highly relevant
3.	SDG values (climate, social, health, pollution) (« low environmental foot print »)	Yes
4.	Renewable energy surplus	Yes: biogas, electricity
5.	Circular economy promotion	Yes
6.	Advocating for public policies	Integrated regional waste management concept
7.	Replicability and upscaling	Yes, for other Governorates
8.	Greatest impact with lowest input (« Lowest hanging fruits »)	Technologies are already developed and piloted in other countries
9.	Private business involvement	Entire operation could completely “privatised”
10.	Highest demand	Yes
11.	Potential co-financing	Yes, as additional component in the ACF project

Characteristics of the area

- Azraq area is the location of the biggest ground water reserve in Jordan
- 1/3 of water consumption in Amman is coming from Azraq.
- Annual rain-water collection is 25 million m³ while annual consumption (extraction) is 60 million cubic meter.
- 900 wells in the area out of which 700 are illegal = operating, w/o permission.
- Groundwater extraction for irrigation has led to the drying-up of important wetland area of the Azraq Oasis.
- Some wells in the area are already affected by increasing salt contents.
- Over the past century, an abundance of studies has been written on the waters of Azraq.
- **There is no sewage network serving the area.**

Characteristics of the Sewage and Fecal Sludge Management in Azraq municipality and area

- Collected septage - daily quantity between 120-160 m³ - is dumped approximately 5 km away from town beside the road.
- A report from the Ministry of Environment indicates ground water contamination, but no measures were taken.
- Next Government managed landfill area is 40 km away.
- Based on the National Plan for Solid Waste Management prepared by the Ministry of Municipality Affairs, the location for a new landfill is 15km away from Azraq city. Estimated costs: USD 16 million.
- No engineering standards or environmental requirements were followed during septic tank construction; no waterproof layer inside septic tank.

Azraq refugee camp: Water network – funded by UNICEF and SDC

- 95% of pipes installed up to end March 2017. 65 (29%) taps out of 225 were constructed.
- No tents in Azraq and for protection reasons water and sanitation facilities are in the immediate vicinity to the dwellings.
- UNICEF introduced 4600 “septic” tanks which are rather “holding tanks” as deeper soak away or drains seems not to be permitted in the area. Each tank serves up to 16 families and is emptied by desludging trucks every 25 days.
- Sewage is taken to a wastewater treatment plant 60 km away. On top of the tank there is a ‘superstructure’ with one toilet and a shower.
- Solid Waste: World Vision organizes the daily collection and transport of an average of 19 tons to the Azraq municipal waste site. About 50% of this is food waste (organics), and 35% is packaging waste.

Innovative solutions

Following the suggestion of the Kingdom-wide Biosolids Management Plan, prepared 2014 under der USAID supported Water Reuse and Environmental Conservation Project it is proposed to install:

- An anaerobic co-processing system of fecal and sewage sludge with
- Thermal post-processing of digestate, and
- application of sub-products as soil improver.

Key technical solution, practical technologies

Installation of one central biogas co-fermentation system and co-treatment of:

- densified faecal sludge (septage) from on-site sanitation systems,
- sewage sludge from the Azraq MBBR stations
- animal manure,
- easy biodegradable sorted organic waste (as pre-treatment to composting plants), and
- settled sludge from food processing industries such as olive oil or dry food.

Required capacity of such a central biogas unit:

- Able to treat up to 200 t/d of different kind of organic wastes,
- 70 t/d of sewage sludge, and
- up to 120 m³/d pre-concentrated septage, plus
- 10 m³/d of other organic waste.

After the biogas process:

- remaining digestate could be dried and pasteurized as biosolids, to be reused as solid improver and fertilizer in the agriculture and fruit orchards.

The biogas produced could fuel a 300 kWh CHP during 15 h/d, selling bioelectricity to the Azraq camp grid, producing an equivalent daily electricity for 4500 shelters.



Proposal 3: Innovative partnership proposal for the upgrading of the Madaba Wastewater Treatment Plant with Valorisation of Fecal Sludge as biochar and syngas

No.	Criteria	High relevance
1.	Innovative technology or concept	Former BMGF concept developments: ash and biochar
2.	Syrian Refugee context	Yes, 10%
3.	SDG values (climate, social, health, pollution)	Yes
4.	Renewable energy surplus	Yes: syngas, bio-oil, heat, electricity
5.	Circular economy promotion	Yes
6.	Advocating for public policies	Integrated regional waste management concept
7.	Replicability and upscaling	Yes, for other Governorates
8.	Greatest impact with lowest input	Technologies are already developed and piloted in other countries
9.	Private business involvement	Entire operation could completely "privatised"
10.	Highest demand	Yes, as there is urgent need to solve the "bio solid" situation
11.	Potential co-financing	Yes, at least for replicability



Ma'daba wastewater treatment facility: Several components were out of order and not brought back to operation, probably as they were not integral parts of the facility, particularly in terms of revenue generation. The picture shows two biogas out of order.



The sludge drying beds on site give an indication of the dimension of the FSM treatment problem, considering that the dried sludge can only be disposed of on the general waste dump side. **The material represents an excellent bio-fertilizer or a good component for further co-composting with other organic matter.** Unfortunately Jordanian regulations discourage the use of the product. **Thus, charring the dried matter to produce biochar would be helpful in organic farming.**

Proposed innovative solutions

Following the suggestion of the Kingdom-wide Biosolids Management Plan, prepared 2014 under der USAID supported Water Reuse and Environmental Conservation Project, the innovative partnership project proposal includes:

- **hydrothermal processing of pre-treated faecal and sewage sludge**
- **marketing and demonstrating of application of sub-products of biochar as soil improver.**

Cost estimation in progress.



Proposal 4: Innovative partnership proposal for upgrading of the Sahab – Modular organic waste and sludge treatment concept

No.	Criteria	High relevance
1.	Innovative technology or concept	Modular concept
2.	Syrian Refugee context	Yes, 25%
3.	SDG values (climate, social, health, pollution)	Yes
4.	Renewable energy surplus	Yes: biogas, electricity
5.	Circular economy promotion	Yes
6.	Advocating for public policies	Integrated regional waste management concept
7.	Replicability and upscaling	Yes, for other Governorates
8.	Greatest impact with lowest input	Technologies are already developed and applied in other countries
9.	Private business involvement	Entire operation could completely "privatised"
10.	Highest demand	Yes, as there is urgent need to solve the "bio solid" situation
11.	Potential co-financing	Yes, at least for replicability or extension

Partnership

The Sahab energy plan from February 2017 aims explore all options to produce energy, including converting waste into energy.

In case the municipality develops separate waste collection, then bio-waste and sanitation sludge could be processed into a digester to produce methane, converted to electricity; non-recyclable material could be used as fuel in specific units.

This partnership with BMGF would include:

- The Sahab district
- BORDA e.V.
- UNICEF
- Farmer Association
- Ministry of Agriculture,
- Ministry of Environment
- Ministry of Water and Irrigation.

Key technical solution, practical technologies

In line with the Kingdom-wide Biosolids Management Plan, prepared 2014 under the USAID supported Water Reuse and Environmental Conservation Project, the innovative partnership project proposal includes a **modular co-digestion and thermal processing of faecal and sewage sludge and bio waste including “marketing” and project demonstration of use of sub-products as soil improver.**

There is general agreement that Jordanian standards should be revised to permit land application for fodder crops, the demand will, over time, drive the market accordingly. Additionally, interest by the government organizations to restore rangelands will also add to demand for bio-solids use in land application