FSM for Disaster Relief

Comparison of the different FSM plants in Cox's Bazar, Bangladesh

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Aim

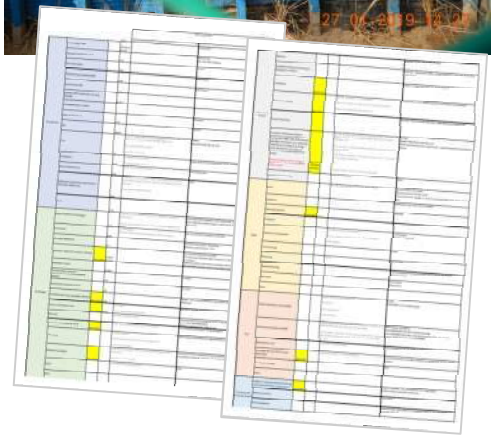
To draw conclusions on best practice FSM for disaster relief, from evidence gathered through practical experience in Rohingya refugee camps Cox's Bazar (CXB), Bangladesh

Methodology

- Background review
- Field activities
- Reporting

Constraints and assumptions

- Data/evidence gathering
- Cost – globally representative?
- Full treatment train – cost and area
- Treatment effectiveness – data Vs theoretical
- Effluent standards
- Centralised/decentralised



Technologies

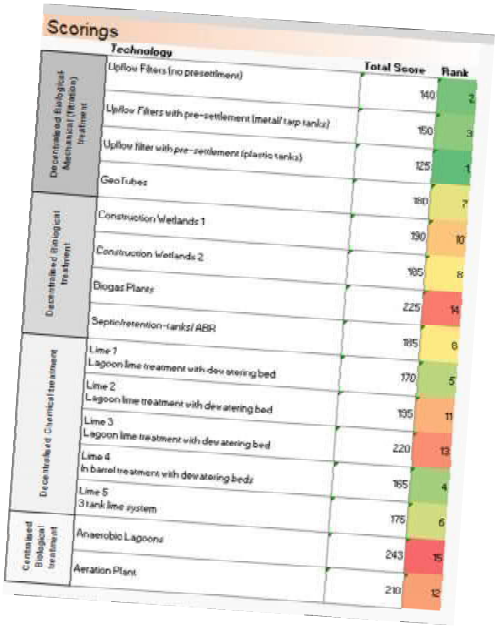
Decentralised biological and/ or mechanical treatment	Upflow Anaerobic Filters
	GeoTubes
	Septic/retention-tanks/ABR
Decentralised biological treatment	Constructed Wetlands
	Biogas Plants
Decentralised chemical treatment	Lagoon lime treatment with dewatering bed
	In barrel lime treatment with dewatering beds
	Three stage lime tanks
Centralised biological treatment	Anaerobic Lagoons
	Aeration Plant

Indicators

Group	Key indicators
Site specifics	Topography and proximity to groundwater
Technology	Area requirement and layout
	Speed of construction and commissioning
	Resilience to flooding/ natural disaster
Treatment process	Process pinch points
	Quality of liquid and solid effluent (pathogen inactivation)
	Complexity and stability
	Disposal of final products (liquid and solid)
Operation and maintenance	Operation and maintenance issues
	Expertise required for set up and operation
Costs	Capital and operational costs (Capex and Opex)
Environmental and social context	Final discharge routes
	Nuisance

Technology rating

- Technology comparison i.e. one technology against the other
- Site data against the typical parameters to identify any outliers
- A rating system of 1 (“most effective” shown in green) to 5 (“less effective” shown in red) for each indicator, for each technology
- Weighting of indicators dependant on site conditions



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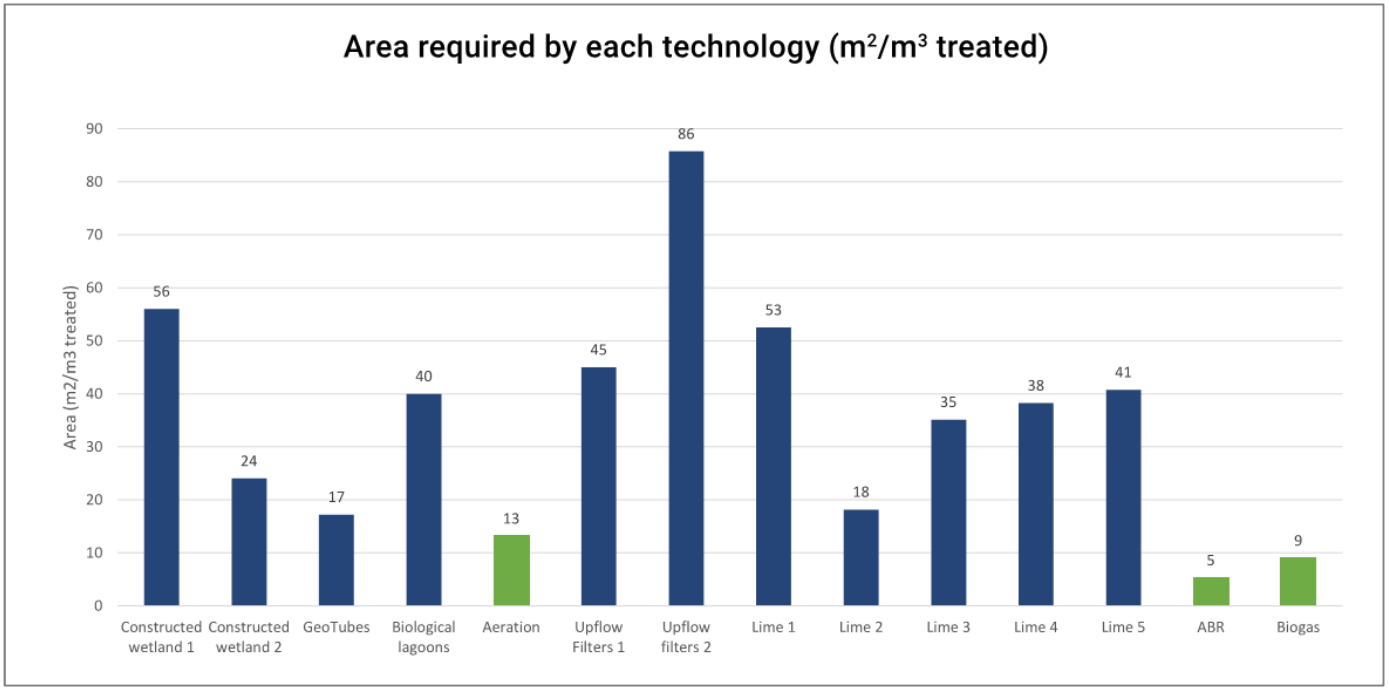
Technology selection – best for 'Footprint Area'

- (Decentralised) Lime – compact & offers full treatment
- (Centralised) Aeration plant – compact BUT energy requirement and needs to include solids handling
- ABR and Biogas – needs to include area for solids & liquid handling & disposal



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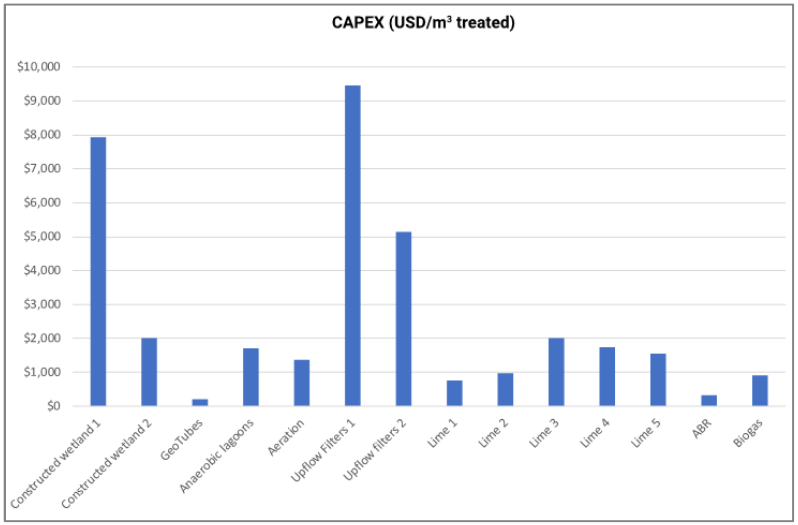
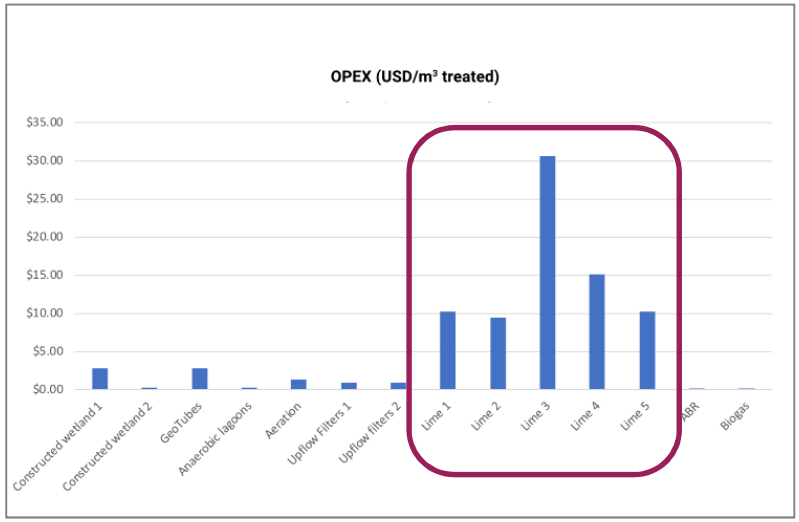
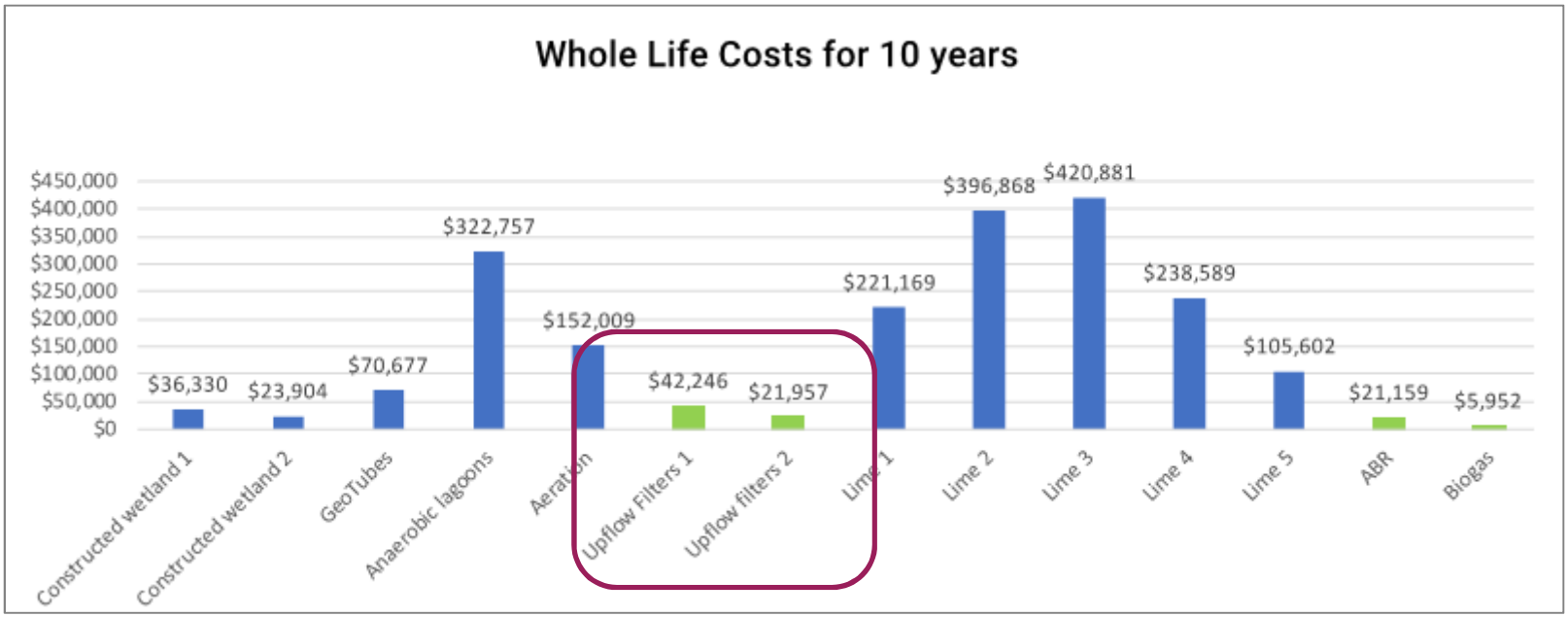
Technology selection – best for 'Cost'







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Other key indicators

- Best for ‘speed of set up’ and ‘resilience for disaster’ – Upflow Filters
- Best for ‘treatment effectiveness’ and ‘stability’
  - Centralised systems i.e. aeration and lagoons
  - Lime best for stability
- Best for (simple) O&M skills – Decentralised (biological & mechanical)

Effluent Quality

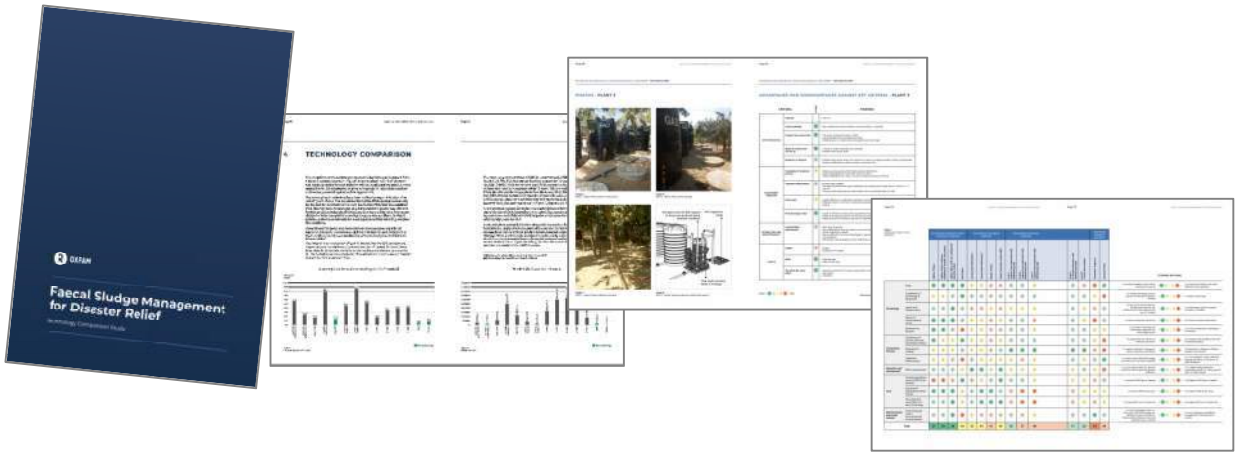
Parameter	Units	Biogas [FS ID: BGP C-10]	ABR	ABR &WSP [FS ID: ACF - EE10]	ABR	GeoTube (with lime)	Upflow Filter	Lime 1	Lime 4	Aeration Plant
Liquid meets DoE standard?										
pH		YES	YES	NO	YES	YES	YES	NO	NO	YES
BOD_5	mg/L	NO	NO	NO	NO	YES	NO	NO	NO	0
Total Nitrogen	mg/L	YES	NO	YES	NO	NO	NO	NO	NO	0
Nitrate	mg/L	YES	YES	YES	YES	YES	YES	YES	YES	YES
Phosphate	mg/L	YES	YES	YES	YES	YES	YES	NO	NO	YES
Suspended Solids (SS)	mg/L	YES	YES	YES	YES	YES	YES	NO	YES	YES
Temperature	C	YES	YES	YES	YES	YES	YES	YES	YES	YES
Coliform	CFU/100 mL	YES	YES	NO	YES	NO	NO	YES	YES	NO
Oil and grease	mg/L	0	0	0	0	0	0	0	0	0
COD	mg/L	NO	NO	NO	NO	YES	NO	NO	NO	NO
Liquid meets protection of public health (WHO) standard?										
Helminth eggs in effluent	No./L	10,000	0	10,000	200	0	100	100	0	0.6
Coliforms in effluent	CFU/100 mL	300	0	25,000	300,000	4,500,000	13,000	0	0	150,000.0
Coliform reduction	CFU/100 mL	2,799,700	3,000	45,000	-1,700,000	-2,500,000	1,960,000	180,000	1,500,000	850,000.0
Coliform	CFU/100 mL	YES	YES	NO	YES	NO	NO	YES	YES	NO
Helminth (Ascaris lumbricoidis)	no./L	NO	NO	NO	NO	YES	NO	NO	YES	YES
Solids meets protection of public health (WHO) standard?										
Coliform	CFU/100 mL	NO	YES	NO	YES	NO	NO	YES	YES	YES
Helminth (Ascaris lumbricoidis)	no./L	NO	NO	NO	NO	NO	NO	NO	YES	NO

Conclusions

- Designers should consider the site specific factors to determine if this technology is the most appropriate (selection tool)
- **Short term** - Lime Treatment
  - speed of set up
  - stability of the treatment process
  - effluent quality
  - but high OPEX therefore not appropriate in longer-term i.e. after one year/immediate phase of an emergency
- **Longer term** (decentralised) - Upflow Filters
  - score well against a number of the key indicators
- **Centralised** (long term) - Anaerobic Lagoons
  - stable and simpler technology i.e. skill level appropriate in a refugee camp context
  - Full treatment & effluent quality

Reporting

- Study Report (barcode/download)
- Selection Tool



Further studies

- Operation in wet season/long term
- Full treatment train checks (Biogas, ABR, Constructed wetlands, (some) Lime). Implications on cost and area
- Actual Vs theoretical (better data)

Upflow filters (1)

Upflow filters (2)

GeoTubes

Constructed Wetland

Lime

Lime

ABR

Biogas

Anaerobic Lagoons

Aerobic Treatment

Anaerobic Lagoons

Aerobic Treatment