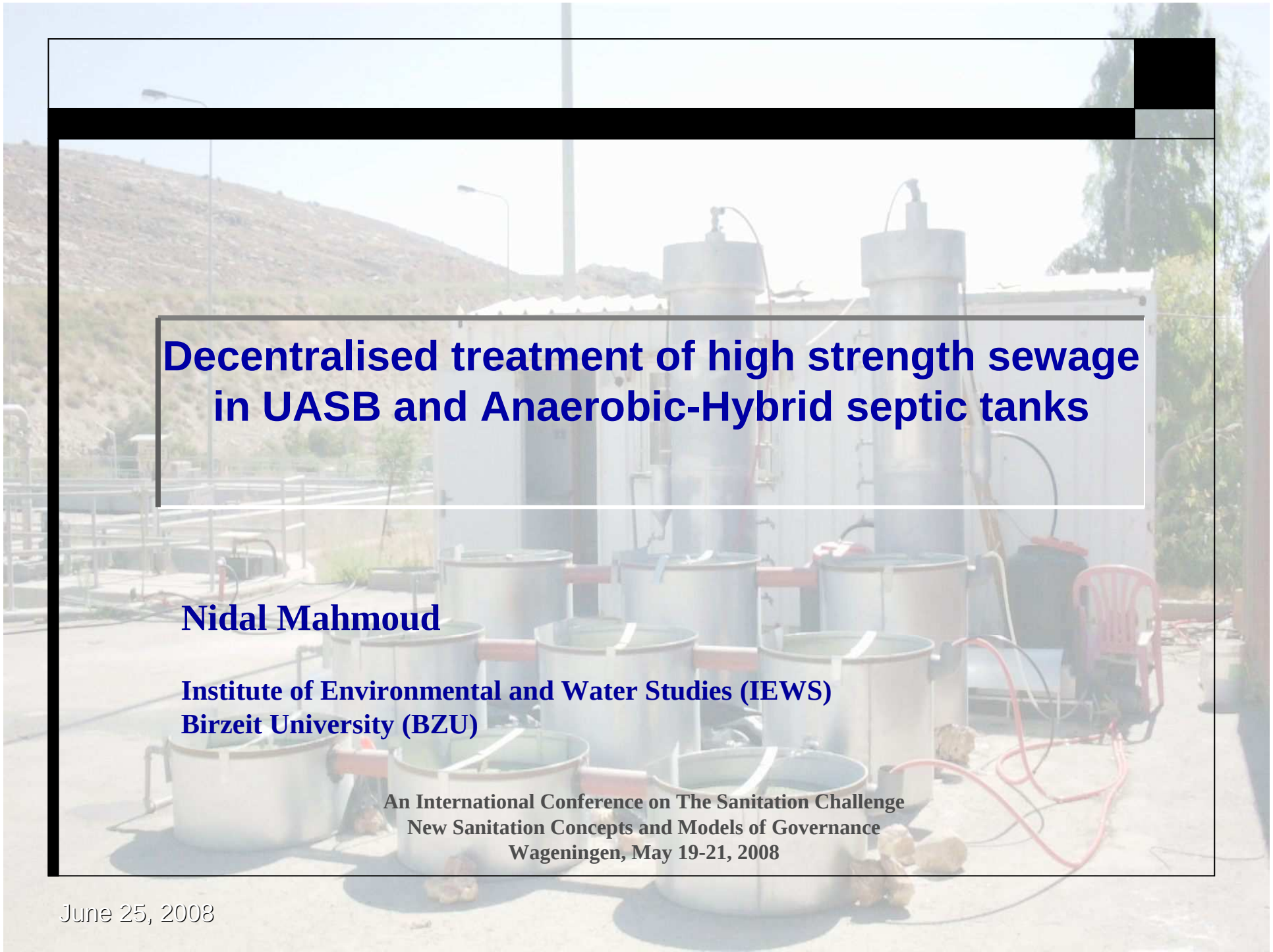

Decentralised treatment of high strength sewage in UASB and Anaerobic-Hybrid septic tanks

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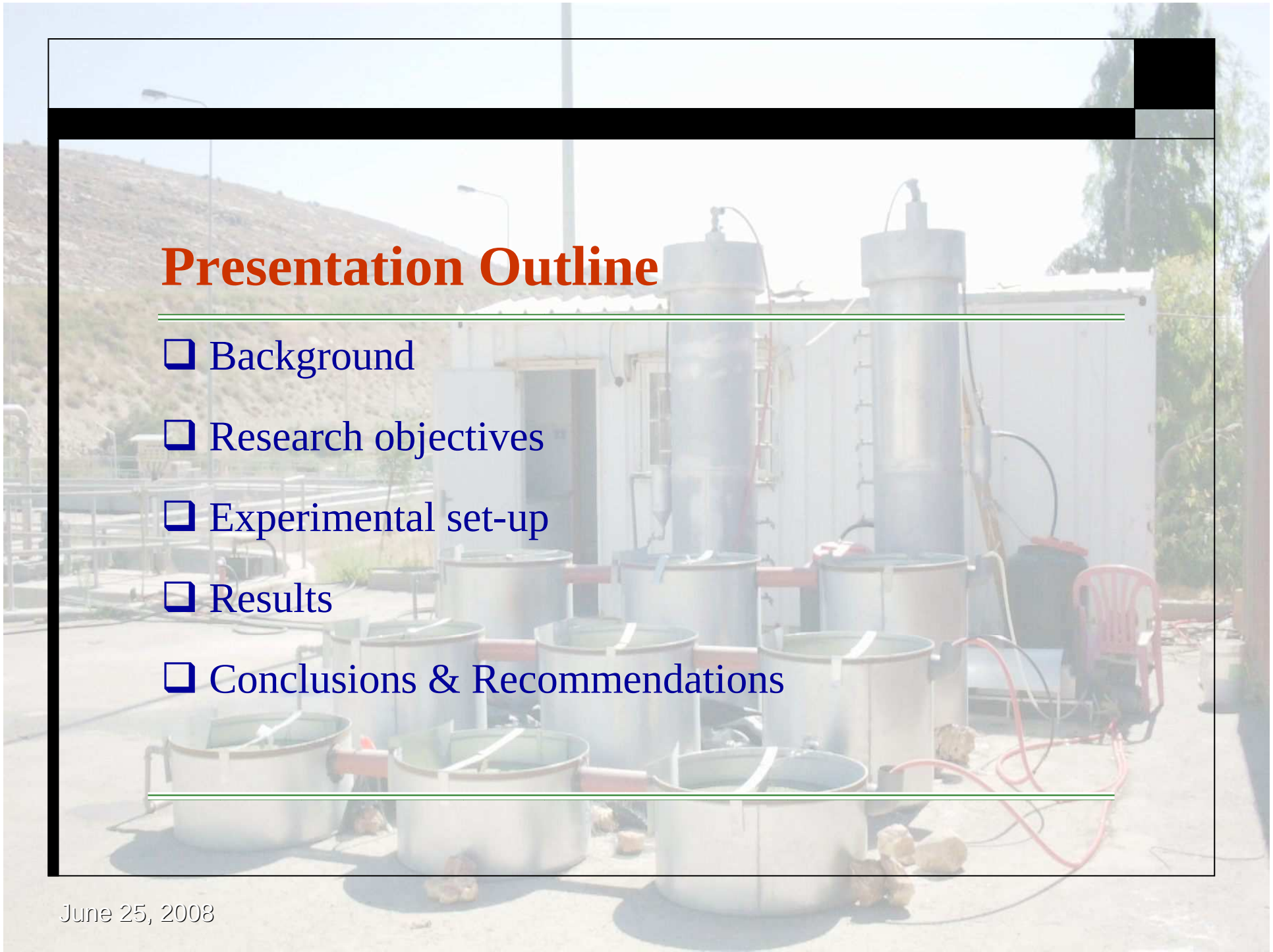


Presentation Outline

- Background
- Research objectives
- Experimental set-up
- Results
- Conclusions & Recommendations

On-site sanitation !

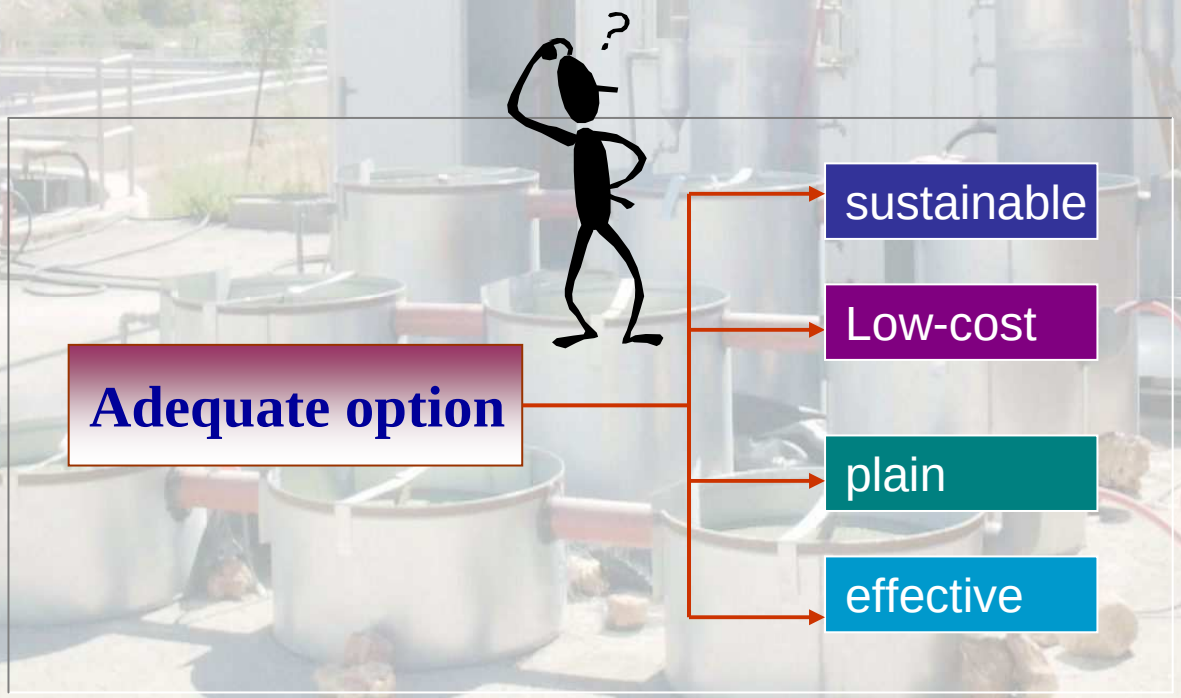
- Create possibilities for
  - Wastewater reuse
  - Resource recovery
  - Treatment of different wastewater streams

  close to the point of origin
- Reduce
  - water consumption
  - energy use
  - investment costs
- Publicly manageable (scale)
- Comply with sparse population

On-site sanitation in Palestine !?

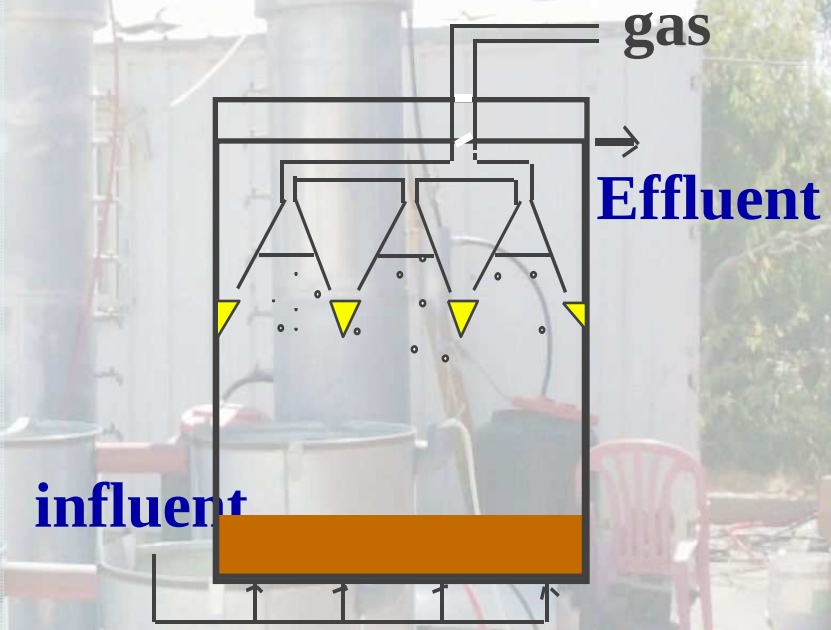
- Cesspits and septic tanks are the primary modes of on-site wastewater disposal and sewage pre-treatment.

- A sanitation intervention is needed.



☑ The UASB-septic tank system represents an effective and low-cost onsite pre-treatment alternative for domestic wastewater (Bogte *et al.*, 1993; Lettinga *et al.*, 1993).

☑ The performance of the UASB-septic tank has been recently investigated under Palestine conditions (Al-Shayah and Mahmoud, 2008; Al-Jamal and Mahmoud, 2008).



Reactors' performance

COD: hot period results

Parameter	UASB-septic tank 1 (R1) (HRT = 2 days)		UASB-septic tank 2 (R2) (HRT = 4 days)	
COD	Effluent (mg/L)	Removal (%)	Effluent (mg/L)	Removal (%)
Total	537 (60)	54 (6)*	493 (95)	58 (7)*
Suspended	97 (43)	85 (6)*	69 (29)	89 (4)*
Colloidal	129 (30)	27 (19)	121 (31)	32 (17)
Dissolved	311 (64)	12 (20)	304 (80)	14 (25)

*: Significant difference ($\rho < 0.05$)

COD: cold period results

Parameter	UASB-septic tank 1 (R1) (HRT = 2 days)		UASB-septic tank 2 (R2) (HRT = 4 days)	
COD	Effluent (mg/L)	Removal (%)	Effluent (mg/L)	Removal (%)
Total	433 (109)	51 (9)	408 (109)	54 (11)
Suspended	62 (34)	83 (10)*	45 (30)	87 (8)*
Colloidal	104 (46)	20 (32)	112 (41)	10 (37)
Dissolved	265 (96)	24 (15)	248 (94)	28 (18)

Problem

☑ The achieved values of VFA and CODdis, in the system operated by Al-Shayah and Mahmoud, of 160 and 304 mgCOD/l; and the effluent biodegradable COD of 225 and 192 mg COD/l indicate that the reactor can achieve further treatment.

Hypothesis

☑ The reactor performance might be improved by:

- enhancement of sludge bed methanogenic activity by for instance inoculating the reactor with well adopted sludge might further
- provision of packing material in the upper part of the reactor

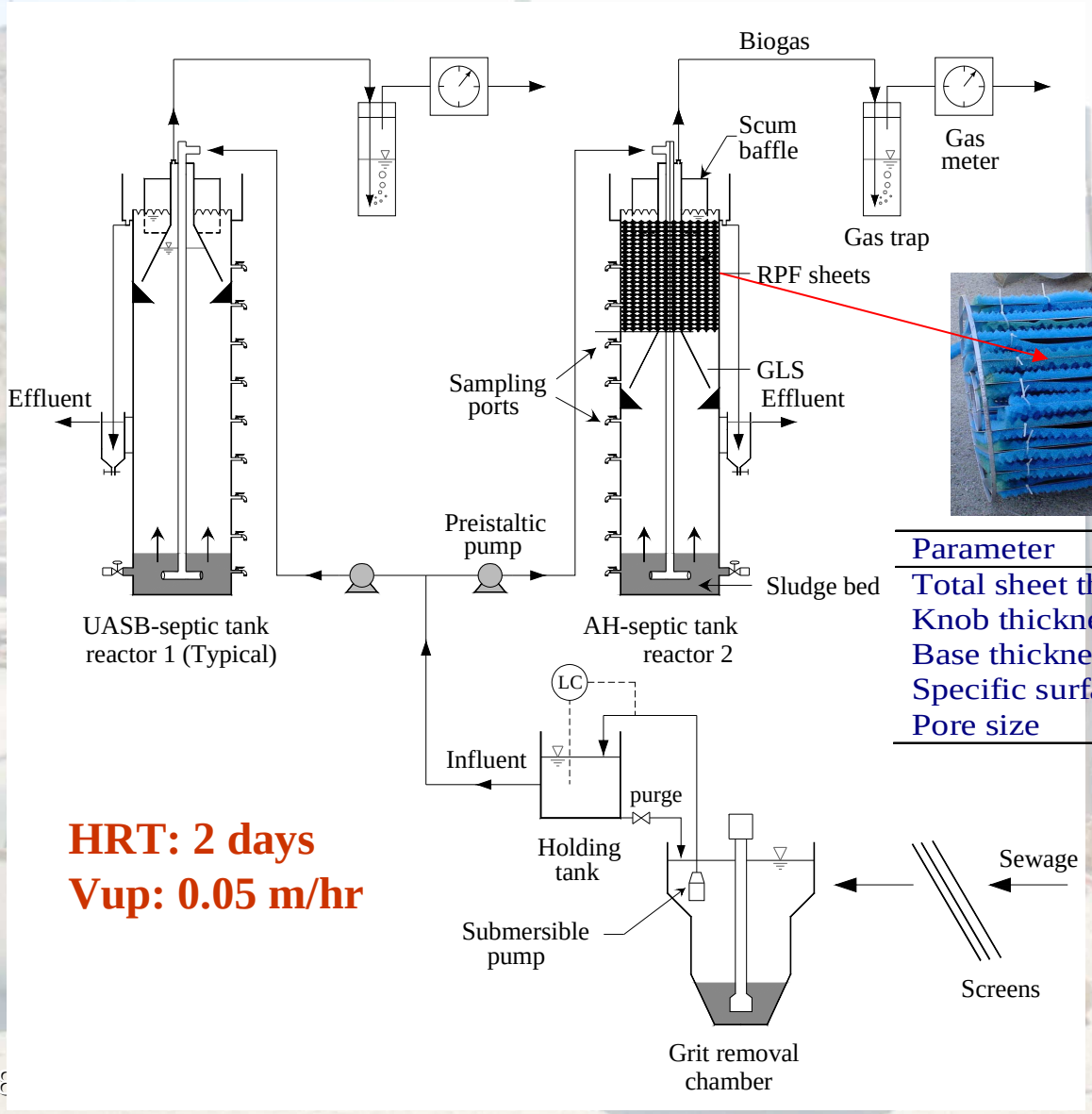
Objectives

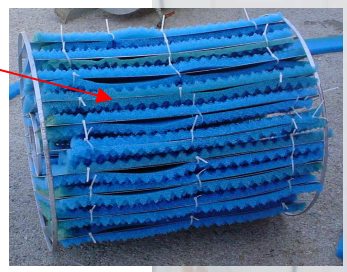
To promote a viable and affordable on-site sanitation alternative for rural communities.

Specific objectives

- The main goal of this research is to asses the possibility of enhancing the process performance of the UASB-septic tank treating sewage under Palestinian conditions by (1) adding a packing media to the top of the reactor, thus converting the UASB-septic tank to an anaerobic hybrid-septic tank; and (2) by inoculating the reactors with sludge of good quality, viz. well adopted sludge.

UASB & AH -STs pilot plants



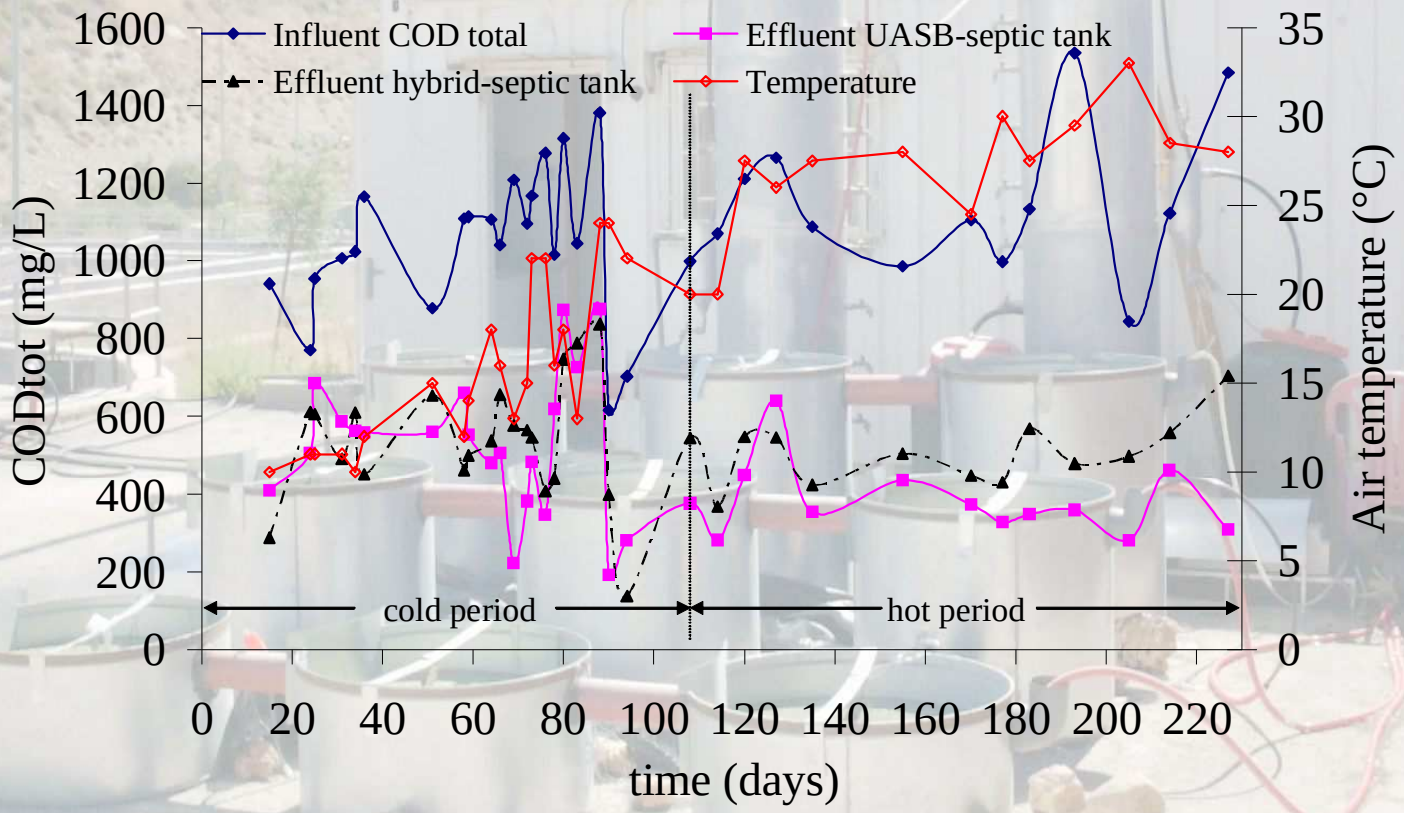


Parameter	Unit	Value
Total sheet thickness	mm	25
Knob thickness	mm	15
Base thickness	mm	10
Specific surface area	m^2/m^3	500
Pore size	mm	2.5

HRT: 2 days
Vup: 0.05 m/hr

Reactors' performance

R1: COD Total



Reactors' performance

Influent and effluent CODtot and removal efficiencies (%) in a UASB-septic tank and an AH-septic tank reactors

		Cold period 15 – 108 day n = 22			Hot period 108 – 227 day n = 13		
		Influent	UASB-ST	AH-ST	Influent	UASB-ST	AH-ST
CODtot (mg/l)	Average	1042	520	539	1141	385	509
COD removal (%)	Average		50	48		66	55
Tair (°C)	Average	16			27		

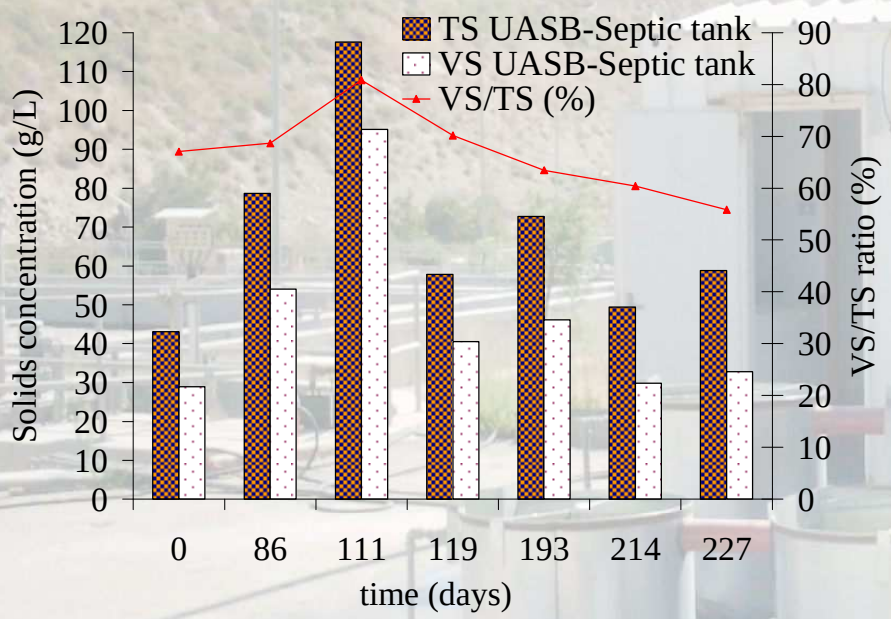
Reactors' performance

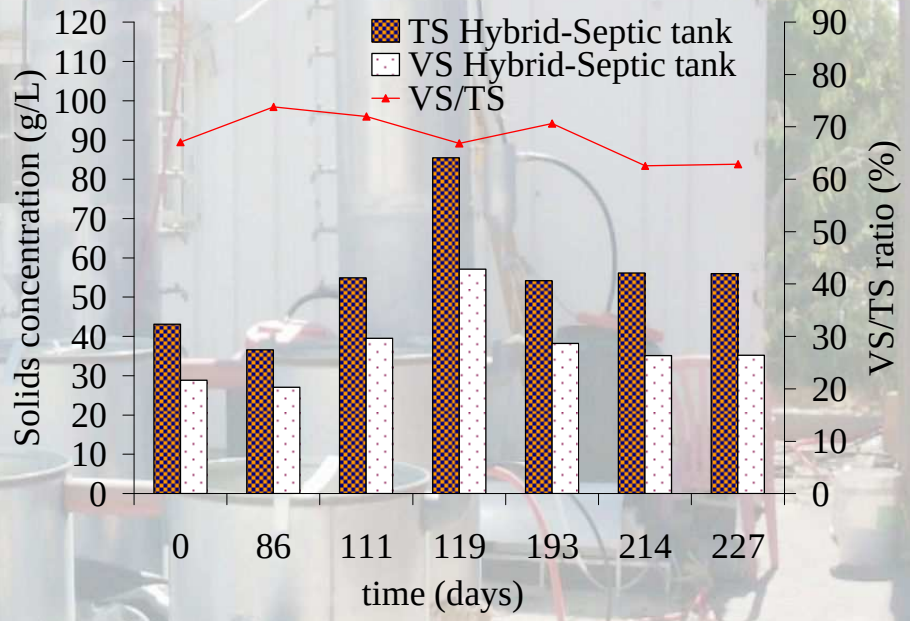
Influent and effluent conc. and removal (%) in UASB-st and AH-st

Parameter		Influent Conc.	UASB-st (HRT = 2 days) Effl. Conc. AVR	UASB-st (HRT = 2 days) R. effic. (%)	AH-st (HRT = 2 days) Effl. Conc. AVR	AH-st (HRT = 2 days) R. effic. (%)
COD	Total	1186	348	70	540	53
	Sus	767	209	72	339	54
	Col	111	18	77	22	78
	Dis	308	121	55	179	45
VFA as COD		110	15	88	21	82
NH_4^+ as N		84	80	-0.06	83	1.2
PO_4^{3-} as P		14.3	12	14	11	24
TSS		1125	45	94	59	95
FC				99.33		
		8.40E+09	3.37E+07		3.80E+07	99.16
Tair (°C)		29				
Patm.		0.92				

Measurements over 50 days (177-227 day)

Reactors' performance





Sludge bed development in a UASB-st and AH-st

Reactors' performance

VS, TS, and VS/TS ratios (0-227 days)

	VS	TS	VS/TS
UASB-st	47	68	67
AH-st	37	55	68

Reactors' performance

The VFA/CODdis had remarkably reduced from 40% in the influent to 12% in the effluent of both reactors, with a substantial decrease of VFA concentration in the effluent.

Conversion in UASB –septic tanks: 2 days HRT

Parameter	This research	Al-Shayah and Mahmoud (2008)
H (%)	29	16
A (%)	30	19
M (%)	36	15

Conclusions

- The performance of the UASB-septic tank reactor was substantially improved by starting up the reactor with well adopted anaerobic sludge.
- The UASB-septic tank reactor is more efficient as compared to the AH-septic tank reactor.

Recommendations

- Application of UASB-septic tank for grey water treatment should be assessed.
- Application of decentralized "community onsite and/or one house or cluster on-site" in Palestine is recommended
- Performance of the reactors during the second year of operation should be assessed.
- A post-treatment step is recommended in most cases after UASB- septic tank systems.
- Hydrodynamic behavior of the UASB septic tank should be assessed


Thank You !