From Standards to Finance

Operational Business Models for DEWATS & circular resource approaches as climate change adaptation option in Agriculture, North Jordan



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Findings from project performed under the NDC Action umbrella focusing on:

"DWATS as climate change adapation option for smallholder farmers in North Jordan"

Supported by:



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copenhagen climate centre











Short Introduction BORDA











People. INNOVATING. Sanitation.

- Bremen Overseas Research and Development Association (BORDA), Not-for-profit German NGO founded in 1977
- Expert organization in the field of sanitation, innovation, and integrated resources management / wastewater NEXUS
- **OUR MISSION**

To improve the living conditions of disadvantaged communities and protect the environment through expansion of **Basic Needs Services** in areas of **decentralized sanitation**, **solid waste and wastewater management**, water and energy supply.



















Project Overview & Objective









Problem Structuring & Conceptual Background of NDC Project

416 mio. m³/a

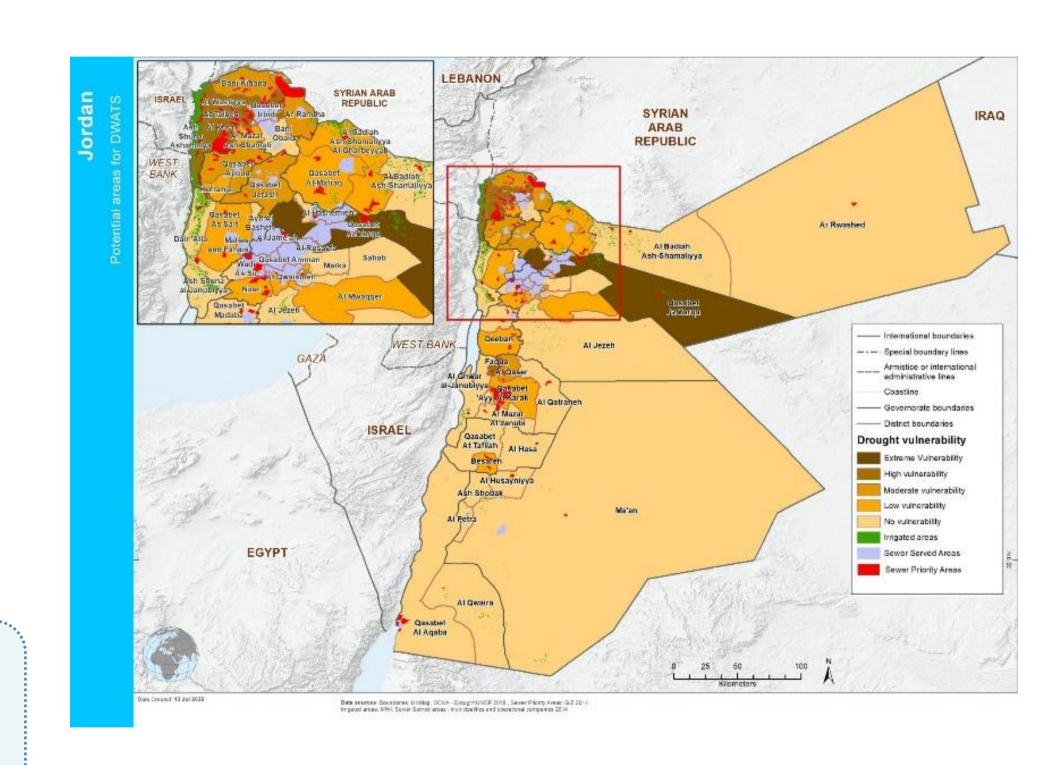
of renewable water supply deficit in Jordan.

(UNEP, 2021 - NDC Action Project Report)

Jordans harsh climate perpetuated by climate change is increasingly affecting

- → Agricultural water supply & productivity, food security
- → Heightened poverty risk for smallholder farmers

Wastewater contains valuable water, nutrient, and energy resources & has immense potential to address rising environmental challenges / climate change mitigation

















Short Introduction

















- Combat pollution & WASH related diseases via increased hygiene by decentralized wastewater, faecal sludge & solid waste management solutions & capacity building
- Increase water security through recycling of treated nutrient rich wastewater for irrigation in agriculture
- Improve soil health & food security through innovative integrated resource approaches and recycling of nutrients
- Address climate change through more sustainable nature-based sanitation with minimized resource inputs + enhanced resource outputs; & capture GHG to produce biogas
- Enable access to fertilizer through production of compost from recycling streams of organic waste & faecal sludge
- Support broader sectoral development 4 all and address financial deficits, with robust systems that last, have a low O&M requirement, are low costs, and enable additional revenue streams via circular resource approaches

















Principles: WW-WEF Nexus

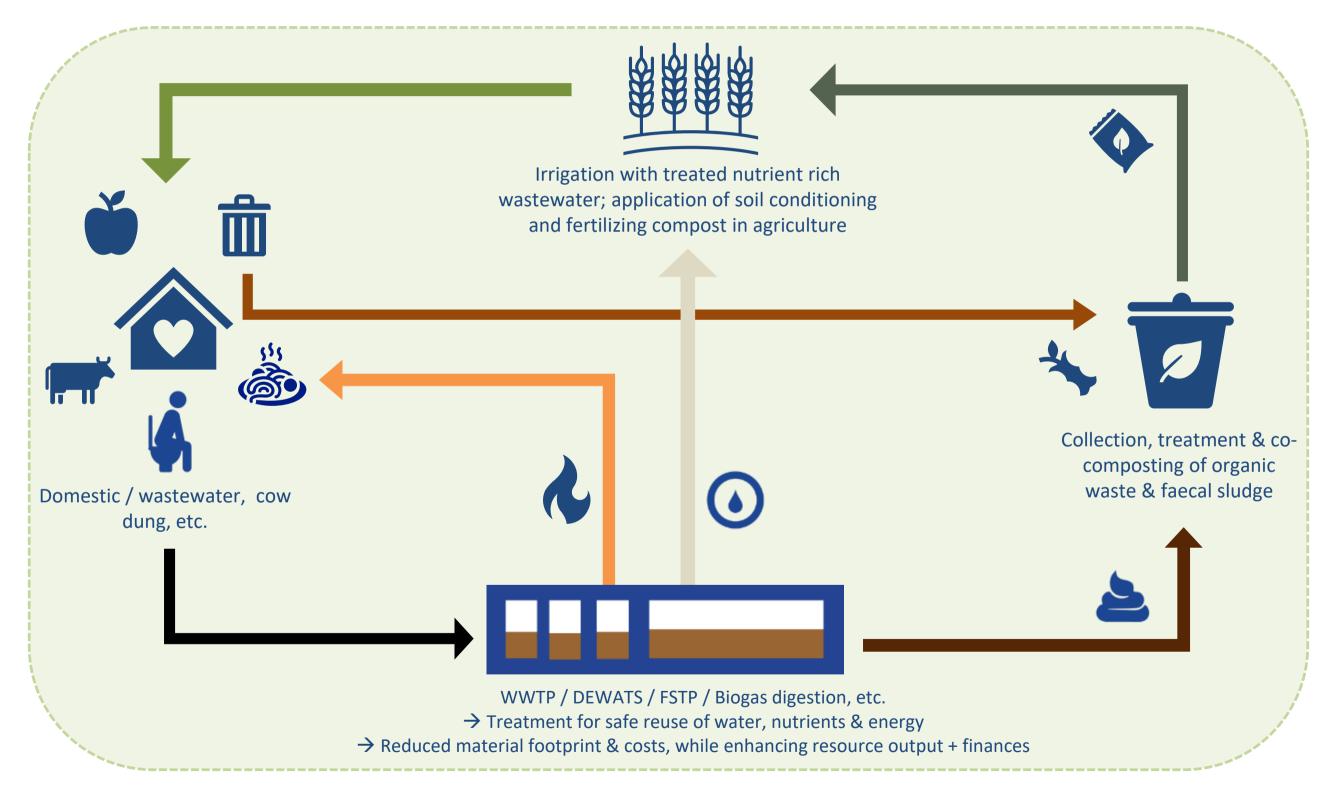








Addressing rising water insecurity, land degradation & food insecurity, and climate change through circular resource approaches, resource sensitive systems, and climate change adaptation/mitigation measures



















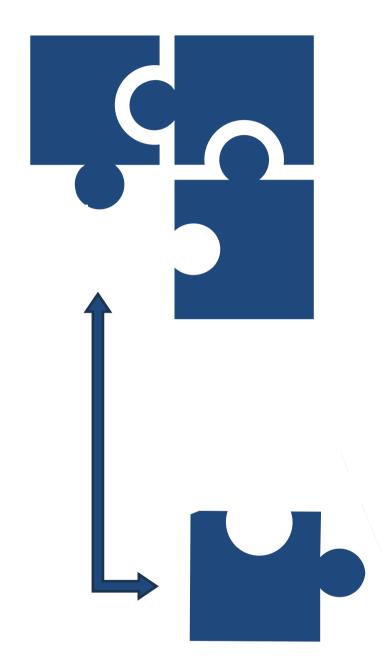
Project Overview & Objective











Overarching Goal & Intervention

Enhance resilience of vulnerable smallholder farmers to climate risks & food insecurity

Adaptive measure: establishing decentralized wastewater treatment & use of non-conventional water source



Objective of this Project

This project aimed to address the gaps in assessment of market, technology, & potential business models to accelerate the adoption of decentralized wastewater treatment systems (DWATS) as non-conventional water source in Jordan.

















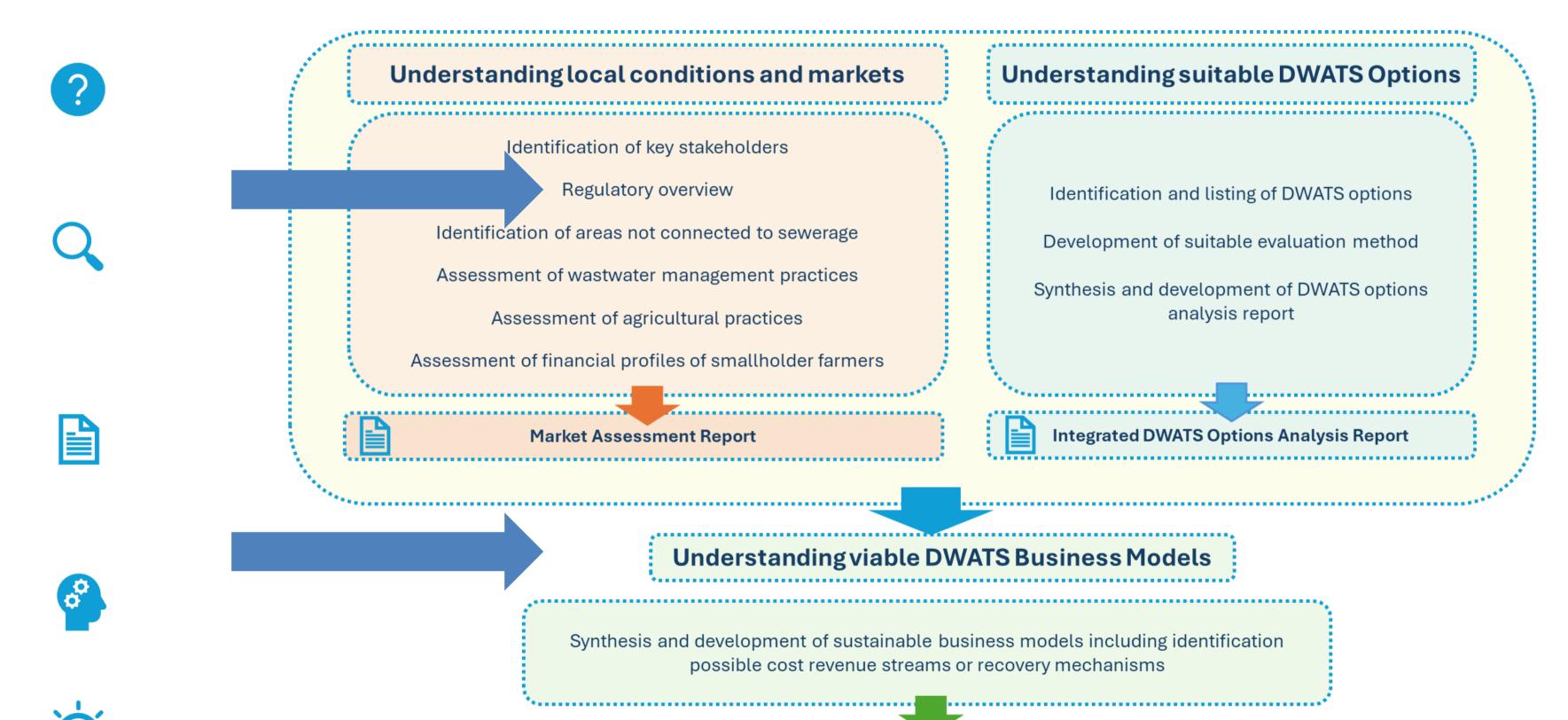
Breakdown of Intervention Components Borda Borda Borda

















Sustainable DWATS Business Model Report











OC 1: Results of Regulatory Overview









			JS			JS	MWI, 2016			
		893/2021				893/2006	Systems <500 / <5000*			
Parameter	Unit	Class A (parks, playgrounds and side roads inside cities)	Class B (Fruit trees, sides of roads outside the cities, and green areas)	Class C (Industrial crops, field crops, and forest crops)	Class A (Cooked vegetables, parks, playgrounds and side roads inside cities)	Class B (Fruit trees, sides of roads outside the cities, and green areas)	Class C (Industrial crops, field crops, and forest crops)	Infiltration trench for trees	Drip irrigation	Open irrigation
рН		6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9
BOD5	mg/l	30	100	200	30	200	300	-	-	-
COD	mg/l	100	200	300	100	500	500	150	150	150
TSS	mg/l	50	100	100	50	200	300	50	50	50
TN	mg/l	70	70	70	45	70	100	-/70*	-/70*	-/70*
NO3-N/NO3	mg/l	16	16	16	30	45	70	-	-	-
NH ₄	mg/l	-	-	_	_	_	-	-	-	-
PO4-P/ PO4	mg/l	10	10	10	30	30	30	-	-	-
E. Coli	MPN/100ml	100	1000	-	100	1000	-	-	1000	100

→ Lack standards for small scale systems. While recommended in DWAM Policy (2016), 1 single set of standards remains.

















OC 2: Results Technology Options









Technology Evaluation performed for following pre-selected options under 2 regulatory scenarios:

Scenario B: MWI, 2016

		Option B1	Option B2	Option B3	Option B4	Option B5	
		Passive anaerobic & aerobic	Passive anaerobic & intensified aerobic	Passive aerobic	Pond system	Activated Sludge Process	
	Screen	none	none	yes	yes	yes	
0.5	Pretreatment	settler	settler		Anaerobic	settler	
Reactors	Primary	ABR/AF	ABR/ AF	French VFCW	pond(s) &	SBR	
- Se	Secondary	VFCW aerated HFCW			Facultative	301	
	Tertiary/ disinfection	/ disinfection WSTR		WSTR	WSTR	sandfilter+UV	
8	COD/TSS	yes	yes	yes	yes	yes	
and	TN (<500 PE)	yes	yes	yes	yes	yes	
Compliance	TN (500 - 5.000 PE)	no	yes	yes	yes	yes	
	E. coli (drip-irr.)	yes	yes	yes	yes	yes	
ت	E. coli (flood-irr.)	yes	yes	yes	no	no	
Eva	poration loss	10% + 15%	15%	10% + 15%	10% + 15%	<2%	
Reactor footprint (m ² /PE)		4.3	1.2	4.1	4.6	0.2	
Energy (kWh/m³)		0	0.2 - 0.4	0	0	0.8	
General complexity		low to medium	medium	low to medium	low	very high	
CAPEX estimate (USD/PE)		200 to 440	200 to 440	100 to 340	110 to 240	160 to 420	
OPEX estimate (USD/PE*y)		1.1 to 4	4 to 22	1.1 to 4	lower than 1.1 to 4	8 to 28	

Scenario A: JS 893/2021

- Requires advanced denitrification
- Large reactor volumes
- Recirculation of ww
- Additional aerators/pumps
- Complex process control
- Requires advanced P removal, dosing of precipitants & complex process control.
- → None stated on left, only advanced SBR process with additional processes for nutrient removal

















OC 2: Results Technology Options









Calculating performance scores/ Compare/ Evaluate (following the WSM as proposed by CLUES of Eawag)

Criteria	Subcriteria	Indicator	B1	B2	B3	B4	B5
Environmental	Resource recovery	Water recovery, evaporation losses	0.1	0.2	0.1	0.1	0.6
	Complexity	General complexity	0.5	0.3	0.5	0.6	0.1
	Debugtage	Varying loads	0.3	0.3	0.3	0.3	0.3
Technical	Robustness	OM variations, powercuts and mistakes	0.6	0.3	0.6	0.6	0.1
	ОМ	Sludge production and quality	0.5	0.5	0.5	0.5	0.1
	ОМ	OM requirements	0.5	0.5	0.5	0.6	0.1
•		Surface requirements	0.0	0.1	0.0	0.0	0.1
Financial		Electricity requirements	0.6	0.1	0.6	0.6	0.1
Financial		CAPEX	0.1	0.1	0.3	0.3	0.1
		OPEX	0.5	0.5	0.5	0.6	0.1
Social Acceptance		Land depreciation	0.2	0.2	0.2	0.2	0.3
		Performance score	3.6	3.0	3.8	4.2	2.0
	Order of pe	3	4	2	1	5	

- → Either technology could be the best applicable solution for a specific location
- → In general passive and naturebased solutions were found to score by far best with the selected criteria, which strongly emphasise O&M requirements
- → Varying indicator weights show that results are robust (performance scores stay in same order)

Conclusion: The best technology depends on context-specific needs, balancing cost, simplicity, and efficiency

















OC3: DWATS Business Models













Focusing on DWATS options profitability and cash flows (CAPEX & OPEX in relation to revenue streams via treatment fees, service costs savings through avoided costs such as cesspit emptying, and selling of treated effluent for irrigation)

Economic Feasibility Analysis

Extends to environmental and social benefits, e.g. improved water quality, water value added through available water resources for irrigation and improved harvest, circular resources approaches (nutrients in TWW), public health, and job creation

Methodology: Monte Carlo Simulation; Benefit-Cost Analysis & Cost Effectiveness Analysis

Key Metrics: CAPEX & OPEX, NPV, IRR, benefit/cost ratios, AIC/AIB - CAPEX/OPEX, Total AIC/AIB, Payback period

Baseline: North Jordan, 5000 PE system size (only wwtp given regional focus), 30 years system lifetime, analysis for 2 scenarios: A (standards 2021) and scenario B (DWAM 2016),

















OC 3: Results DWATS Business Model









CAPEX & OPEX ranges estimate from OC2

	Standards 2021		Recomme	nded standards D	WAM 2016		
Motrio	Option A.1	Option B1	Option B2	Option B3	Option B4	Option B5	
Metric	Activated sludge + advanced nutrient removal	Passive anaerobic & aerobic	Passive anaerobic & intensified aerobic	Passive aerobic	Pond system	Activated sludge process	
CAPEX (USD/PE)	240 to 630	200 to 440	200 to 440	100 to 340	110 to 240	160 to 420	
Max	630	440	440	340	240	420	
Min	240	220	200	100	110	160	
Avg	435	330	320	220	175	290	
OPEX (USD/PE*y)	16 to 56	1.1 to 4	4 to 22	1.1 to 4	<1.1 to 4	8 to 28	
Max	56	4	22	4	4	28	
Min	16	1.1	4	1.1	1	8	
Avg	36	2.55	13	2.55	2.5	18	

















OC 3: Results DWATS Business Models









tor		Financi Assessm	Economic Assessment				Financial Viability		Economic Viability			
dica	Assessment Table 17:				Table 19:				Table	e 16:	Table 18:	
Analysis & In	NPV	B/C	IRR	Pay back	E-NPV	E-B/C	E- IRR	Pay back	Fin. AIC- CAPEX	Fin AIC- OPEX	Econ. AIC- CAPEX	Econ AIC- OPEX
An	Mio. US\$	ratio	%	Year	Mio. US\$	ratio	%	Year	US\$/ m³	US\$/ m³	US\$/ m³	US\$/ m³
A1	-3,18	0.114	<-10	0	1,623	1.419	11.6	14	2.45	1.98	1.35	1.60
B1	-1,21	0.252	-4.3	0	4,00	3.678	26	6	1.86	0.14	1.03	0.11
B2	-1,48	0.271	-11.4	0	3,69	2.786	24.2	6	1.80	0.71	1.00	0.58
В3	-0.708	0.366	-1.4	0	4,46	5.256	38.2	4	1.24	0.14	0.69	0.11
В4	-0.501	0.449	0.4	0	4,29	5.993	44.5	4	0.98	0.14	0.55	0.11
B5	-1,69	0.205	<-10	0	3,37	2.51	23.8	7	1.63	0.99	0.90	0.80

- > In Financial Analysis, none of options demonstrated financial viability under current fees, service cost avoidance and selling price of TWW
- → Low to high economic viability
- → High variance between standards scenario and respective technology options, while most viable option under scenario B B4

















Results: Summary









Financial and Economic Viability:

From a socio-economic perspective, **investment in sanitation brings enormous return** to population. 6 DWATS options analyzed using **Benefit-Cost (B/C) Analysis** & **Cost-Effectiveness** showed potential for long-term economic sustainability.

- → While high economic potential, very high differences depending on standards and technology options.
- > Overall socio-economic gains likely considerably higher, but persisting difficulty in overall assessment.

Sustainability & Cost Recovery:

operational Business models emphasize **tariffs**, **user fees**, and **public-private partnerships (PPP) under circular approaches** to ensure cost recovery. However, current restrictions in biosolids management and circularity.

Adaptation to Climate Change:

DWATS can **support climate adaptation** & agricultural resilience by providing reuse options for treated wastewater resources, aiding smallholder farmers in water-scarce regions. Further high potential for climate mitigation measures.

















Results: Recommendations Forward











Adopt **hybrid governance models**, incorporating PPP, encourage private sector participation through financial incentives such as subsidies, tax reliefs, and incentivizing service contracts, etc.



A differentiated set of standards for smaller system capacities (as valid in other regions), along with considerations towards improved resource circularity in various applications // Nexus management -> enabling wider climate mitigation



High % of unconnected localities in North of Jordan. If standards do not align with financial budgets or economies of remote areas & respective development plans, risk of inaction. Recommended **gradual standardization along feasible development plans & budgets**.



Conduct **broad feasibility studies on local level** for various communities to understand detailed and overall infrastructural solutions (including sewerage)



Implement a **flagship pilot as living lab and demonstration site towards viable operational models**, awareness campaigns, research for further scaling (e.g. low 0&M intensive systems could be clustered), detailed financial analysis under integrated resource approaches, etc.



Need for **elaborated Life Cycle Assessments/technology evaluation matrices** to better understand climate mitigation measure + improve decision making to technology choice; inclusion of wider sustainability parameters & GHG mitigation



















Thank you!

Any questions?

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