Improving MEDiterranean irrigation and Water supply for smallholder farmers by providing Efficient, low-cost and nature-based Technologies and practices

Target: Engineering Constructed Instream Wetland Treatment (CWT) Pilot in the desert (El-Wahat El-Bahariya), Egypt

(WP 2: Technology development & adaptation)

MED-WET Project - Heliopolis University, Egypt

22/1/2023

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Heliopolis University
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PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA

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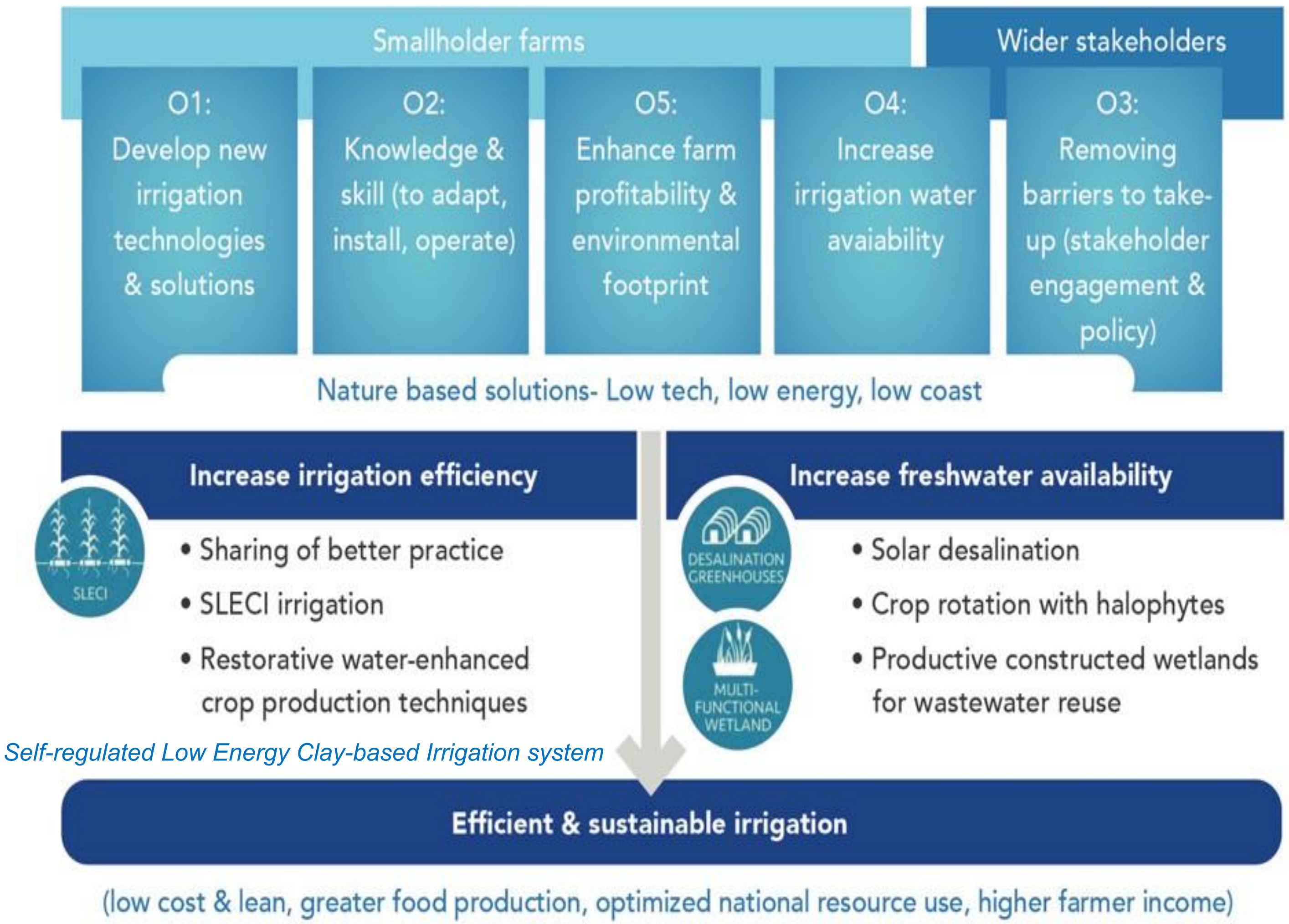
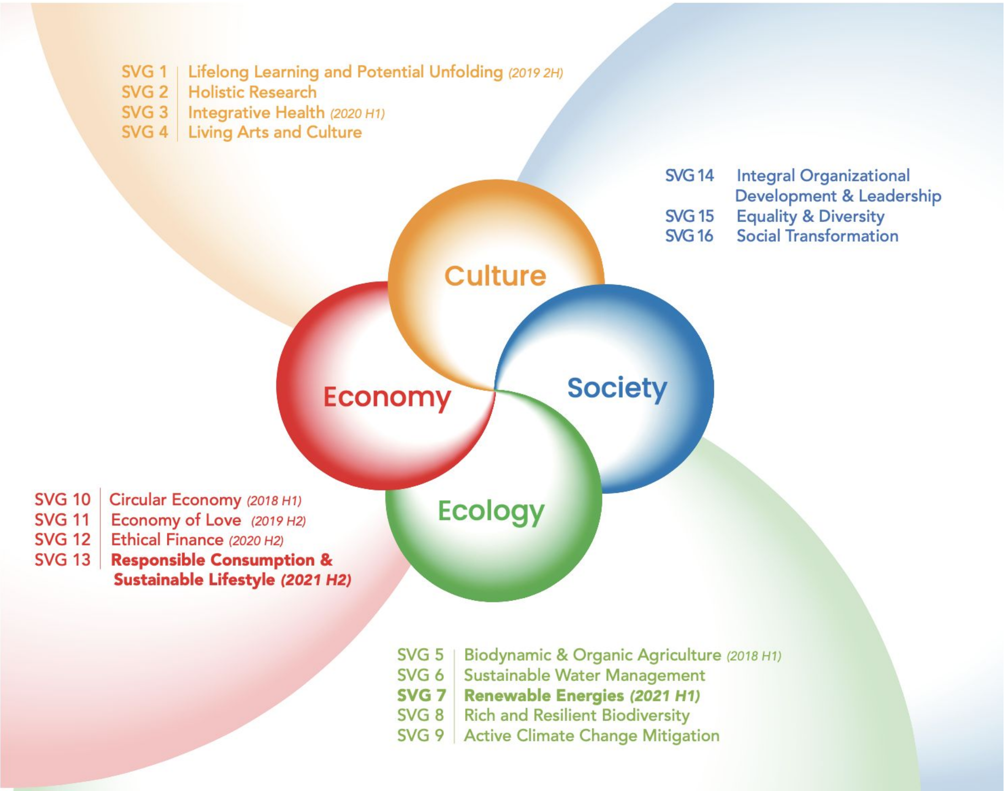
Improving MEDiterranean irrigation and Water supply for smallholder farmers by providing Efficient, low-cost and nature-based Technologies and practices

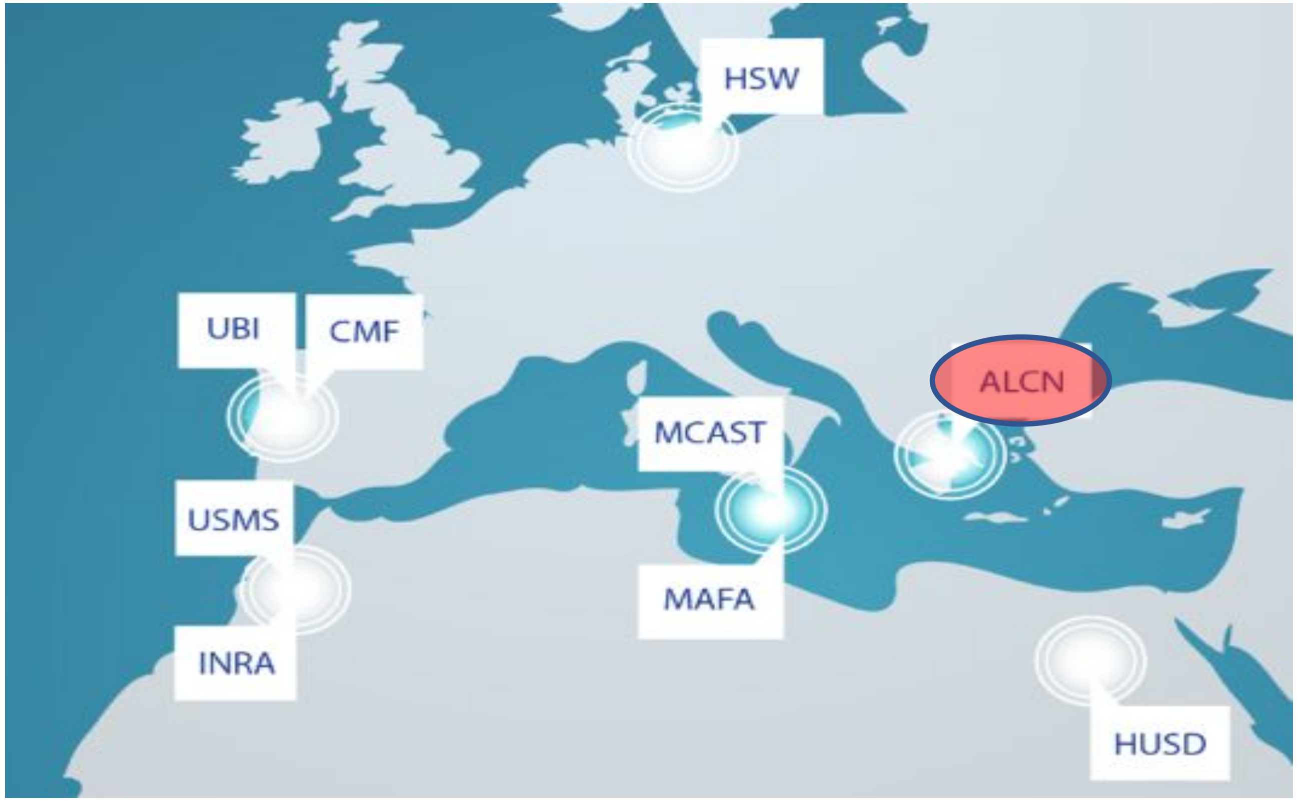


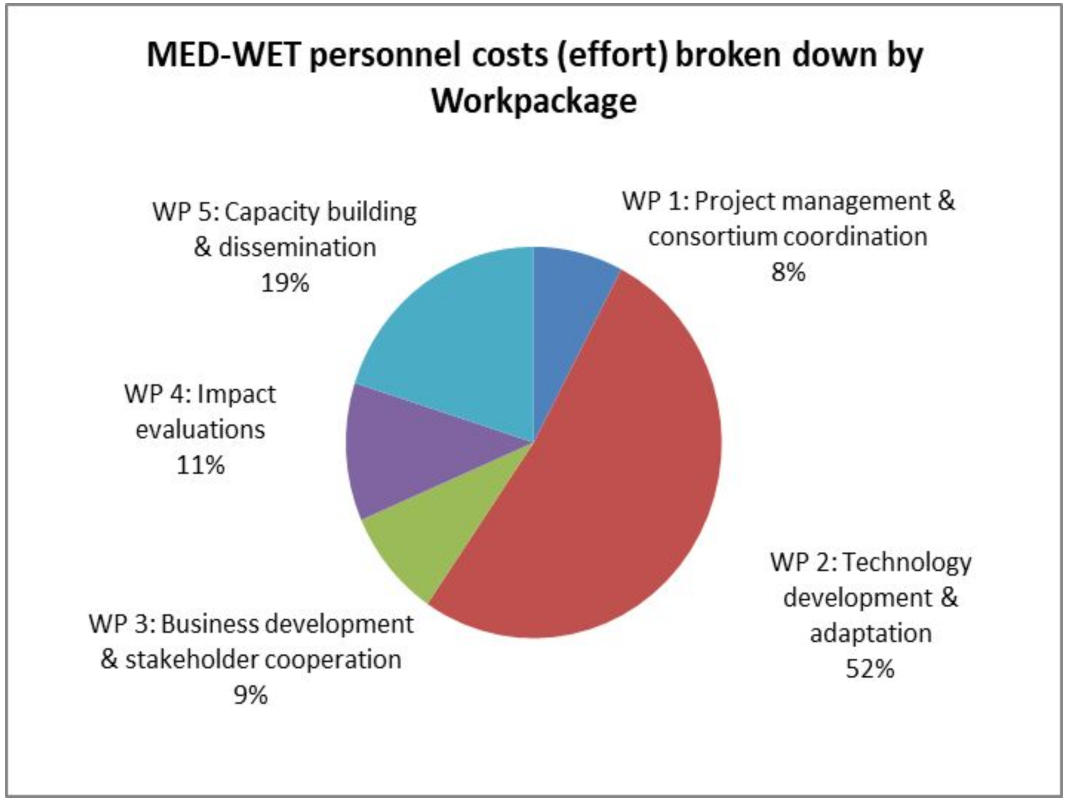


Ecology □ SVG (6)

Culture □ SVG (2)

Improving MEDiterranean irrigation and Water supply for smallholder farmers by providing Efficient, low-cost and nature-based Technologies and practices





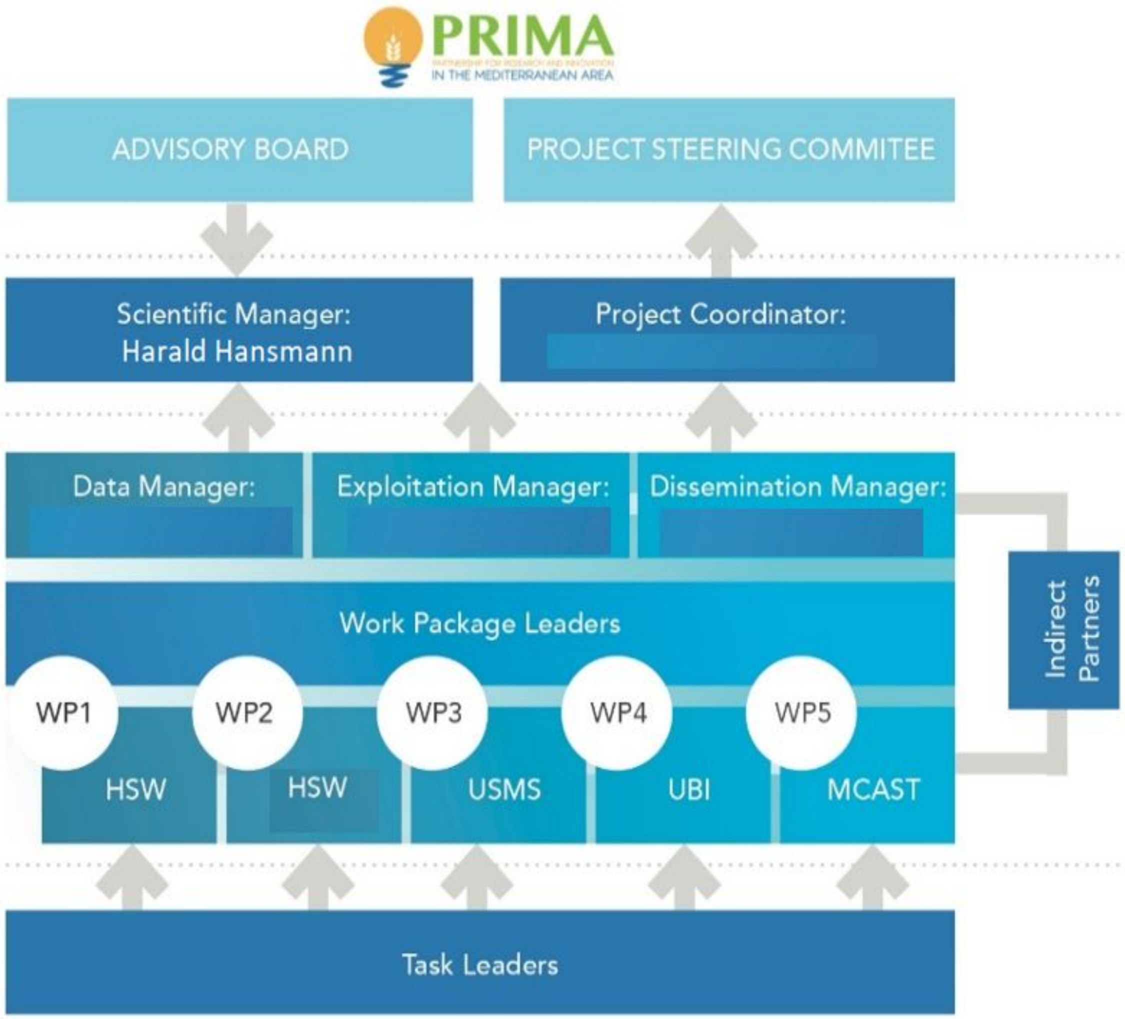
Improving MEDiterranean irrigation and Water supply for smallholder farmers by providing Efficient, low-cost and nature-based Technologies and practices

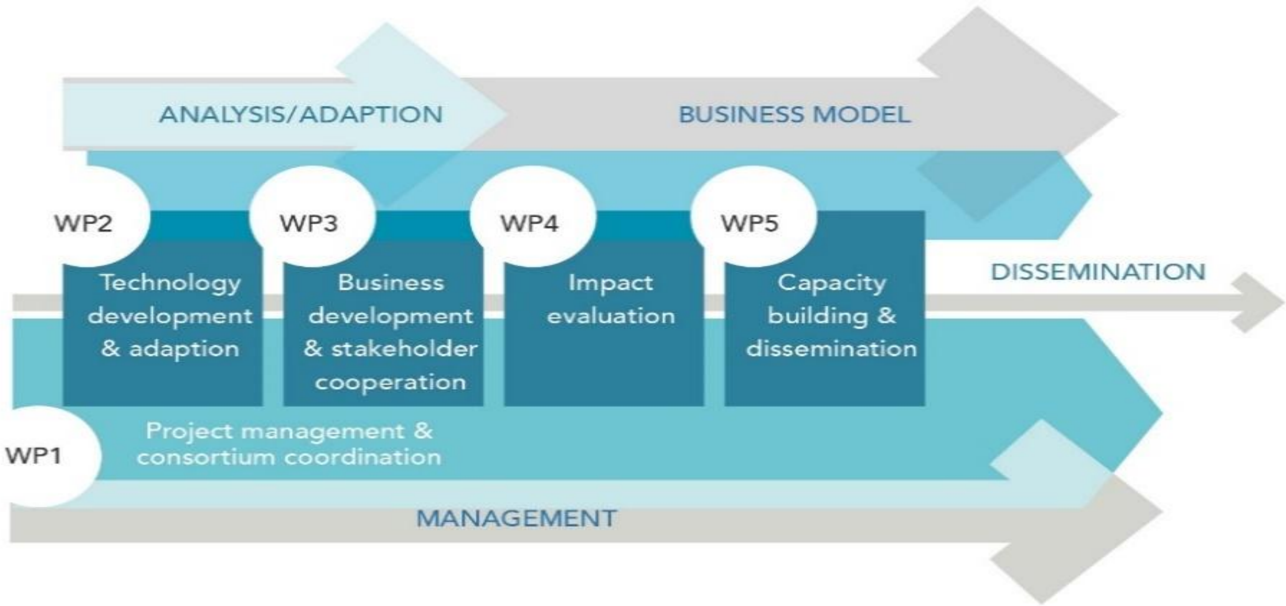
- **WP1: Project management and coordination (Lead: HSW)**
- **WP2: Technology development and adaptation (Lead: HSW)**
- **WP3: Business development & stakeholder cooperation (Lead: USMS)**
- **WP4: Impact evaluations (Lead: UBI)**
- **WP5: Capacity building and dissemination (Lead: MCAST)**

The three technologies are:

Self-regulated Low Energy Clay-based Irrigation system (SLECI)
Desalination using renewable solar energy
Low-cost nature-based efficient wetland treatment

Improving MEDiterranean irrigation and Water supply for smallholder farmers by providing Efficient, low-cost and nature-based Technologies and practices





Improving MEDiterranean irrigation and Water supply for smallholder farmers by providing Efficient, low-cost and nature-based Technologies and practices

- **MedWet is a 3-year project till 31 Oct 2024**
- **List of partners**

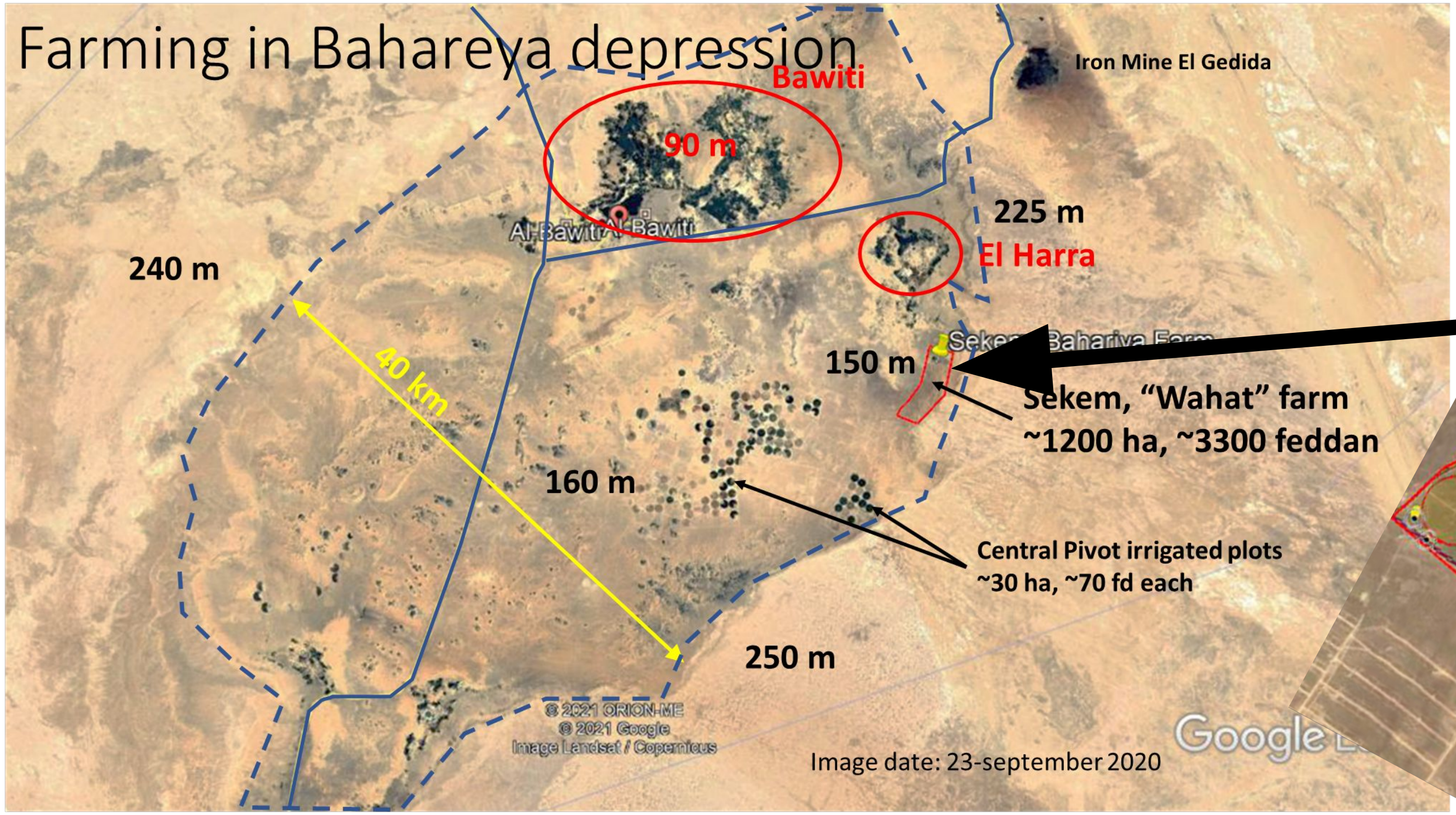
N°	PI name	Organisation	Main role	Type	Country
1	Harald Hansmann	Hochschule Wismar (HSW)	Project coordination, WP1 lead, tech developer (SLECI), Scientific lead, WP2 lead	UNI	DE
2	Wael Khairy	Heliopolis University for Sustainable Development (HUSD)	Pilot lead	UNI	EG
3	Malcolm Borg	Malta College for Arts, Science & Technology (MCAST)	WP5 lead	UNI	MT
4	Joseph Cutajar	EcoGozo Directorate (EcoGozo)	Pilot lead	GOV	MT
5	Bassou Bouazzama	Institut National de la Recherche Agronomique du Maroc (INRA)	Pilot lead	RTD	MA
6	Nadya Wahid	Sultan Moulay Slimane University (USMS)	WP3 lead	UNI	MA
7	João Leitão	University of Beira Interior (UBI)	WP4 lead	UNI	PT
8	Ricardo Goncalves	Municipality of Fundão (CMF)	Pilot lead	GOV	PT

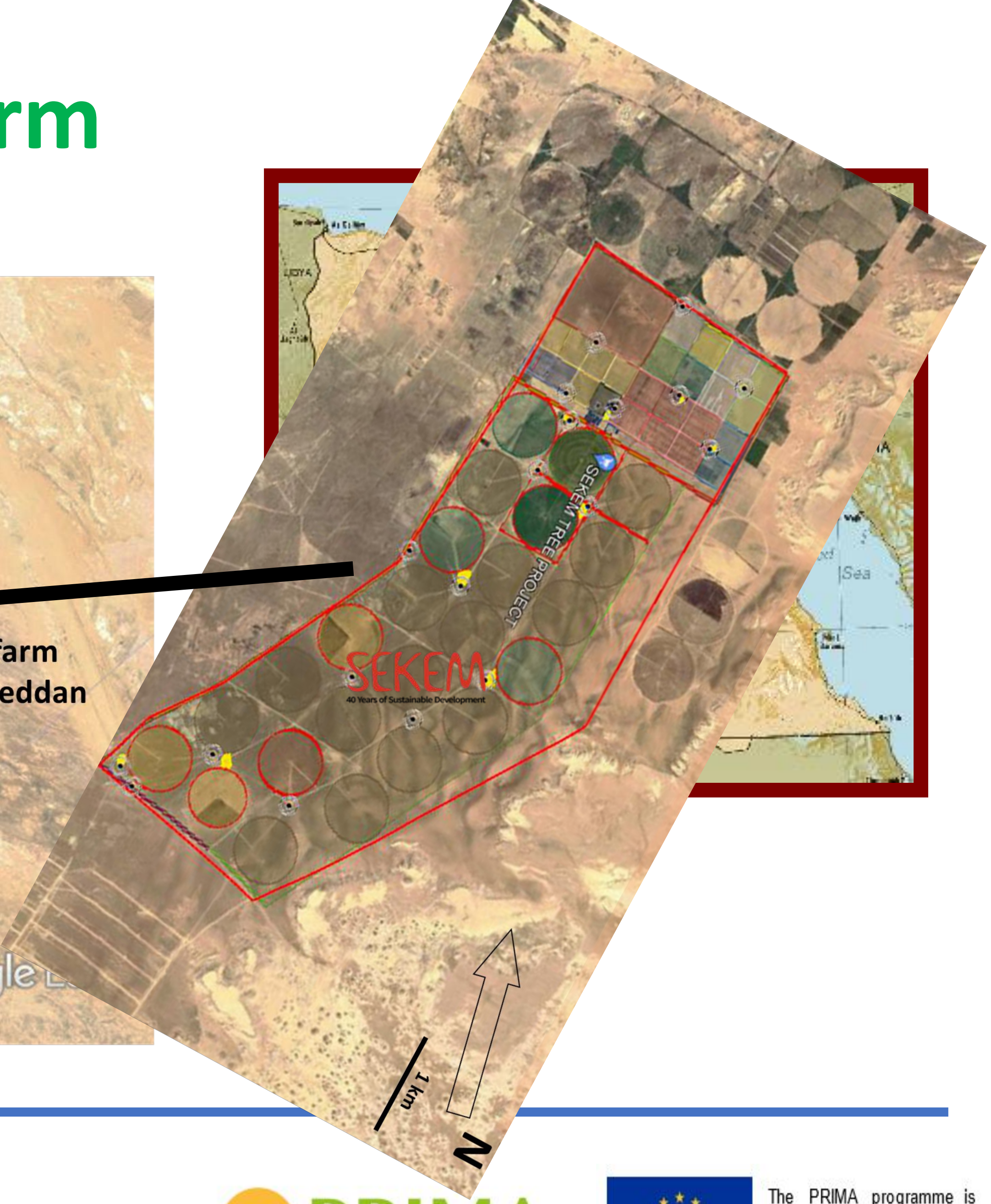
Improving MEDiterranean irrigation and Water supply for smallholder farmers by providing Efficient, low-cost and nature-based Technologies and practices

P2: HUSD	Cost (€)	Justification
Travel	13,000	Travel of 4 persons for project's meetings, workshops and scientific conferences and project's closing event
Equipment	32,000	Components of MED-WET prototypes
Other goods and Services	28,500	Workshop organization, dissemination material costs, lab analysis, kits, internships accommodation, publication costs and conference registration, local transportation, stakeholder engagement meetings
Total	73,500	

- **MedWet's overall budget is 1.25 million Euro**
- **Net HU budget is 73,500 Euro (102,000 Euro)**

El-Wahat El-Baharia – Sekem Farm





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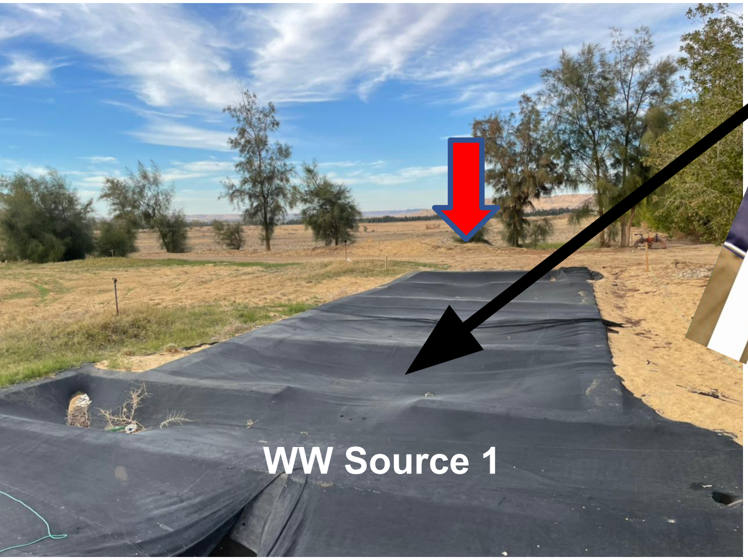
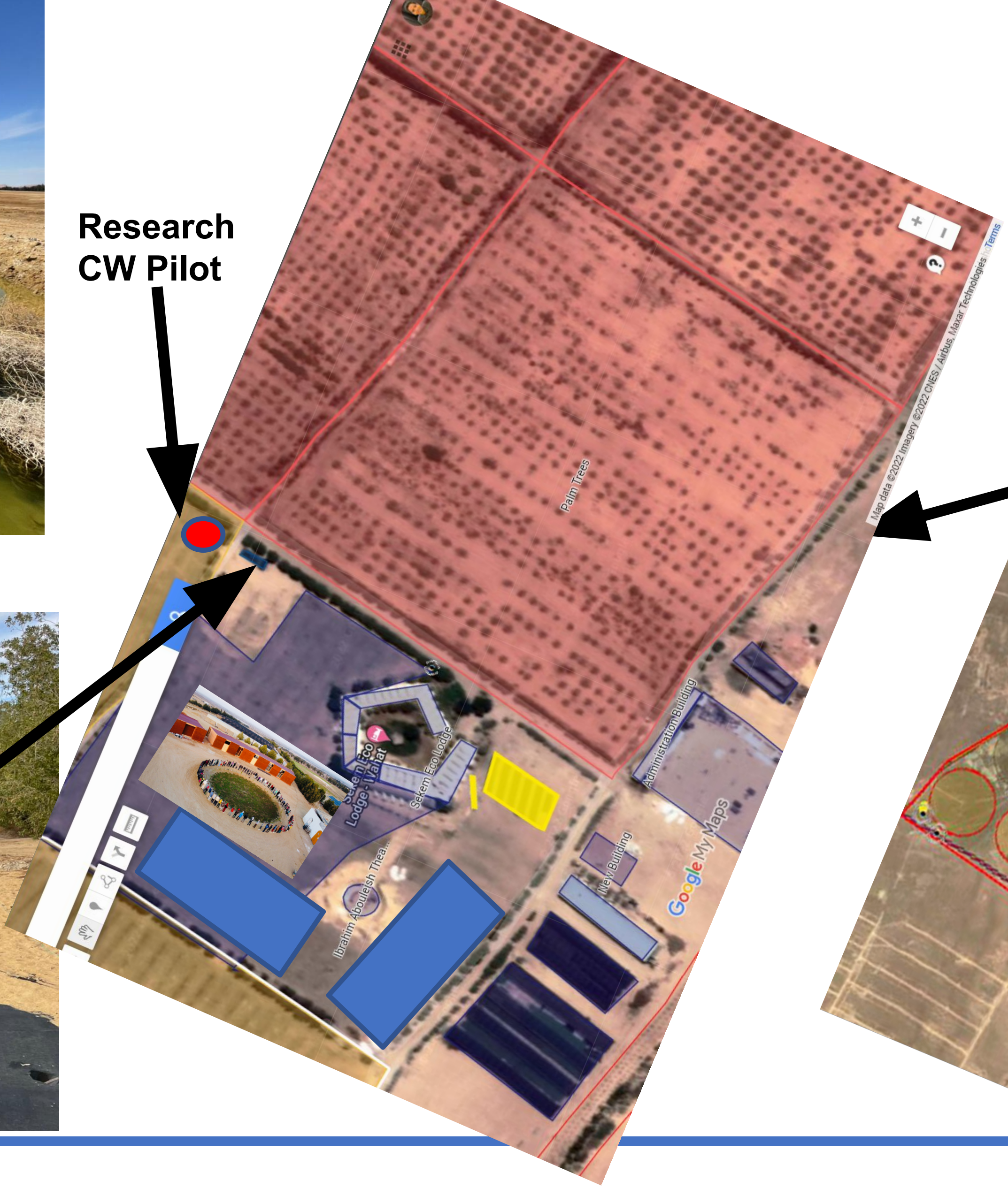
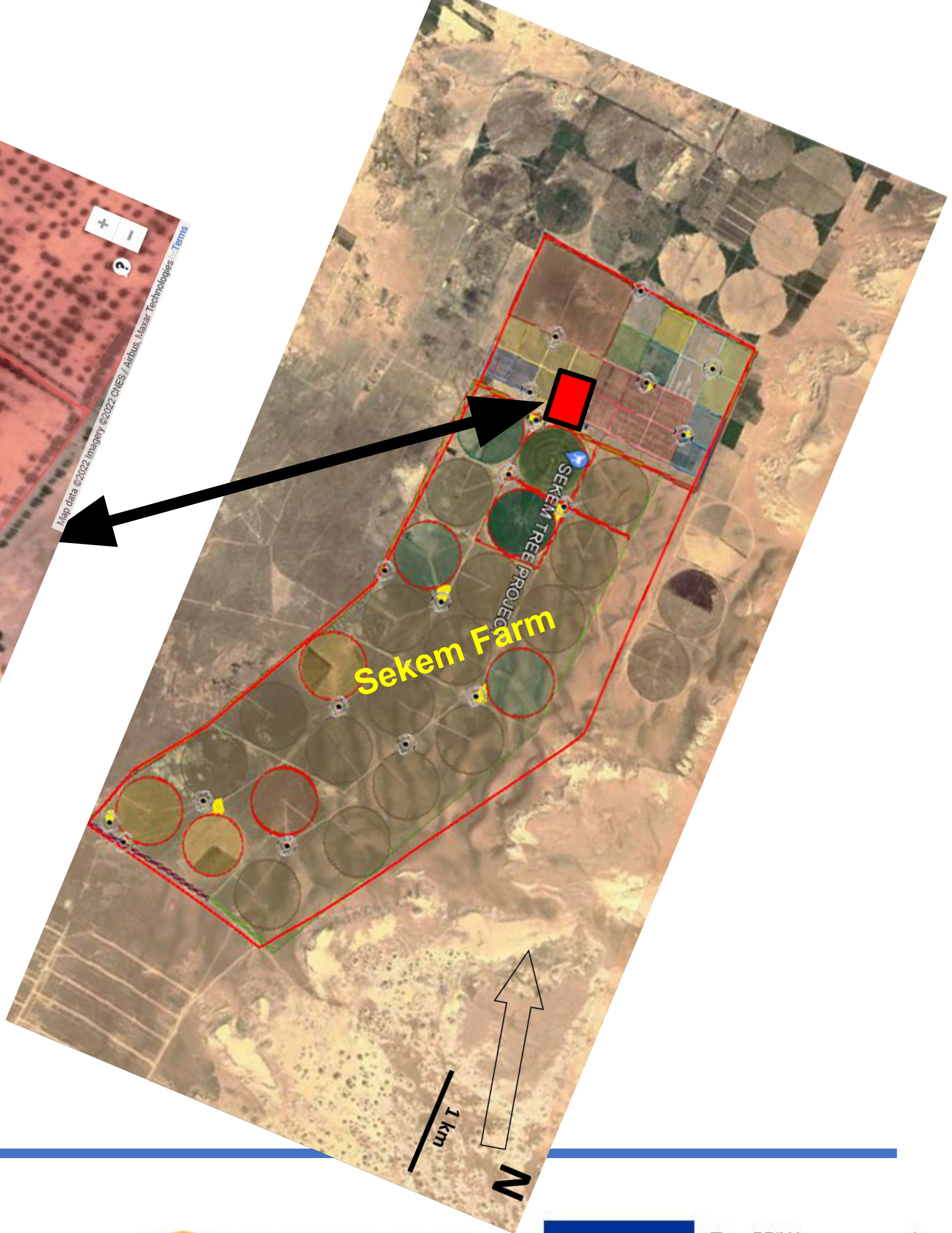


Research CW Pilot





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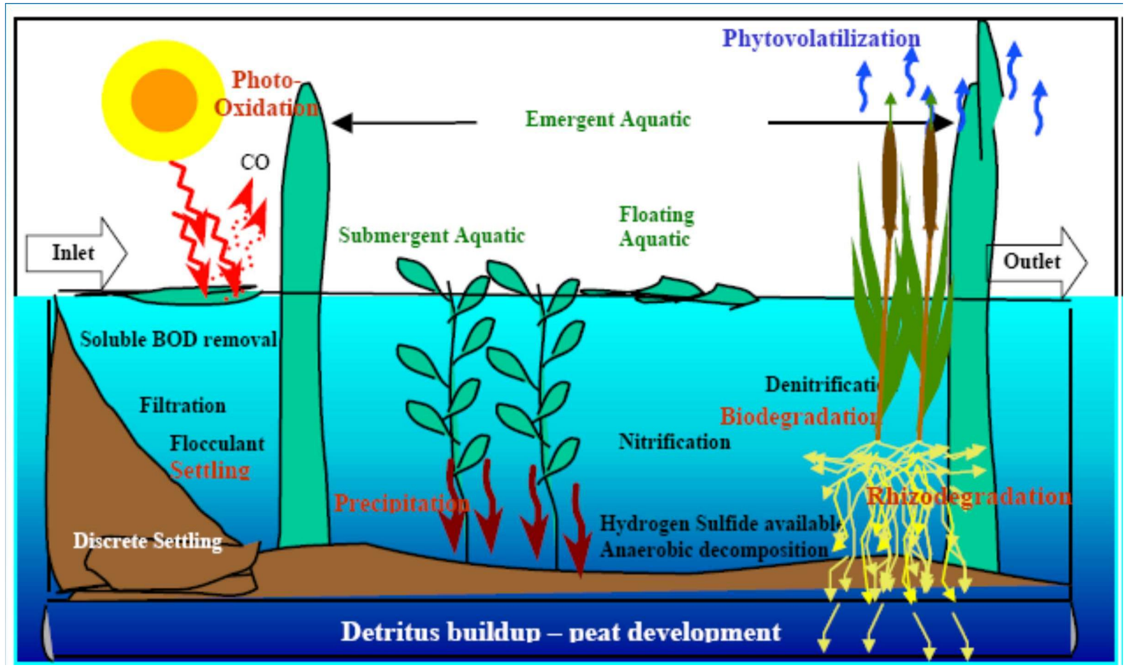
What does "engineering constructed wetlands" mean?

Constructed engineering wetlands are basins with shallow and low speed waters. It is constructed by engineers and provided with "substrate medium" that functions to naturally treat the polluted water. Substrate supports rooted and floating vegetation. It consists of plants, biofilms, soil, micro-organisms and organic letter, in which aerobic and anaerobic reactions occur without energy (low-cost technology) to treat pollutants efficient and cheap technology for domestic wastewater and agricultural drainage water treatment.



What does “engineering constructed wetlands” mean?
… continued

Microorganisms

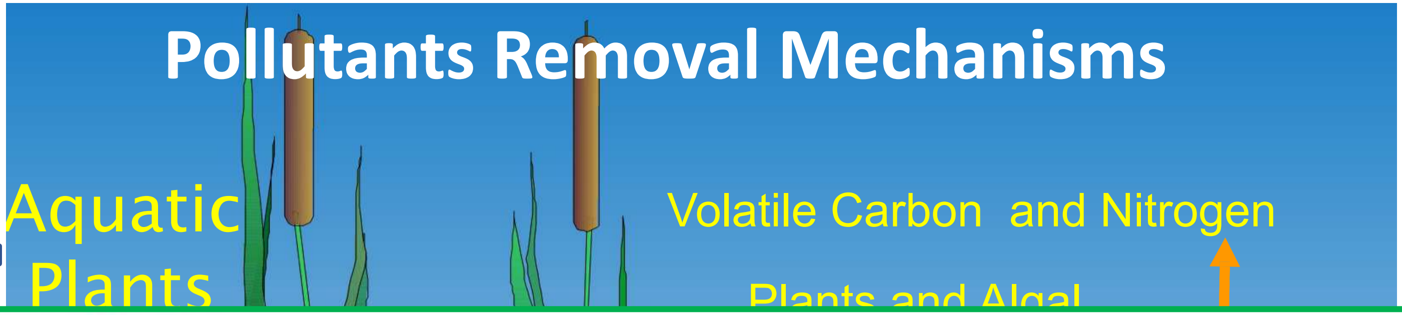
CW are regulated by microorganisms and their metabolism.

Microorganisms include -

Algae

Bacteria,

1. *Canna indica*
2. *Cattail sps.*
3. *Reed*
4. *Water lily*
5. *Water hyacinth*

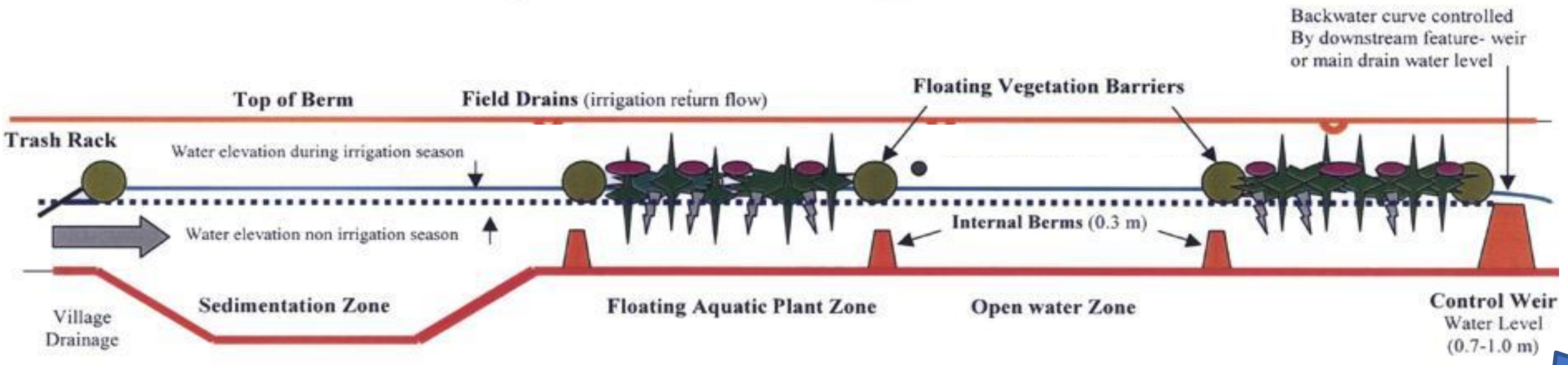


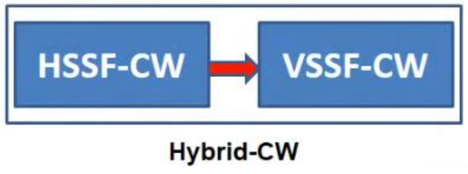
CW systems are capable of removing:

- ✓ Nitrogen & phosphorus,
- ✓ Biochemical oxygen demand (BOD),
- ✓ Chemical oxygen demand (COD),
- ✓ Total suspended solids (TSS),
- ✓ Metals
- ✓ Toxic compounds (like cholorophenols, chlorinated resin & fatty acids) and
- ✓ Pathogens from wastewaters of different origins.

Conceptual Design of CWT

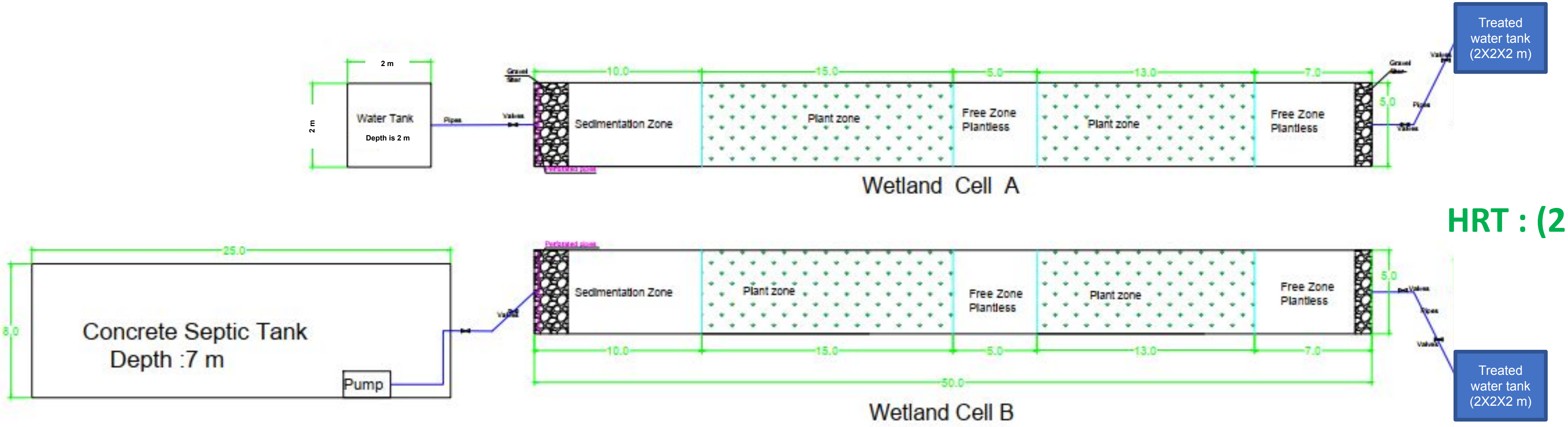
The engineering constructed wetland treatment pilot (*instream-wetland system*) includes wastewater tanks, treated water tanks, lined channels, treatment substrate, pipes, valves, meters and filters as needed.





Research Objective:
is to determine the highest treatment efficiency

Actual Workshop Design & Drawings of the CWT pilot (2 cells) - **Final**



HRT : (2.78 ~ 3 days)

Note :
The Wetland Cell Depth :1.5 m
The Wetland hydraulic (water) designed depth :0.6 m
Lining : Dabsh and concrete 30 cm + 10 cm respectively for bed and sides

Flow (Q) = 20 m^3/day
Detention time : 3 days

The hydraulic Residence Time (HRT) in the CWT pilot

Expressed as mean volume divided by mean outflow rate.

Treatment efficiency of CW depends on HRT.

The "**t**" or hydraulic residence time (HRT) = $\frac{nLWd}{Q}$

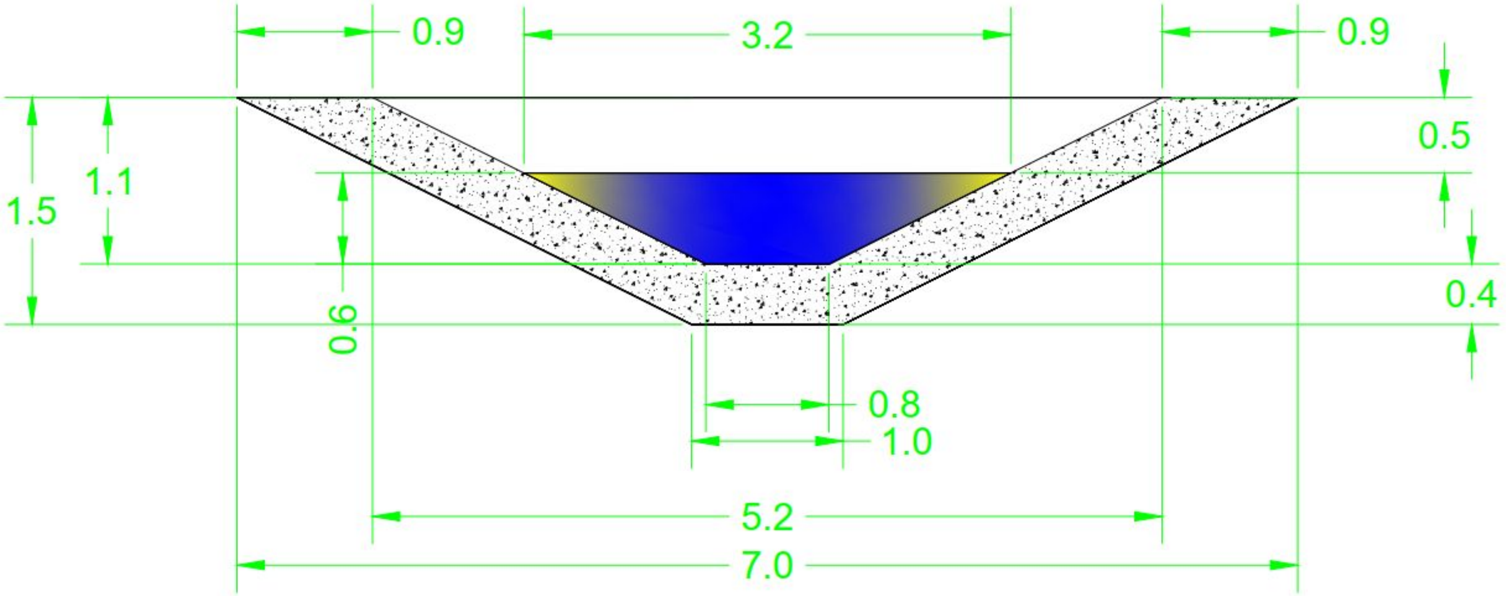
Where : n = effective porosity of media % as a decimal

L = length of bed, m

W = width of bed, m

d = average depth of liquid in bed, m

Q = average flow through the bed, m^3/d



- The CW's geometric depth is 1.5 m
- The CW's hydraulic depth is 0.6 m
- Lining : Gravel and concrete 30 cm + 10 cm respectively for bed and sides
- Flow (Q) = 20 m^3/day
- **HRT : (2.78 ~ 3 days)**

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Mobilizing of equipment (excavation tools, concrete mixers, tractors, materials ...)

Extensive water samples analysis:

Sample	Parameters										
	EC dS/m	pH	Soluble cations (meq L^{-1})				Soluble anions (meq L^{-1})				
			Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}	SAR
جوفية 1	30.3	9.14	103	32	167	1.5	0.2	3.8	260	39	20

In addition to,
High concentrations of iron Fe + -

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Extensive water samples analysis *… continued*

Faculty of Organic Agriculture — Heliopolis University for Sustainable Development — Soil and Water Lab.

Analysis Results of Water Sample (W_{488})

Sample	Parameters										
	EC dS/m	pH	Soluble cations (meq L^{-1})				Soluble anions (meq L^{-1})				RSC	SAR
			Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}		
W_{488}	0.71	8.94	0.20	0.30	5.00	1.5	---	3.20	1.20	2.60	2.70	10.0

EC: Electrical Conductivity; pH: Soil Acidity; RSC: Residual Sodium Carbonates; SAR: Sodium adsorption ratio.

Dr. Mohamed Salah

Results Date: 15.03.2022

Ahmed Youssef

Irrigation Water Quality Standards (US Regional Salinity Laboratory and FAO)

Water Quality Classification	Salinity Hazard		SAR (meq/L)	RSC (meq/L)
	EC at 25 °C (Micromhos/cm)	TDS (mg/L)		
Excellent	<250	<160	Upto 10	<1.25
Good	250-750	160-500	10-18	1.25-2.5
Medium	750-2250	500-1500	18-26	>2.5
Bad	2250-4000	1500-2500	>26	-
Very Bad	>4000	>2500	>26	-

Irrigation Water Quality Standards

Water quality classification	Salinity Hazard		SAR	RSC (meq/L)
	EC at 25° C (Micromhos/cm)	TDS (mg/L)		
Usable water which can be used directly for irrigation without dilution	Upto 1500	1000	Upto 10	Upto 2.5
Marginal water useable after dilution with canal water with 1.1 ratio	1500-2700	100-1700	10-18	2.5-5.0
Hazardous water that is difficult to use without damaging crop or soil	>2700	>1700	>18	>5.0

Irrigation Water Quality Standards (Punjab Irrigation Department)

Water quality classification	TDS (mg/L)	SAR	RSE (meq/L)
Useable/safe	500	0-6	0-1.25
Marginal	500-700	6-10	1.25-2.5
Hazardous	>700	>10	>2.5

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Extensive water samples analysis …

continued

Central Laboratory for Environmental Quality Monitoring

CLEQM Internationally accredited حائزة على الاعتماد الدولى
CALA membership#1409 الاتحاد الكندى لاعتماد المعامل

وزارة الموارد المائية و الرى
المركز القومى لبحوث المياه
المعامل المركزية للرصد البيئي

Final Results Sheet

Client Name: كلية هندسة - جامعة هليوبوليس
Nature of Sample: water

Serial			1
Sample Code			1
Date of Arrival			11/8/2022
Physicochemical Parameters			
pH		-----	8.31
Carbonate	CO_3	mg/l	12.9
Bicarbonate	HCO_3	mg/l	54.6
Total Alkalinity		mg/l	67.5
Electrical Conductivity (EC)		mmhos/cm	14.31
Total Dissolved Solids (TDS)		mg/l	9160
Major Cations			
Calcium	Ca	mg/l	1142.75
Potasium	K	mg/l	162
Magnesium	Mg	mg/l	353.56
Sodium	Na	mg/l	1282
Major Anions			
Chloride	Cl	mg/l	3013.8
Nitrite	NO_2	mg/l	<0.2
Nitrate	NO_3	mg/l	9.66
Phoshate	PO_4	mg/l	<0.2
Sulfate	SO_4	mg/l	2784.78
Trace Metals			
Aluminum	Al	mg/l	0.801
Antimony	Sb	mg/l	<0.004
Arsenic	As	mg/l	<0.001
Barium	Ba	mg/l	<0.006
Cadmium	Cd	mg/l	<0.001
Chromium	Cr	mg/l	0.005
Cobalt	Co	mg/l	<0.003
Copper	Cu	mg/l	<0.001
Iron	Fe	mg/l	0.578
Lead	Pb	mg/l	<0.003
Manganese	Mn	mg/l	0.016
Selenium	Se	mg/l	<0.001
Tin	Sn	mg/l	<0.004
Zinc	Zn	mg/l	0.419

المركز القومى لبحوث المياه ص.ب :١٣٦٢١ / ٦ القناطر الخيرية . القليوبية . جمهورية مصر العربية ت :٤٢١٨٣٥٨١ / ٤٢١٧٤٦٦٥ (٢٠٢) فاكس : ٤٢١٧٤٦٦٣(٢٠٢)
National Water Research Center, P.o. Box 13621/6 , El-kANATER, Egypt Tel.: +202 4218 3581 / +202 4217 4665 Fax : +202 4217 4663
Website : www.cleqm.org.eg E mail: cleqm@cleqm.org.eg

Advanced WQ kit purchase

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Repair of two existing WQ kits

GIGA SYSTEMS

Date:	26.10.2022	Customer No.	....
Customer Name:	Sustainable Resource Management Programme to solve Desert-ed Challenges SuReMaP. (Heliopolis University)	Reference No.	Project No. 610439-EPP-1-2019-1-DE-EPPKA2-CBHE-JP
Invoice No. --		Delivery Note No. --	

Item	Qty.	Type / Disc.	U.P.	T.P.
1	1	pH sensor	5100	5100
2	1	DO membrane	1410	1410
3	1	USB cable	500	500
4	1	Rechargeable battery.	800	800
5	1	DO sensor	5400	5400
6	1	Ammonia sensor	10680	10680
7	1	Nitrate sensor	10680	10680
8	1	Chloride sensor	10680	10680
9	1	pH4 solution	550	550
10	1	pH7 solution	550	550
11	1	pH10 solution	550	550
12	1	Cond solution	600	600
13	1	COD High Range Plus (Hg Free) vial reagent, 0-15000 mg/L, pack of 25	1111	1111
14	1	COD Low Range (Hg Free) vial reagent, 0-150 mg/L, pack of 25	1111	1111
15	1	COD High Range (Hg Free) vial reagent, 0-1500 mg/L, pack of 25	1111	1111
16	1	cap membrane kit	1850	1850
			Sub Total	52,683.00
			S. Taxes 14%	0.00
			Total	52,683.00

Received By:.. ID No.: .... Signature:..

- Tel: (202) 26362674/26324309 - Fax: (202) 26324309 - Email: info@giga-sys.com - Web: www.giga-sys.com
10 El-Sherif Bldgs., Aswan St., Heliopolis, Cairo, Egypt.

Equipping a lab in the study area

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MEDWET component's progress up to now

Goal: implementing the CWT pilot in Sekem farm, El-Wahat El-Baharia

- Soil and water samples analysis (chemical, physical & biological) □ **done**
- Refining the design and detailed drawing of the pilot experiment □ **done**
- Mobilizing of equipment (excavators, trucks, materials ...) □ **done**
- Digging the CWT cells (lining has not started) □ **done**
- Constructing four tanks (2X2X2 m) – two underground and two above ground (lining has not started) □ On-going

S u m m a r y

MEDWET component's progress up to now … *continued*

Goal: implementing the CWT pilot in Sekem farm, El-Wahat El-Baharia

- Installing pipes, connections, meters (discharge gages) and valves has not started
- Installing low-cost nature-based treatment interventions (gravel & sand filters, weirs, substrate, naive aquatic plants & weeds and micro-organisms) has not started
- Testing and checking (the initial operation) delayed (Dec. 22 & Jan. 23)
- Experimental operation "research purposes" for 12 months (research alternatives for determining the highest treatment efficiency) winter and summer seasons 2023 (should start at the end of Feb., 2023)
- "Operational and Maintenance Manual" next phase

Summary

MEDWET component's progress up to now

Goal: implementing the CW pilot in Sekem farm, El-Wahat El-Baharia

Current Challenges :

- Delay in implementing the CWT pilot site
- Long distance between HU and the CW pilot □ supervision
- Completing the fine works (treatment interventions □ selecting and securing the native aquatic rooted and floating plants)
- WQ kit repair and training - new WQ kit purchase
- Bacteria and biological analysis in the laboratory
- Contract of the consultant (Dr. Sherin Yahia)
- Operation of ITT in Belbies for comparison
- Mid-term report (pending) & Financial reporting (MEL platform Prima)
- National Security clearance of MedWet
- Approval of MedWet Project by STDF -- budget

Improving MEDiterranean irrigation and Water supply for smallholder farmers by providing Efficient, low-cost and nature-based Technologies and practices

- **A research paper**: ***Key Technologies for Irrigation and Water Supply for Small-holder Farmers in the Mediterranean region*** (Sustainability) MDPI
- Malta Partners’ meeting: (12-16) June 2023
- Project's partners meeting in Egypt: April-June 2024

Success Indicators

- Moving toward fulfilling the MedWet goals and contributing to its target (WP 2: Technology development & adaptation) clear roadmap with no foreseen obstacles or challenges
- Satisfaction of the recipients owners, stakeholders and neighbors
- Realizing NWRP2037 and Egypt Vision 2030 of Egypt pollution alleviation
- Upscaling and Outscaling contribute to filling the gap between water supply and demand

MedWet Project's stakeholders (Egypt)

#	MED-WET Stakeholders List (Egypt)		
#	Entity type	Entity	Representative Name
1	Govermental institution	National water research center (NWRC)	Prof. AbdelAzim Mohamed Terbak
2	Govermental institution	Drainage research institute (DRI)	Dr. Shereen Yahia Agamy
3	Govermental institution	Agriculture research center (ARC)	Prof. Alaa Mohamed Zoheir Hamed El Bably
4	Private sector (large)	SEKEM For Land Reclemation	Dr. Amr Sabahy
5	Private sector (large)	Egyptian Biodynamic Association (Demeter Egypt)	Mr. Justus Harm
6	NGO/farmers.	Life From water	Mr. Mohannad Hesham
7	NGOlfarmers	Water Will	Eng. Hesham Sadek
8	Owner	SEKEM Development Foundation	Maximilian Abouleish
9	Private sector	NuriWEF	Eng. Ali
10	Private sector	TULIMA	Mr. Seif Salam
11	Private sector	Gebal Egypt	Eng. Hassan Hussany, Eng. Amr Kheriy

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Benefits of implementing a CWT pilot in remote areas (El-Wahat El-Baharia)

- ✔ Efficient and cheap technology increases the available non-conventional water resources for the isolated communities in rural and desert areas.
- ✔ Reclamation of nutrient-rich effluent for irrigation purposes.
- ✔ Protecting the groundwater and surface ponds from pollution reduces the environmental impacts
- ✔ Useful for safe sludge management and on-site reuse zero wastes
- ✔ Good application of the circular economy concept for the smallholder farmers support the local business creation and smallholders irrigation in remote communities

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Benefits of implementing a CWT pilot in remote areas (El-Wahat El-Bahariya)

The Mediterranean region faces significant water scarcity which is further exacerbated by irresponsible human activities, population growth, changing food consumption patterns and climate change. Agriculture is the major water consumer and hence requires increasingly more efficient and sustainable irrigation technologies that are widely applicable and accepted by smallholder farmers. They must hence be low-cost, lean solutions that optimize natural resource use and income. This project- Improving Mediterranean irrigation and Water supply for smallholder farmers by providing Efficient, low-cost and nature-based Technologies and practices (MED-WET)- has been developed to ultimately improve the irrigation efficiency of small farmers in the Mediterranean region especially through the optimal use of scarce water resources for lasting food and water security.

Arid countries, such as Egypt (among other middle eastern countries) are facing a water scarcity crisis, which requires optimizing the use of all available water resources. Due to water scarcity, reuse of drainage water is becoming an increasingly important water source. In Egypt, however, large portions of water in the drainage network can not be used as they contain high contaminant loads. Treatment Wetlands proved to be a viable solution. It works as basins with shallow waters and substrate to support rooted vegetation, plants, biofilms, media/soil, water and letter are acting together to treat and eliminate pollutants with high efficiency. The treated water can be used to irrigate trees and non-fruitful & non-edible crops. With sufficient treatment precautions, farmers can utilize the treated water as safe-for-reuse with nutrient-rich water for irrigating their crop farms. Crop selection and placement is targeted to accommodate water and nutrient needs and tolerance.

Demonstration of regenerative water and nutrient cycles among households and agricultural plots; development of low-cost evaporation and condensation systems; as well as regenerative, climate-adaptive farming practices in the Mediterranean. Develop new irrigation technologies and solutions widely applicable for smallholder farmers

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