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CARDIMED

CLIMATE ADAPTATION AND RESILIENCE
DEMONSTRATED IN THE MEDITERRANEAN REGION

Valorisation of non-conventional water loops on Aegean islands

Fabio MASI, PhD - IRIDRA



Funded by
the European Union



The mediterranean is a climate hotspot



The mediterranean is a climate hotspot



Land and sea are warming much faster than global average

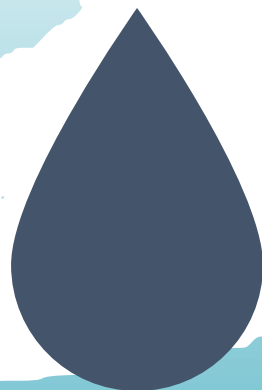


CARDIMED

The mediterranean is a climate hotspot



180 million people already suffer from water scarcity



The mediterranean is a climate hotspot



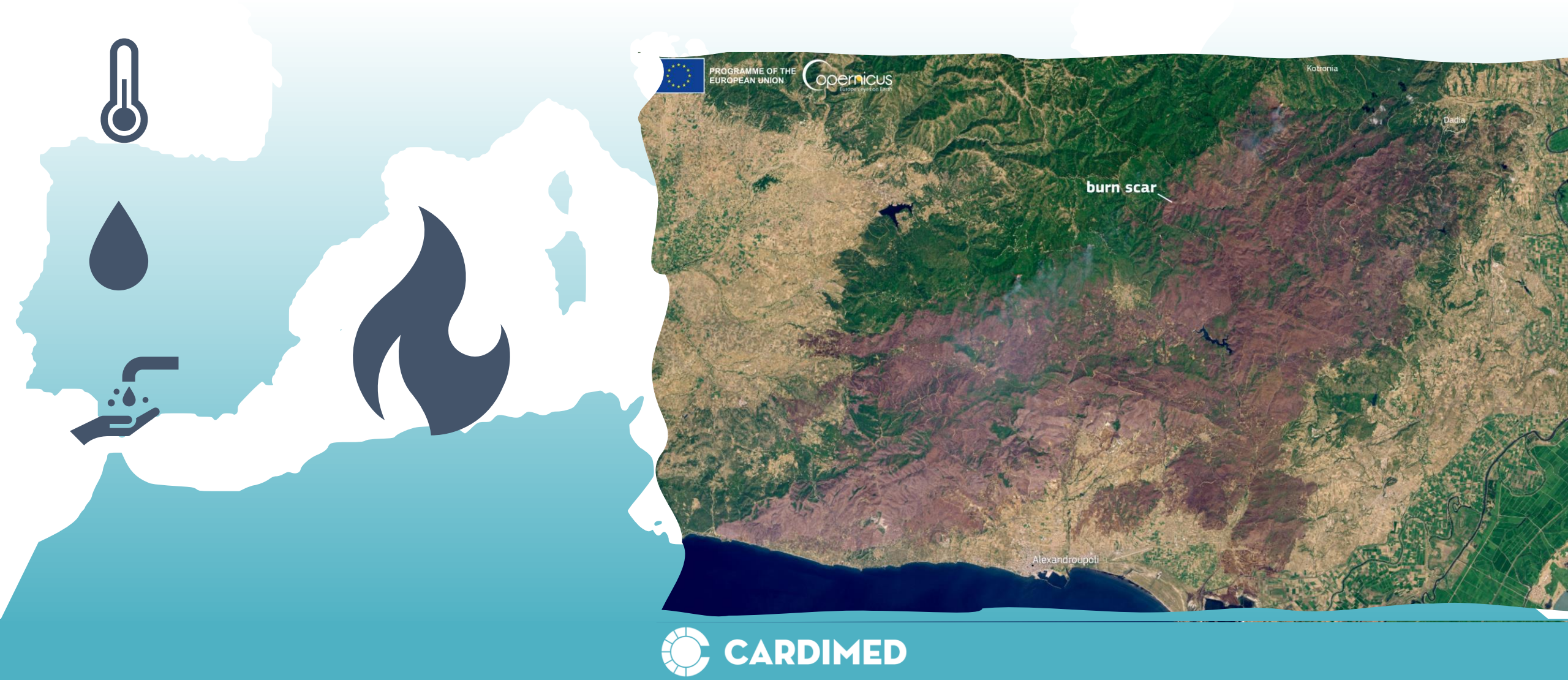
Crop yield will reduce due to extreme events, drought, degradation



The mediterranean is a climate hotspot



By 2100 **burnt areas** may double



Nature-based solutions and EU policy



- Within the European Green Deal NBS are recognized as solutions that support climate change (CC) adaptation:
 - “Implementing NBS on a larger scale would increase climate resilience; **It is vital to better quantify their benefits, and to better communicate them to decision-makers and practitioners at all levels to improve take-up**” (EU Adaptation Plan, 2021)
 - “The promotion of healthy ecosystems, green infrastructure and **NBS should be systematically integrated into urban planning**” “Particular attention will be paid to measures to incentivize and eliminate barriers for the take-up of NBS” (EU Biodiversity Strategy, 2020)
- However:
 - Less than 5% of all funding in the water sector alone goes to NBS (OECD, 2020).



Project General Info

- **Call:** HORIZON-MISS-2022-CLIMA-01
- **Type:** Horizon Innovation Action
- **Duration:** 54 Months
- **Start:** 1st September 2023
- **# of Partners:** 51 (14 countries)
 - 10 Universities & 7 Research Organizations
 - 9 SMEs, 1 large Company and 8 NGOs
 - 6 Regions and 5 Municipalities
 - 5 Authorities/Utilities

of Affiliated Organizations: 3



Project Vision and Pillars



To Investigate systemic transformations in Climate Resilience in the MED Region, by unifying and mainstreaming all initiatives addressing climate adaptation and mitigation through NBS and other engineered infrastructure

Pillar 1

Digital Technologies
for Climate Adaptation



Pillar 2

Socio-economic Resilience



Pillar 3

Water-Energy-Food-Ecosystems
Nexus



Pillar 4

Nature-based Solutions



Systemic Transformation for Regional Climate Resilience

Our biggest challenge is **NOT** the development and application of the envisaged innovation of each pillar but to **holistically connect these solutions at a systems level**.

Nature-based Solutions interventions



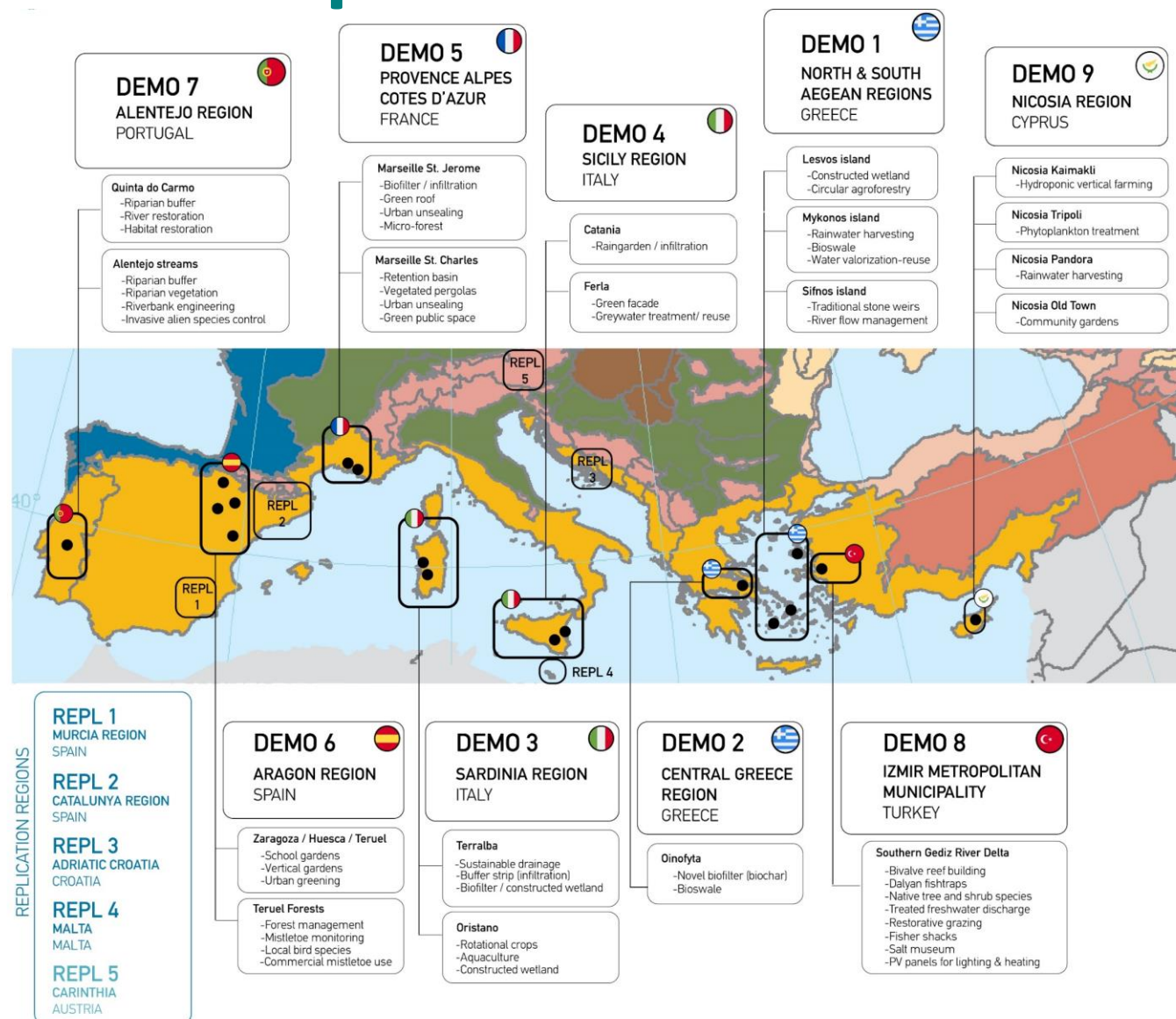
83 interventions of **47** different NBS types across **10** regions (9 DEMOS) on **20** locations involving **28** communities.

-  RAINWATER MANAGEMENT
-  VERTICAL GREENING SYSTEMS & GREEN ROOFS
-  TREATMENT & RECOVERY
-  RIVER RESTORATION
-  SOIL & WATER BIOENGINEERING
-  PUBLIC GREEN SPACES
-  FOOD PRODUCTION

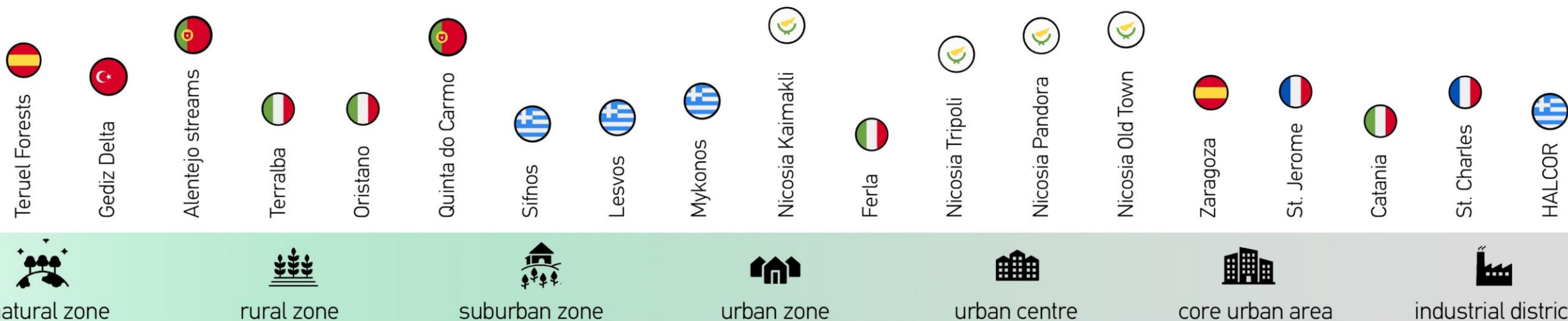
Langergraber et al., 2021

| Classification | | D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 |
|---|--|----|----|----|----|----|----|----|----|----|
| (River) Restoration | (28) River restoration | | | | | | | | | |
| | (29) Floodplain | | | | | | | | | |
| | (32) Coastal erosion control | | | | | | | | | |
| Soil & Water Bioengineering | (33) Soil improvement and conservation | | | | | | | | | |
| | (34) Erosion control | | | | | | | | | |
| | (35) Soil reinforcement to improve root cohesion and anchorage | | | | | | | | | |
| | (36) Riverbank engineering | | | | | | | | | |
| (Public) Green Space | (37) Green corridors | | | | | | | | | |
| | (38) Green belt | | | | | | | | | |
| | (39) Street trees | | | | | | | | | |
| | (40) Large urban park | | | | | | | | | |
| | (41) Pocket/garden park | | | | | | | | | |
| Food & Biomass Production | (43) Green transition zones | | | | | | | | | |
| | (44) Aquaculture | | | | | | | | | |
| | (45) Hydroponic and soilless technologies | | | | | | | | | |
| | (48) Photo Bio Reactor | | | | | | | | | |
| | (49) Productive garden | | | | | | | | | |
| | (50) Urban forest | | | | | | | | | |
| Rainwater Management | (51) Urban farms and orchards | | | | | | | | | |
| | (1) Infiltration basin | | | | | | | | | |
| | (2) Infiltration trench | | | | | | | | | |
| | (3) Filter strips | | | | | | | | | |
| | (4) Filter drain | | | | | | | | | |
| | (5) (Wet) Retention pond | | | | | | | | | |
| | (6) (Dry) Detention pond | | | | | | | | | |
| | (7) Bioretention cell | | | | | | | | | |
| | (8) Bioswale | | | | | | | | | |
| | (10) Tree pits | | | | | | | | | |
| | (11) Vegetated grid pavement | | | | | | | | | |
| | (12) Riparian buffer | | | | | | | | | |
| Vertical Greening Systems & Green Roofs | (51) Rainwater Harvesting | | | | | | | | | |
| | (52) Detention vaults and tanks | | | | | | | | | |
| | (13) Ground-based green facade | | | | | | | | | |
| | (14) Wall-based green facade | | | | | | | | | |
| | (15) Pot-based green facade | | | | | | | | | |
| Remediation, Treatment & Recovery | (16) Vegetated pergola | | | | | | | | | |
| | (17) Extensive green roof | | | | | | | | | |
| | (20) Mobile green and vertical mobile garden | | | | | | | | | |
| | (21) Treatment wetland | | | | | | | | | |
| | (22) Waste stabilization pond | | | | | | | | | |
| | (26) Anaerobic treatment | | | | | | | | | |
| | (27) Aerobic (post) treatment | | | | | | | | | |
| | (23) Composting | | | | | | | | | |
| | (25) Phytoremediation | | | | | | | | | |
| | (55) Disinfection (for water recovery) | | | | | | | | | |
| | (56) Biochar/Hydrochar production | | | | | | | | | |
| | (57) Physical unit operations for solid/liquid separation | | | | | | | | | |
| | (59) Adsorption | | | | | | | | | |

Demonstrators & replication sites



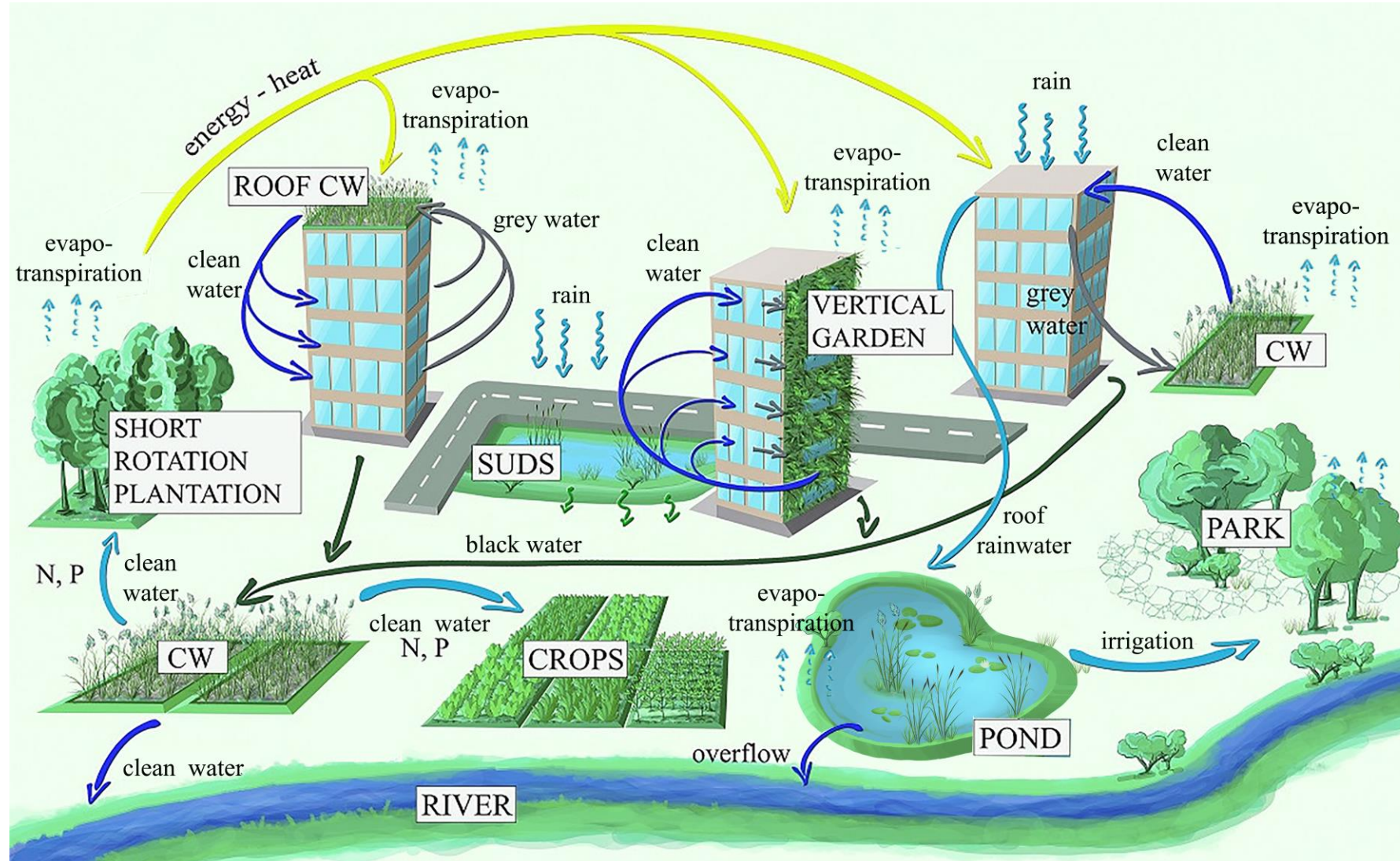
Demonstrators & replication sites



Demonstrators & replication sites



NEXUS IN SMART CITIES



Demonstrators & replication sites



DEMO 1

DEMO 2

DEMO 3

DEMO 4

DEMO 5

DEMO 6

DEMO 7

DEMO 8

DEMO 9

Lesvos island

Mykonos island

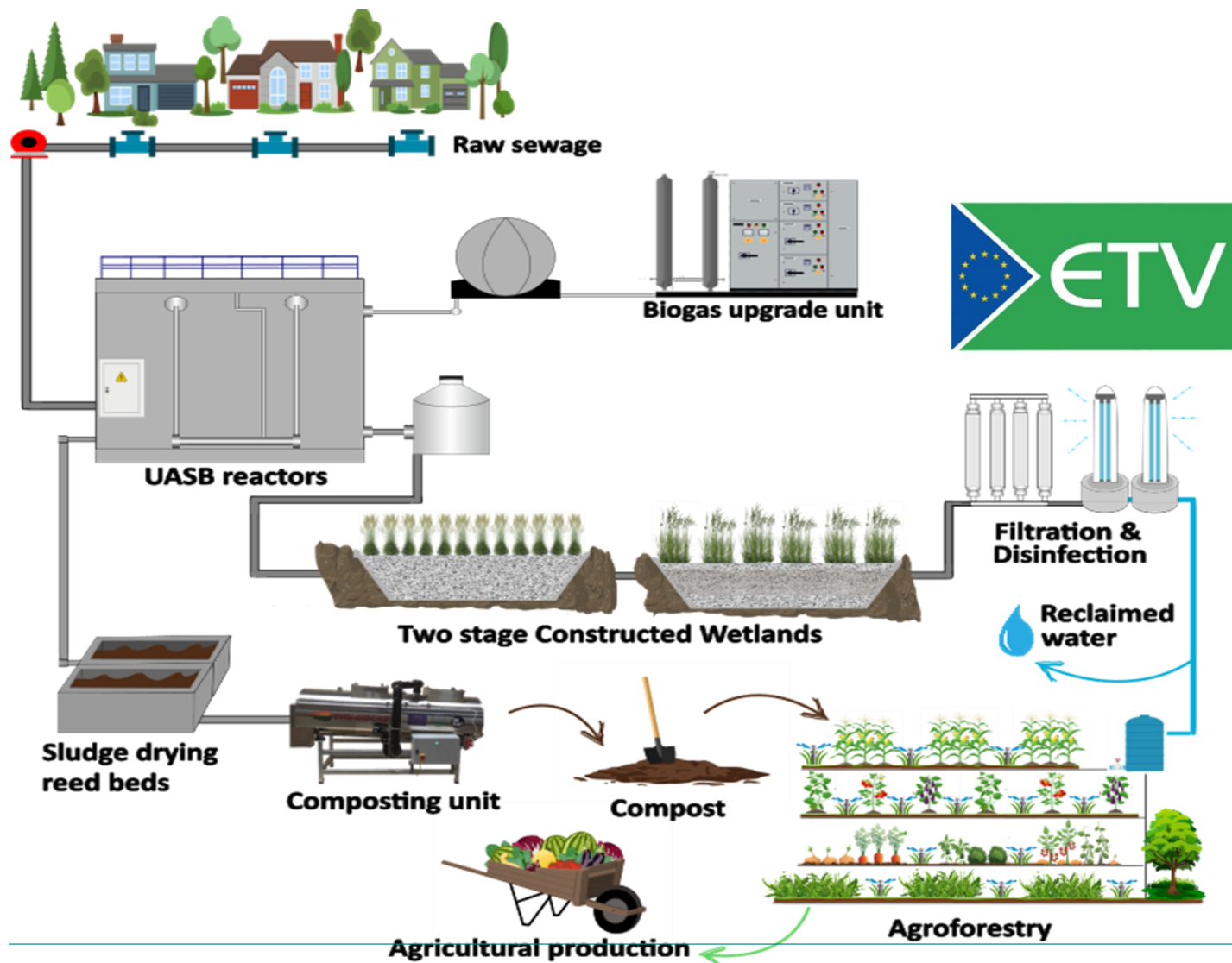
Sifnos island

Valorization of non-conventional water loops on Aegean islands

Solutions

- Constructed Wetlands
- Circular Agroforestry
- Water valorisation
- Subsurface water harvesting
- Bioswale
- Traditional stone weirs
- River flow management

Demo 1 – Antissa – Lesvos Island (GR)



Scope

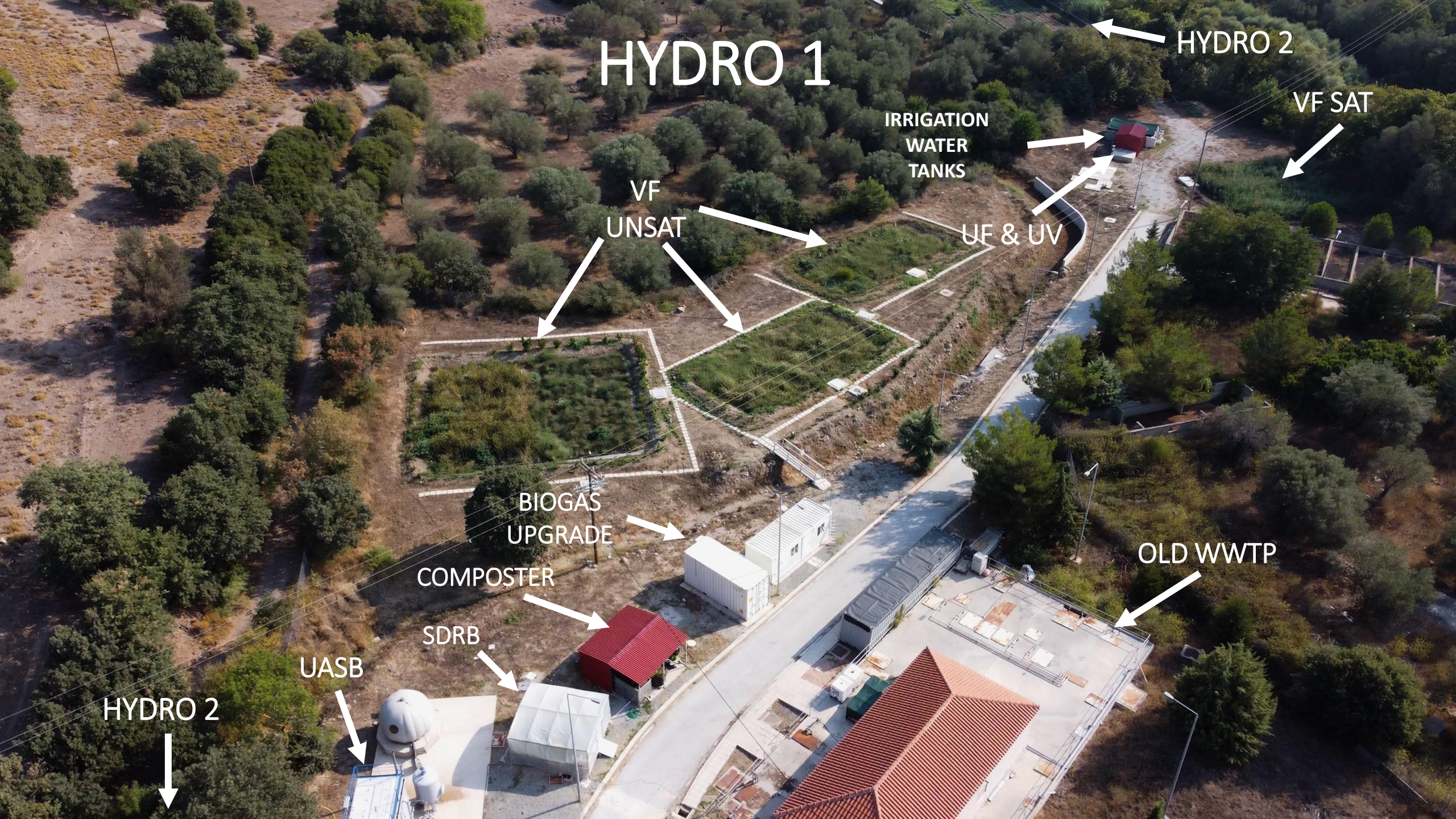
Valorisation of municipal wastewater, energy production, diversified agricultural production, nutrients recycling

Advantages

- Low-cost treatment
- Nutrient recycling
- Versatility (fertiligation or irrigation)
- Composting of sludge and green biomass
- Biodiversity enrichment

Challenges

- Community engagement
- Dealing with variable flow rates
- Evidence of cost efficiency



HYDRO 1

HYDRO 2

VF SAT

IRRIGATION
WATER
TANKS

VF
UNSAT

UF & UV

BIOGAS
UPGRADE

COMPOSTER

SDRB

UASB

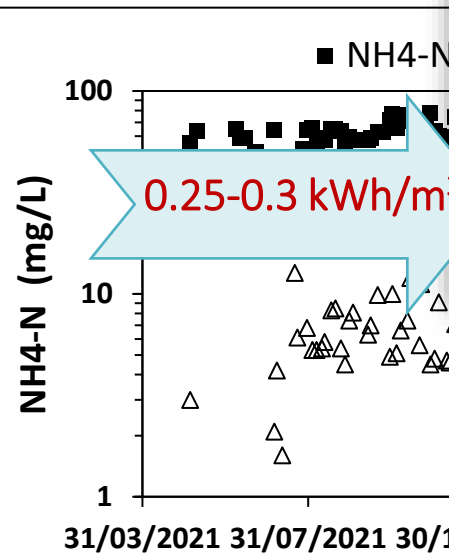
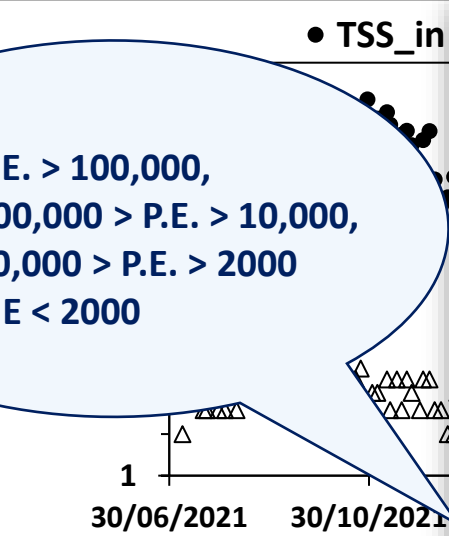
HYDRO 2

OLD WWTP

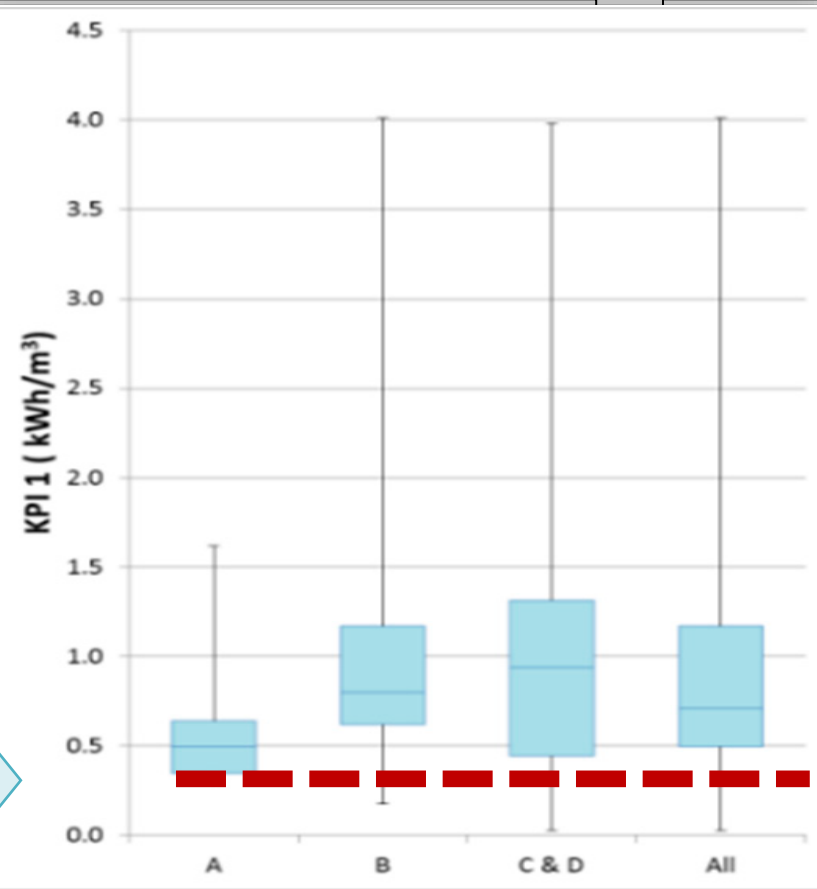
HYDRO1, Decentralized WWT, Lesvos Island Greece

OPERATION

Class A P.E. > 100,000,
Class B 100,000 > P.E. > 10,000,
Class C 10,000 > P.E. > 2000
Class D P.E. < 2000



0.25-0.3 kWh/m³



Specific energy consumption indicators per plant
(Christoforidou et al., 2020)

GOD (mg/h)
EC (/100)

EU, 2020

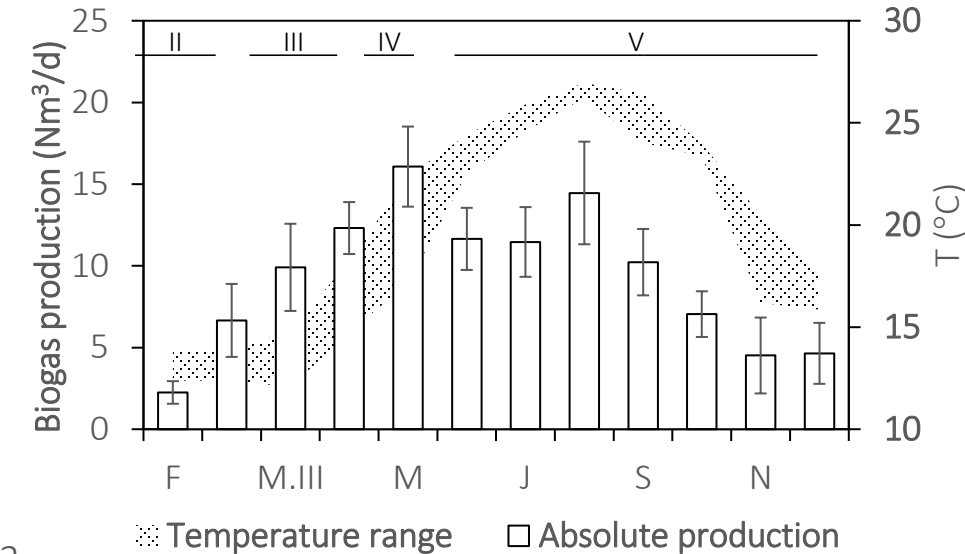
ENERGY

Biogas
Composition

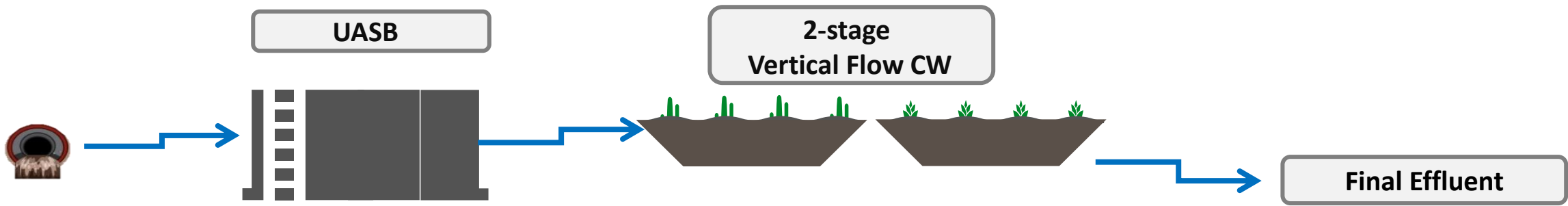
| | |
|-----------------|-----------|
| CH ₄ | 75 – 82 % |
| CO ₂ | 15-20 % |

Biogas Yield

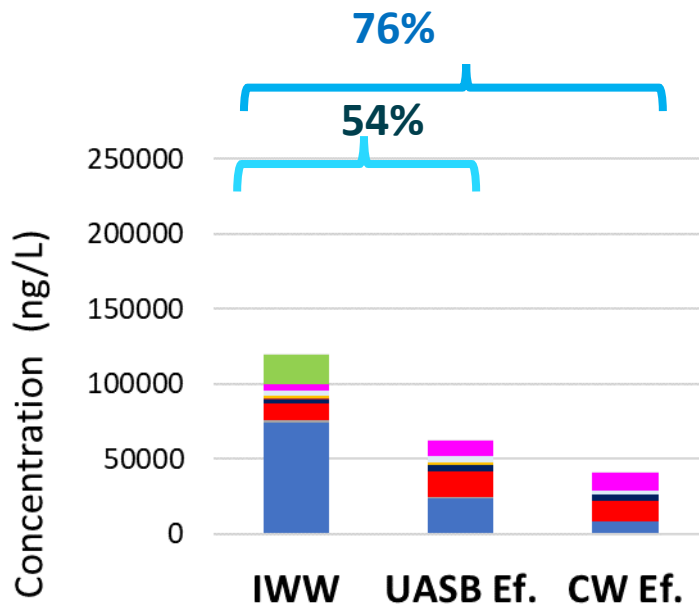
0.32 m³ / kg COD_{removed}



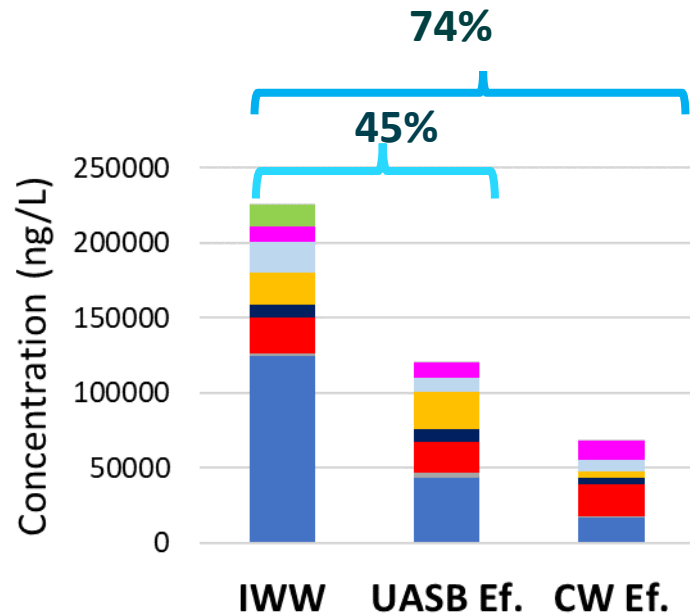
Fate and Removal of Emerging Contaminants in Decentralized Applications



Fall 2021

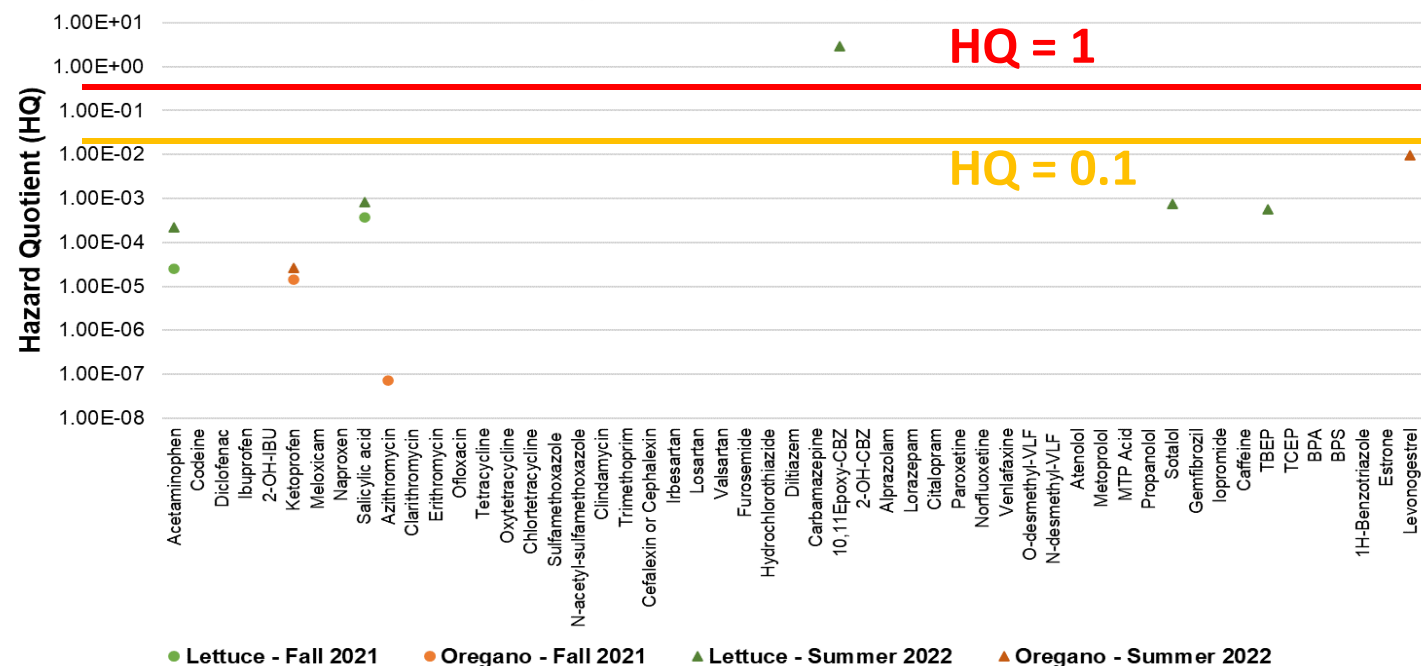
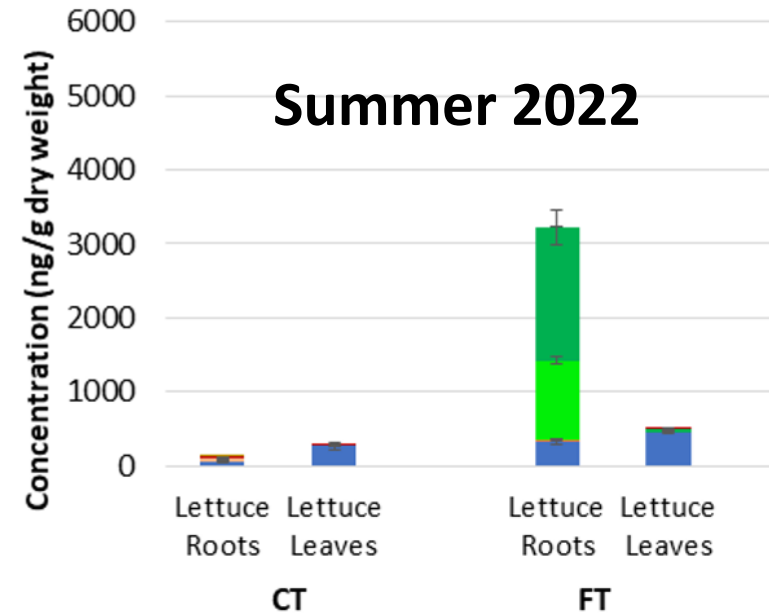
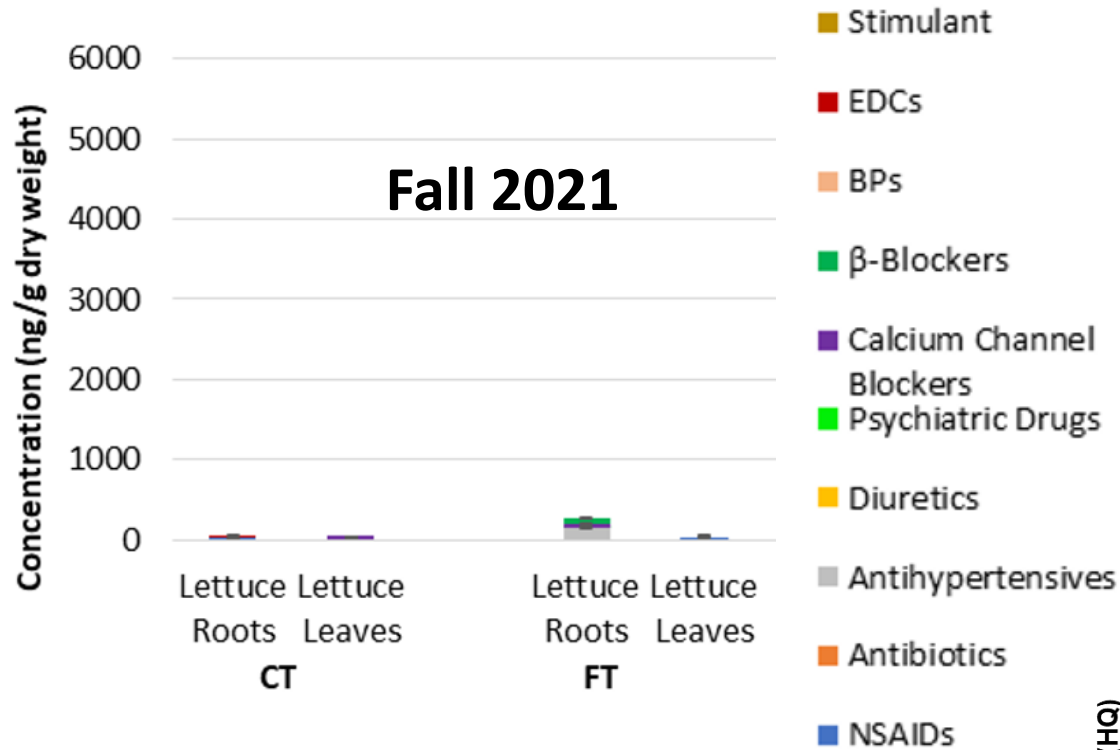


Summer 2022



- BPs
- Stimulant
- EDCs
- β -Blockers
- X-ray contrast agent
- Psychiatric drugs
- Lipid regulator
- H1-H2 Receptor Antagonists
- Diuretics
- Antihypertensives
- Antibiotics
- Analgesic and antiinflammatory

Human health risk assessment: lettuce



No risk generally expected to human health due to the ingestion of **lettuce** and **oregano** irrigated with treated wastewater

HYDRO2. Agroforestry system - Lesvos island Greece

previous status

VS

current status



Main field - October 2020



Main field - today



Second field - June 2021

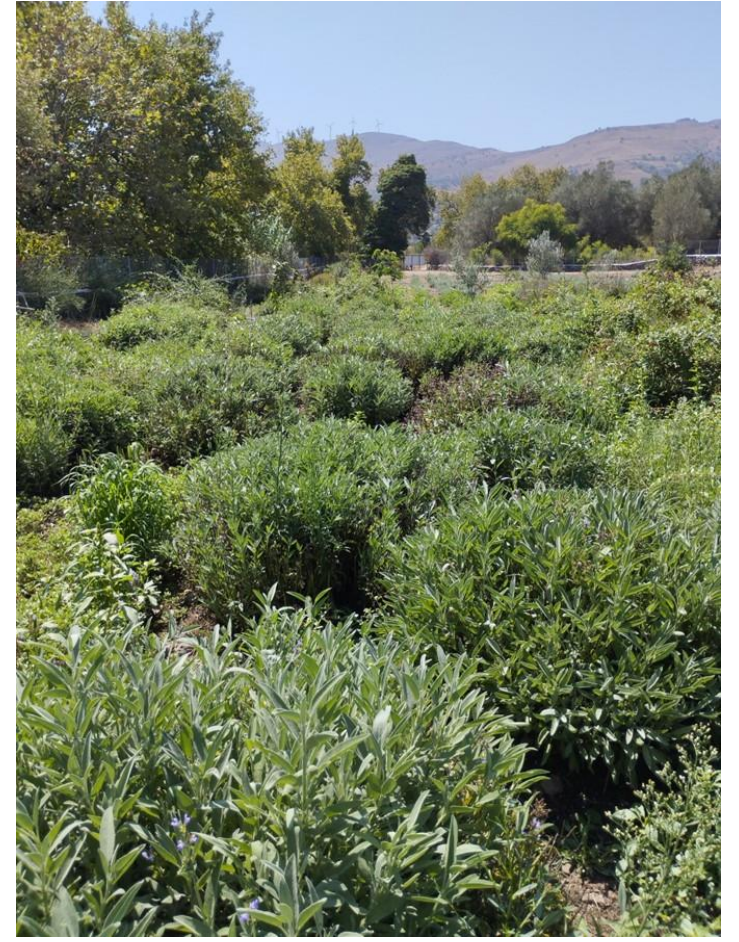


Second field - today

- About 10,000 plants are growing
- Wide diversity of trees, crops, aromatic plants and vegetables
- More than 15 tonnes of harvested products

HYDRO2. Agroforestry system - Lesvos island Greece

Current status





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Thank you for your attention!



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