20 project partners are working across eleven countries to develop INNOQUA – a modular suite of bio-based on-site wastewater treatment systems. The project is now entering its system validation phase, with operating units installed in Spain and Ireland. This technical bulletin provides a brief project overview and progress report, together with data on wastewater characteristics and discharge requirements in the target markets.

PROJECT BACKGROUND

The key aim of the INNOQUA project is to integrate individual modular, low-cost, sustainable and biologically-based water treatment and reclamation technologies in configurations matched to local contexts and markets.
Worldwide about 2.5 billion people are still without adequate sanitation. Nearly 1,000 children under 5 die each day due to preventable water and sanitation-related diarrheal diseases[1].
In the EU the percentage of the population connected to waste water treatment plants varies from 40% to 90%, across the 28 member states. Around 20 million rural inhabitants are without adequate sanitation systems.
Social acceptability and affordability are key project drivers, as is the potential for re-use of treated wastewaters.
Target geographies for the project include: EU (France, Ireland, Italy, Romania, Spain, UK), Ecuador, Peru, Tanzania, Turkey and India

TECHNOLOGIES

INNOQUA uses four treatment technologies, which can be combined in different configurations to suit local conditions. System operation is remotely monitored and managed by a monitoring and control unit (MCU) that receives and processes data in real time from probes measuring (for example): dissolved oxygen (DO), conductivity (salinity), oxidation-reduction potential (ORP) and pH.

The four technologies are:

1. Lumbrifilter

2. Daphnia filter

3. Bio-Solar Purification (BSP)

4. UV treatment




Overviews of the technologies are available on the project website: innoqua-project.eu/technologies

[1] https://www.un.org/sustainabledevelopment/water-and-sanitation/

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PROGRESS TO DATE

A great deal of background research is already complete, with information collected on market drivers and legislation of wastewater treatment in the target geographies. Initial Life Cycle Impact Assessment (LCIA) and Whole Life Costing (WLC) evaluations have been completed for the INNOQUA solutions.

Demonstration sites have been identified, waste-water characteristics determined, and treated wastewater quality targets collated.

System validation is nearing completion at prototype facilities hosted by NUIG (Ireland) and UDG (Spain). Data from these validation trials will be published in a future Technical Bulletin.

DEMONSTRATION SITES

Key learnings from the project prototypes have informed installation of demonstration facilities at operational locations in nine further countries.

Country	Source of wastewater	Reuse planned?	Proposed reuse
Ireland	Dairy and beef farm	Yes	Agricultural land or yard cleaning
France (A)	Aquaculture facility	No	-
Italy	Domestic dwelling	No	-
France (B)	Offices	Yes	Irrigation of ornamental plants
UK	Domestic dwellings	No	-
Turkey	Domestic dwellings and offices	Yes	Irrigation of ornamental plants
Romania	Tourist Pension and restaurant	No	-
Ecuador	Domestic apartment complex	Yes	Irrigation of ornamental plants
Peru	Educational institution	Yes	Irrigation of ornamental plants
Tanzania	Domestic dwellings and training centre	Yes	Irrigation of (edible) banana crops
India	Domestic dwellings	No	-

Although each technology can be used in isolation (where influent and required effluent characteristics are appropriate), it is envisaged that a 'Base' INNOQUA platform will see effluent treated first in the Lumbrifilter before passing on to the Daphnia filter. The 'Advanced' platform will comprise Lumbrifilter, Daphnia filter and UV treatment in series, whilst (where local climate allows) a 'Sunny' platform will include the BSP unit. In all cases, system monitoring and control will be delivered by the MCU. The planned configurations for the demonstration sites are set out below.

Country	Lumbrifilter	Daphnia filter	UV	BSP
Ireland (farm)	✓	×	×	×
France (A)	(Lumbricomposting)	×	×	×
Italy	✓	×	✓	×
France (B)	✓	✓	×	×
UK	✓	✓	✓	×
Turkey	✓	✓	✓	×
Romania	✓	✓	×	×
Ecuador	✓	✓	×	×
Peru	✓	✓	✓	✓
Tanzania	✓	✓	✓	×
India	✓	✓	✓	✓

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TREATMENT CAPABILITIES

Preliminary performance / design data for the Lumbrifilter and Daphniafilter are presented below – to help readers judge whether they might be suited to their own wastewaters.

The Daphnia filter is normally preceded by the Lumbrifilter, which minimises the potential for suspended solids to impact on treatment performance. The Lumbrifilter does not require wastewater to be pre-screened (to remove suspended solids) where loads are around 10PE. For applications where loads are expected to reach or exceed 50PE, then fine screens must be installed ahead of the Lumbrifilter, to manage sludge production. The remaining suspended organic material passes into the filter, where it is converted to microbial biomass. This is – in turn – consumed by the earthworms.

By contrast, the Daphniafilter utilises the filter-feeding characteristics of the organism to remove fine suspended particles in the size range 35/40µm. Flow velocities and water temperature must be managed, to provide optimum conditions for the organisms. Data on pilot system performance and maintenance will be presented in future Technical Bulletins.

Performance of the Lumbrifilter over ten years of operation (pilot plant treating wastewater loads of 500PE)

Parameter	Input (average)	Output (average)
TSS (mg/L)	329	22
COD (mg/L)	737	84
BOD_5 (mg/L)	329	8
Total nitrogen (mg/L)	93	25
Total Kjeldahl N (mg/L)	93	5
NO_3^- (mg/L)	<1	20
Total phosphorus (mg/L)	10	9
E. coli (per 100ml)	20,178,692	1,374,711
Enterococci (per 100ml)	4,738,923	255,055

Design specification for Daphniafilter

Parameter	Maximum influent concentration	Minimum influent concentration
Dissolved oxygen (mgO_2/L)	-	0.5
pH	9	6.5
Conductivity (mS/cm)	12	-
Temperature (°C)	26	6
Ammonium (mg/L)	15 (40*)	-
Free ammonia (mg/L)	2	-
NO_3^- (mg/L)	25 (150*)	-
NO_2^- (mg/L)	0.5 (2*)	-
PO_4^{3-} (mg/L)	10 (15*)	-
Turbidity (FTU)	to be confirmed (tested to 27)	-

*These are critical / toxicity levels for Daphnia

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WASTEWATER CHARACTERISTICS AND RE-USE STANDARDS

The tables below list the expected characteristics of the wastewaters that will be treated at ten of the demonstration sites, together with the required quality limits for discharge of treated effluents to receiving water bodies.

Selected wastewater characteristics for the demonstration sites (on a mg / L basis, unless otherwise specified)

Country	Flow Volume (m^3/day)	pH	Temperature (°C)	Suspended Solids	COD	BOD_5	Total ammonium	Total phosphorus
Ireland	1.65	7.5	14.0	1,000	4,000	2,000	130	40
France (A)	8.00	7.5	15.0	-	700	350	50	10
Italy	1.20	7.1	17.0	-	-	-	-	6
UK	8.00	-	-	400	600	300	-	15
Turkey	3.10	7.5	15.5	220	500	220	26	8
Romania	2.40	-	23.0	225	437	280	-	14
Ecuador	2.00	7.2	-	195	250	94	-	5.2
Peru	22.5	8.2	20.5	134	872	1,065	-	-
Tanzania	2.40	-	-	-	-	-	-	-
India	10.8	7.5	27.0	250	550	225	100	40

Treated effluent limits, where discharged to surface water body (on a mg / L basis, unless otherwise specified)

Country	pH	Temperature (°C)	Suspended Solids	Dissolved Oxygen	COD	BOD_5	Total nitrogen	Total phosphorus
Ireland	-	-	35	-	125	25	-	-
France (A)	8.5	30	35	12	125	25	15	2
Italy	8	-	25	-	100	20	15	2
UK	8	20	35	-	125	25	25	-
Turkey	9	-	30	-	-	30	-	-
Romania	7.5	35	35	-	125	25	-	1
Ecuador	-	-	13	-	200	100	50	10
Peru	8.5	+-3*	-	4	40	15	-	-
Tanzania	8	26	-	-	394	-	-	-
India	9.5	+5**	-	-	50	10	10	-

NEXT BULLETIN (JULY, 2019): PRINCIPLES OF LUMBRIFILTRATION

If you have any comments or questions on the content of this bulletin, please post them to our LinkedIN group:
https://www.linkedin.com/groups/12148159/

Or contact: info@innoqua-project.eu

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