SUSTAINABLE WATER REUSE.
THE CASE OF RURAL AREAS AND SMALL SETTLEMENTS

Dra. ISABEL MARTÍN

WORLD CONGRESS AND EXPO ON RECYCLING
July 20-22, 2015
Barcelona, Spain

Autovía Sevilla-Huelva (A-49), Km 28
41820 Carrión de los Céspedes
Sevilla, España
Tlf.: (34) 954 75 90 20
Fax: (34) 954 75 52 95

Background of wastewater Treatment and Reuse

- The access to drinking water, proper sanitation, treatment of urban wastewater and a safe water reuse provide the backbone of development in a country.

- There is an important imbalance between developed and developing countries/areas.

- Problem is more or less solved in large and medium cities-areas with adequate social, economic and technological development.

- Population most affected is concentrated on rural and scattered areas, and on marginal zones of large cities in underprivileged countries.

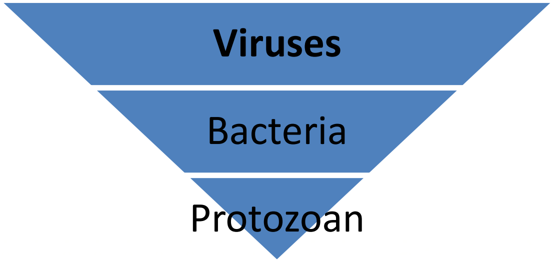
Background of wastewater treatment and reuse

Large/urban communities, developed countries

Availability of infraestructure for wwt and reuse

Good quality in water resources
Water pollution issues, primarly concerned with amenity values and toxic substances.

High coverage in sanitation and higiene



Policies defined and enforced

Background of wastewater treatment and reuse

Small/rural communities, developing countries


Water scarcity: limited food production



Not or inadecuate sanitation and/or WWTP and WWRP

Quality degradation in water resources, risks for public health

Helminths

Viruses, bacteria, protozoan

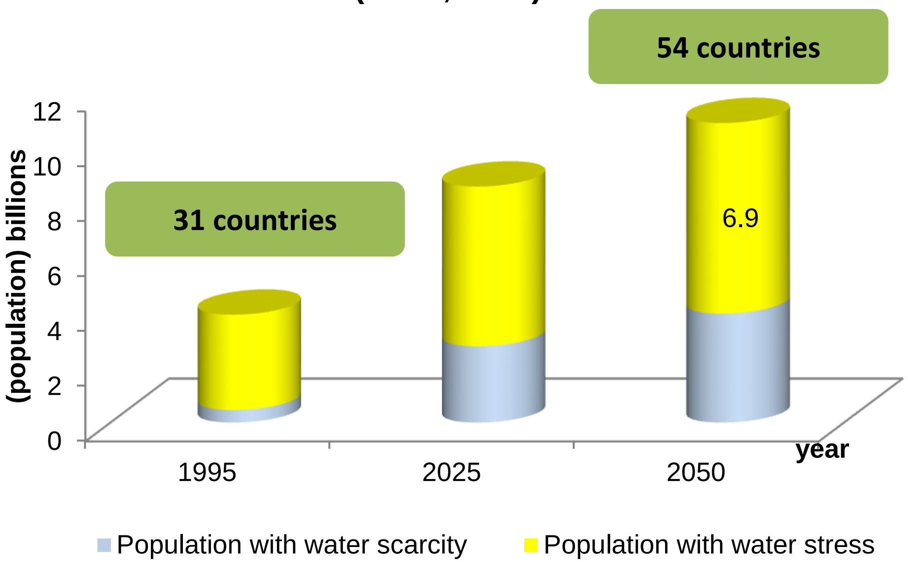
Difficult to ascribe cause due to high background levels

Policies non-defined and unenforced.

❖ Some countries are making considerable effort to reverse it.

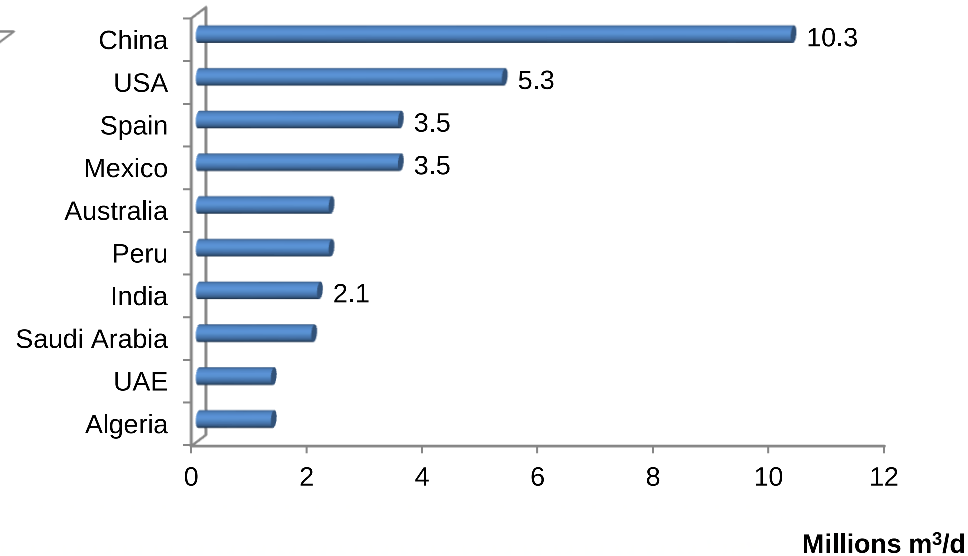
Forecast on water resources

COUNTRIES WITH WATER SCARCITY AND WATER STRESS (WHO, 2006)



TREATED WASTEWATER REUSE (IWRMP)

FUTURE EVOLUTION (2009-2016)

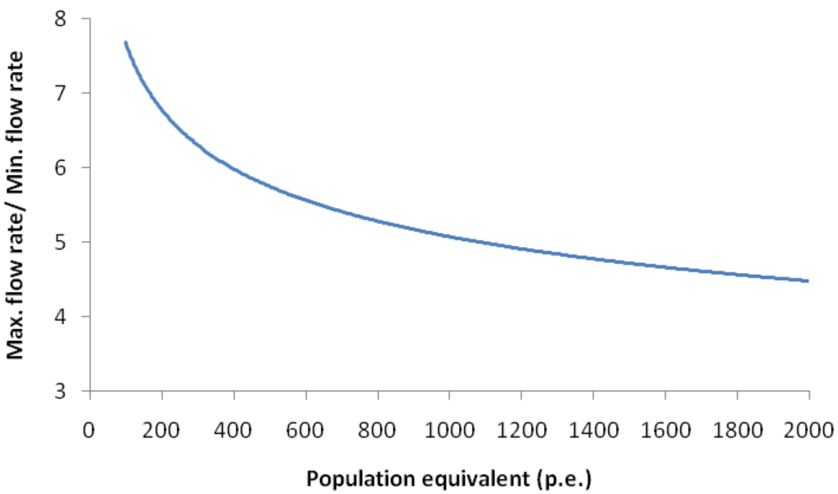


TECHNOLOGY OPTIONS
FOR WASTEWATER TREATMENT

"To consider": wastewater in small communities

- High communities dispersion→ complexity in infrastructure management
- Characteristics of wastewater :

High oscilations in flow rate during the day, to be taken into account in the dimensioning and design.



Wastewater quality:

Small communities usually generate a "small", but highly polluted volume of wastewater

Parameter	Regular range
TSS (mg/l)	300 – 500
BOD_5 (mg/l)	400 – 600
COD(mg/l)	800 – 1.200
Nitrogen(mg N/l)	50 – 100
Phosphorus (mg P/l)	10 – 20
Grease(mg/l)	50 – 100
Total coliforms(CFU/100 ml)	10^7-10^8

Wastewater treatment technologies

Intensive/conventional

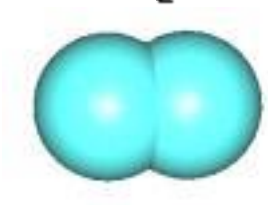
Extensive/non-conventional

Wastewater treatment technologies

Oxigen support

Energy consumption

O_2

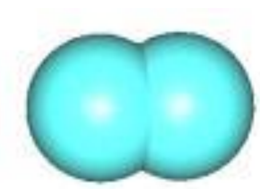


INTENSIVE TECHNOLOGIES

High energy consumption

Low implementation surface

O_2



EXTENSIVE TECHNOLOGIES

Low/cero energy consumption

High implementation surface

Wastewater treatment in small communities

Most existing WWT technologies are applied to small settlements, although some are more appropriate than others

Do we really learn from our mistakes?

Commonly, in small settlements have been implemented technologies with high treatment costs.

PROBLEM: settlements can not afford these costs (inoperative facilities or with severe operative problems)

Most sustainable technologies for WW treatment

In small communities should prevail those meet with the following requirements (EPA, 1977):

- Processes requiring **minimum operator time**
- Equipment requiring **minimum maintenance**
- **Efficient functioning** with a wide range of flow rates and loads
- **Minimum power consumption.**
- Facilities where possible equipment or process failures cause **minimum loss of effluent quality**.
- Maximum integration into the **environment.**

EXTENSIVE/NON- CONVENTIONAL TECHNOLOGIES

Pre-treatment

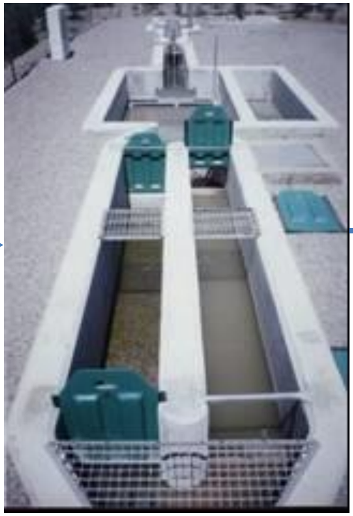
SCREENING

or

Coarse solid screen (manual cleaning) and fine solid screens

Authomatic cleaning system (scraper)

GRIT CHAMBER



Static grit chamber

GREASE CHAMBER

Static grease chamber

Aerated grit-grease chamber

Primary treatment

SEPTIC TANK

Plastic unit

Concrete unit

IMHOFF TANK

Concrete

Metal sheet

PRIMARY SETTLING TANK

Imitating natural processes

Green Filter

Area of land surface on which a tree plantation has been established, with the inlet normally being introduced through trenches or by flooding. The inlet to green filter should be a secondary treated wastewater .

The treated effluent percolates through the soil to be incorporated into the aquifers. The quality of percolation is controlled by lysimeters and/or piezometers.

Intermittent sand filters

Shallow beds (0.6-1.1 m deep), equipped with a surface distribution system for the sewage and a drainage piping to collect the treated effluent at the bottom of the filter.

Peat filters

Consist of beds with a series of filtrating layers composed, from the top down, of **peat,** gravel and fine gravel. The water purification occurs mainly in the peat layer, while the rest of the strata basically retain the upper layers.

Constructed Wetlands (CW)

CW technology operates as a complex ecosystem made of the following elements (Vymazal, 2008; Kadlec *et al*., 2009):

- **Water**, which flows through the filtrating substrate and/or vegetation.
- **Substrate**, which is the support of the plants and has to retain the microbial population (in the form of a biofilm).
- **Emerging aquatic plants** (macrophytes), which supply surface area for the formation of bacterial films, facilitate the filtration and adsorption of the wastewater constituents, help to oxygenate the substrate and remove the nutrients, etc…

Constructed Wetlands (CW)

Uses

Urban-Industrial wastewater treatment

Restauration and recreation of water ecosystems

Stabilization -dehydration of sludge

Landscape integration

Lagooning system

It is made up of several lagoons connected in series. Their depth is gradually reduced and they alternately present conditions of absence or presence of oxygen. They reproduce the water self-purification process that is found in natural water courses .

Trickling filter (Percolating filter)

Aerobic process, where the preliminary treated wastewater, percolates by gravity through a filling material (stones, plastic material) , which constitutes the medium on which microorganisms develop and grow, forming a biofilm of variable thickness. The filling material is fixed, inside the reactor, and provides a high specific surface area.

Rotating Biological Contactor

Systems where microorganisms adhere to a medium which is half-submerged (approximately 40% of its surface area) and rotates in the wastewater.

TECHNOLOGY OPTIONS FOR WATER RECLAMATION

Risks associated to wastewater use

Water reclamation treatments

- Physico-chemical
  - In line
  - Conventional
  - Advanced
- Filtration
  - Sand
  - Disc
  - Membranes
  - Sieve
- Desalination
  - Electrodialysis reversal (ER)
  - Reverse osmosis (RO)
- Disinfection
  - Chlorination
  - Ozonation
  - Photocalalysis
  - UV
- Biological treatment
  - Membrane bioreactor (MBR)
  - Non-conventional Technologies

CENTA´s Center

45,000 m^2 for wastewater treatment and REUSE in small communities, by conventional and NON-CONVENTIONAL TECHNOLOGIES

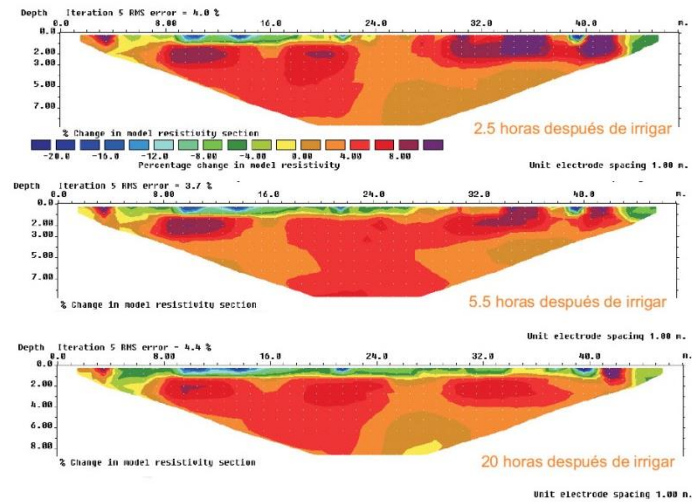
R&D&I Experimental Center, Seville, Spain

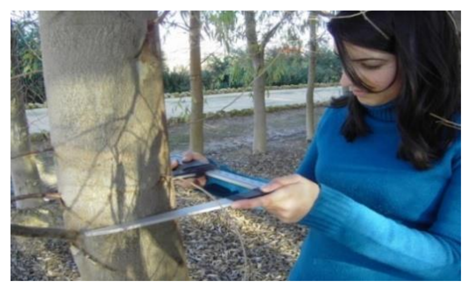
www.centa.es

www.centa.es

CENTA´s researches on wastewater treatment and REUSE

Green Filters (silviculture for energy production, emerging contaminants removal for aquifer recharge)





CENTA´s researches on wastewater treatment and reuse

Jatropha curcas (biodiesel production)

Short-term effects of reclaimed water irrigation: Jatropha curcas L. cultivation

A. De Miguel *et al*. 2012. Ecological Engineering (50), 44-51

CENTA´s researches on wastewater treatment and REUSE

Sunflowers (biodiesel production)

CENTA´s researches on wastewater treatment and REUSE

Intensive Green Filters (energy production, soil as reclamation treatment)





CENTA´s researches on wastewater treatment and REUSE

Permeable Reactive Barriers (aquifer recharge)

Palygorskite

Activated carbon

Zeolite

CENTA´s researches on wastewater treatment and REUSE

Intermittent Sand Filters for water reclamation

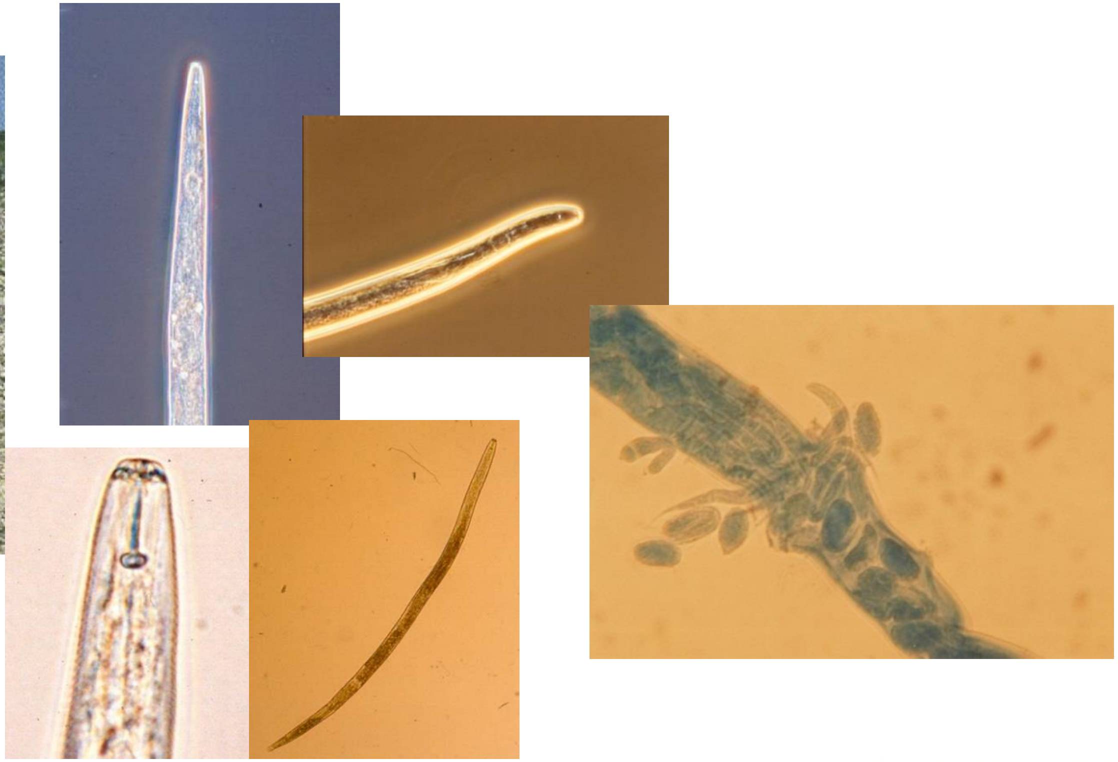
Filter substrate thickness: 0.6 m

Filter substrate thickness: 1.5 m

CENTA´s researches on wastewater treatment and REUSE

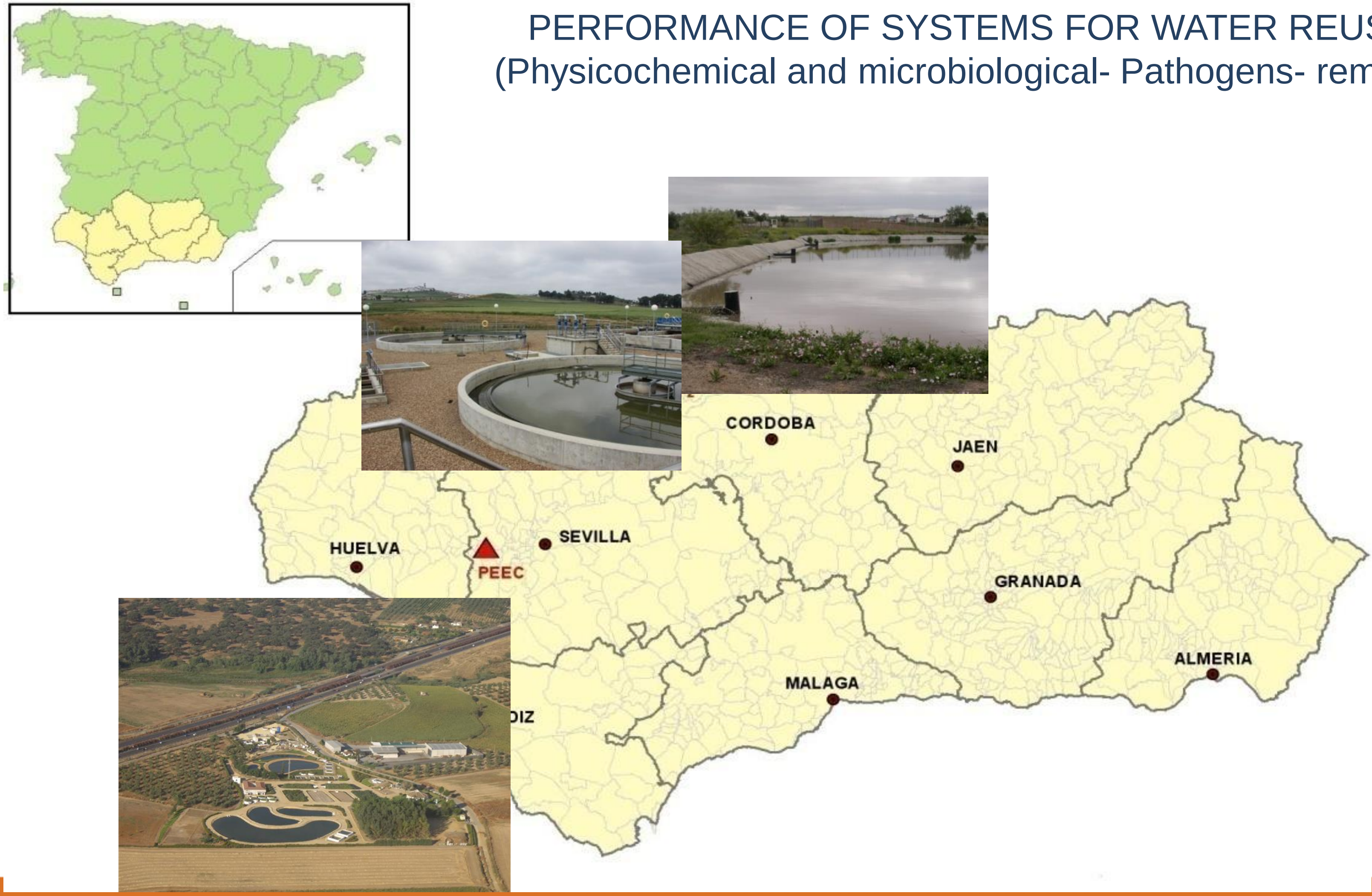
Nematodes as a factor for consideration in the wastewater treatment and water reuse process.

C. Santos, I. Martín and E.M. Trujillo. 2013. Desalination and water treatment 1-6

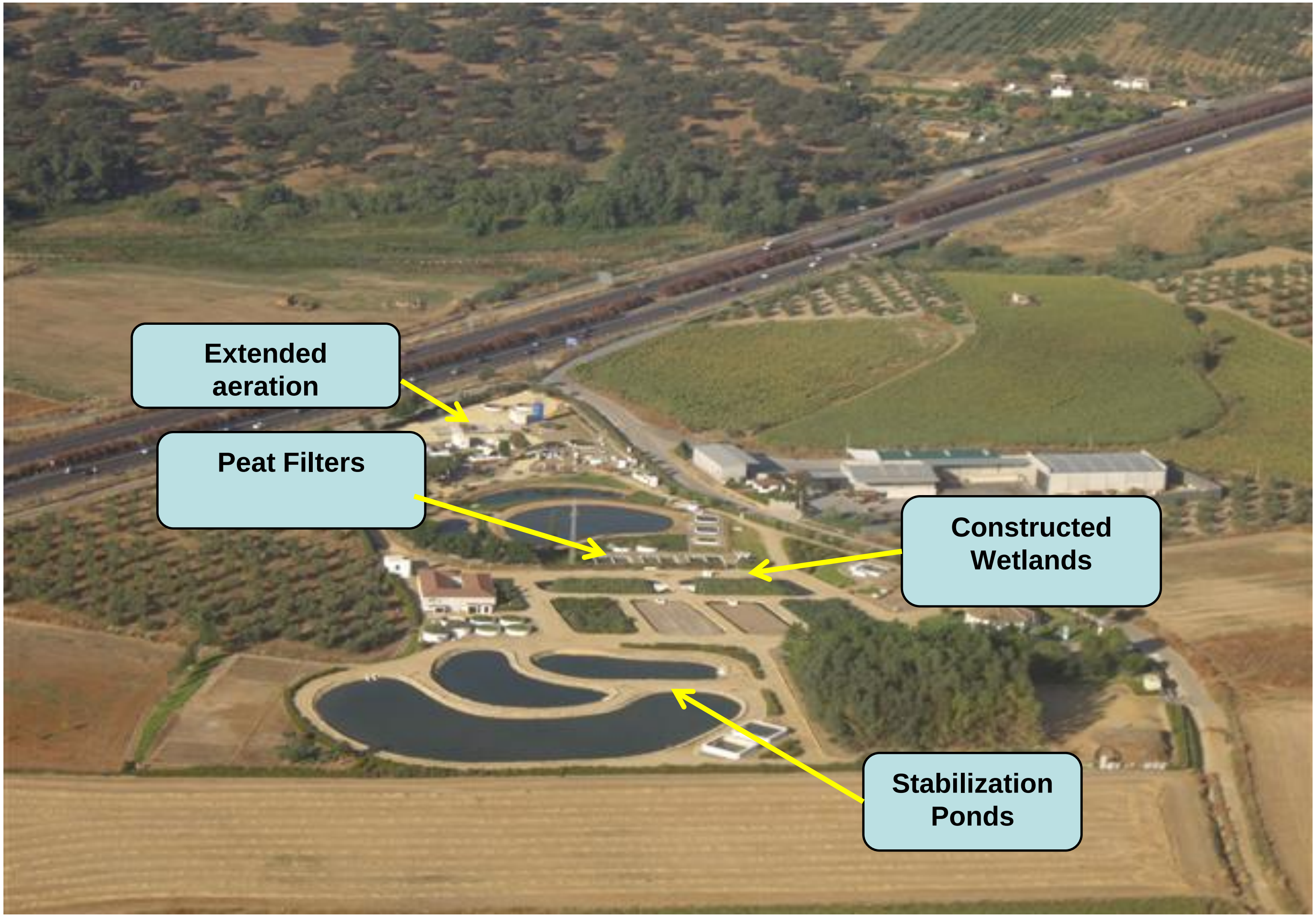


CENTA´s researches on wastewater treatment and REUSE

PERFORMANCE OF SYSTEMS FOR WATER REUSE
(Physicochemical and microbiological- Pathogens- removal)

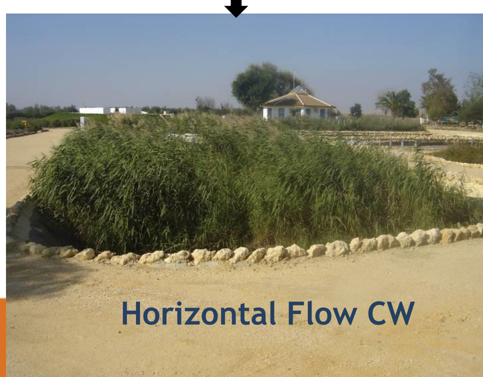


CENTA´s researches on wastewater treatment and REUSE



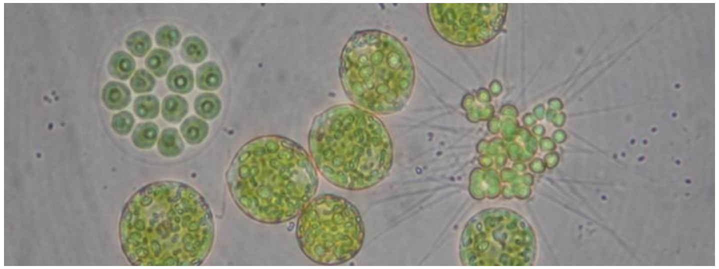
CENTA´s researches on wastewater treatment and REUSE

CWs combination



CENTA´s researches on wastewater treatment, RECYCLING and REUSE

www.life-biosol.eu



Bio-Solar Water Recycling

Demonstration wastewater treatment system dedicated to wastewater reuse and recycling

BioSolWaRe-LIFE

Project background

While Europe is considered to have adequate water resources, water scarcity and drought is an increasingly frequent and widespread phenomenon in the EU. According to recent estimates, at least 11% of Europe's population and 17% of its territory had been affected by water scarcity by 2007. This puts the cost of droughts in Europe over the past 30 years at 100 billion euros.

Project objectives

In this frame, the BioSolWaRe-LIFE project will develop and test an **innovative**, more **efficient** and **competitive** wastewater treatment method based on an **ecological process** called **bio-solar purification** (BSP) mainly addressed to **small** and **isolated** populations (10-10,000 inhabitants). This process uses biological (microalgae photosynthesis) and solar (photo-oxidation) technologies to **enable 80% water reuse**, the **recovery** and **valorisation of greenhouse gases and organic wastes**.

Expected results

The project expects to develop an operational pilot wastewater treatment plant that will:

- Allow fresh water savings through reclaimed water.
- Process 50 m^3 per day of purified and disinfected wastewater.
- Improve energy and carbon balances compared to existing wastewater treatment and reuse processes.

Duration of the project

54 months (01/07/2014- 31/12/2018)

Total budget in euro: 2,322,837.00

EC contribution in euro: 1,146,793.00

Coordinating beneficiary:

HelioPur Technologies

Contact e-mail: contact@heliopurtech.com

Associated beneficiaries:

FCC Aqualia

Contact e-mail: frogalla@fcc.es

Coldep

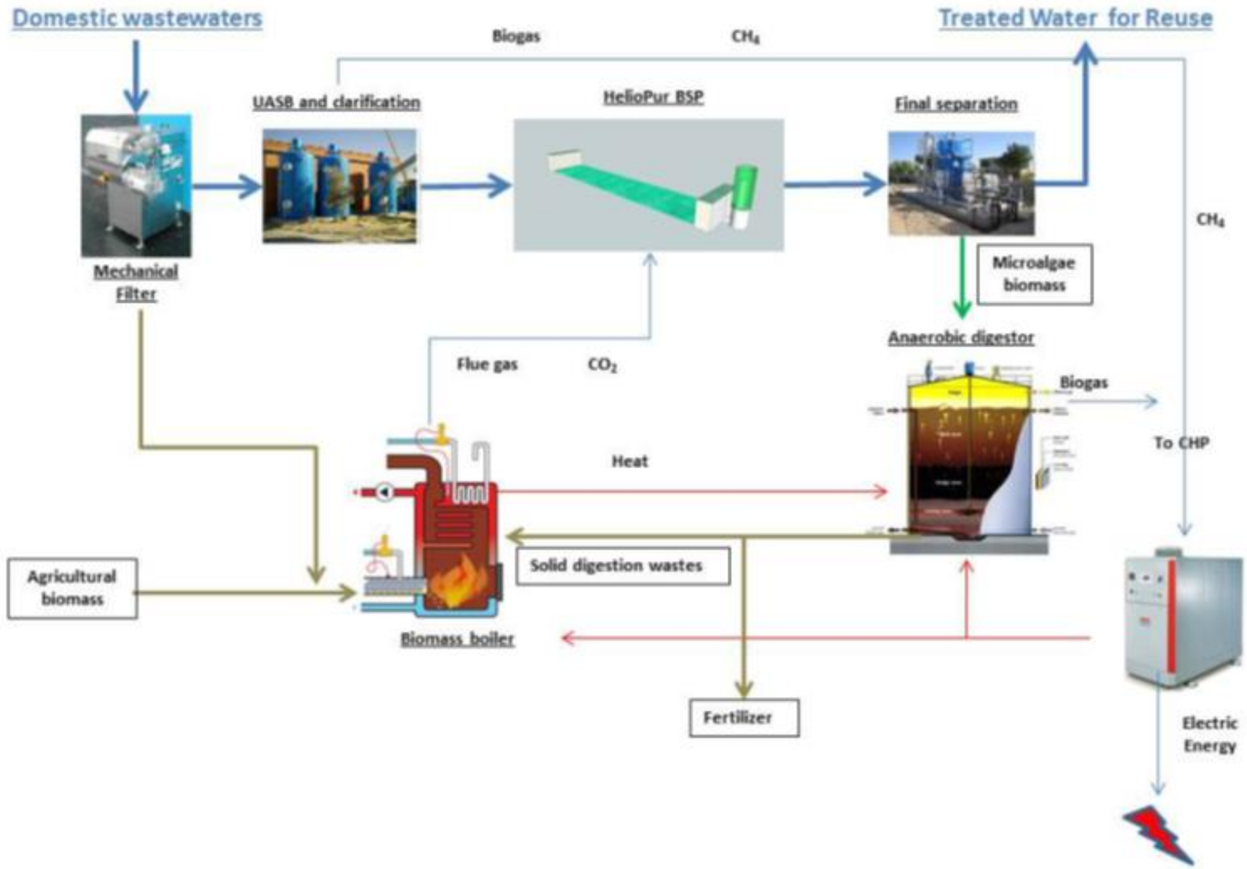
Contact e-mail: julien.jacquety@coldep.com

centa

Contact e-mail: centa@centa.es

CENTA´s researches on wastewater treatment and REUSE

LCA



CENTA´s researches on wastewater treatment and REUSE

SARASWATI: *Supporting consolidation, replication and up-scaling of sustainable wastewater treatment and reuse technologies for India*

CENTA´s researches on wastewater treatment and REUSE

Research and Development on Wastewater Treatment and Reuse
(Mali and Tunisia)

CENTA´s researches on wastewater treatment and REUSE

Unión Europea

Fondo Europeo de Desarrollo Regional

Invertimos en su futuro

PROGRAMA Cooperación Transfronteriza España-Fronteras Exteriores

CROSS-BORDER CAMPUS FOR SUSTAINABLE MANAGEMENT OF WATER RESOURCES

CENTA´s researches on wastewater treatment and REUSE

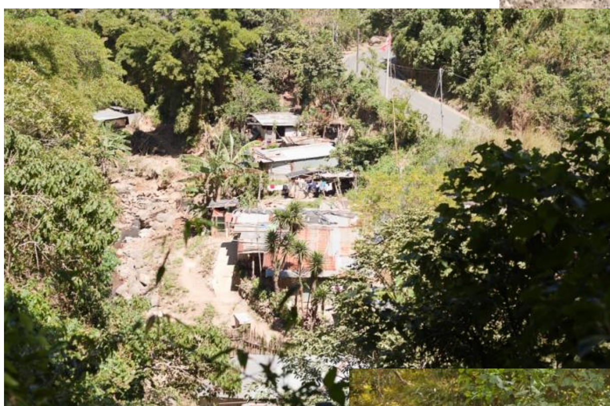
Design and implementation of an integrated system for wastewater treatment and reuse in the environment of Wadi Al Aroub
Hebron (Palestine)

CENTA´s researches on wastewater treatment and REUSE

Application of suitable sanitation technology for sustainable human development in small communities in El Salvador.
Wastewater-Reuse








CONCLUSIONS

- The limited financial and physical resources for wastewater treatment, the socio-economic situation and the context of urbanization affect principally to **small communities, rural and low income areas, creating the conditions for unplanned and uncontrolled wastewater reuse.**

- It is therefore in those types of agglomerations where it should be done a **bigger effort to correct deficiencies, starting on sanitation and continuing on wastewater treatment and reuse**, without forgetting that must be **found options which reconcile the requirement to treated and reuse wastewater, safely, with simple operating techniques and operating and maintenance costs that may be really defensible.**

THANK YOU

For further information: imartin@centa.es