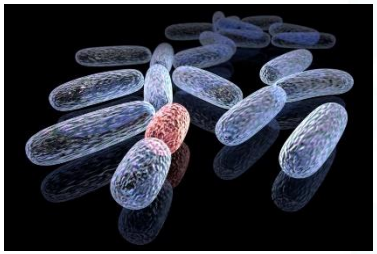
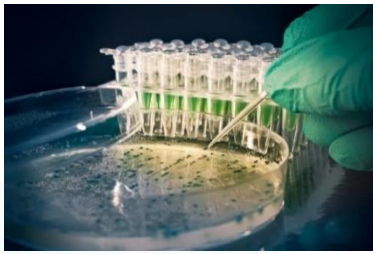
COST Action ES1403

New and emerging challenges and opportunities in wastewater reuse

Chair: D. Fatta-Kassinos, UCY
Vice Chair: C. Manaia, UCP





Porto, Portugal

12th of July, 2017

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Thank you !

Local Organisers

Dr. Adrián M.T. Silva

Dr. Vítor J.P. Vilar

U.PORTO
FEUP FACULDADE DE ENGENHARIA UNIVERSIDADE DO PORTO

The European PhD School on Advanced Oxidation Processes

AOPs PhD School

Dr. Luigi Rizzo, Chair

University of Salerno, Italy

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Thank you !

NEREUS COST Action ES1403 Summer School organisers

- **Dr. Luigi Rizzo**
  University of Salerno, Italy, Leader of WG 4
- **Dr. Sixto Malato**
  Plataforma Solar de Almería, CIEMAT, Spain, Vice Leader of WG 4
- **Dr. Celia Manaia**
  Universidade Católica Portuguesa, Portugal, Vice Chair
- **Mr. Toumazis Toumazis**
  Nireas-IWRC, UCY, Nereus COST Action administrator

- **Dr. Deniz Caraca** (Science Officer)
- **Mr. Christophe Peeters** (Administrative Officer)

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NEREUS COST Action

Water Scarcity/Stress

By **2025**, **1800 million people** are expected to be living in countries or regions with **"absolute" water scarcity** (<500 m^3 per year per capita), and **two-thirds of the world population** could be under **"stress" conditions** (between 500 and 1000 m^3 per year per capita).

Source: FAO, 2017

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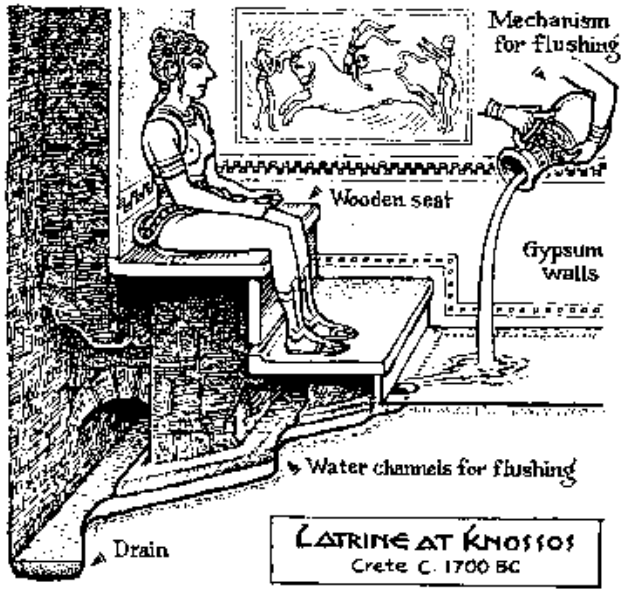
The evolution of wastewater management

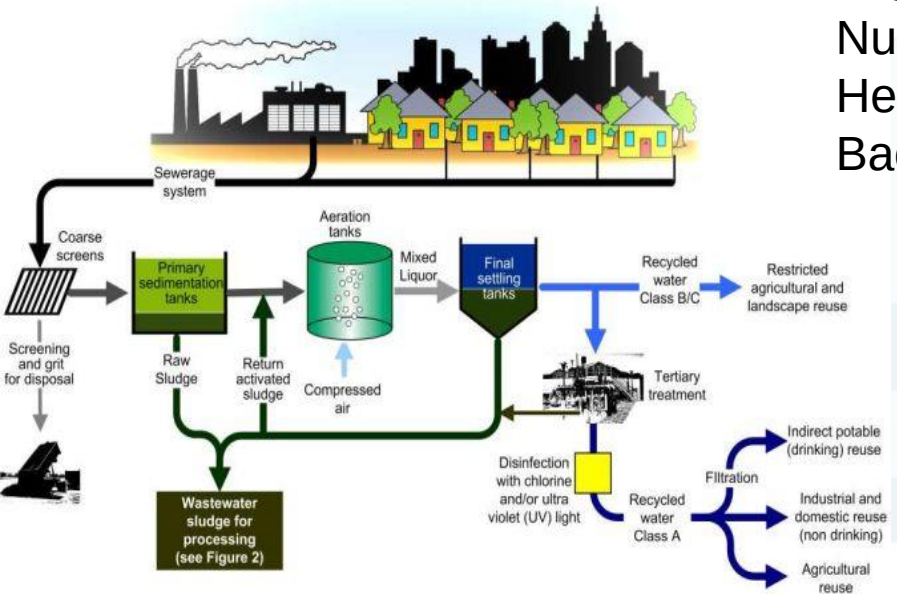


Sir E. Chadwick raised the first question of the need to purify wastewater in a report in 1842 in England.

The germ theory by Koch and Pasteur in the 1880s heralded a period of scientific enlightenment.

Since the 1980s, giant strides have been made in the physical, biological, and chemical sciences with respect to the fundamentals involved.

Organic load (<20 mg/L, TOC)
Nutrients
Heavy metals
Bacteria



Resource recovery
Re-use

Biogas
Bioplastics Biosolids

Energy-sufficient

Contaminants of Emerging Concern

CEC

Brominated Flame Retardants

Siloxanes (cosmetic: to soften, moisten)

Quats

Parabens (parahydroxybenzoates or alkyl esters of parahydroxybenzoic acid, preservatives)

Biocides/Antibacterial (triclosan)
Roof-paints (mecocrop, terbutryn)

Sweeteners (sucralose)

Fragrances

Bisphenol A (epoxy resins - food and drinking packaging - water pipes)

Phthalates (plasticizers - toys, clothing, building materials)

Alkyphenolic compounds (surfactants, cosmetics)

PFOA & **PFOS** (Perfluorooctanoic acid Perfluorosulfonates)

Disinfection by-products

Algal toxins

Hormones (natural / synthetic)

Pharmaceuticals

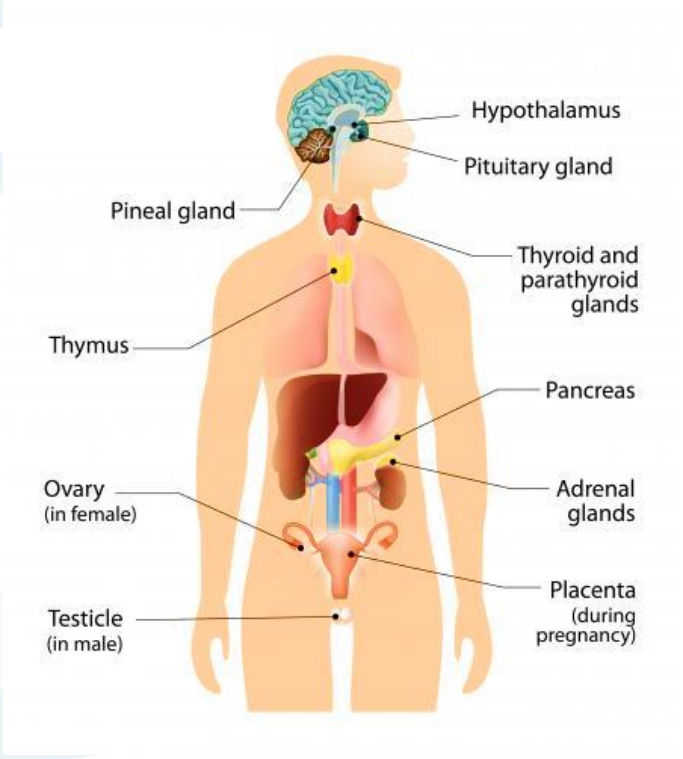
Illicit drugs

What do we know so far ?

tumors, neurotoxicity, DNA alterations, kidney diseases…

… cause disruption of the endocrine system

- Agonistic effect
- Antagonistic effect
- Interfere with the metabolic processes in the body, affecting the synthesis or breakdown rates of the natural hormones



https://www.epa.gov/endocrine-disruption/what-endocrine-system

reproduction, immunity, behavior, growth and development

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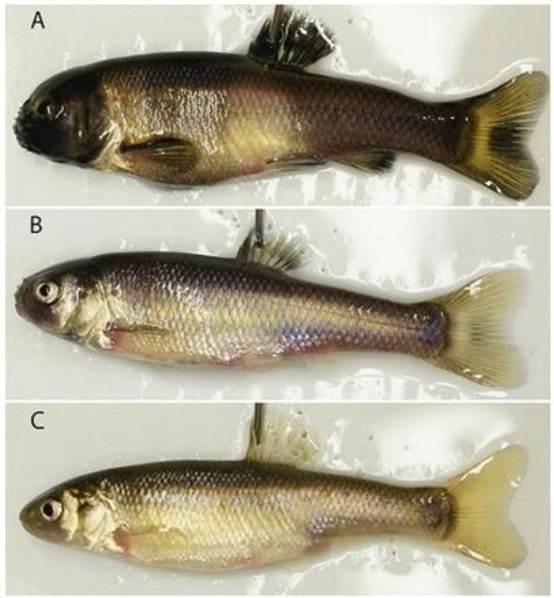
So far…about pharmaceuticals

Two cases of direct cause and effect identified (wildlife):

- … that of **diclofenac**, used as a veterinary drug for cattle. Tens of millions of vultures in Asia died - feeding on the corpses of treated cows.
- ... feminization of male fish, reported in many countries; **ethinylestradiol**.

Possibility of other effects on wildlife, current or future.

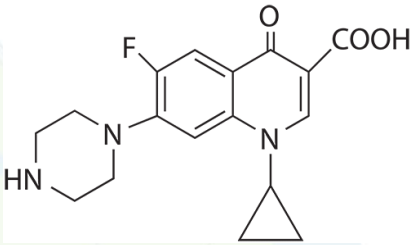


Fish A is a normal male fathead minnow. Fish C is a normal female. **Fish B is a male that was exposed to female hormones and looks more like a female**.

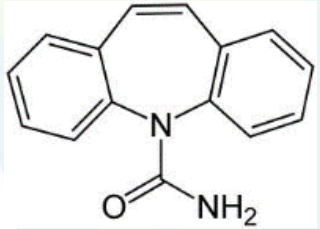
Exposure Factors / Characteristics

- **Constant introduction to environment**
- **Synergy**
- **Chronic Effect**
  - Long-term
  - Low-dosage

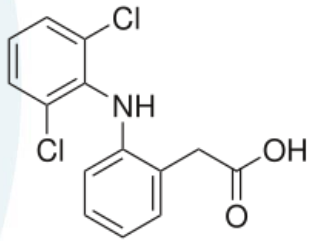
- Complex molecules, often with multiple ionic sites
- Strongly influenced by pH
- Some tend to partition to aqueous phase/solid phase
- Designed to be biologically active



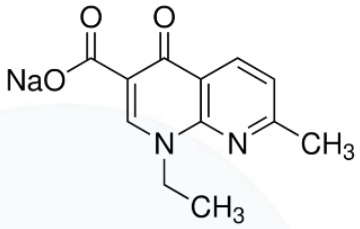
ciprofloxacin



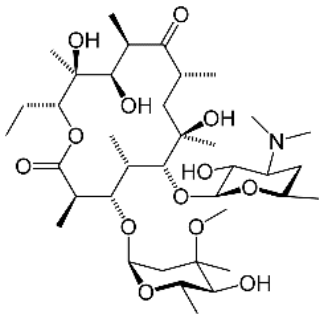
carbamazepine



ibuprofen



nalidixic acid



erythromycin

diclofenac

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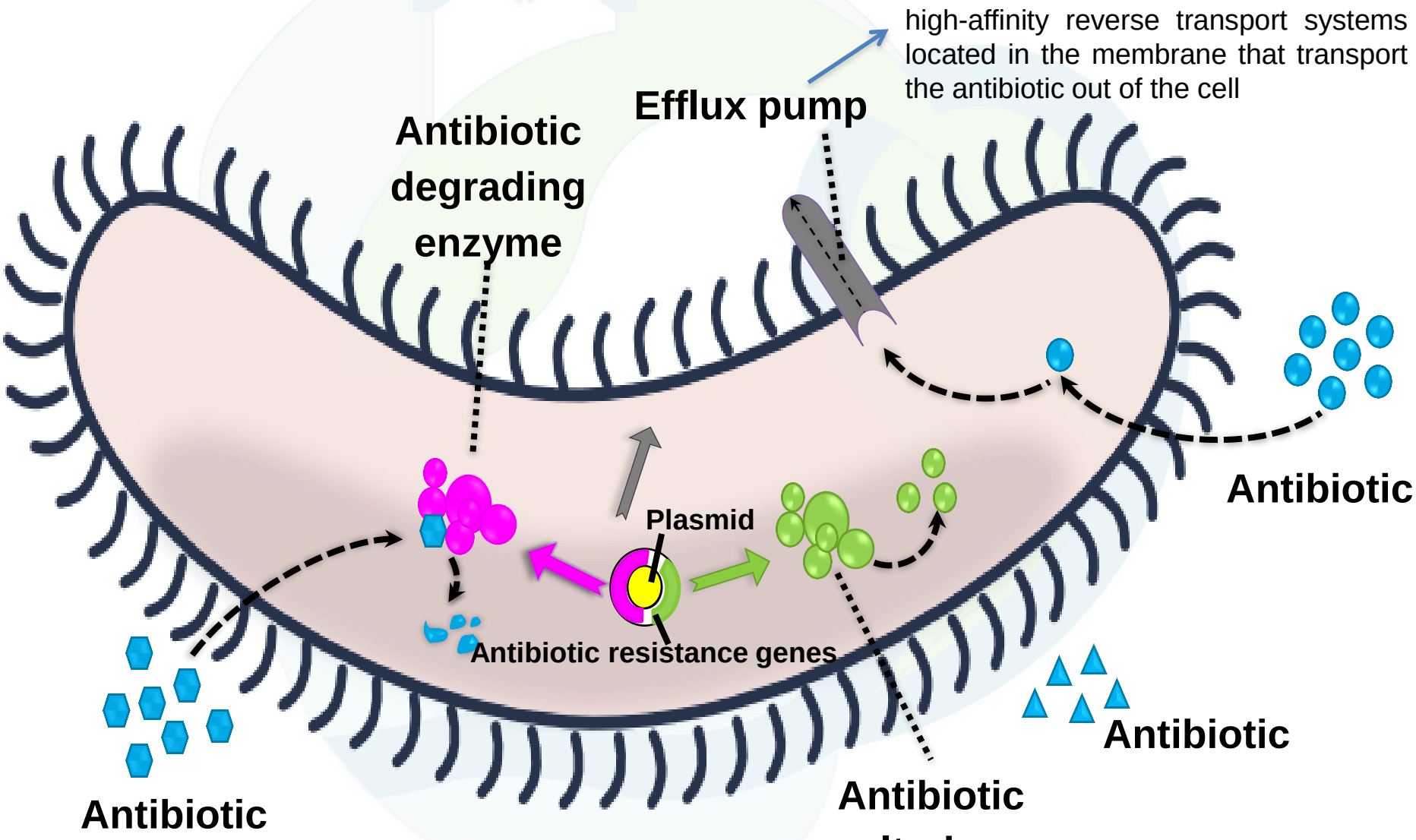
Antibiotic Resistance



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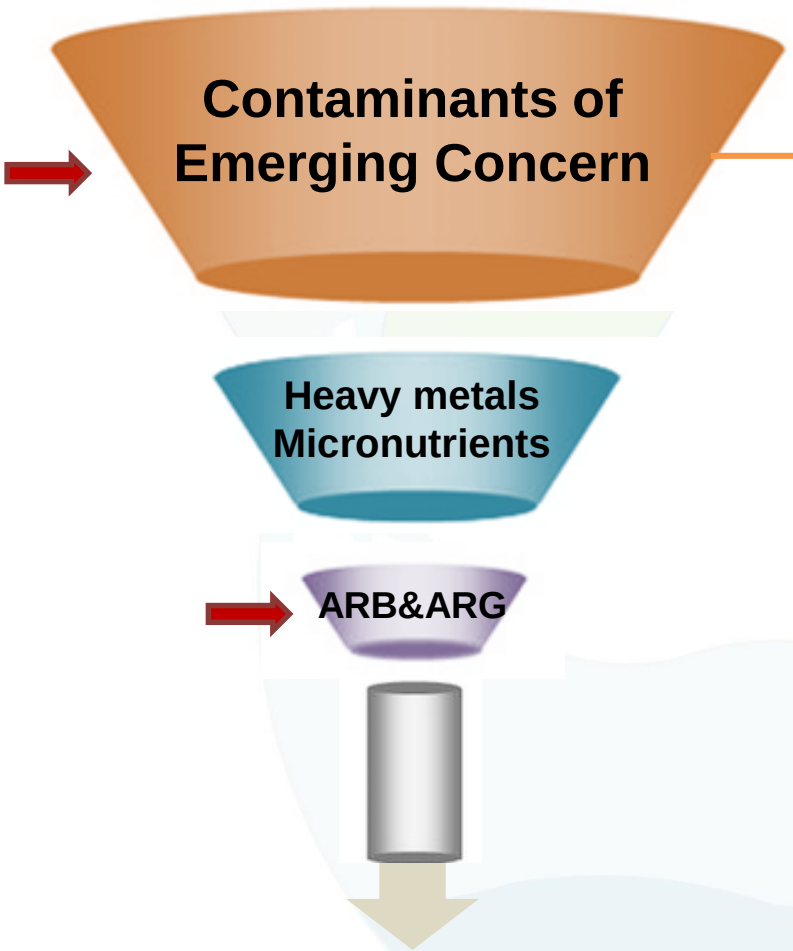
Treated wastewater effluent load according to current knowledge



- Endocrine Disrupting Compounds, Carcinogens
- Pharmaceuticals and Personal Care Products (including metabolites)
- Other Currently Non-Specified Chemicals (including Disinfection By-products and Transformation Products)

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WW reuse and quality parameters

The European Council Directive 91/271/EEC concerning urban wastewater treatment in Article 12 states that … ***"Treated wastewater shall be reused whenever appropriate"***.

To date, countries with organized wastewater reuse schemes have developed national or regional regulations/guidelines based on **conventional chemical** and **microbiological parameters**.

Parameter
Chemical Oxygen Demand
Biochemical Oxygen Demand
Suspended Solids
Heavy metals
Faecal coliforms
Intestinal worms
Basic toxicity testing (if any)

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NEREUS COST Action

New and **E**merging challenges and opportunities in wastewater **REUS**e

→ **Emerging Challenges of wastewater reuse**

Although reuse is accompanied by a number of benefits, **several questions still exist:**

Current Open Challenges:

- ✓ **contaminants of emerging concern**
- ✓ their **transformation products** (through biotic and abiotic processes)
- ✓ their potential **uptake by crops**
- ✓ the **effects** that these contaminants may induce **in the environment**
- ✓ the **evolution** and **release** of **antibiotic resistance**
- ✓ the identification of **technologies** that are able to remove such contaminants from wastewater
- ✓ the identification of **means** and **solutions** to overcome these problems, and **promote safe reuse practices**.

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Primary Objective of NEREUS

A **multi-disciplinary network** to determine which of the current challenges related to wastewater reuse are the most concerning ones in relation to public health and environmental protection, and how these can be overcome.

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Wastewater reuse applications

Urban uses	irrigation, street cleaning, fire protection systems, washing, toilet flushing, dust control
Agricultural uses	food crops commercially processed, pasture for milking animals, fodder, aquaculture
Industrial uses	process water, cooling water, recirculating cooling towers, making concrete, dust control
Recreational uses	golf courses irrigation, recreational impoundments
Environmental uses	aquifer recharge, stream augmentation, wildlife habitant
Potable uses	aquifer recharge for potable use, augmentation of surface potable supplies, treatment until potable water quality

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COST Countries

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- Belgium
- Bosnia & Herzegovina
- Bulgaria
- Croatia
- Cyprus
- Czech Republic
- Denmark
- Estonia
- Finland
- France
- Germany
- Greece
- Ireland
- Israel
- Italy
- Lithuania
- Luxembourg
- Malta
- Montenegro
- Netherlands
- Norway
- Poland
- Portugal
- Serbia
- Slovakia
- Slovenia
- Spain
- Sweden
- Switzerland
- United Kingdom
- Romania

International Partner Countries

- Australia
- Pakistan
- Singapore
- South Korea
- United States of America

Near Neighbor Countries

- Georgia
- Jordan
- Tunisia
- Ukraine

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WGs Members (statistics)

	Male	Female	Total
Action	**200** (194)	**170** (164)	**370** (358)
WG1	44	49	93
WG2	37	19	56
WG3	19	21	40
WG4	90	67	157
WG5	10	14	24
ECIs	87	87	174

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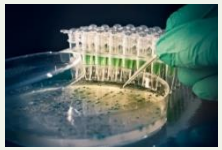
Action Working Groups

Working Group		Title	Leader / Vice Leader
	WG1	Microbiome and mobile antibiotic resistome in treated ww and in downstream environments	Eddie Cytryn Thomas Berendonk
	WG2	Uptake and translocation of organic microcontaminants and ARB/ARG in crops	Josep Maria Bayona Benny Chefetz
	WG3	Effect-based bioassays required for ww reuse schemes	Jaroslav Slobodnik Norbert Kreuzinger
	WG4	Technologies efficient/economically viable to meet the current ww reuse challenges	Luigi Rizzo Sixto Malato
	WG5	Risk assessment and policy development	Lian Lundy Mario Carere

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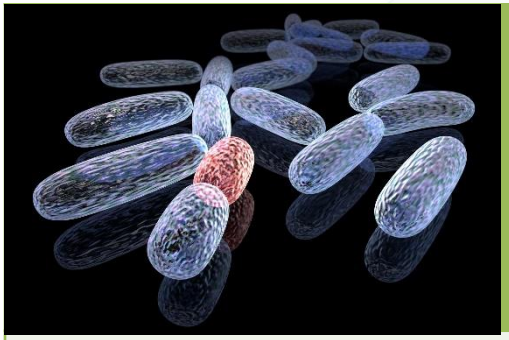
Working Group 1



Microbiome and mobile antibiotic resistome in treated wastewater and in downstream environments

- Propose the standardization of the ARB+ARG detection and quantification in water and soil samples
- Identify most prevalent and/or hazardous ARB+ARG with ability to persist, spread and proliferate after wastewater disposal + reuse scenarios
- Assess the fate, if possible quantitatively, of ARB+ARG discharged in treated wastewater and released in surface water or soils
- Identify the conditions favoring ARB+ARG persistence or proliferation

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Working Group 2

Uptake and translocation of organic microcontaminants and ARB/ARG in crops

- Consolidate knowledge on the uptake and translocation of microcontaminants and ARB+ARG in crops
- Identify the main physicochemical characteristics affecting the uptake and translocation of microcontaminants and ARB+ARG
- Develop a set of recommendations regarding the minimisation of biomagnification processes and environmental and human health impacts associated with wastewater reuse

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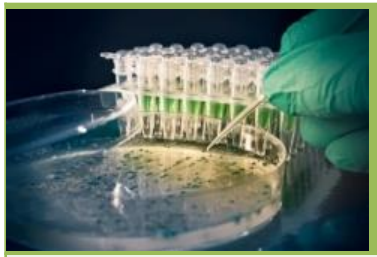
Working Group 3



Effect-based bioassays required for wastewater reuse schemes

- Assessment of the existing information available in the literature with regard to biological effects and wastewater based on different tests applied
- Identification of potential relationships between the physicochemical characteristics of the wastewater and the biological effects derived
- Determination of the most appropriate and relevant bioassays / bioassay battery for wastewater quality evaluation
- Propose the harmonization of the procedures used during the application of the bioassays determined

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Working Group 4

Technologies efficient/economically viable to meet the current wastewater reuse challenges

- Understand the fate of microcontaminants during treatment
- Assess the fate of ARB+ARG during biological processes and characterize removal mechanisms (in collaboration with WG1)
- Assess the effect of AOPs on ARB+ARG and the subsequent risk for effluent reuse related to oxidation TPs and residual release (in collaboration with WG2)
- Assess the economical feasibility of AOPs compared to more conventional advanced treatment processes/technologies in wastewater reuse
- Identify the combinations (and economical feasibility) between biological, advanced treatment and required reuse infrastructure in terms of global efficiency/compliance with standard parameters (e.g., BOD, COD, N, P etc.) and microcontaminants including ARB+ARG

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Working Group 5

Risk assessment and policy development

- Develop quality criteria for selected contaminants of emerging concern and ARB+ARG for wastewater reuse
- Propose a battery of assays for wastewater evaluation for reuse purposes
- Develop a risk assessment framework for wastewater reuse
- Propose guidelines/suggestions on possible technologies and systems able to produce wastewater of quality in compliance to the quality criteria to be set (with respect to ARB+ARG, biological risks, etc).
- Overcome existing barriers in the field of wastewater reuse and valorize wastewater as a non-conventional water resource

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Nereus Coordinators/Facilitators

- **STSMs:** F. Walsh, E. Heath, H. R. Andersen
- **BSC:** H. M. Schaar, M. Vasquez
- **Dissemination & Outreach activities:** M. Suarez, M. de Kreuk
- **Equal Opportunities:** D. Lambropoulou, T. Kosjek
- **Training events:** G. Li Puma, Th. Wintgens, E. Meers
- **Inter-Working Group Facilitator:** J.Drewes
- ***WG secretaries***

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First Meeting, May 2015

Barcelona, Spain

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Second Meeting, October 2015

Luxembourg

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Third Meeting, March 2016

Luqa, Malta

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Fourth Meeting, September 2016

Sarajevo, Bosnia & Herzegovina

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WGs Meetings





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WG1 Training Event

Barcelona, June 2016

CSIC, *hosted by Dr. Josep Bayona and Dr. Benjamin Piña*

Total number of STSMs

- **GP1** (1/1/2015-31/8/2015)
  1. Massimiliano Marvasi
- **GP2** (1/9/2015-30/4/2016)
  1. Popi Karaolia
  2. Ivone Vaz-Moreira
  3. Francisco Pedrero Salcedo
  4. Rui Ribeiro
  5. Therese Kettner
  6. Sinead Murphy
  7. Felipe Lira
- **GP3** (1/5/2016-30/4/2017)
  1. Anna Wegrzyn
  2. Ana Martinez Piernas
  3. Saulo Della Giustina
  4. Carmine Fiorentino
  5. Roberto Marano
  6. Jessica Subirats Medina
  7. Marjeta Cesen
- **GP4** (1/5/2017-30/4/2018)
- + 5 more
  1. Tjaša Gornik
  2. Chmingui Walid
  3. Milena Milaković
  4. Heidemarie Schaar

Total STSMs: 19 +

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STSMs during GP3 (1/5/16-31/4/17)

Name	Topic	From	To	Host	Days
Dr. Saulo Della Giustina	Chlorination of Wastewaters-Effects on ARG&B and Antibiotics	Catalan Institute of Water Research- ICRA, Girona, **Spain**	NIREAS-International Water Research Center, School of Engineering, University of **Cyprus**	Dr. Despo Fatta-Kasinos	**36** 26/6-31/7
Mr. Carmine Fiorentino	Fate and elimination of organic chemicals during wastewater treatment : modelling implementation and simulation	University of Bologna, **Italy**	Technical University of Denmark, **Denmark**	Prof. Stefan Trapp	**28** 22/8-18/9
Ms Ana Belen Martinez-Piernas	Behaviour of Carbamazepine and its transformation products in soil and lettuce grown under controlled conditions	University Of Almeria, La Canada De San Urbano, **Spain**	CNR Istituto di Ricerca sulle Acque, **Italy**	Dr. Giuseppe Mascolo	**9** 19/9-18/12
Dr. Anna Wegrzyn	Distribution of sulfonamide resistance genes in bacterial endophytes isolated from *Miscanthus sp*.	Silesian University of Technology, **Poland**	Helmholtz Zentrum München German Research Center for Environmental Health, **Germany**	Dr. Peter Schröder	**45** 1/11-15/12
Dr Marjeta Cesen	Optimisation of a novel passive sampler based on diffusion in hydrogel for the determination of timeaveraged concentrations of selected compounds of emerging concern in wastewater	Jožef Stefan Institute, **Slovenia**	Research Centre for Toxic Compounds in the Environment, **Czech Republic**	Dr. Branislav Vrana	**66** 24/2-30/4
Ms Jessica Subirats Medina	Effects of WWTP effluents and antibiotics on the composition of natural bacterial communities and their associated resistome	ICRA, **Spain**	National Research Council of Italy, **Italy**	Dr. Gianluca Corno	**62** 27/2-29/4
Mr Roberto Marano	Integron-associated ARG in wastewater	Agricultural Research Organization, **Israel**	University of Helsinki, **Finland**	Dr. Marko Virta	**15** 9/4-23/4

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STSMs during GP4 (1/5/17-31/4/18)

Name	Topic	From	To	Host	Days
Ms. Tjaša Gornik	Application of Molecularly Imprinted Polymers (MIPs) in wastewater treatment and reuse	Jožef Stefan Postgraduate School, Ecotechnology, **Slovenia**	"Department of Biomedical SciencesFaculty of Health and Society, Malmö University", **Sweden**	Dr. Börje Sellergren	**90** 03/08-31/10
Mr. Chmingui Walid	Identification and quantification of pharmaceutical compounds in environmental matrices under real field conditions of wastewater reuse in agriculture	National Research Institute for Rural Engineering, Water, and Forestry (INRGREF), **Tunisia**	Nireas-IWRC, University of Cyprus, **Cyprus**	Dr. Despo Fatta-Kassinos	**31** 01/10-31/10
Ms. Milena Milaković	Characterization of mobilome that is involved in antibiotic resistance dissemination in aquatic environment	Ruđer Bošković Insitute, **Croatia**	Helmholtz Zentrum Munchen, Research Unit for Comparative Microbiome Analysis, **Germany**	Dr. Michael Schloter	**55** 9/10-3/11
Ms. Heidemarie Schaar	Toxicological evaluation of ozonation and subsequent activated carbon filtration for advanced wastewater treatment as a basis for water reuse with standardised bioassays	Vienna University of Technology, **Austria**	BioDetection Systems b.v., **The Netherlands**	Dr. Bram Brouwer	**5** 2/10-6/10

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Blue Circle Society

The scientific network of ESRs and PhD students

The Blue Circle is able to **meet separately** during the WGs meetings and **come up with suggestions** and **ideas** that are relayed to the WGs leaders and participants, the steering group and the management committee.

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Blue Circle Society Coordinators

Dr. Marlen Vasquez

Dr. Heidemarie Schaar

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Blue Circle Society

The Blue Circle activities:

- **participate** in **training schools** and **STSMs** in order to transfer knowledge among participating institutions
- **actively participate** in all **WGs** and fulfil specific tasks
- **establish links** between the Blue Circle and other relevant ECI-networks
- **identify the on-going relevant research projects** and any other similar activities regarding the Action
- **implement continuous dissemination activities** (information, methodologies and results through conventional and social media)
- **organize activities of science communication** in various countries
- **present its work and outcomes during STSMs** and also present how the participation in the Action helped and/or enhanced the professional maturity of the ECIs, during a special session in the **final conference**.

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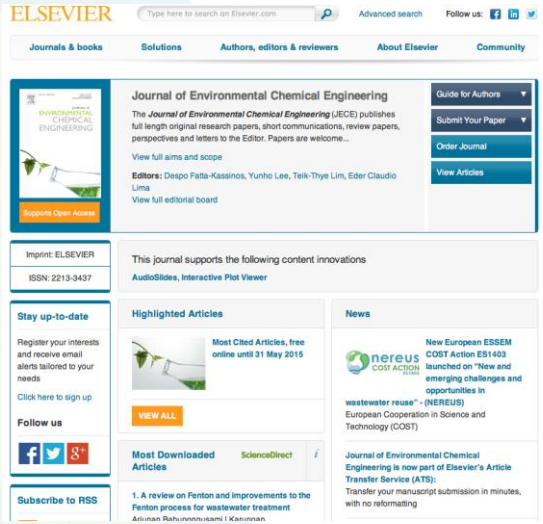
Social Media



@NEREUS_WWreuse

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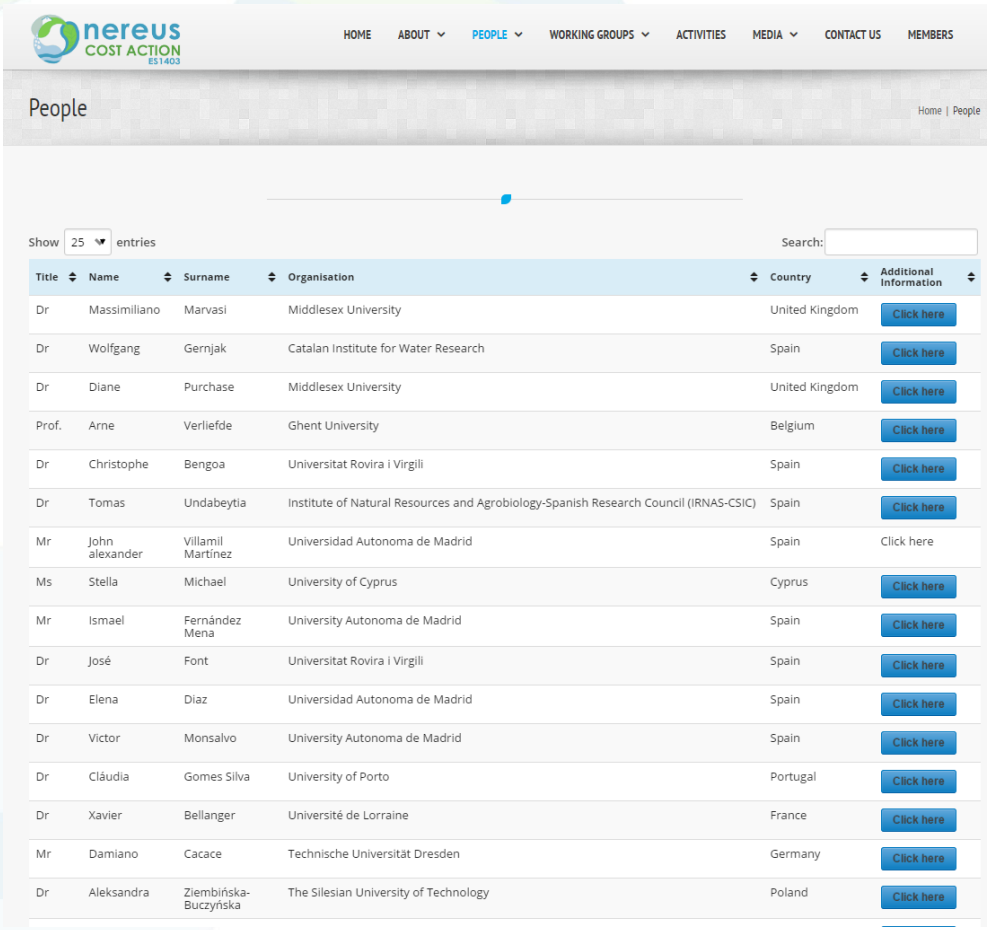
http://www.nereus-cost.eu



Title	Name	Surname	Organisation	Country	Additional Information
Dr	Massimiliano	Marvasi	Middlesex University	United Kingdom	Click here
Dr	Wolfgang	Gernjak	Catalan Institute for Water Research	Spain	Click here
Dr	Diane	Purchase	Middlesex University	United Kingdom	Click here
Prof.	Arne	Verliefde	Ghent University	Belgium	Click here
Dr	Christophe	Bengoa	Universitat Rovira i Virgili	Spain	Click here
Dr	Tomas	Undabeytia	Institute of Natural Resources and Agrobiology-Spanish Research Council (IRNAS-CSIC)	Spain	Click here
Mr	John alexander	Villamil Martínez	Universidad Autonoma de Madrid	Spain	Click here
Ms	Stella	Michael	University of Cyprus	Cyprus	Click here
Mr	Ismael	Fernández Mena	University Autonoma de Madrid	Spain	Click here
Dr	José	Font	Universitat Rovira i Virgili	Spain	Click here
Dr	Elena	Diaz	Universidad Autonoma de Madrid	Spain	Click here
Dr	Victor	Monsalvo	University Autonoma de Madrid	Spain	Click here
Dr	Cláudia	Gomes Silva	University of Porto	Portugal	Click here
Dr	Xavier	Bellanger	Université de Lorraine	France	Click here
Mr	Damiano	Cacace	Technische Universität Dresden	Germany	Click here
Dr	Aleksandra	Ziembińska-Buczyńska	The Silesian University of Technology	Poland	Click here

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On-going and forthcoming activities

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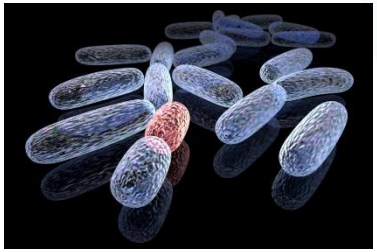
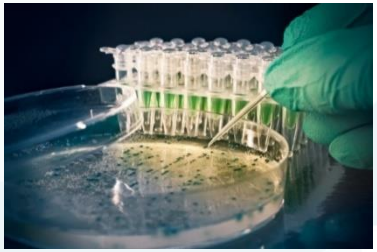
nereus COST ACTION ES1403

WG2

Training school on "the uptake of microcontaminants and ARB&ARG testing in wastewater and soil samples"





Patras Meeting

21 - 23 March 2017

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WG2 - Training School

Thematic Areas

- Uptake and bioaccumulation of pharmaceuticals by crops grown in fields irrigated with reclaimed wastewater
- Solid phase extraction of crops and plants **+ hands-on experience**
- Chromatographic analysis of micropollutants in crops and plants **+ demonstration**
- Stress-related phenomena and detoxification mechanisms induced by common pharmaceuticals plants
- Evaluation of stress related physiological markers of plants (physiological, biochemical and molecular) (real time qPCR, phasmatophotometric methods, enzymatic activity assays, etc.) **+ hands-on experience**
- Methodologies for public health risk assessment

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WG2 - Training School

Study tours

- Visit to **WWTPs** that combine wastewater reuse schemes
- Study tour to long-term (more than 10 years) **reclaimed wastewater irrigated sites** and collection of samples of soils and fodder plants for further analysis in the lab **(hands-on experience)**
- Study tour to the **greenhouse** of the Agricultural Research Institute of Cyprus where plants are irrigated with reclaimed wastewater
- Visit to the **experimental station** of the Agricultural Research Institute of Cyprus where control field experiments are taking place.

Challenges and Solutions related to Xenobiotics and Antimicrobial Resistance in the Framework of Urban Wastewater Reuse: Towards a Blue Circle Society

Nireas International Water Research Center (Nireas-IWRC) of the University of Cyprus is proud to announce the **XENOWAC II conference,** a decade after the first XENOWAC conference (XENOWAC I) took place in Cyprus in March 2009. The Conference embraces the work performed in the framework of NEREUS COST Action ES1403 and H2020-MSCA-ITN-2015/675530 ANSWER both coordinated by Nireas-IWRC. Join us and be part of this leading event for presenting and discussing the latest concepts and developments in the field of contaminant of emerging concern and urban wastewater reuse. We will try to answer various quite challenging questions including the following:

- A new perspective on wastewater contaminants – Is it about time to look for THE contaminant?
- The deeper we look ... the more numerous the risks are?
- WASTEWATER once ... wastewater forever?
- How can we create a Blue Circle Society?

FIRST ANNOUNCEMENT

Highlights!

- Talks from international authorities in the field
- Exchange of information between academia and stakeholders
- A platform for early-career investigators to present their work
- Satellite event by the **Joint Programming Initiative (JPI)** on Water Challenges
- Science Slam
- Wonderful venue, social activities and great food

MAIN TRACKS

- "New" chemical contaminants of emerging concern in urban wastewater
- Microbiome and mobile antibiotic resistome in urban wastewater
- Spread, fate and transmission of contaminants and antimicrobial resistance under wastewater reuse scenarios
- Uptake and translocation of organic microcontaminants and antimicrobial resistance in crops
- Fate prediction through modelling approaches
- Effect-based bioassays required for wastewater reuse schemes
- Technologies efficient/economically viable to meet the wastewater reuse challenges
- Large demostration projects
- Data management and Prioritisation
- Risk assessment and Policy development
- XENOWAC II Science Slam

ABSTRACT SUBMISSION DEADLINE 31ST OF MARCH 2018

www.xenowac2018.com
10-12 October 2018
GrandResort Hotel / Limassol, Cyprus

XENOWAC II

A decade after...

Organised and Hosted by:

Πανεπιστήμιο Κύπρου
University of Cyprus

nireas
International Water Research Center

NEREUS COST Action ES1403

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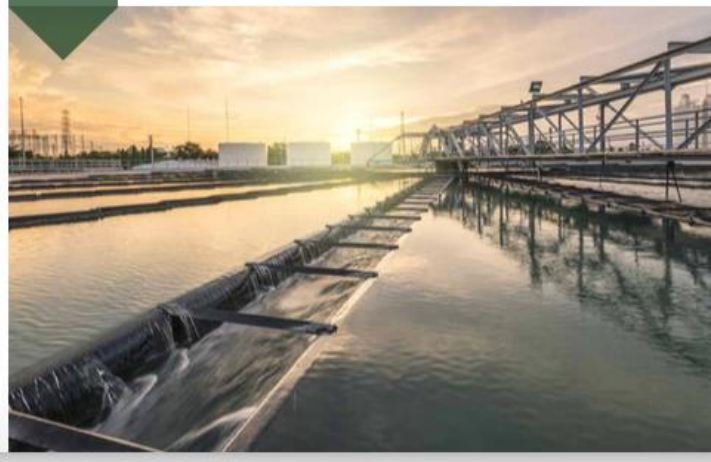
COST is supported by the EU Framework Programme Horizon 2020

MSCA ITN 765530 ANSWER

ANSWER

We look forward to welcoming you all to Limassol for **XENOWAC II !**



Organizing Committee

- Despo Fatta-Kassinos (Conference Chair), Nireas-IWRC, University of Cyprus (CY)
- Celia Manaia, Universidade Católica Portuguesa Escola Superior de Biotecnologia (PT)
- Thomas Berendonk, Technische Universität Dresden (DE)
- Eddie Cytryn, Agricultural Research Organization Volcani Center (IL)
- Christophe Merlin, CNRS-University of Lorraine (FR)
- Josep Bayona, Consejo Superior de Investigaciones Científicas (ES)
- Benny Chefetz, The Hebrew University of Jerusalem (IL)
- Jaroslav Slobodnik, Environmental Institute s.r.o. (SK)
- Norbert Kreuzinger, Technische Universität Wien (AT)
- Luigi Rizzo, University of Salerno (IT)
- Sixto Malato, Plataforma Solar de Almería, Centro de Investigaciones Energēticа, Medioambientales y Tecnológicas (ES)
- Lian Lundy, Middlesex University (UK)
- Mario Carere, Italian Institute of Health (IT)
- Luc Hornstra, KWR Watercycle Research Institute (NL)
- Sergio Silva, Adventech- Advanced Environmental Technologies Lda (PT)
- Dominique Darmendrail, JPI Water Coordinator Agence Nationale de la Recherche (FR)
- Valeria Dulio, Executive Secretary of the NORMAN Network

Organizers of the ANSWER Young Scientists and Blue Circle Society

- Irene Michael-Kordatou, Nireas-IWRC, University of Cyprus (CY)
- Lida Ioannou-Ttofa, Nireas-IWRC, University of Cyprus (CY)
- Toumazis Toumazi, Nireas-IWRC, University of Cyprus (CY)
- Marlen Ines-Vasquez, Cyprus University of Technology (CY)
- Heidemarie Schaar, Technische Universität Wien (AT)

www.xenowac2018.com
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XENOWAC II

A decade after...

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Thank you for you attention

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