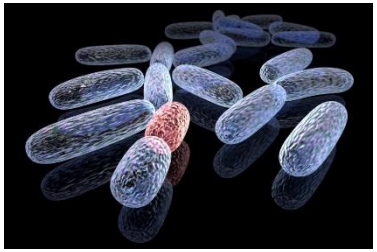
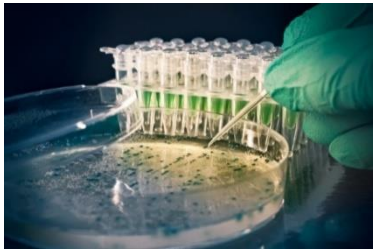
nereus COST ACTION ES1403

Experience from the COST Action ES1403

New and emerging challenges and opportunities in wastewater reuse





2019 Water JPI Workshop
on International Cooperation Towards a Common Strategy

Paris

25th of June, 2019

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COST Actions

- COST (European Cooperation in Science and Technology) is a funding organisation for research and innovation **networks**.
- Actions help connect research initiatives across Europe and beyond and …
- … enable researchers and innovators to grow their ideas in any science and technology field by sharing them with their peers.
- Duration: 4 years
- COST Actions **do not fund research** but **networking** (trips & stay) within the Action (i.e., **trainings**, summer schools, workshops/conferences, **short term scientific missions**, etc.).

Treated wastewater effluent load according to current knowledge

The focus of work

- **Contaminants of Emerging Concern**
  - Endocrine Disrupting Compounds, Carcinogens
  - Pharmaceuticals and Personal Care Products (including metabolites)
  - Other Currently Non-Specified Chemicals (including Disinfection By-products and Transformation Products)
- **Antibiotic resistance**
- **Nano plastics**
- **other**

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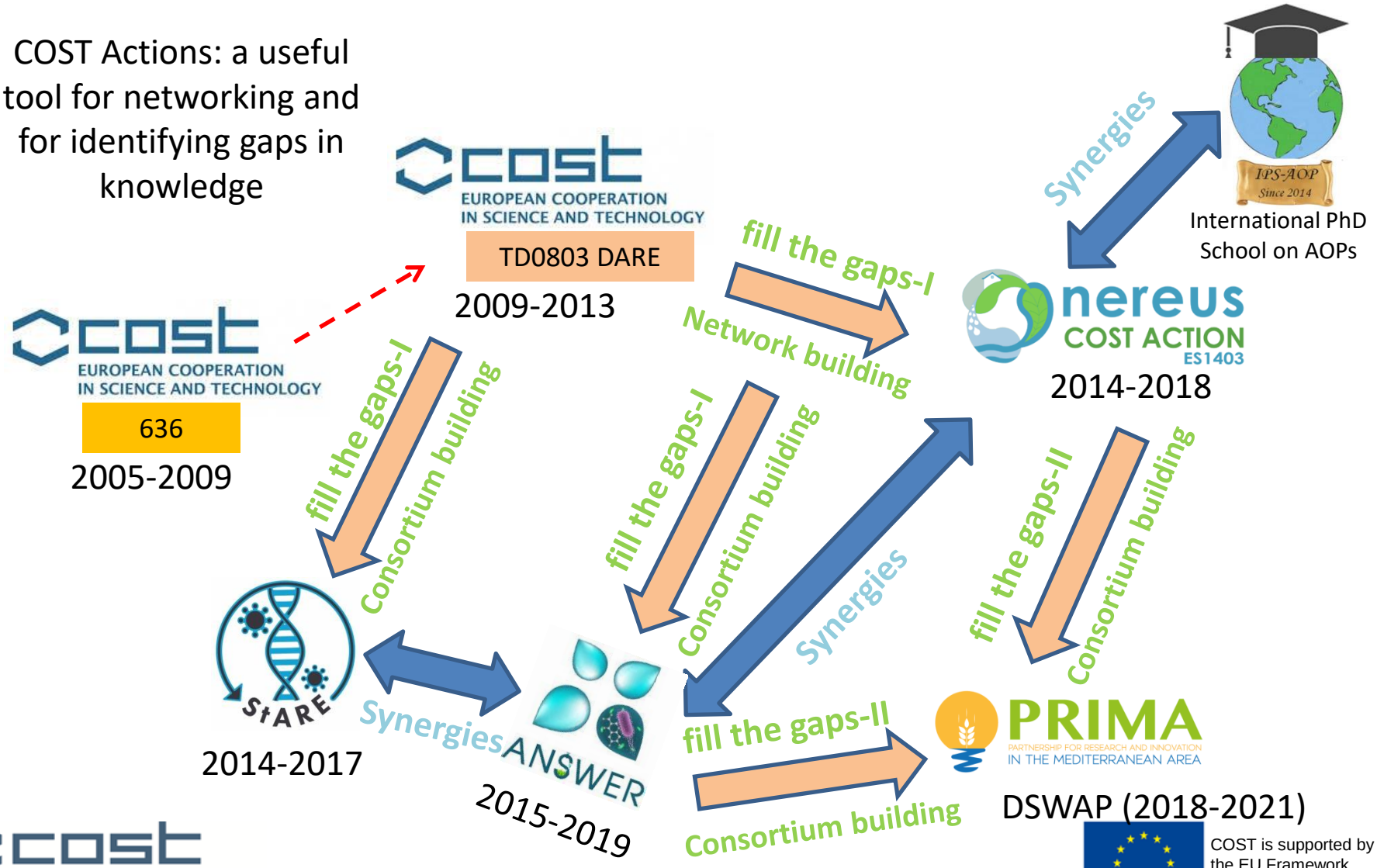
Our story…

COST Actions: a useful tool for networking and for identifying gaps in knowledge



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Primary Objective of NEREUS

what? to establish a multi-disciplinary network

why? to determine which of the current challenges related to wastewater reuse are the most concerning ones in relation to

public health

environmental protection

and how these can be overcome.

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Programme Horizon 2020

- **Grant Holder**

  Nireas-IWRC of the University of Cyprus

- **Chair**

  Despo Fatta-Kassinos

- **Vice Chair**

  Celia Manaia, Catholic University of Porto

Duration: 2014-2018 / 800000 EUR

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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 Christophe Merlin
	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

chemistry, biology, epidemiology, engineering, etc...etc...

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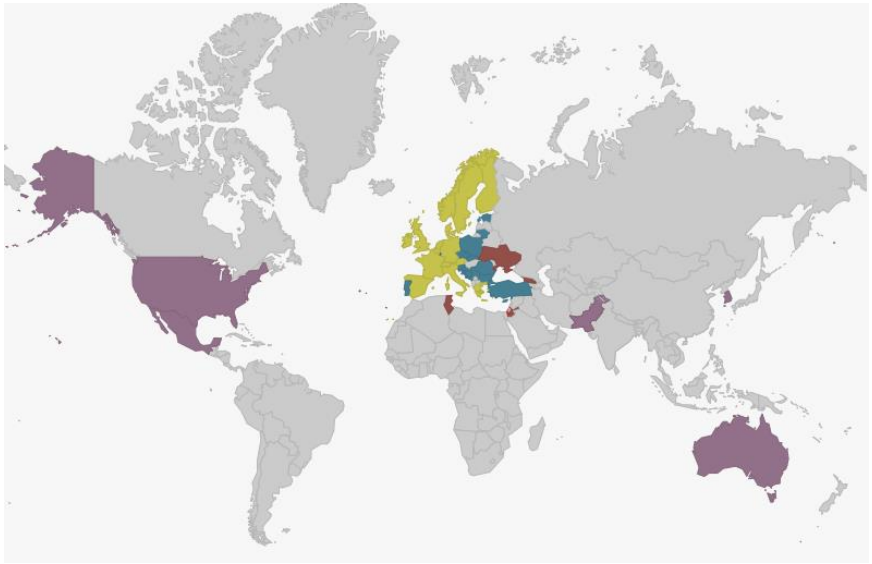
Our Network

33 COST Countries

4 Near Neighbour Countries

6 International Partner Countries



Total Number of members: **380**

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nereus
COST ACTION

COST Countries

- Austria
- 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
- Romania
- Serbia
- Slovakia
- Slovenia
- Spain
- Sweden
- Switzerland
- Turkey
- United Kingdom

International Partner Countries

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

Near Neighbor Countries

- Georgia
- Jordan
- Tunisia
- Ukraine

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Who participated

- Scientists / Professionals
  - from
    - Academia
    - Research organisations
    - National research agencies
    - Companies: technologies, bioassays, microbiology, advanced chemical analytical techniques, etc.
    - WWTPs operators
    - Regional authorities
    - Policy development authorities (ministries)

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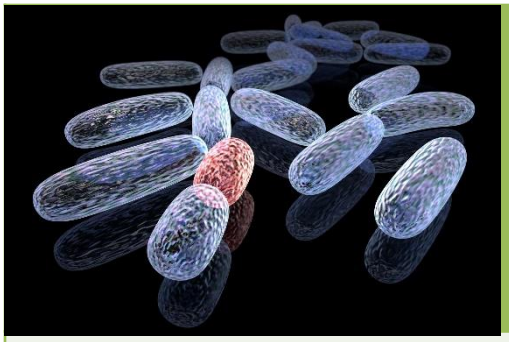
Working Group 1



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

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

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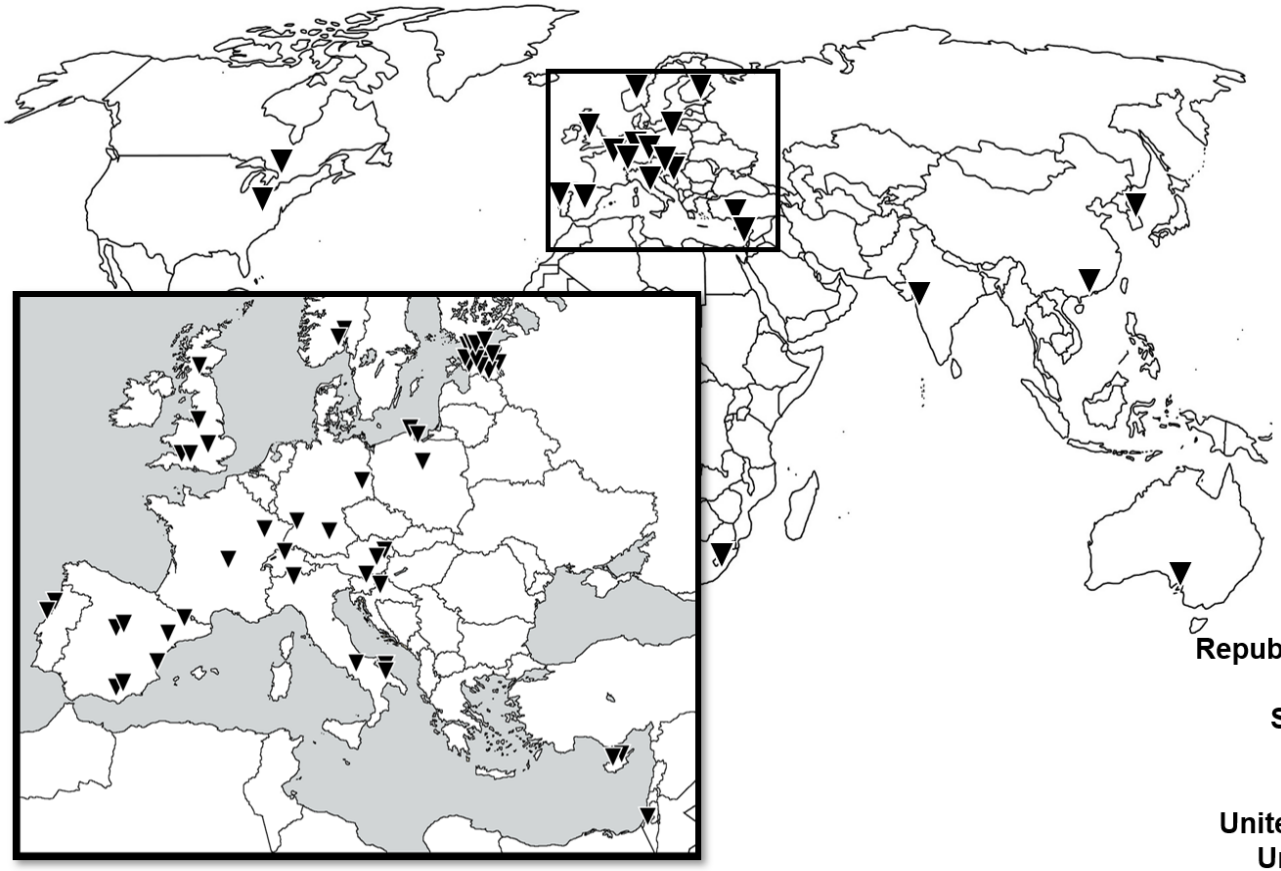
nereus COST ACTION ES1403

Application and evaluation of a simple method for assessing antibiotic resistance in urban wastewater treatment plants: Insights from a global multinational initiative: cefotaxime-resistant fecal coliforms



Australia
Austria
Canada
China
Croatia
Cyprus
Estonia
France
Germany
India
Israel
Italy
Norway
Poland
Portugal
Republic of Korea
Slovenia
South Africa
Spain
Switzerland
United Kingdom
United States

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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&ARGs in crops
- Identify the main physicochemical characteristics affecting the uptake and translocation of microcontaminants and ARB&ARGs
- 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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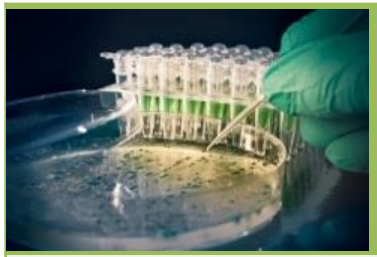
Working Group 3



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

- Consolidate knowledge on the fate of CEC during treatment
- Assess the fate of ARB&ARGs during biological processes and characterize removal mechanisms (in collaboration with WG1)
- Assess the effect of AOPs on ARB&ARGs and the subsequent risk for effluent reuse related to oxidation transformation products and residual ARB+ARG release (in collaboration with WG2)
- Assess the economical feasibility of AOPs compared to more conventional advanced treatment processes/technologies in wastewater reuse

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Working Group 5

Risk assessment and policy development

- Develop quality criteria for selected contaminants of emerging concern and ARB&ARGs for wastewater reuse
- Propose a battery of assays for wastewater evaluation for reuse purposes
- Develop a risk assessment framework for wastewater reuse
- Overcome existing barriers in the field of wastewater reuse and valorize wastewater as a non-conventional water resource

voluntary basis !!!

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Scientific Outputs

Cristina Becerra-Castro Training School on "Methods for detecting and quantifying antibiotic resistant bacteria and antibiotic resistance genes in the environment"

Barcelona, Spain
13-15 June 2016, CSIC

hosted by Dr. Josep Bayona and Dr. Benjamin Piña

Scientific Outputs

Uptake of microcontaminants by crop plants and ARB&ARGs testing in wastewater, soil and plant samples

Nicosia and Limassol, Cyprus
29-31 May 2018
Nireas-IWRC (UCY), ARI, CUT

hosted by Dr. Despo Fatta-Kassinos, Dr. Anastasis Christou and Dr. Vassilis Fotopoulos

Scientific Outputs

Porto, Portugal
10-14 July 2017, University of Porto

hosted by Dr. Adrian M.T. Silva and Dr. Vítor J.P. Vilar

Advanced treatment technologies and contaminants of emerging concern

Co-organized by NEREUS COST Action ES1403 and the "European PhD School on Advanced Oxidation Processes"

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Short-Term Scientific Missions

Statistics:

- **34** STSMs

Austria, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Israel, Italy, Poland, Portugal, Serbia, Slovenia, Spain, Sweden, Switzerland, The Netherlands, Tunisia, UK

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Short-Term Scientific Missions

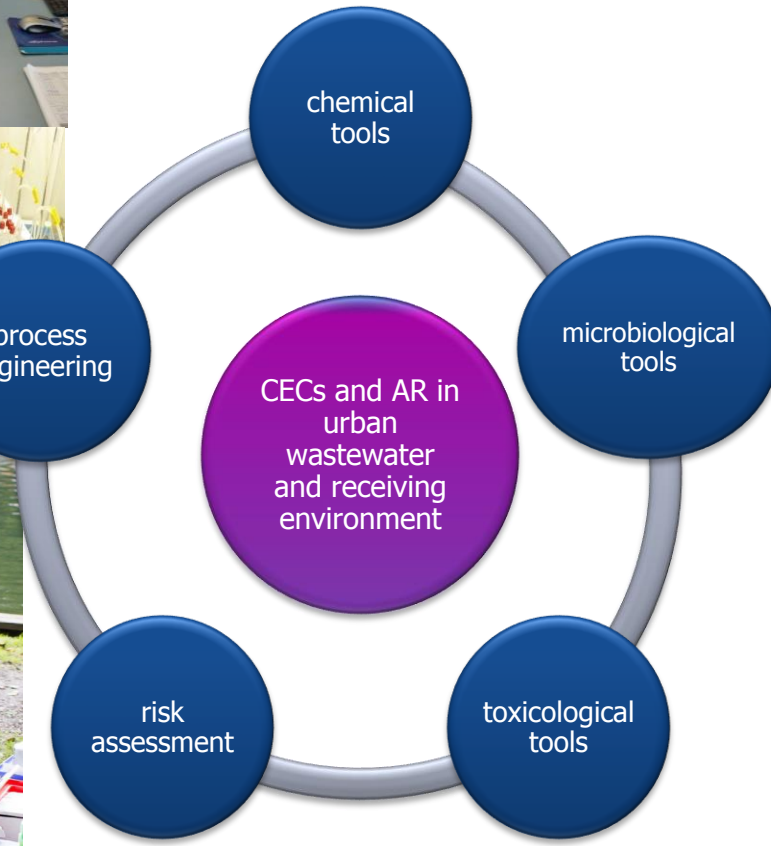









The STSMs covered a wide range of scientific activities



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Short-Term Scientific Missions

*"I believe that the STSMs of the COST Programme are a **fruitful way to foster scientific excellence"** - Dr Massimiliamo Marvasi (Middlesex University, UK)*

(STSM topic: Fitness of ARB in different water sources; Host institution: University of Florence, Italy; Duration: 2/7/2015-31/8/2015)

*"An excellent opportunity to **acquire new skills** in bioinformatics" - Dr Ivone Vaz-Moreira (Catholic University of Portugal, Portugal)*

(STSM topic: Bacterial communities in secondary and tertiary treated effluents; Host institution: Spanish National Center for Biotechnology, Spain; Duration: 1/9/2015-31/10/2015)

*"This STSM was an opportunity to **strengthen my network across Europe"** - Dr Felipe Lira (Spanish National Centre of Biotechnology, Spain)*

(STSM topic: Bioinformatics analysis of antimicrobial resistance genes and bacterial communities in wastewater treatment influent and effluent; Host institution: Catholic University of Portugal, Portugal; Duration: 28/2/2016-1/4/2016)

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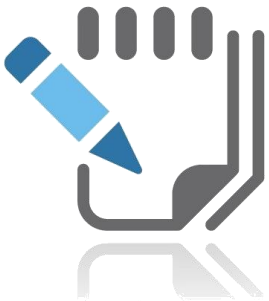
Short-Term Scientific Missions

*"This STSM enabled the establishment of **long and lasting scientific bounds**" - Dr Rui Martins (University of Coimbra, Portugal)*

(STSM topic: Solar photocatalytic ozonation using N-TiO_2 for water recovery; Host institution: University Rovira i Vergili, Spain; Duration: 15/1/2018-4/2/2018)



*"It was a great opportunity to **exchange ideas** and to **develop new joint projects**" - Dr Ana-Rita Ribeiro (University of Porto, Portugal)*

(STSM topic: Modelling peroxone (O_3/H_2O_2) process efficiency: Effect of wastewater components; Host institution: Loughborough University, UK; Duration: 5/2/2018-10/3/2018)

*"The sharing of knowledge and experience conducted in the laboratory has been an excellent opportunity for my **career development**" - Mr Antonino Fiorentino (University of Salerno, Italy)*

(STSM topic: Urban wastewater disinfection by solar Photo-Fenton: effect on antibiotic resistance; Host institution: University of Almeria, Spain; Duration: 21/1/2018-18/4/2018)

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Blue Circle Society (192 members)

The THINKTANK of ECIs and PhD students

The BCS was able to **meet separately** during the WGs meetings and **came up with suggestions** and **ideas** that were relayed to the WGs leaders and participants, the Steering Group and the Management Committee.

BCS Coordinators:

Dr. Marlen Vasquez

Dr. Heidemarie Schaar

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Blue Circle Society

The NEREUS BCS:

- **participated** in **training schools** and **STSMs** in order to transfer knowledge among participating institutions
- **actively participated** in all **WGs** and fulfilled specific tasks
- **established links** with other relevant ECIs-networks
- **identified the on-going relevant research projects** and any other similar activities regarding the Action
- **implemented continuous dissemination activities**
- **organized activities of science communication**
- **presented the work and outcomes of the STSMs** and also presented how the participation in the Action helped and/or enhanced the professional maturity of the ECIs

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Blue Circle Society

- Organization of three **“Café Scientifique”** events in **Germany**, **Portugal** and **Cyprus**
- Organization of the **workshop "From Black... to Blue..."** during the Young Water Professionals day of the **10th Micropol & Ecohazard Conference 2017**, Vienna, 17 September 2017
- Organisation of a **workshop** at the **10th Eastern European YWPs Conference**, Croatia, 9 May 2018
- **Synoptic material** informing on specific topics related to the Action's methodology and findings (in **layman form**)
- **Glossary** - **Wikipedia** page on wastewater
- Short **video** dedicated to the NEREUS COST Action

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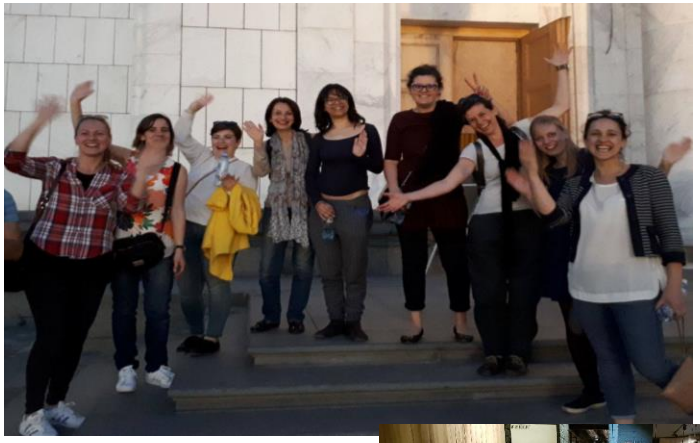
Blue Circle Society



Policy-related developments

JRC
EUROPEAN COMMISSION

Status of Minimum Quality Criteria (published) – 7 February 2018

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Policy-related developments

European Environment Agency

- Workshop on "Antibiotic resistance and urban wastewater" (Copenhagen, October 2018), with the intention to hold a focused discussion between experts and European policy advisors, to consider the possible need for action.

- Outputs may contribute towards various EU policy initiatives e.g. the evaluation of the Urban Waste Water Treatment Directive and the Strategy for Pharmaceuticals in the Environment.

*The **Chair/Vice Chair** and the **WG1 Vice Leader** contributed in the EEA workshop/discussion - current knowledge on the implications related to wastewater treatment and the transmission of AR in the environment.*

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Policy-related developments

European Food and Safety Authority

EFSA conference 2018 - Science, Food & Society, Parma, 18-21 September 2018

*The **Vice Leader of WG1** participated in the conference as a speaker in the break-out session on "Advancing Risk Assessment Science – Biological Hazards/Threats" and delivered a presentation on "Reuse of wastewater for irrigation in agriculture: what are the risks?", where important outcomes of the NEREUS COST Action with respect to wastewater reuse and crops' uptake were presented.*

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Policy-related developments

- Common Implementation Strategy
- Ad hoc Task Group Meeting Water Reuse with the Member States, Milan, 23-24 October 2018.
- Table of Contents for the envisaged guidance documents in support Commission's proposal of Water Reuse Regulation.

*The **Vice Leader of WG3** participated in the meeting, where he presented the main Action's scientific outcomes.*

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An added value outcome for projects & funders

- A brief document on how each project can contribute to the revisions of Directive, and policy development as a deliverable

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Scientific publications/conferences

- **>40 scientific publications**

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Research grants

>10 successful collaborative research grants, e.g:

- H2020-MSCA-ITN-2015/675530 (**ANSWER**)
- H2020-MSCA-RISE-2016/734560 (**ALICE**)
- H2020-MSCA-ITN-2018/812574 (**REWATERGY**)
- H2020-RUR-2018-2020 (**SuWaNu Europe**)
- H2020-MSCA-IF-2017/799281 (**PReStO**)
- **IRGP 45** (South Australian Government Premier's Research and Industry Fund, Australian International Research Grant Program)
- **ECOSI** (UNESCO Programme and Budget for 2014-2015, Major Programme II, MLA6)
- Bilateral Project **Italy-China** (PGR00866, 2016-2018)
- **SOFENDIS** (**Spanish** project, CTQ2016-78255-R, 2016-2019)
- **DSWAP** (Partnership for Research and Innovation (PRIMA), Management of Water 2018 Call)

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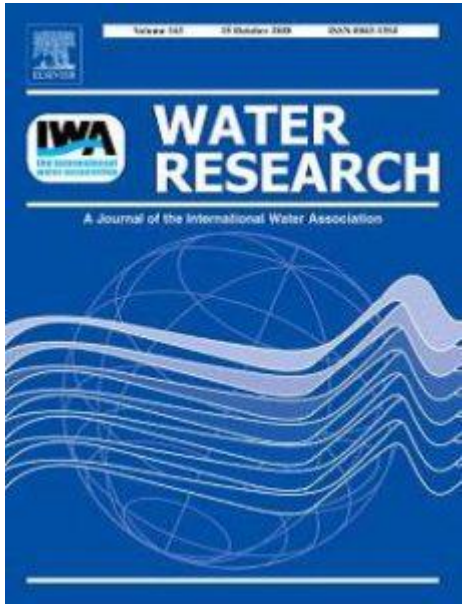
Special Issue

Special Issue on “Challenges related to antimicrobial resistance in the framework of urban wastewater reuse”



Guest Editors

Tong Zhang	University of Hong Kong
Eddie Cytryn	Volcani ARO, Israel
Despo Fatta-Kassinos	UCY, Cyprus
Erica Donner	University of South Australia

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Special Issue

Special Issue on “Urban wastewater reuse and chemical contaminants of emerging concern”

Guest Editors

Norbert Kreuzinger	TUWien, Austria
Luigi Rizzo	University of Salerno, Italy
Despo Fatta-Kassinos	UCY, Cyprus

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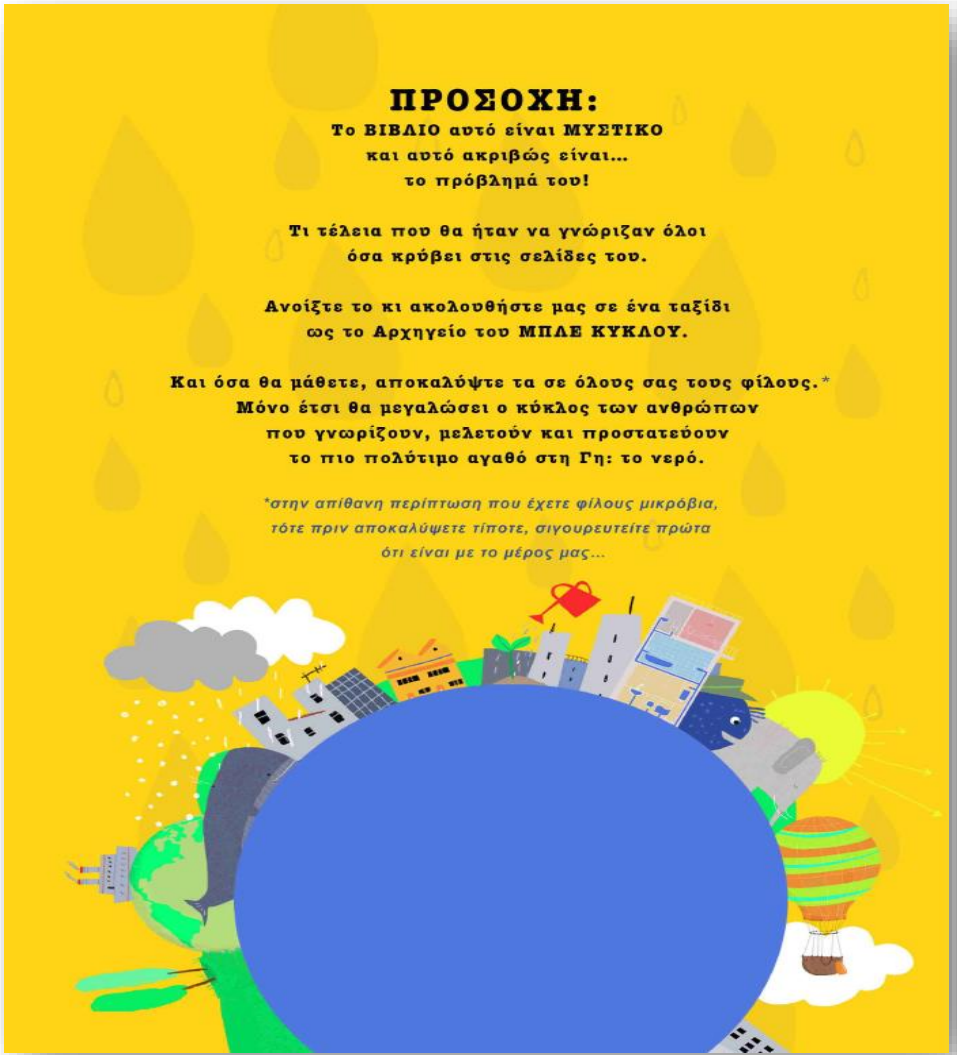
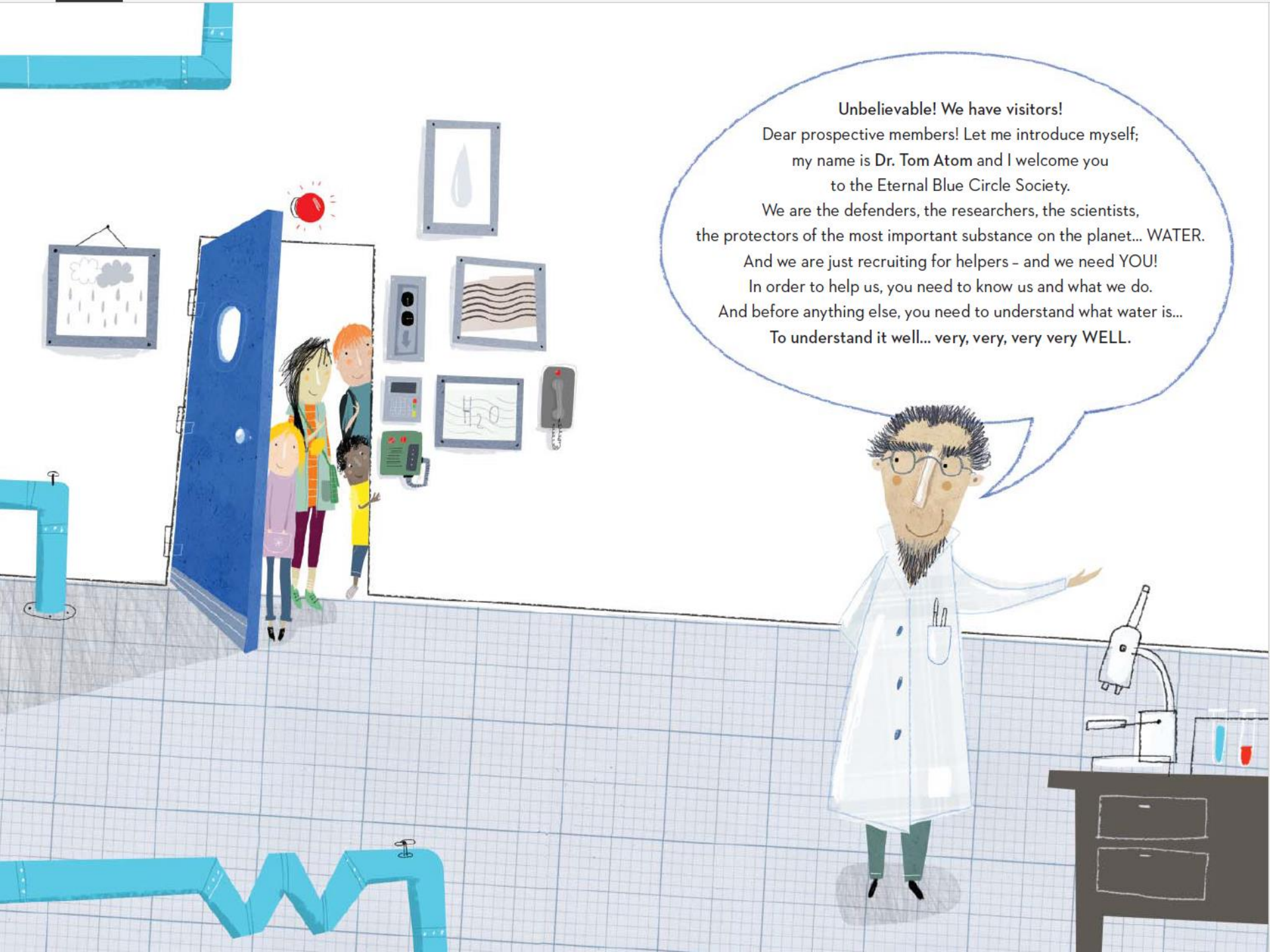
A book for children

Author: Mr. Antonis Papatheodoulou / Nireas-IWRC group
Illustrator: Ms. Iris Samartzi

ΕΚΔΟΣΕΙΣ ΠΑΠΑΔΟΠΟΥΛΟΣ
www.epbooks.gr




Unbelievable! We have visitors!
Dear prospective members! Let me introduce myself;
my name is Dr. Tom Atom and I welcome you
to the Eternal Blue Circle Society.
We are the defenders, the researchers, the scientists,
the protectors of the most important substance on the planet... WATER.
And we are just recruiting for helpers – and we need YOU!
In order to help us, you need to know us and what we do.
And before anything else, you need to understand what water is...
To understand it well... very, very, very very WELL.
H2O


Dress warmly because... we will fly with Dr Celia Circle to discover water's journey together.
We do not yet know a lot about how so much water appeared on Earth billions of years ago... but we know that, since then, the same water travels continuously and changes form constantly.
The sun warms water in seas, lakes and rivers. This water vaporises, which means it takes its gaseous form, becoming water vapour and, together with the water vapour coming from growing plants (called 'transpiration') goes up into the sky...
As it goes up in the atmosphere, water vapour gets cold and turns into water drops or even tiny water crystals... which fall back to earth as rain, snow or hail.
Water falls back into the sea or on dry land. Part of the water that falls on dry land goes into the ground and travels to the roots of plants. It is temporarily stored in lakes or deep within rocks. And it ends up back in the sea through streams and rivers...
And there, thanks to the sun, the same journey begins, again...
Its journey starts again and repeats itself where it ends... that is why we call it
THE WATER CYCLE,
an eternal cycle that never stops.
Can you see this town next to the lake? Let's land and I will tell you all about it, as it also hides other water cycles and routes made not by nature but... by us!

Dear new members, welcome!

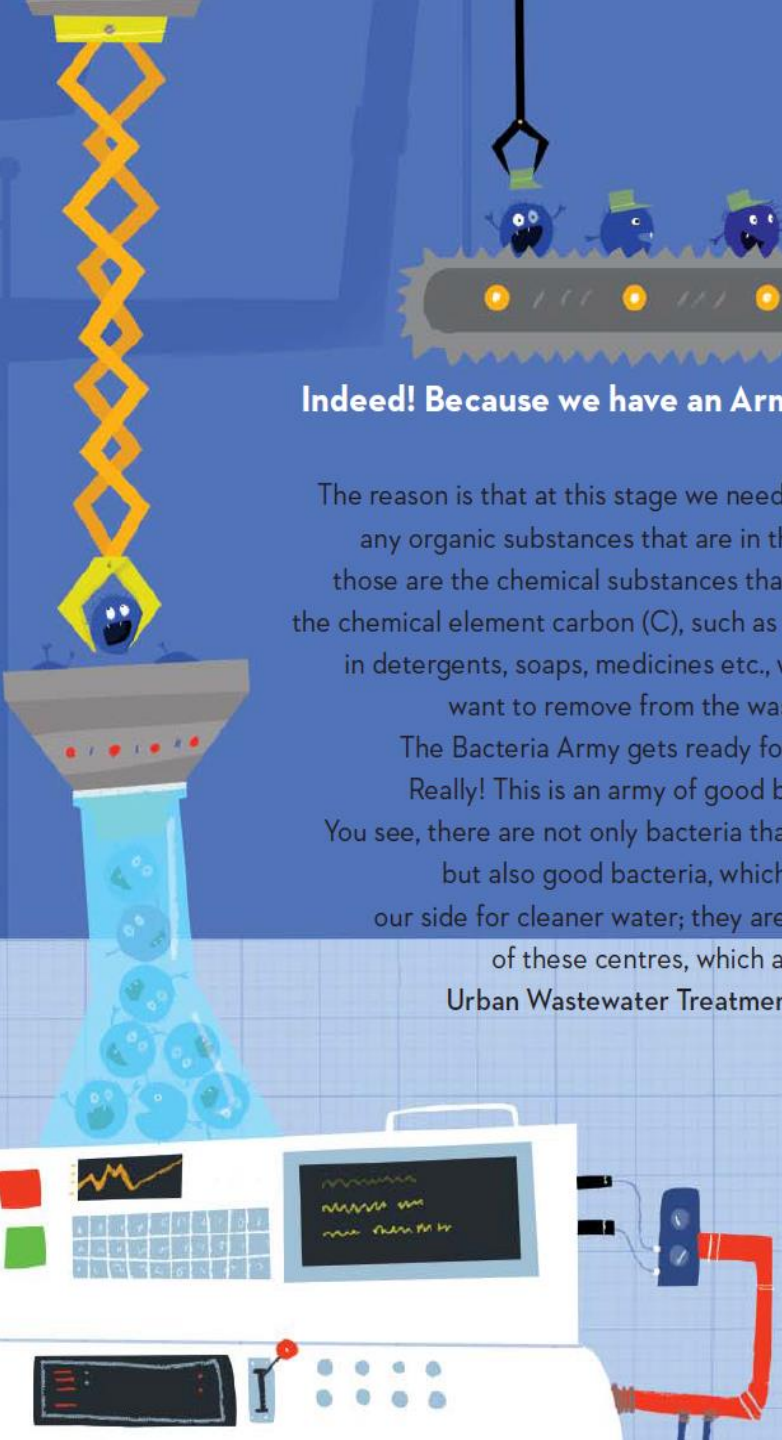
They say optimists see the glass half-full whereas pessimists see it half-empty! Well, a responsible Eternal Blue Circle Society member does not bother with all that... they bother with what exactly is in the glass... the bucket... the pipe... Because the water we throw away, used water, is not just hydrogen and oxygen like **Dr Tom Atom** told you; easy for him to say!

The water we throw away carries with it lots of waste, which we call '**pollutants**'! Here are some:

Whatever was on your body, the clothes, floors, dishes and cars we washed; soap, detergent, food, drink, cooking oil, colourants, sand, chemical residues, faeces and urine from our toilets, often mixed with used toilet paper, medicines we threw away down the toilet or sink, or we took and which passed to the toilet via our urine, bacteria from human faeces and so much more.

Indeed! Because we have an Army, too!

The reason is that at this stage we need to clean any organic substances that are in the water; those are the chemical substances that contain the chemical element carbon (C), such as the ones in detergents, soaps, medicines etc., which we want to remove from the wastewater.
The Bacteria Army gets ready for battle...
Really! This is an army of good bacteria...
You see, there are not only bacteria that pollute but also good bacteria, which fight on our side for cleaner water; they are soldiers of these centres, which are called **Urban Wastewater Treatment Plants.**

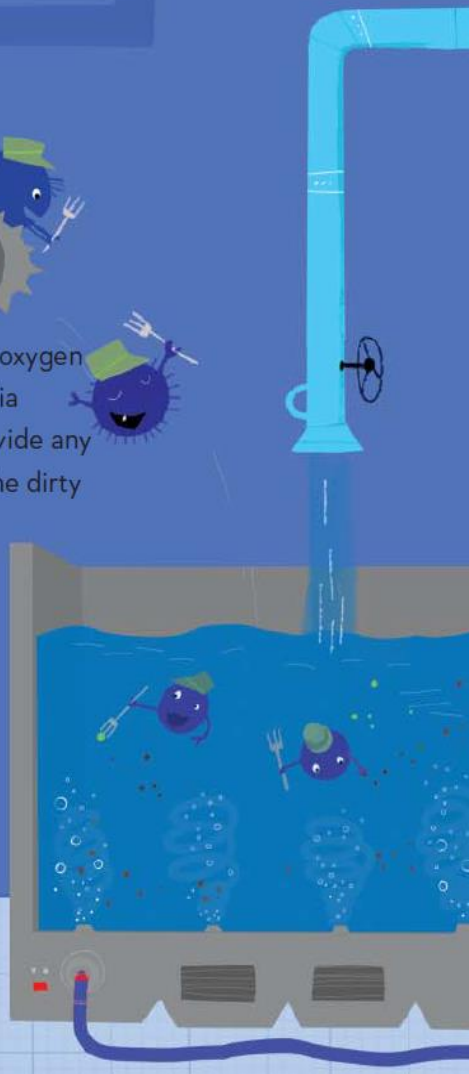


The only thing our bacteria need is oxygen and food... we provide the oxygen via aeration but we do not need to provide any food; that is because their food is the dirty water; the organic substances there. This way, our army does not exactly go to battle...

but rather to lunch!

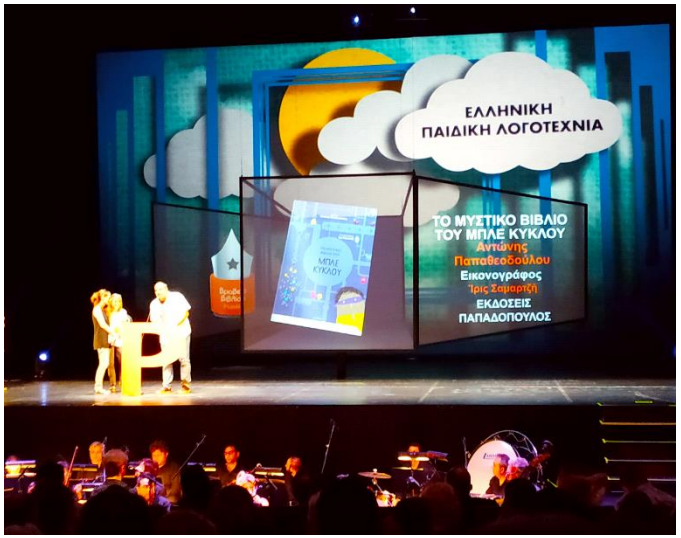
After lunch, the now treated urban wastewater is transferred to sedimentation tanks, while the bacteria regroup for their next battle. Please note that we have more weapons; membranes with very small pores, special materials that work as pollutant adsorbents and disinfection processes...

But I need to tell you a secret.
There are some pollutants that get away. And those are our worst enemies...



Awards

1st place in Public Awards 2019 (Greece) – Category "Greek Children's Literature"



Public Awards' Ceremony, Athens Concert Hall, 13 June 2019, Athens

2nd place in Anagnostis Awards 2019 (Greece) – Category "Educational Books"

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Fifth Meeting March 2017

Patras, Greece

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Sixth Meeting September 2017

Vienna, Austria

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Seventh Meeting March 2018

Sofia, Bulgaria

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Advantages / Challenges from writing the proposal to implementing the research project

1. New countries during the course of implementation (relates to the problem of varying starting dates in other projects)

2. New people during the course of implementation (repeat discussions)

3. Money were not enough ☺

4. Funding returned if not used after each Granting Period

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CONTACTS

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Email: dfatta@ucy.ac.cy

Vice-Chair: Celia Manaia
Country: Portugal
Institution: Escola Superior de Biotecnologia, Universidade Católica Portuguesa
Email: cmanaia@porto.ucp.pt

WG1
Leader: Eddie Cytryn
Country: Israel
Institution: Agricultural Research Organization (Volcani Center)
Email: eddie@volcani.agri.gov.il

Vice-Leader: Thomas Berendonk
Country: Germany
Institution: Technische Universität Dresden
Email: thomas.berendonk@tu-dresden.de

WG2
Leader: Josep Maria Bayona
Country: Spain
Institution: Consejo Superior de Investigaciones Científicas (CSIC)
Email: josep.bayona@idaea.csic.es

Vice-Leader: Benny Chefetz
Country: Israel
Institution: The Hebrew University of Jerusalem
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WG3
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Country: Slovakia
Institution: Environmental Institute and NORMAN Association
Email: slobodnik@ei.sk

Vice-Leader: Norbert Kreuzinger
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Institution: Vienna University of Technology
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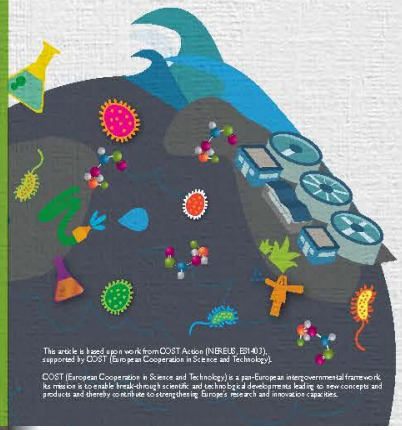
http://www.cost.eu

http://www.nereus-cost.eu

http://www.cost.eu/COST_Actions/essem/Actions/ES1403

https://twitter.com/NEREUS_WWreuse

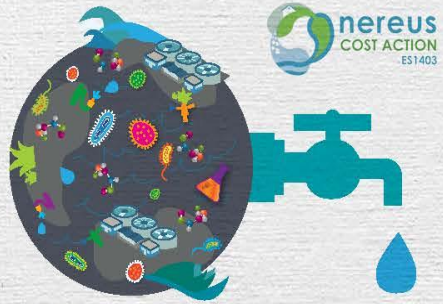
https://www.linkedin.com/groups/COST-Action-ES1403-Nereus-6934609/about



This article is based upon work from COST Action (NEREUS, ES1403), supported by COST (European Cooperation in Science and Technology).

COST (European Cooperation in Science and Technology) is a pan-European intergovernmental framework. Its mission is to enable break-through scientific and technological developments leading to new concepts and products and thereby co-ntribute to strengthening Europes research and innovation capacities.

nereus COST ACTION ES1403



NEW AND EMERGING CHALLENGES AND OPPORTUNITIES IN WASTEWATER REUSE

cost EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

COST is supported by the EU Framework Programme Horizon 2020

NEREUS ACTION'S OBJECTIVES

The main objective of the COST Action NEREUS ES1403 is to develop a multi-disciplinary network to provide insight into the current challenges related to wastewater reuse practices. It specifically focuses on public health and environmental perspectives and on developing solutions for overcoming these challenges.

The Action intends to:

(i) deliver best-practice recommendations for wastewater reuse in irrigation, and solid scientific knowledge to stakeholders, policymakers and the public

(ii) develop uniform means for assessing wastewater quality with respect to contaminants of emerging concern including antibiotic-resistant bacteria and resistance genes (ARB&ARG)

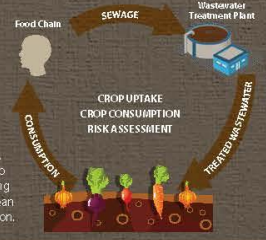
(iii) establish specifications for technologies able to produce wastewater with minimal levels of such contaminants according to the needs of the reuse practice

(iv) compile valid and reliable information to be used in regulatory frameworks

NEREUS aims at enhancing and valorizing wastewater reuse, thus, making major contributions to the European scientific and technological excellence, wider society and economy.

IMPACT OF THE ACTION

The benefits of the Action will be of scientific and technological, economical and societal character. Addressing the knowledge gaps and establishing norms and guidelines will enhance the development of trust required to enable fuller implementation of wastewater reuse. This will have a significant added value in the economy of the countries trying to establish solid water balances, avoiding at the same time investment in more expensive and energy-exhaustive means like for example water desalination, import of water, etc. Undoubtedly, society has much to gain from this Action including sustainable water resources, clean environment and health protection.



GENDER BALANCE

To ensure the largest impact on both male and female participants, a balance in gender amongst the participants is being sought.

THE BLUE CIRCLE SOCIETY FOR EARLY CAREER INVESTIGATORS

ACTION'S DURATION AND PARTICIPANTS

The Action started on the 7th of November 2014 and it will run for four years. Thirty COST countries have already signed the MoU as follows:

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

Australia, Georgia, Jordan, Singapore, South Korea, Tunisia, Ukraine, USA.

Seven universities/institutes/organizations (i.e. University of South Australia, GIST-Gwangju Institute of Science and Technology, Nanyang Technological University, US EPA National Risk Management Research Laboratory, University of Arizona and University of Cincinnati, University of Queensland) from four International Partner Countries (i.e. Australia, South Korea, Singapore and the USA), and two representatives from the

WORK PLAN AND ORGANIZATION

The work plan of the Action is organized into **5 Working Groups (WGs)** with the following objectives:

WG1 - Microbiome and mobile antibiotic resistome in treated wastewater and in downstream environments
(i) to propose standardization of procedures used for ARB&ARG detection and quantification in water and soil samples, (ii) to identify the most prevalent and/or potentially hazardous ARB&ARG in effluents and downstreams environments, (iii) to assess the fate of ARB&ARG discharged in treated wastewater and released in surface water and soils, and (iv) to identify the conditions favoring ARB&ARG persistence or proliferation.

WG2 - Uptake and translocation of organic microcontaminants and ARB&ARG in crops
(i) to consolidate existing relevant knowledge, (ii) to identify the main physicochemical characteristics affecting the behavior of microcontaminants including ARB&ARG with regard to uptake and translocation, and (ii) to develop a set of recommendations regarding the minimization of biomagnification processes and environmental and human health impacts associated with wastewater reuse.

WG3 - Effect-based bioassays required for wastewater reuse scheme
(i) to consolidate existing relevant knowledge, (ii) to identify the potential relationships between the physicochemical characteristics of the waste-water and biological effects, (iii) to determine the most appropriate and relevant bioassays to assess the effects of the reuse practices, and (iv) to propose the harmonization of the procedures used for this purpose.

WG4 - Technologies efficient/economically viable

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