

# REPORT 2020



Institut Català  
de Recerca de l'Aigua

Instituto Catalán  
de Investigación del Agua

Catalan Institute  
for Water Research

Cerca system



Research institute attached to the University of Girona

# Annual Report 2020

This new proposed Directive on the quality of water for human consumption shall protect human health from any adverse effects of any contamination of water intended for human consumption and should promote as well the universal access of such water in all EU. (Drinking Water Directive).



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## Annual Report 2020 ICRA

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## PRESENTATION

As for each year, we now transmit for 2020 a brief report on the activities of the Catalan Institute for Water Research (ICRA) 2020 was of course an atypical year for everybody, and this was also the case for the future of the ICRA. The SARS-COV2 pandemic and its consequences for the world health situation represented a total change of priorities on both a personal and a scientific level. Scientists from all over the world have made every effort possible to find solutions or approaches that can contribute to a cause that affects us all.

In the domain of water research ICRA has also been working on this issue since the beginning of the lockdown process in March 2020. The capacity of waste water to indicate the activities (and illnesses) of the general population has been a key factor in epidemiological tracing in Catalonia and has been coordinated by ICRA. Through the **SCORWATER** project samplings were taken to detect the virus at several water treatment plants in the Odena Basin in the Anoia district. After this initial research ICRA pursued the mission entrusted to it by the Government of Catalonia for the coordination of the **SARS-COV2 Surveillance Network**, working directly with the Catalan Department of Health, the Catalan Water Agency (ACA) and the University of Barcelona (UB). This mission has been extended into 2021 and 2022, thus making it possible to trace the development of the pandemic on a municipality by municipality basis, as indicated by the various water treatment plants.

Although its overall activity has been affected by the presence of the pandemic, ICRA has continued to make every effort to increase its ability to obtain and conduct appropriate research projects. During this period, ICRA has presented a total of 37 proposals for projects to Spanish, Catalan and European financing agencies, collecting total funding of € 2.95M. Despite the pandemic, the Knowledge and Technology Transfer (KTT) office has maintained the same number of projects as in the previous year, achieving an overall total of € 0.370M.

Another very important aspect for ICRA was the formalisation in late 2020 of the purchase of the building lease for two thirds of the H2O Building, thus sharing the property with the University of Girona. This operation guarantees the continuing use of the building as the Institute's head office in the future.

Last but not least, I would like to thank all ICRA staff for all their hard work and dedication throughout what has been such a particular year.

I cordially invite you to read further details about our activities.

Yours faithfully,  
**Damià Barceló**  
DIRECTOR



# 01

## DESCRIPTION

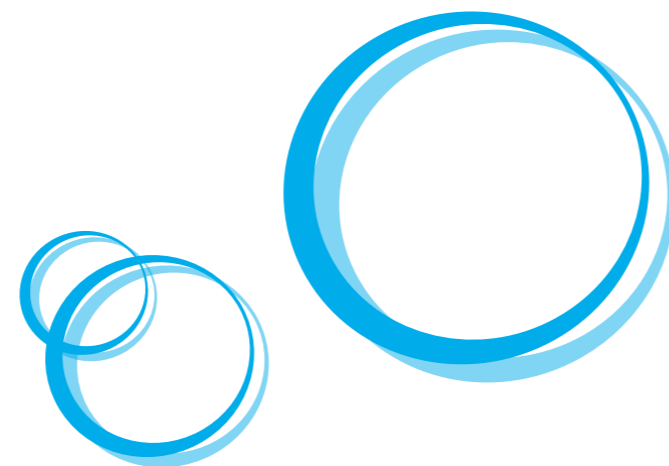
The Government of Catalonia established the Catalan Institute for Water Research (ICRA), within the framework of its Catalan Research Centres Programme (CERCA), on the 26th of October 2006. ICRA forms part of the CERCA programme.

ICRA is supported by its trustees: the Catalan Ministry of Business and Knowledge (DECO), the Catalan Water Agency (ACA) and the Universitat de Girona (UdG).

ICRA is a multidisciplinary water research centre, covering the complete water cycle. Research at the Institute deals with a range of topics, including the availability of water resources, the importance of biodiversity, assessing water quality (chemical, microbiological, ecological, etc.) and the development and evaluation of treatment technologies, as well as the transfer of this knowledge to the wider society, industry and the business network.

ICRA's mission is to be a point of reference for water science and technology in the Mediterranean. Its research, therefore, focuses on the rational use and effects of human activity on water resources and aquatic ecosystems, based on the importance of water as a fundamental resource for both natural systems and human needs.

ICRA's headquarters are located at the H<sub>2</sub>O building at the Universitat de Girona's Science and Technology Park, inaugurated on the 7th of October 2009. The H<sub>2</sub>O building is equipped with cutting-edge facilities and technologies that are used to carry out national and international research projects. The Institute's scientific equipment was co-financed by the Ministry of Economic Affairs and Digital Transformation (MINECO) and the European Regional Development Fund (ERDF), within the framework of the ERDF Operational Programme for Catalonia 2007-2013. Furthermore, between 2010 and 2011, and within the framework of the 2010 Spanish budget (MICINN, now MINECO) ICRA was awarded a nominal subsidy to purchase the equipment required to commission artificial river facilities.



# 02

## ORGANISATION

### BOARD OF TRUSTEES

### COMMITTEES

### DEPARTMENTS & STAFF

- DIRECTOR, DEPUTY DIRECTOR, GENERAL DIRECTOR, GENERAL MANAGER & SECRETARY

### R&D&I SUPPORT SERVICES

- ADMINISTRATION
- R&D&I OFFICE
- TECHNICAL-SCIENTIFIC PLATFORMS: SCT & PLANTEA

### WATER FRAMEWORK DIRECTIVE PROJECT

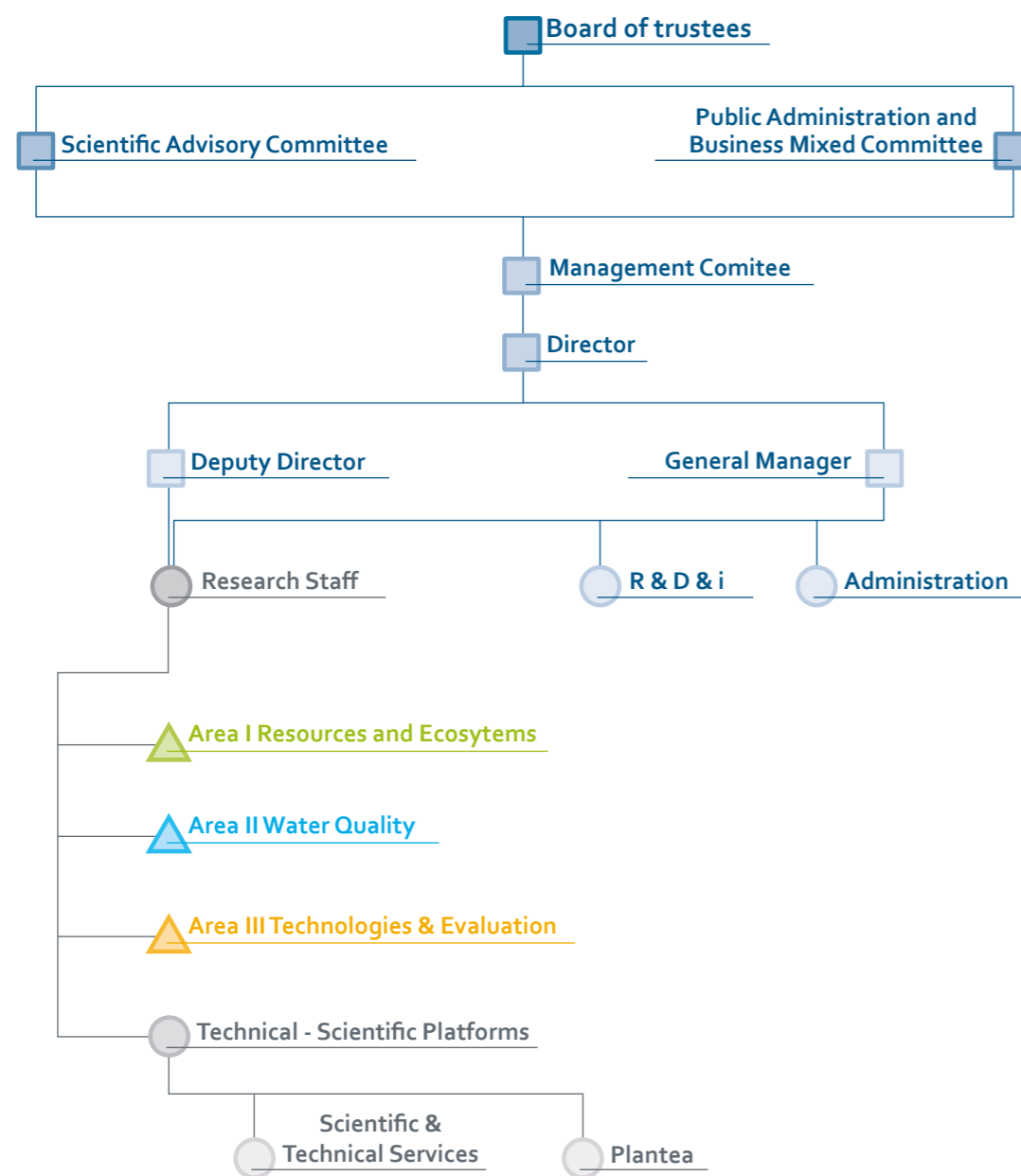
### HR EXCELLENCE IN RESEARCH AWARD

### EQUALITY GENDER PLAN

# BOARD OF TRUSTEES

The Board of Trustees is ICRA's highest governing body. The trustees are the Catalan Regional Government's Ministry of Business and Knowledge (DECO), the Catalan Water Agency (ACA) and the Universitat de Girona (UdG).

In 2020, the ICRA Board of Trustees held three meetings. An ordinary session on 15/05/2020, an extraordinary session on 20/09/2020 to adapt ICRA bylaws and another extraordinary session on 09/12/2020 to establish the formalization of the purchase building H2O.



## MEMBERS

### CHAIR

**M. Àngels Chacon i Freixes**  
 (until September 2020)  
 Minister for Business and Knowledge  
 Ministry of Business and Knowledge  
 Regional Government of Catalonia

**Ramón Tremosa**  
 (since October 2020)  
 Minister for Business and Knowledge  
 Ministry of Business and Knowledge  
 Regional Government of Catalonia

### DEPUTY CHAIR

**Joaquim Salvi**  
 Rector  
 Universitat de Girona

### MEMBERS

**Francesc Xavier Grau i Vidal**  
 Secretary for Universities and Research  
 Secretariat for Universities and Research  
 Ministry of Economy and Knowledge  
 Regional Government of Catalonia

**Joan Gómez Pallarès**  
 Managing Director of Research  
 General Directorate of Research  
 Ministry of Economy and Knowledge  
 Regional Government of Catalonia

**Anna Albar**  
 Managing Director  
 Science and Technology Park  
 Universitat de Girona

**Josep Calbó**  
 Vice-Rector for Strategic Projects  
 Universitat de Girona

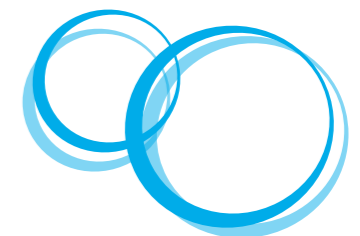
**Lluís Ridao**  
 Director of the Catalan Water Agency  
 Catalan Water Agency  
 Ministry of Territory and Sustainability  
 Regional Government of Catalonia

### TRUSTEE SECRETARY

**Lluís Rovira**  
 Director of CERCA (Catalan Research Centres)  
 General Directorate of Research  
 Ministry of Business and Knowledge  
 Regional Government of Catalonia

### NON-TRUSTEE DEPUTY SECRETARY

**Josep M. Alcoberro**  
 Legal Department of CERCA (Catalan Research Centres)  
 Ministry of Business and Knowledge  
 Regional Government of Catalonia



# COMMITTEES

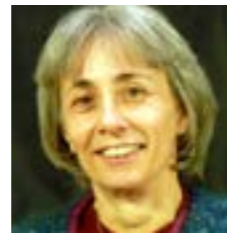
## SCIENTIFIC ADVISORY COMMITTEE

The **Scientific Advisory Committee** is appointed by the Board of Trustees and includes an unspecified number of scientists of acknowledged repute and expertise in the field of water and all other related areas of science. This Committee's membership represents the ICRA's different priority areas of research. One of its most significant tasks is to ensure the quality of the research carried out at the ICRA. Accordingly, it acts as an advisory body for all issues relating to the scientific activities submitted for its consideration and, when requested, it will also act as an evaluating body for these activities.



**Bernd Bilitewski**

**Chair of the Scientific Advisory Committee.** Emeritus Professor of the Institute for Waste and Pollutant Management, Dresden University of Technology (DE).



**Jeanne Garric**

Director of the Ecotoxicology Laboratory, Aquatic Ecosystems Biology Unit, Department of Water Quality and Pollution Prevention, INREA (FR).



**Clifford Dahm**

Emeritus Professor of Department of Biology, University of New Mexico, Albuquerque (USA).



**Jörg Overmann**

Director of the Leibniz-Institute German Collection of Microorganisms and Cell Cultures (DSMZ) and Head of the Department Microbial Ecology and Diversity Research, Leibniz, Germany (DE).



**Amadeo Rodríguez Fernández-Alba**

Head of the European Reference Laboratory for Pesticides. Faculty member of the Department of Hydrogeology and Analytic Chemistry, Universidad de Almería, Almería (ES).



**Maria Reis**

Full Professor in Environmental Biotechnology, Department of Chemistry, Sciences and Technology Faculty, Universidade Nova de Lisboa (UNL), Portugal (PT).



**Peter Vanrolleghem**

Holder of the Canada Research Chair on Water Quality Modelling (modelEAU) and Professor of the Department of Civil Engineering and Water Engineering, Université Laval, Quebec, Canada (CA).



**Paola Verlicchi**

Professor in Environmental and Sanitary Engineering, Engineering Faculty, Department of Engineering, Università di Ferrara, Italy (IT).



**Stan Gregory**

Emeritus Professor, Department of Fisheries & Wildlife, Oregon State University (USA).



**Despo Fatta-Kassinou**

Associate Professor, Director of Nireas – IWRC, Department of Civil and Environmental Engineering and Nireas International Water Research Center (Nireas-IWRC), University of Cyprus.



**Fang Wang**

Professor, Institute of Soil Science, Chinese Academy of Sciences.



**Yolanda Picó García**

Full Professor, Universitat de València, Desertification Research Centre (CIDE).



**Krishna Pagilla**

Ralph & Rose Hooper Engineering Professor and Chairman, Civil and Environmental Engineering Department; Director, Nevada Water Innovation Institute, University of Nevada.



**Susan D. Richardson**

Arthur Sease Williams Professor of Chemistry, Department of Chemistry & Biochemistry, University of South Carolina (USA).



## PUBLIC ADMINISTRATION AND BUSINESS MIXED COMMITTEE

The Public Administration and Business Mixed Committee is the body for business participation in the Foundation. It may be consulted by the Board of Trustees and by the Director and may issue recommendations for guidance.

**The functions of the Public Administration and Business Mixed Committee are:**

- Assisting in detecting industry needs and suggesting specific business proposals.
- Identify attractive technology development opportunities
- Promote participation in joint research projects and facilitate access of the Foundation to public and private resources
- Assist in the creation of spin-offs
- Participate in activities related to the Foundation's objectives



**Xavier Tristán Prat**

Chair of the Business Committee  
Acting Manager of the Costa Brava Consortium (CCB) and Head Engineer for Technical Services at the CCB. Member of the Advisory Council for the Sustainable Development of Catalonia (CADS).



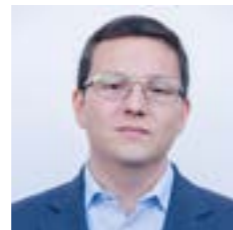
**Sergi Martí Costa**

Managing Director of STENCO, AQUA AMBIENT IBÉRICA and TRAINING INDUSTRIAL.



**Jaume Carol Pañach**

Managing Director of FLUIDRA. President of the Catalan Water Partnership (CWP), the Catalan Water Cluster and member of the Catalan Sports Cluster Board (INDESCAT).



**Carlos Montero**

Managing Director of CETaqua.



**Jesús Gómez del Blanco**

Managing Director of RECIPHARM Pares S.L.U., the Spanish subsidiary of RECIPHARM AB (Sweden)



**Antonio Ordóñez**

Director of Research, Development and Innovation - GS INIMA Environment, S.A.



**Jorge Juan Malfeito Sánchez**

Director of R&D&I at ACCIONA Agua S.A.



**Valentin Garcia**

Director of Hydraulic Public Works, National and International, at SOIL AGUAS, SOIL Group.

## DEPARTMENTS & STAFF



**Director**

**Damià Barceló**

Research Professor of the Institute of Environmental Assessment and Water Studies (IDAEA), of the Spanish National Research Council (CSIC).



**Deputy Director**

**Sergi Sabater**

Full Professor of Ecology at the Universitat de Girona.



**General Manager**

**Iván Sánchez**

General Manager



**Executive Secretary**

**Olga Corral**

Executive Secretary, Director's Office

In 2020,  
**115** people contributed  
to ICRA's R&D&I activities

**97** Researchers

**14** Management/  
Administration personnel

**3** R&D&I personnel

**1** Framework Directive  
Project personnel



# R&D&I SUPPORT SERVICES

The General Manager of ICRA is responsible for all the basic services that provide support for R&D&I:

- Administration
- R&D&I Office
- Technical and scientific platforms:
  - > Scientific and Technical Services (SCT)
  - > PLANTEA

## ADMINISTRATION

In 2020, the active administrative services that performed specific functions within each field of activity were:

- Human Resources
- Purchasing and Procurement (Outsourcing)
- Finance and Accounting
- Information Technologies
- Communication, Image and Promotion
- Quality and Environment
- General Services

The **Outsourcing Service** has managed three types of contract: services, supplies and construction, with the objective of providing ICRA's three research areas and the SCT with both basic and special scientific equipment.

This equipment has been 50% co-financed by the EU's European Regional Development Fund (ERDF) under the Catalan ERDF Operative Programme 2007-2013 and it also received funding from MINECO (the Spanish Ministry of Economic Affairs and Digital Transformation), directly and through the Third Additional Provision (DA3<sup>a</sup>) of the Catalan Statute of Autonomy.



**Iván Sánchez**  
General Manager



**Olga Corral**  
Executive Secretary,  
Director's Office



**David López**  
Human Resources  
Head



**Susana Roca**  
Eco-Fin Head



**Janina Manrique**  
Accounting  
and Support to  
Research



**Laura Sancho**  
Administration  
Technician



**Rubén Díaz**  
IT Head



**Pere Royo**  
Reception



**Sandra Monleón**



**Carla Santiago**  
Reception  
May-June

## ADMINISTRATION VISITING STUDENT



**Achraf Aloui**  
Internship Student,  
Montilivi HS (Girona)

# R&D&I OFFICE



**Jaume Alemany**  
R&D&I Office Manager



**Laura Bertolini**  
European and  
International Project  
Officer



**Rina Weltner**  
Project Manager

## Objectives and activities of the R&D&I Office

The R+D+I Office aims to contribute to increasing the capacity of the ICRA to obtain and execute research projects and to gain international prestige from obtaining external funding and establishing international alliances. The Office helps researchers to increase their participation in basic and applied research projects, at both national and international level, and to increase their relationship with the productive and industrial sector for the implementation of research results.

The Office helps researchers from ICRA in the definition and implementation of a strategy for their participation in public calls for research funding at local, national and international level. From the Office we offer our researchers help in finding calls, for preparing and submitting proposals, and we also offer them advice on financial and legal issues relating to calls. Finally, the Office also provides support for the administrative and financial management of the projects granted and the contracts for the transfer of knowledge with local, national or international companies.

In terms of national funding, a total of 26 proposals were submitted to Spanish and Catalan funding agencies in 2020. Six of them were awarded for a total amount of € 188,000. Additionally, eight projects from 2019 calls were awarded in 2020 for a total amount of € 0.6 M. At this moment, 14 proposals from 2020 calls are still pending its resolution for a global amount of € 1.57 M€.

In 2020, the National Projects Unit managed twelve research projects, ten of them funded by the Spanish National Funding Agency and the Spanish Ministry of Science, Innovation and Universities (AEI-MCIU), one project funded by the Catalan Government through Eurodistrict collaboration program, and one project funded by the Catalan Agency for Competitiveness (ACCIÓ) and ERDF. Also, this unit managed 18 Fellowship Grants (nine funded by AEI-MINECO and nine funded by the Catalan Government), and two networking projects also funded by the Catalan Government.

As for the Knowledge and Technology Transfer Unit (KTT), a total of six collaborative contracts were signed with private companies and public entities during 2020, the total amount is € 364,000. Despite COVID-19 pandemic the number of projects compared to 2019 remained stable. The average budgeted per project has decreased significantly but ICRA was awarded a public tender of € 295,000 which led to a significant increase (more than 70%) of the global amount on KTT.

Regarding IPR management, six assets emerging from research results have been evaluated in collaboration with researchers (inventors) for protection and possible future commercialization. One of these assets was presented at On Campus call form Collider for its valuation. Two European patents have been applied for; one is a joint patent with Universitat de Girona and the other patent is a joint patent with ICREA institution.

In 2020 ICRA presented or took part in 25 European proposals, four of which were successful. Among them, one H2020 Societal Challenge collaborative project iWAYS was funded for a total of more than half a million euros. The Office is currently managing a total of 23 European and other international projects, among others the ERC Starting ELECTRON4WATER, six H2020 Societal Challenge collaborative projects, three MSCA Individual fellowships and three MSCA Innovative Training Network, two of which coordinated by ICRA. The total extramural international contribution of active projects amounts to € 7 million.

For 2021 our aim is to work intensively with international consortia in order to prepare and present at least 20 European/International proposals as we did in 2020. Apart from the new EC Framework Programme Horizon Europe, we will be working to actively participate in Joint Programming Initiatives, ERANET schemes and the Partnership on Research and Innovation in the Mediterranean Area (PRIMA) calls. We have a brilliant and very motivated young and senior researchers that will apply for ERC Grants and Marie Curie Individual Fellowships.

## TECHNICAL AND SCIENTIFIC PLATFORMS

Since one of the objectives of ICRA is to transfer knowledge and provide practical solutions, the Scientific and Technical Services (SCT) provide analytical services and PLANTEA for scaling up processes to pilot plant scale.

In 2020, the technical and scientific platforms were consolidated to provide a quality scientific and technical support service to researchers.

The SCT also carried out continuous training and specialisation of technicians.

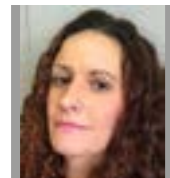
### ICRA HEAD OF SCT



**Sara Insa Aguilar**  
Chemical Analysis Unit  
and Mass Spectrometry  
Unit (GC-MS)



**Alex Sánchez Melsió**  
Biological and Molecular  
Techniques Unit and  
Microscopy Unit



**Diana Álvarez Muñoz**  
Mass Spectrometry Unit  
(LC-MS)

### ICRA RESEARCH TECHNICIANS



**Olga Montojo Jordan**  
ICRA Research  
Technicians



**Mireia Núñez Marcé**  
ICRA Research  
Technicians



**María Simón Font**  
ICRA Research  
Technicians



**Natàlia Serón Mallo**  
ICRA Research  
Technicians

The platforms are the following:

#### Platform (PLANTEA)

- **SCIENTIFIC AND TECHNICAL SERVICES (SCT)**
- **WATER SCIENCE AND TECHNOLOGIES RESEARCH PLATFORM (PLANTEA)**

## SCIENTIFIC AND TECHNICAL SERVICES (SCT)

The health situation arising from the COVID-19 pandemic has impacted negatively on most economic activities worldwide and has consequently also had an impact on the functioning of the Scientific and Technical Services (SCTs). Thus, the analytical production of the 2020 SCTs, both chemically and microbiologically, has been minimized due to lockdown and subsequent restrictions.

Generally speaking, the dynamics of the SCT 2020 was characterised by the fulfilment of its tasks adapted to the exceptional situation. Teleworking was encouraged as much as possible. The new technologies enable research and transfer support activities, minimising the presence of people with no impact on the quality of the results. Therefore, the continuity of the service rendered by the SCT, both from rehearsal and advisory viewpoints, remained almost uninterrupted. The ongoing projects were developed and contributions to new challenges were made, such as projects derived from COVID research and related to the SARS Vigilance Network. Regarding this topics, some of the SCT members are part of research teams of pending calls.

Regarding infrastructures, three main procedures for equipment procurement were completed:

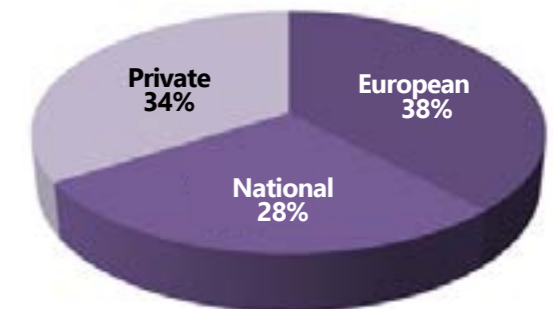
- Biosafety cabin to handle toxic/cytotoxic substances together with the qualification of a specially designed space to ensure maximum user protection, which will consist of a SAS (Sterile Access System) and a clean room, where the cockpit will be located. It is a unique facility, which will involve the completion of a standardised and rigorous working protocol.
- Real-time endocycler for quantitative PCR. The purchase of a second thermocycler in the structure of the Unit of Biological and Molecular Techniques (UTBM) is part of the desire to renew that essential equipment acquired during the first years of operation of the SCT, now almost at the end of its useful life. Acquisition of this new thermocycler will allow for continuity in quantification of antibiotic resistance genes and in particular, optimization of quantification of SARS-CoV-2 genes.

- High-resolution mass spectrometer (HRMS) chromatographer for environmental and metabolomic research. This equipment will allow the detection and identification of organic molecules and metabolites by the exact mass, a feature essential to the realization of undirected analysis and of compounds suspected in environmental samples, mainly aqueous matrices and organisms.

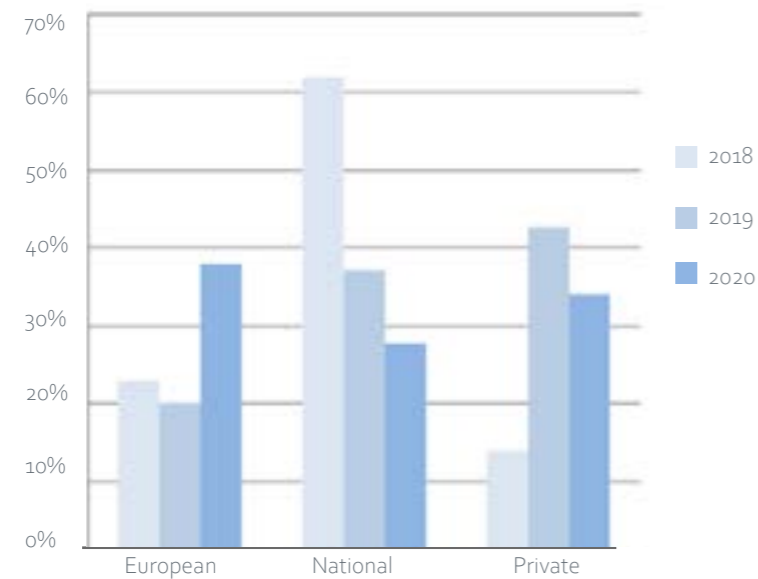
- Finally, with the aim to have an experienced staff with the maximum competence, the Dr. Diana Álvarez joined the SCT team in mid-2020, at the head of the Mass Spectrometry Unit (MSU) coupled to liquid chromatography.

### TECHNOLOGY TRANSFER

In terms of analytical demands fulfilment, the overall economic data of 2020 derived from the activity of the SCT comes from three sources of funding: national, European, and external (private) projects. The following figure shows that although most of the dedication of the SCTs was directed towards the achievement of internal projects, a significant fraction of the income derives from external requests (34%), which shows the consolidation trend of the SCT as a service platform.



The distribution of resources from the SCT's analytical tasks over the last three years makes it possible to see an increase in dedication to European projects, doubling the income from the results of 2019, as can be seen in the following graph. Regarding external contributions and taking into account the uniqueness of 2020, they have experienced a substantial increase over the previous years, which reinforces the external client's trust and loyalty to the SCT project.



## WATER SCIENCE AND TECHNOLOGIES RESEARCH PLATFORM (PLANTEA)

### The Catalan Institute for Water Research (ICRA) is the home of the Water Science and Technologies Research Platform (PLANTEA)

The Water Science and Technologies Research Platform (PLANTEA) is a space where research and industrial development projects can be carried out with pilot plants of different sizes (up to semi-industrial scale).

These pilot plants make it possible to carry out research projects on advanced treatment of both wastewater and treated water or water that can be made potable, and on projects for monitoring, eliminating, and evaluating the effects of contaminants in water, as well as studies that require large-scale equipment.

This facility has been 50% co-financed by the EU's European Regional Development Fund (ERDF) under the Catalan ERDF Operative Programme 2007-2013 and, also received funding from MINECO (Spanish Ministry of Economic Affairs and Digital Transformation) directly and through the Third Additional Provision (DA3ª) of the Catalan Statute of Autonomy.

### SCIENTIFIC-TECHNICAL PLATFORMS

The PLANTEA test platform currently provides ICRA with benchmark facilities for carrying out three different aims:

- The study of wastewater transport and treatment systems in conditions as similar as possible to the real world (pilot plants).
- The study of the response of fluvial ecosystems in different conditions thanks to the installation of an experimental stream facility (ESF).
- An artificial aquatic mesocosm ecosystem that makes it possible to carry out studies on exposing organisms such as mussels and/or fish to chemical contaminants.

### LAB AND PILOT SCALE PLANTS AT PLANTEA UNIT (LABORATORY L06)

During 2020 there have been several pilot plants in operation in the PLANTEA platform to mimic wastewater treatment systems.

Within the context of the ANTARES project, funded by the Agencia Estatal de Investigación (Spanish Government), an anaerobic membrane bioreactor (AnMBR) has been operated since October.

The reactor focuses on the anaerobic treatment of municipal wastewater with the aim of enhancing the biodegradation of certain micropollutants. To achieve this, graphene oxide will be added to the reactor once the reactor reaches the steady state condition and the interaction between this conductive material and the anaerobic biomass will be monitored.

Regarding oxidation technologies, PLANTEA counts with equipment to carry out lab-scale ozonation and UV based oxidation processes (medium pressure mercury lamps, low pressure mercury lamps) enabling to study traditional and novel advanced oxidation processes (UV/persulphate, UV/HOCl). Finally, on pilot scale a 254nm UV installation is available for up-scale trials.

Also, an automated filtration unit for testing ceramic micro- and ultrafiltration was installed in 2020 in the context of the NOWELTIES project. The ozonation set-up and the ceramic filtration set-up can also be operated in an integrated manner to research catalytic ozonation.

Three technologies have been operated for the treatment and reuse of greywater in the context of the circular economy (CLEaN-TOUR project): a) forward osmosis hollow fiber membranes at different scales; b) semi-industrial scale low energy requirement membrane bioreactor (Smart Air MBR); and c) hydroponic-constructed wetlands. As to the latter, one system is installed at Hotel Samba (Lloret de Mar) with ornamental and edible plants (but on stand-by most of 2020 for COVID). In parallel, a new hydroponic pilot plant was built in the PLANTEA platform to test edible plant synthetic greywater treatment and crop production. It is made up of several lines that can work in parallel, with distinct influent water, and sensors for temperature, humidity, and light intensity.

The PLANTEA laboratory has unique facilities allowing us testing different wastewater transport and treatment technologies and processes. The fact that has a direct connection to a sewage pumping station facilitates the use of real wastewater for the experiments conducted in the PLANTEA pilot plants. There are three pilot scale sewer systems simulating two rising mains from a sewer network and one gravity section, which are being operated to study the biochemical transformations occurring in these systems. These installations, which are the first of their kind in Europe, allow the researchers to investigate why and how sulphide and methane form during wastewater transport and how their formation can be prevented. Also, PLANTEA offers the possibility of operating 5 reactors to investigate different wastewater

treatment processes. All these installations are fully monitored and controlled by different PLC systems connected to a SCADA program, allowing real-time control of the processes taking place in each of the pilot plants. This is possible thanks to the numerous monitoring systems in PLANTEA facilities such as dissolved oxygen, pH, redox, nitrate and hydrogen sulphide sensors and online gas analysers for the online monitoring of two potent greenhouse gases, nitrous oxide and methane.

Finally, it is worth mentioning the wide set of commercial and custom-made apparatus for field studies such as several refrigerated autosamplers, a multi-hood system for online monitoring of greenhouse gas emissions from bioreactors, online ion-selective electrodes ... allowing us to conduct a wide range of experimental field work in all the parts of the urban wastewater system.

### THE EXPERIMENTAL STREAMS FACILITY MAKES IT POSSIBLE TO SIMULATE THE RESPONSE OF FLUVIAL ECOSYSTEMS TO DIFFERENT ENVIRONMENTAL CONDITIONS

Experiments on this facility could not be carried out by 2020, as on 14 March of that year ICRA closed the centre, following the indications of the Spanish Government, according to the decree of state of alarm. During 2020, although activity was started preventively in late May, it was decided that this facility would not initiate any experimental procedure, as there was no guarantee of continued experiments under the circumstances. The economic cost of initiating experiments was very much borne in mind, as they represent weeks of work, with no guarantee of continuity given the circumstances for the COVID-19 pandemic..

### ARTIFICIAL AQUATIC ECOSYSTEM

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## FRAMEWORK DIRECTIVE PROJECT

### COMPLEMENTARY ACTIONS OF THE WATER FRAMEWORK DIRECTIVE PROJECT

#### Strategic project on knowledge acquisition regarding the obligations from the Water Framework Directive

Since the publication of the Water Framework Directive, the European Commission has adopted and published new legislation and requirements for control programmes. One of its aims is to improve the knowledge of the chemical state of water masses, especially for those organic pollutants of which there is little knowledge. Consequently, ICRA launched the strategic water framework project. Its main objective was to determine the emergence of priority substances and new emerging contaminants to the Catalan water masses to provide new tools for their improvement of chemical status.

COMPLEMENTARY ACTIONS to the DRAFT WATER Framework Directive began in late 2018, making a close collaboration with the Catalan Water Agency. It is a strategic project for ICRA that promotes the acquisition of new knowledge to fulfil the obligations arising from the Water Framework Directive. The European Commission has adopted new requirements for control and control programmes, with the aim of improving our current knowledge of the chemical

status of water masses. Particularly worrying is the broadening of our knowledge of organic pollutants with unknown frequency of occurrence and concentrations. Consequently, ICRA has continued during 2020 the strategic draft of the framework directive on water by completing the monitoring of the sampling points that were previously classified as hot points, distributed throughout the Catalan river network.

During 2020, the project has carried out some complementary actions with regard to chemical analysis. A total of 171 samples and 234 chemical compounds have been analyzed and new analytical procedures have been established for chloroalkanes, glyphosate and carbendazim.

All this new information has been integrated with previous evidence and has produced a scientific document, completed and published in the end of 2020 (Llorens et al. 2020). *Science of the Total Environment* 747: 141224. DOI: 10.1016 / j.scitotenv.2020.141224).

Project Manager - **Esther Llorens**

## HR EXCELLENCE IN RESEARCH AWARD

In December 2015, the Catalan Institute for Water Research (ICRA) received the "HR Excellence in Research" award from the European Commission.

This award and its logo recognises that ICRA endorses the policies and practices of The Human Resources Strategy for Researchers (HRS4R), established by the European Commission to implement principles of the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers (Charter & Code).

In December 2018, ICRA performed Internal Review for Interim Assessment to HRS4R



HR EXCELLENCE IN RESEARCH

Work is also being done on integration of the OTM-R Policy (Open, Transparent and Merit-based Recruitment of Researchers) into ICRA's HR Policy.



# 03

## RESEARCH AREAS

ICRA's Research Plan is structured in three main research areas, each with a mission and a vision aligned with those of ICRA.

The ICRA's areas and respective lines of research are as follows:

### AREA I RESOURCES AND ECOSYSTEMS

#### LINES

- AI1 Hydrological Processes
- AI2 Lacustrine and Reservoir Systems
- AI3 Fluvial Systems
- AI4 Modelling of Ecosystems and Basins

### AREA II WATER QUALITY

#### LINES

- AII1 Chemical Contamination of Water Bodies
- AII2 Contaminants in Wastewater
- AII3 Quality and Microbial Diversity
- AII4 Ecotoxicological Response of Biota to Contaminants

### AREA III TECHNOLOGIES AND EVALUATION

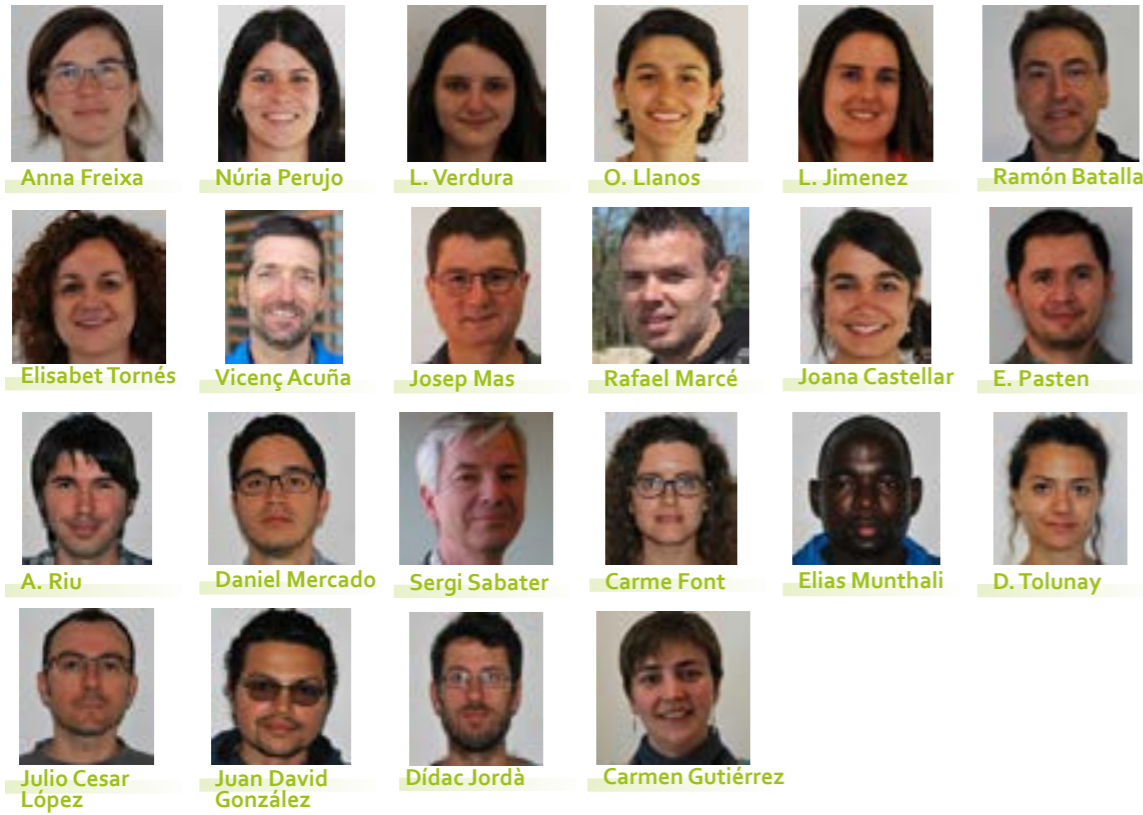
#### LINES

- AIII1 Water Supply and Advanced Treatment
- AIII2 Wastewater Treatment, Reuse and Resource Recovery
- AIII3 Modelling and Management Systems
- AIII4 Unit Operations

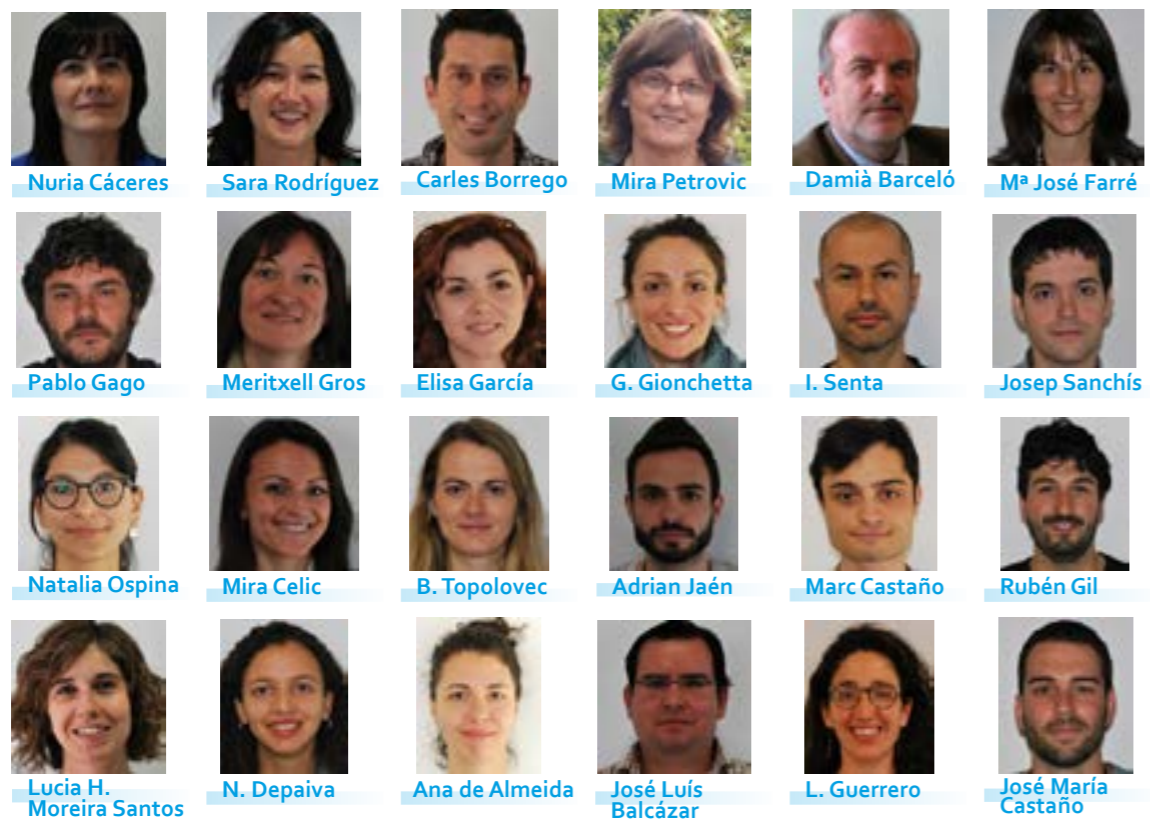


# HUMAN RESOURCES AREES

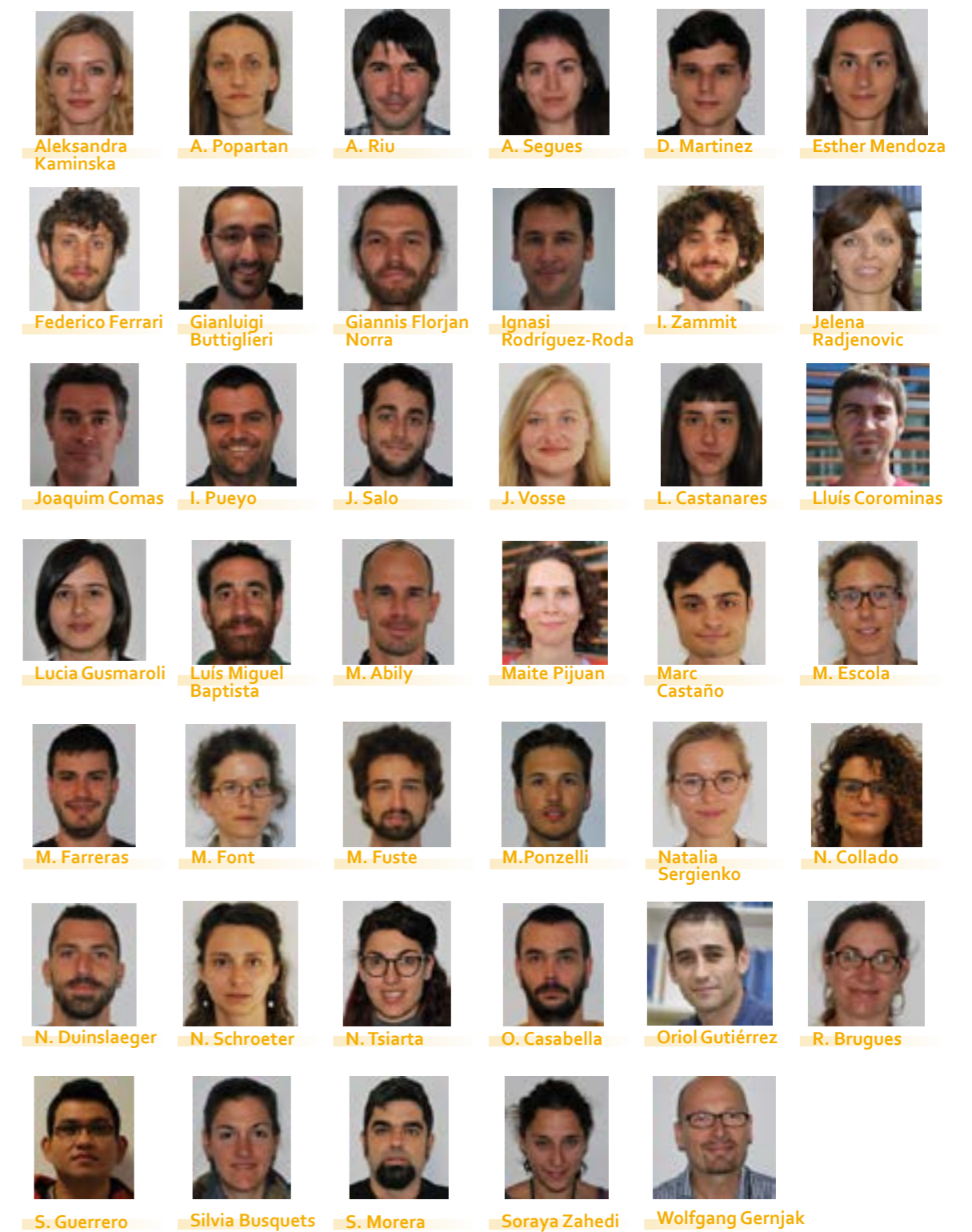
## AREA I. RESOURCES AND ECOSYSTEMS



## AREA II. WATER QUALITY AREA



## AREA III. TECHNOLOGIES AND EVALUATION



# Area I

## RESOURCES AND ECOSYSTEMS

1 Technical Support Personnel  
Carmen Gutiérrez

THE LINES OF RESEARCH OF THE RESOURCES AND ECOSYSTEMS AREA ARE:

- ▷ A11 HYDROLOGICAL PROCESSES
- ▷ A12 LACUSTRINE AND RESERVOIR SYSTEMS
- ▷ A13 FLUVIAL SYSTEMS
- ▷ A14 MODELLING OF ECOSYSTEMS AND BASINS

## 21 RESEARCHERS IN THE AREA

Group leader

Vicenç Acuña

1 Research professor (UdG associated)  
Sergi Sabater

1 Research professor (UdG associated)  
Josep Mas Pla

1 Research professor (UdL associated)  
Ramón Batalla

2 Research scientists  
Vicenç Acuña  
Rafael Marcé

7 Postdocs researchers  
Anna Freixa  
Didac Jorda  
Carme Font  
Núria Perujo  
Elisabet Tornes  
Laura Jiménez  
Ernesto Pasten

5 Predoctoral researcher  
Juan David González  
Elias Msongolera Munthali  
Duygu Tolunay  
Oriana Lucia Llanos  
Laia Verdura

4 Research technicians  
Julio César López  
Daniel Augusto Mercado  
Joana America Castellar  
Adrià Riu





# Area I

## RESOURCES AND ECOSYSTEMS

The activities of the ICRA Resources and Ecosystems Area have developed through projects reaching their conclusion, the arrival of other new projects and activities with companies and public bodies. During 2020, our area issued two one-year grants for predoctoral research on the fields on hydrology and ecology. The grantees (G. Córdoba-Ariza and L. Verdura) will support the existing research projects and apply for a competitive scholarship during their stays. Postdoctoral researchers (Drs. J.C. López, D. Jordà, E. Tornés, A. Freixa, E. Pastén-Zapata, D. Mercado, J. Castellar, and N. Perujo) have contributed to the research projects, as well as the research technicians (A. Riu, C Gutiérrez) and graduate students working towards their PhDs (O. Llanos), or realizing a research stay among us.

We continued on the research of the sustainable use of water resources in the face of global change through the continuation of the project HIDSOS-IV to complete the setup of a monitoring network of suspended sediments and nutrients in the Pyrenees, we also collaborated in several efforts conducted by the Catalan Water Agency (ACA) in both applied and scientific products. Thus, the EESAM project with ACA has been developing a modelling platform to support water managers when designing the Plans of Measures of the River Basin District Plans. National projects such as SPACESTREAM contributed new results to the effects of flow intermittency, carbon dynamics and ecosystem services in Mediterranean rivers. Another national project, PACE-IMPACT, started in 2018,

looks for the occurrence of pharmaceutical products and resistome impacts in the groundwater microbiome in distinct hydrogeological environments, as a basis for addressing such groundwater pollution cases.

ERANET projects of the ERA4CS call (CLIMALERT and WATEXR) have added a new perspective by linking global and regional climate models to ecological research. Both projects deal with climate services, and on how to mitigate the adverse effects of extreme climate events when knowing in advance of their occurrence (4-5 weeks to seasons).

The participation in European and International network projects was also relevant in 2020. At the European level, RiE researchers continued their contribution to the Horizon 2020 Edicitnet, and the COST Action SMIRES, whereas the NCEAS-SNAPP project and the ISIMIP Lake Sector network expanded the research networks beyond the European borders. A new EU project DRYVER (H2020- 869226-2) will initiate further research on intermittent streams.

All these projects resulted in a larger understanding on the effects of climate change on hydrological systems, whether surface water or groundwater. They depict and describe the complex relationships between flow intermittency and biodiversity, including the effect of emerging pollutants as ecological stressors, and human use availability of water resources.

Change' HIDSOS-IV previously funded by ENDESA SA. Once the measurements were finished the control network was dismantled and the equipment re-calibrated and re-inventoried in the ICRA Pool of scientific instrumentation for future investigations. The whole set of data is being processed for the calibration and validation of the TETIS® distributed model, which lead to the implementa-

tion of global change scenarios in this representative basin of the Southern Pyrenees. The team continued publishing research on hydro-geomorphological processes, along with the continuous national and international collaborations with the aim to consolidate and to internationalize the research of the Resources and Ecosystems and Area.

## ▶ LINE I.2 LACUSTRINE AND RESERVOIR SYSTEMS

In 2020 the research lines related to forecasting water quality in lakes were consolidated. WATEXR (JPI Climate ERA4CS, "Integration of climate seasonal prediction and ecosystem impact modelling for an efficient adaptation of water resources management to increasing climate extreme events") produced the first results in near operational settings. The prediction systems for the different case-studies are in beta versions, ready to be used as a QGIS plug-in. But the most relevant milestone was the identification of the limits and opportunities of seasonal climate prediction in the water sector, with precise assessments of the events and seasons most successfully predicted. Also supported by WATEXR, the ISIMIP Lake Impact sector started to produce the first high impact results, with more than 60 research teams contributing to impact simulations. The first contributions gravitate around the impacts of climate change on the mixing regimes of lakes. The ISIMIP Lake Sector has become a hub for collaborations in the lake water quality arena, and it is already a well-known instrument for the lake water quality modelling community. ICRA has decisively contributed to the network coordinating all activities related to the Lake Sector.

In the context of the project MANTEL (H2020 ITN, "Management of climatic extreme events in lakes and reservoirs for the protection of Ecosystem Services"), the ITN student Elias Munthali settled new methodologies to detect extreme events in historical water quality data series using historical records from Sau Reservoir. He also started the analysis on how those events impact the water quality in the reservoir, using an inventive approach based on the causality in quantiles methodology. He also conducted a series of experiments and field assessments on the impact of natural organic matter on the formation of disinfection-by-products, a topic of interest for ATLL. All these results are already in review in scientific journals. Moreover, the investigations on the fate of sedimentary carbon in lakes that dry out in the project C-HydroChange (Excelencia) progress well after some turbulences related to personnel leaving the project due to the COVID19 crisis. It is worth to mention the publication of a high impact study on the role of drying inland waters in the global carbon cycle.

## ▶ LINE I.1 HYDROLOGICAL PROCESSES

As central focus in 2020, the team continued the monitoring of streamflow at the Vernagà hydro-metric station (Gavarres Massif) to obtain data from this intermittent stream, with the general objective of assessing the foreseen impacts of flow reduction and the increase of drought severity on invertebrates' community. The site was re-equipped with water-stage and air-pressure sensors and lapse-time cameras, and it will also be used to test flow last-generation sensors (task

already underway). A complete database on hydrology, land uses and water quality for the whole Onyar river basin was assembled in order to study the effects of scale and changes in land and water uses on water resources in the Girona region. As in previous years, the team keeps processing data on flow discharge, sediment transport and nutrient loads in the river Noguera Pallaresa obtained within the frame of the Research Contract 'Sustainability of Water Resources under Global

## ▶ LINE I.3 FLUVIAL SYSTEMS

During this reporting period, our research continued through, (i) the effects of flow intermittency on the stream biota and biogeochemistry, (ii) the integration of ecosystem services in freshwater ecosystems management, (iii) the effects and fate of emerging contaminants in freshwater ecosystems; and (iv) the use of nature-based solutions in the urban water system.

The SPACESTREAM project (CGL2017-88640-C2-1-R) started on January 2018 and will finish by mid-2021. This project had as its main goal to characterize the hydrological dynamics and its effects on the organic matter transport and transformation. Additionally, the effect of the longitudinal variation in hydrology on algal communities has been assessed at the Algar river basin, a Mediterranean sub-basin within the Ebro. The hydrology and

organic matter joint dynamics is currently being modelled, in a work still in progress. This work, when finalized, will allow us to predict the variation in the transport and transformation of organic matter dynamics under different climatological scenarios, including those foreseen by climate change. In the CLIMALERT project, we continued developing the integration of ecosystem services in the water management, in an exercise performed in the Algars River basin, within the Ebro basin. This work, still ongoing, allowed us to gain insights in the complex modelling of socio-environmental systems which are extremely complex in rivers driven by water scarcity. Research on flow intermittency has also been performed within the framework of the SMIRES COST Action (CA15113). The arrival of the new EU project DRYVER (H2020-grant agreement 869226-2) at the end of 2020 opened new perspectives to the ongoing work on intermittent streams. ICRA will lead some aspects of the modelling tasks of a large European consortium, and particularly those related to the upscaling of ecosystem services apportioned by intermittent streams to the European scale. A new project on the relevance of climate change on the biota has started, based on the signals provided by diatom assemblages. Those already detected in intermittent systems shed the light to further insights on the ability of these small algae as early-warning indicators of future changes in water availability.

The research on the integration of ecosystem services in freshwater ecosystems management was done through the project "Integration of ecological status and ecosystem services for the design and prioritization of management measures" (EESAM). Here, we have been developing a modelling platform to simulate hydrology as well as both diffuse and point pollution sources, as well as the effects on ecological status and ecosystem services. A series of publications and applications are expected during 2021-2.

Regarding the use of nature-based solutions in the urban water system, a decision-support system has been developed, with two tier levels, one based on expert knowledge and one on a review of evidence within the framework of an international expert project, the NCEAS-SNAPP. The decision-support system is already operative and online (<https://snapp.icra.cat/>), although it has not yet been launched, as we are at this moment improving graphical design aspects to enhance the user experience when using the system. The associated publication will be submitted to Water Research few weeks before the launch of the decision-support system. Finally, we have been also working on the Edicitnet Horizon 2020 project on a review / perspective publication on the terminology, classification, and scoring of nature-based solutions for urban challenges and ecosystem services. Although the work was completed along 2020, the publication has appeared this 2021 (Castellar et al. 2021).

(Musacchio A, 2020) was defended in January 2020 at the Università di Pavia as joint doctorate between it and the Universitat de Girona.

Finally, a new two-year project GW-GEN, devoted to carry out preparatory actions for the drafting of a competitive proposal on the understanding of the occurrence and migration of antibiotics and resistance genes in the hydrogeological environment, was funded by the 2020 "Europa Investigación" call.

## AI- PHD DISSERTATIONS

Juan David González-Trujillo  
 (Universitat de Girona) Dissecting the assembly process of benthic communities from Neotropical streams.

Miriam Colls  
 (Universitat de Girona) Biofilm Responses to Flow Intermittency in Mediterranean Rivers.

## VISITING SCIENTISTS

Tornes Bes, Elisabet,  
 Universitat de Girona (UDG)

## VISITING STUDENTS

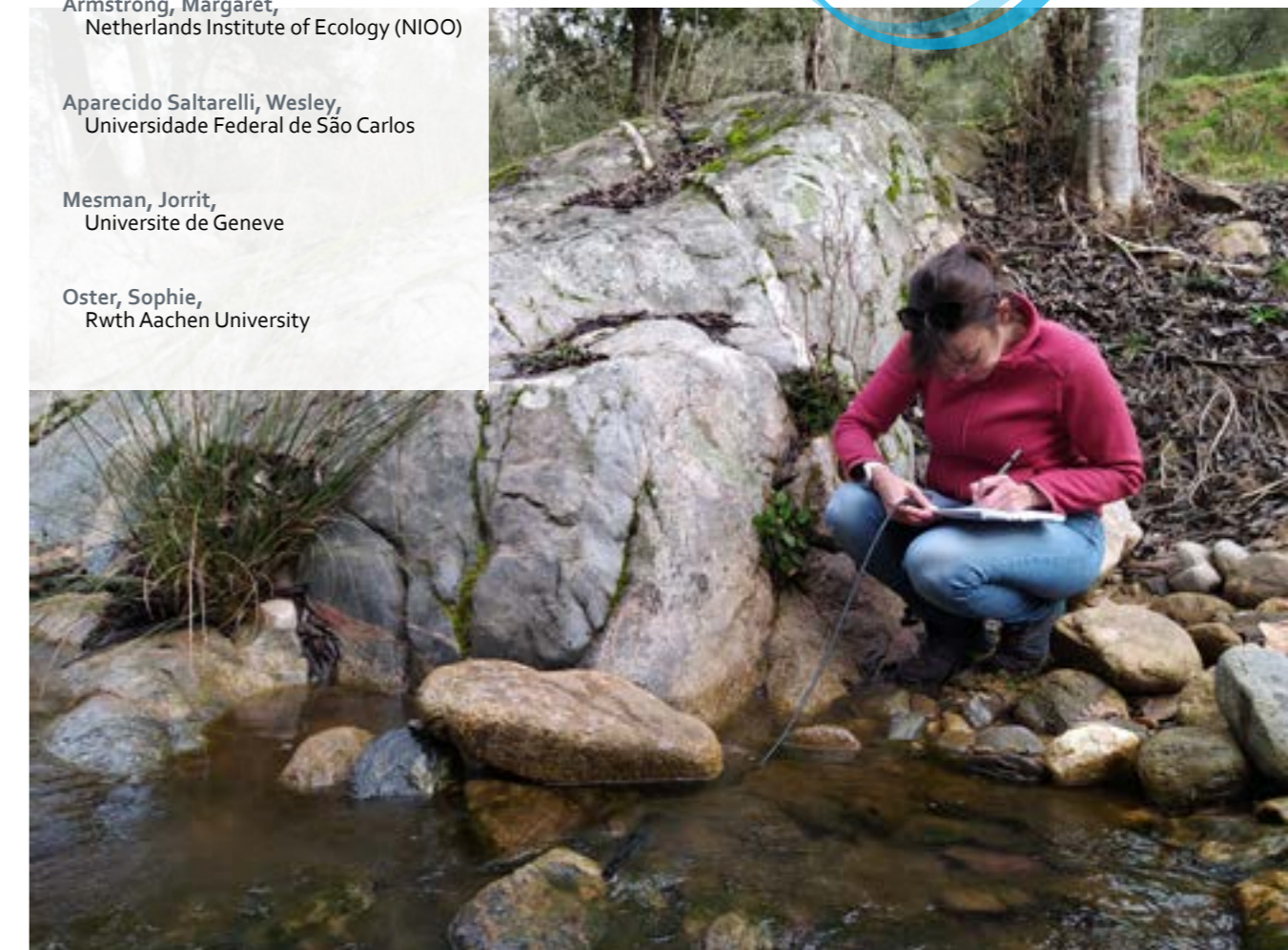
Alberca Ballell, Miquel,  
 Universitat de Girona (UDG)

Armstrong, Margaret,  
 Netherlands Institute of Ecology (NIOO)

Aparecido Saltarelli, Wesley,  
 Universidade Federal de São Carlos

Mesman, Jorrit,  
 Universite de Geneve

Oster, Sophie,  
 Rwth Aachen University



## ▶ LINE I.4 MODELLING OF ECOSYSTEMS AND BASINS

Research in this line is linked to the project PACE-IMPACT which looks for the occurrence of pharmaceuticals in groundwater. Research goes on with the analysis of groundwater sample data gathered from springs in the Osona hydrogeological system as a means to provide a field-based insight on the processes that control the transport of pharmaceutical compounds in the upper part of the aquifer. Microbiological monitoring evaluates antibiotic resistance in spring water. Efforts of statistical analysis has been devoted to interpret the association of antibiotic occurrence with organic matter fractions in groundwater. This project implies a collaboration with researchers of the Water Quality area.

Moreover, the project is currently considering how to optimize a monitoring network affected by emerging contaminant pollution based on a cost-benefit perspective. A task including the

risk to human health derived from this specific type of pollution is being considered by gathering former experiences and methodological approaches and applying them to our field site data.

Climate change issues on nitrate pollution has been addressed in N Germany by adapting former methodologies used in Catalonia in research projects. In this sense, we provided advice and collaboration to the Hydrogeology Department at Ruhr-Universität Bochum (Germany).

Water management research has been developed as an international collaboration with Università di Pavia (Italy) on the study of nitrate evolution in a part of the Lombardy aquifer. This cooperation involved the developed of a numerical flow and transport model that, using a socio-hydrogeological approach, can be applied to support governance processes. A PhD dissertation.

# Area II

## WATER QUALITY AREA

THE WATER QUALITY AREA LINES OF RESEARCH ARE:

- ▷ AII1 CHEMICAL CONTAMINATION OF WATER BODIES
- ▷ AII2 CONTAMINANTS IN WASTEWATER
- ▷ AII3 QUALITY AND MICROBIAL DIVERSITY
- ▷ AII4 ECOTOXICOLOGICAL RESPONSE OF BIOTA TO CONTAMINANTS



## 24 RESEARCHERS IN THE AREA

Group leader  
Mira Petrovic

**1** Research Professor (ICREA associated)  
Mira Petrovic

**1** Research Professor (CSIC associated):  
Damià Barceló

**1** Research Professor (UDG Associated)  
Carles Borrego

**3** Research Scientists  
José Luis Balcazar  
Sara Rodríguez Mozaz  
María José Farré

**9** Postdoc Researchers  
Lucia Helena Moreira  
Pablo Gago  
Meritxell Gros  
Josep Àngel Sanchís  
Rubén Gil  
Ana Carolina Magahna  
Natalia Ospina  
Ivan Senta  
Laura Guerrero

**5** Predoctoral Researchers  
Jose María Castaño  
Marc Castaño  
Mira Celic  
Adrián Jaén  
Barbara Topolovec

**3** Research Technicians  
Elisa García  
Giulia Gionchetta  
Natalia De paiva

**1** RDI Technician  
Miyako Nitta

# Area II

## WATER QUALITY

### ▶ LINE II.1 CHEMICAL CONTAMINATION OF WATER BODIES

#### Evaluation of alternative treatment strategies for the elimination of emerging pollutants from wastewater. The use of suspect screening analytical methodologies for the study of transformation products of pollutants.

Algal treatment has become a promising approach among water treatment technologies to remove emerging micropollutants due to their high capability to remove nutrients, heavy metals and bacteria. The performance of these microorganisms was evaluated in 2 studies i) a high rate algae pond, where the removal of a set of selected pharmaceuticals and their main transformation products from wastewater was evaluated ii) a microalgae laboratory-scale experiment, where the biotransformation of selected surfactants and their transformation products in the so-called produced water (PW) from oil and gas extraction processes was also studied using suspect screening methodologies. These low-cost and eco-friendly systems open up the possibility of reuse by industry or agriculture of effluent treated with these alternative treatments. The efficiency of alternative water treatment technologies alone and also coupled to advanced oxidation processes (AOPs) for the removal of emerging pollutants was also investigated. Four different combinations of treatments (UV/H<sub>2</sub>O<sub>2</sub> treatment before/after conventional activated sludge or fungal treatment) were investigated in terms of presence and removal of the model pharmaceutical metoprolol and its TPs in real hospital wastewater. The generated intermediates were identified with an automated suspect screening approach, which allowed to comprehensively study their presence and transformation pathways along the combined treatments.

#### Bioaccumulation and Impact of emerging pollutants in aquatic organisms and in the spread of antibiotic resistance.

The impact of the contaminants in the aquatic environment can be evaluated by assessing selected toxicological effects and/or by measuring the bioaccumulation of the target pollutants in the aquatic organisms. During 2020, and in collaboration with other colleagues at the Universidad Rey Juan Carlos and the Universidad de Extremadura, we finished our work about the detection of pharmaceutical compounds as well as biomarkers of effects in seafood from North Western Spain. In addition, we applied the principles of human health risk assessment to place the measured tissue concentrations in the context of human exposure to these compounds through seafood consumption. Among pharmaceutical compounds, antibiotics are a family of compounds of high consumption and importance as well as of high environmental concern. The relevance of antibiotics in the spread of antibiotic resistance was studied in collaboration with other researchers in Europe in the framework of projects such as StARE "Stopping Antibiotic Resistance Evolution" EU, 2013 Water JPI, where a comprehensive monitoring of a broad set of antibiotics was performed in the final effluent of wastewater treatment plants (WWTPs) of 7 European countries. The antibiotic occurrence data in the final effluents were used to evaluate their impact on microbial communities in aquatic systems and on the evolution of antibiotic resistance. A strategy to evaluate antibiotic resistance in wastewater treatment was also proposed and evaluated in a transnational study in the framework of the Cost Action NEREUS (ES14,03-NEREUS). The development and validation of such approach, based on targeting cefotaxime-resistant (CTX-R) coliforms as indicators was published during 2020.

#### Evaluation of the effect of microplastics in the impact of organic micropollutants in aquatic organisms.

New emerging pollutants such as microplastics and nanoparticles can act as carriers of organic contaminants and alter their impact in aquatic organisms. The project PLAS-MED "Microplastics and micropollutants in the Mediterranean coast: Toxicity and impact in the environment and human health" (MINECO CTM2017-89701-C3-2-R) started in 2018 with the aim of studying the role of microplastics in the transference, bioaccumulation and toxicity of pharmaceuticals and other emerging pollutants in aquatic organisms. The results of mesocosm experiments with fluvial biofilm as model organisms were evaluated. The impact of microplastics on the bioaccumulation, biotransformation and impact of selected contaminants (clarithromycin and triclosan) in river biofilms was thus reported in 2020 and the corresponding papers being prepared. Besides laboratory experiments, water, sediments and biota samples collected in monitoring campaign in coastal areas in Spain (Ebro estuary and in Mar Menor lagoon in Murcia) in Winter 2018 and Spring 2019, were analyzed for the assessment of the presence of selected emerging pollutants and microplastics. A metabolomics approach, a powerful tool to better evaluate the ecotoxicological response of aquatic organisms in areas impaired by the presence of such contaminants, was applied both to mesocosms and field samples. Also in the frame of PLAS-MED project, a review paper and a chapter were published related to the presence of microplastics in the Mediterranean sea and to environmental metabolomics respectively.

#### Study of occurrence and fate of disinfection byproducts and their precursors in drinking and recycled water.

Within the frame of the project NDMA\_Predict, CTM2017-85335-R, the group worked in development of nontarget methodologies for the characterization of dissolved organic matter (DOM) in freshwater bodies using high-resolution mass spectrometry (HRMS) tools and fingerprinting approaches, contributing to further understand the relationship between DOM composition and disinfection by-products (DBPs) generation in drinking water treatment and (ii) identifying potential DBP precursors in custom van Krevelen diagrams.

These methodologies have been directly applied to two case studies. In the first one, the chlorination of Sau, Susqueda and Pasteral waters resulted in the detection of >650 new halogenated features. In addition, deep changes were spotted in the structure and composition of tannin-, lipids-, soot- and lignin-like features. The formation of haloacetonitriles after chlorination was observed to be closely connected to the occurrence of N-containing lignin-like features, while trihalomethanes correlated with a wide spectrum of non-nitrogenated lignin-related substances. The second case study involved the step-by-step analysis of a real-scale water reclamation scenario in the lower Llobregat River. Overall, the emission of tertiary-treated water into the river had a limited impact in the drinking water fingerprint (only 34 HRMS features could be traced back to the original wastewater discharge) and it did not significantly alter the river DOM composition nor its nitrosodimethylamine formation potential (NDMA-FP). However, the discharge of chlorine-disinfected tertiary effluent did have relevant implications for the river chemistry: Chloramines were generated due to incomplete disinfection, which triggered the (photo) generation of brominated and/or chlorinated species in the river. In addition, NDMA levels were increased in the discharge point, but they plumped down again downstream due to photolysis and environmental dilution.

The developed methodologies were also employed in a collaboration with the Norwegian University of Science and Technology (Trondheim) to study the water quality and DOM composition of water from aquaculture systems under different fish food conditions.

Finally, the recent activities in the frame of NDMA\_predict have been related to the nontarget analysis of water samples by and in the development of predictive models to accurately estimate the NDMA-FP of a water sample from its non-target HPLC-HRMS data.



## ▶ LINE II.2 CONTAMINANTS IN WASTEWATER

### Study of the occurrence, fate and elimination of emerging contaminants in engineered systems

Within the H2020 MSCA ITN-EJD project NOWELTIES - Joint PhD Laboratory for New Materials and Inventive Water Treatment Technologies. Harnessing resources effectively through innovation the group is involved in studying elimination of recalcitrant organic micropollutants (OMPs) in treatments based on advanced oxidation processes (AOP), such as non-thermal plasma. The main objective of this study elimination and to elucidate transformation pathways of selected recalcitrant perfluorinated compounds (PFAS): GenX, Perfluorooctanoic acid (PFOA), Heptadecafluorooctanesulfonic acid (PFOS), Undecafluorohexanoic acid (PFHxA), Tridecafluorohexane-1-sulfonic acid (PFHxS), Perfluorobutyric acid (PFBA), Nonfluorobutane-1-sulfonic acid (PFBS). Non-thermal plasma in liquid and gas-liquid environments generates in situ oxidizing species, such as hydroxyl radicals, ozone, hydrogen peroxide, peroxy nitrates etc., capable to degrade recalcitrant OMPs from the solution relatively quickly, and even using low power discharges. This oxidative breakdown is influenced by the scavenging capacity of matrix components, resulting in the accumulation of transformation products (TPs) rather than complete mineralization. During 2020 initial experiments were performed in collaboration with the Institute of Physics Belgrade (Serbia).

First round of experiments was conducted using laboratory scale plasma equipment, non-thermal plasma, and pin-to-liquid discharge. The aim of the experiments was to provide preliminary results and evaluate the effect of selected parameters on removal of PFAS. The selected parameters were: concentration of the compounds, volume of the sample, treatment time, and type of working gas. The preliminary results were used to select the optimal working conditions for the future experiments since this is the first time that this type of plasma equipment was used for the degradation of selected PFAS. The results had shown a promising degradation % for several compounds, especially for long-chained PFAS, such as PFOA and novel compound Genx, after 5 minutes of treatment. As for the short-chained PFAS, there was very poor removal efficiency as expected based on the previous research so next experimental steps will include longer treatment time and different volume. Argon as a working gas showed promising results from efficiency and economical point of view.

H2020 project EMERGE focuses on studying the effects of different emission reduction solutions for shipping in Europe and to develop effective strategies to decrease the environmental and climatic impacts of shipping. Our role in the project focuses on the analysis of organic contaminants in waste streams discharged from ships to the marine environment. The main concern is on scrubber waters, which originate from exhaust gas cleaning systems (EGCs). Scrubber systems remove compounds from the exhaust gas (mainly SO<sub>x</sub>, NO<sub>x</sub>, PM, organic matter and metals) and contains acidifying compounds formed by dissolved SO<sub>x</sub>, potentially toxic compounds such as polycyclic aromatic hydrocarbons (PAHs) and metals.

Along this year, a suspect screening analysis to identify the most relevant organic contaminants present in scrubber and sea water (e. g. PAHs and alkylated derivatives) was carried out by using a GC-APCI-QTOF MS system. The samples selected for this purpose were produced by a pilot-scale scrubber system at Chalmers University (Sweden). The identified suspects were prioritized based on their potential toxicity and environmental relevance, the availability of analytical standards and chromatography quantification issues, to develop an analytical methodology based on capillary gas chromatography coupled to tandem mass spectrometry for their routine monitoring in scrubber and sea water samples.

### Evaluation of wastewater treatment processes using advanced methodologies for comprehensive characterization of dissolved organic matter (DOM) in wastewater

Within the frame of 2020 MSCA EF project SMART-WORKFLOW (Development of a smart workflow based on high resolution mass spectrometry for the assessment of the performance of wastewater treatment technologies) the group was involved in the study aimed to generate workflows (understood as a procedural sequence for data acquisition, data processing and data mining) applicable to both currently used and novel innovative wastewater treatment technologies, providing in-depth assessment on their performance regarding the removal of polar organic compounds and generated transformation products. The main objective of SMART-WORKFLOW was to integrate the last advances in chemical analysis (including the use of powerful instrumentation such as high resolution mass spectrometry (HRMS)) and statistical analysis of

data to develop and optimize a smart methodology for the assessment of the overall efficiency of wastewater treatment using different technological approaches.

The focus was put on advanced oxidation processes (AOPs), where the influence of the radicals SO<sub>4</sub><sup>•-</sup> and OH<sup>•</sup> as initial species, and their corresponding secondary oxidants generated (O<sup>•-</sup>, CO<sub>3</sub><sup>•-</sup>, NO<sub>3</sub><sup>•</sup>, Cl<sub>2</sub><sup>•-</sup>, Cl<sup>•</sup>, etc.) are still unknown in complex natural waters, such as effluents from WWTPs. Experiments were carried out using secondary effluent from different local wastewater treatment plant. The developed workflow allows the evaluation of the treatments in terms of overall oxidation through the careful study of Van Krevelen diagrams, where all the masses of the HRMS chromatograms are considered. The potential formation of transformation products with sulfur due to the sulfate radicals was also evaluated using statistical tools based on the isotopic pattern and accurate mass. Finally, the behavior of a large number of micropollutants with a wide range of physicochemical properties was studied using suspect screening strategies.

SMART-WORKFLOW contributed to the development of the widest method developed so far in terms of number of compounds and allowed, for the first time, a comprehensive evaluation of the presence and behavior of organic pollutants during water treatment processes, thus representing an important advance regarding the evaluation of contamination in wastewater, and expanding the focus and obtaining a much broader picture of the molecular profiles and the potential contamination problems.

### Fate and environmental risks of organic contaminants in agroecosystems

Within the frame of the H2020-MSCA-IF project RESOURCE (Groundwater quality assessment in areas with intensive livestock: is manure recycling a major source of pollution and dissemination of antibiotic resistance genes?), carried out together with researchers from the Microbiology unit (see next section) and from RiE, the group worked at evaluating the chemical and microbiological status of groundwater bodies in areas with intensive livestock production by analyzing veterinary pharmaceuticals and antibiotics, antibiotic resistance genes and the characterization of the dissolved organic matter (DOM) fingerprint in hot-spot sites. In 2020, the team focused on the compilation of the project results and in exploring the potential relationships between antibiotics, environmental variables (e.g. nitrates, phosphates, DOC) and DOM, to gain understanding about the DOM components that would have a major interaction with antibiotics. A summary of the project results was published in an article at the "Results in Brief" sec-

tion of the European Commission's CORDIS website entitled "Assessing the impact of agriculture on Spanish groundwater".

Other activities in 2020 include: (i) the assessment of the environmental sustainability of vinasse reuse as a fertilizer in sugarcane crops through the potential dissemination of organic contaminants from vinasse to soils and groundwater, using target and extended suspect screening methodologies. This work was done in collaboration with researchers at the Universidad Estadual Paulista (UNESP) in Brazil and results were compiled in a scientific publication; (ii) the collaboration with researchers at TiA on the potential of anaerobic digestion of livestock wastes (e.g., slaughterhouse wastewater, animal manures, etc.) to produce biogas and reduce pharmaceuticals and antibiotic residues and (iii) evaluating the degradation of pharmaceuticals in blackwater treatments and their fate in soils and natural waters in blackwater fertilized areas, in collaboration with researchers at the Swedish University of Agricultural Sciences (SLU) in Sweden.

### Wastewater-based assessment of human exposure to chemical pollutants

Within the framework of the H2020-MSCA-IF SCHEME (Sewage chemical information mining & development of a novel concept for the assessment of human exposure to pollutants through wastewater analysis), a comprehensive analytical methodology has been developed for the determination of biomarkers of human exposure to chemicals from personal care and household products in wastewater. The list includes biomarkers of exposure to parabens, UV filters, phosphorous flame retardants, bisphenol A, phthalates, and alternative plasticizers, as well as oxidative stress biomarkers.

In 2020, both offline and online SPE-LC-MS/MS methods for determination of the selected biomarkers were developed and evaluated. After optimization of MS/MS parameters, several LC columns, elution solvents and gradient programs were tested for the optimal separation of target compounds. In addition, different SPE sorbents and procedures were explored to obtain good extraction recoveries of selected biomarkers with rather different physico-chemical properties. The preliminary results were presented at the 16th Annual Workshop On Emerging High-Resolution Mass Spectrometry (Hrms) And Lc-Ms/Ms Applications In Environmental Analysis And Food Safety. In addition, a review paper on the assessment of human exposure to personal care and household products by wastewater-based epidemiology was recently published in Trends in Environmental Analytical Chemistry.

## ▶ Line II.3 Quality and Microbial Diversity

### Exploring the implications of bacteriophages on the acquisition and spread of antibiotic resistance in the environment

Despite the fact that bacteriophages (or simply phages) are the most abundant biological entities and have the potential to transfer genetic material between bacterial hosts, their contribution to the acquisition and spread of antibiotic resistance genes (ARGs) in the environment has not been extensively studied. In order to overcome these limitations and to gain a better understanding of the mechanisms and factors that promote antibiotic resistance, Dr. Ana de Almeida Kumlien (Marie Skłodowska-Curie Individual Fellowship) and, more recently, Dr. Edgar González (Mexican National Council for Science and Technology – CONACYT – Fellowship) have joined our research group as postdoctoral fellows. Dr. Almeida Kumlien is experienced in water industry and water treatment innovations and Dr. González has a wide expertise in clinical microbiology and phage therapy. Their research activities are mainly focused on the acquisition and spread of antibiotic resistance through phage-mediated horizontal gene transfer. To do so, we have isolated several phages from untreated and treated wastewater samples. These phage lysates will be used to assess their activity as gene transfer agents among different bacterial hosts. Recently, we published an opinion article in the renowned journal *Trends in Microbiology* where we highlight the potential contribution of phages to AR in the context of water treatment and the current knowledge gaps

### Role of migratory birds on the dissemination of antibiotic resistance genes

Antimicrobial Resistance (AR) has become a serious and growing threat to humans, animals, and the environment. While important progress has been made in understanding the epidemiology of AR in clinical settings, limited information is available on the role of wildlife in the evolution and dispersal of AR across biomes. In 2020 we started project DARABi (Dissemination of Antibiotic Resistance by Aquatic Birds: disentangling the contribution of microbes, bird ecology and

anthropogenic pollution (DARABi), PID2019-108962GB-C22, funded by the National Research Agency, Ministerio de Ciencia e Innovación). DARABi is aimed to explore the prevalence of AR in different waterbird species, considering: i) their ecological relationships (dietary habits, foraging time, and migratory routes) in environments affected by contrasting levels of anthropogenic pollution (sites across Andalusia differing in their degree of pollution), and ii) their capacity to travel over long distances (migratory vs. sedentary species). DARABi is a coordinated project between the Universidad de Sevilla and our research group at ICRA. The project started in June 2020 and our main goal is to assess to what extent different waterbird species are reservoirs of antibiotic-resistant bacteria (ARB) and resistance genes and to link the abundance and diversity of their gut resistome and mobilome to the anthropogenic pollution at their natural habitats. We will use a combination of cultivation-dependent and cutting-edge gene-based molecular techniques (including metagenomics and whole-genome sequencing) to identify, quantify, and characterize the resistome, the mobilome, and the microbiome of different waterbird species in relation to the bird ecology.

### The sewer resistome and its response to chemical treatments

In December 2020, the project SEWAGENE (Accumulation, Spread and Removal of Antibiotic Resistance in Sewer Systems, Ref. CTM2016-75653-R funded in 2016 by the Spanish “Ministerio de Economía y Competitividad”) finally ended. During the last four years, we have explored the effect of chemical treatments on the diversity and abundance of antibiotic resistance genes (ARGs) and mobile genetic elements (MGEs). Particularly, we have characterized the microbiota of sewer biofilms at different sites within a full-scale sewer and identified the content of these biofilm sin ARGs and potential pathogens (Auguet et al., 2017, *Sci. Total Environ.* 605–606: 1047–1054). Recently, we have also identified the alterations caused by dosing free nitrous acid (FNA) in the composition of sewer biofilm community and the effect that this chemical compound had on the sewer resistome and mobilome (Gionchetta et al., 2021, *Chem. Engineer. J.* 405: 126657). The latter study provides a comprehensive estimation on the diversity,

abundance, and differential distribution (sewage vs. biofilms) of ARGs and MGEs in an experimental sewer system and a quantitative estimation of the effect of FNA dosage on the resistome and mobilome of sewers. Overall, FNA had a negligible impact on sewer biofilm communities and deserve further research considering the well-known role of biofilms as reservoirs of ARGs and potential pathogens, especially in sewers. However, we observed a reduction in the relative abundance of ARGs and MGEs in suspended cells, which can be considered as a beneficial side effect of the FNA dosage and may be helpful to guide future policy recommendations to lessen the spread of antibiotic resistance across the urban water cycle.

We are currently analyzing metagenomic and metatranscriptomic datasets obtained from two experiments carried out during 2020 that consisted on the dosage of nitrate in a full-scale sewer in L’Escala (Alt Empordà) and in a mid-scale sewer pipe (pilot plant) constructed at ICRA. We are confident that results from these experiments will provide an in-deep understanding of the effects of chemical treatments—and the associated associate stress—on sewer microbiota and, particularly, on the sewer resistome and mobilome.

### Catalan Surveillance Network of SARS-CoV-2 in Sewage

The Catalan Institute for Water Research (ICRA) is coordinating the Catalan program for the surveillance of SARS-CoV-2 in sewage. The program started in early July as an early warning tool to anticipate COVID-19 outbreaks in Catalonia. The results on the concentration of viral gene markers across the territory are provided in an online platform ([sarsaigua.icra.cat](https://sarsaigua.icra.cat)), discussed weekly with the Public Health Agency of Catalonia (ASPCAT) and the Catalan Water Agency (ACA) and are used as a complementary indicator in the decision-making process.

A total of 56 WWTPs serving 193 municipalities are sampled throughout the country, representing 80% of the Catalan population. Territorial equilibrium is guaranteed by monitoring at least 1 WWTP per county. Thirty-six WWTPs are sampled weekly and 18 fortnightly. 24-hour, flow-proportional composite samples are collected at the entrance of each WWTP every Tuesday and send to reference laboratories for the analysis of SARS-CoV-2 genetic biomarkers. The laboratories involved in the surveillance network are the Laboratory of Viruses Contaminants of Water and Food led by Prof. R. Gironés and Dr. Sílvia Bofill (Universitat de Barcelona); ii) the Laboratory of Enteric Viruses led by Prof. A. Bosch and Prof. Rosa Maria Pintó (also at the UB); and iii) the Center for Omic Scien-

ces from the Biotechnology Area of the Technological center EURECAT (Reus).

Weekly results on the concentration of SARS-CoV-2 target genes in wastewater are visualized in the on-line platform developed ad-hoc by EURECAT in collaboration with ICRA. This platform integrates both the data generated by the laboratories and the metadata generated during sampling. Data visualization includes an interactive map of the sampled territory showing the level of SARS-CoV-2 prevalence in wastewater and detailed graphs with the concentration of different gene targets (N1, N2, and IP4) over time. All data are freely available for investigation purposes at the Zenodo on-line repository (<https://zenodo.org/record/4244774>).

## AII- PHD DISSERTATIONS

Mira Cêlic (Universitat de Girona) Target analysis and suspect screening of wastewater derived contaminants in receiving riverine and coastal areas and assessment of environmental risks.

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# Area III

## TECHNOLOGIES AND EVALUATION

THE TECHNOLOGIES AND EVALUATION AREA'S LINES OF RESEARCH ARE:

- ▷ AIII1 WATER SUPPLY AND ADVANCED TREATMENT
- ▷ AIII2 WASTEWATER TREATMENT, REUSE AND RESOURCE RECOVERY
- ▷ AIII3 MODELLING AND MANAGEMENT SYSTEMS
- ▷ AIII4 UNIT OPERATIONS



1 Technical Support Personnel  
Veròncia Rocasalva

### 42 RESEARCHERS IN THE AREA

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Ignasi Rodríguez Roda Layret  
Joaquim Comas

2 ICREA Research Professors  
Wolfgang Gernjak  
Jelena Radjenovic

3 Research Scientist  
Gianluigi Buttiglieri  
Lluís Corominas  
Maite Pijuan

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Ian Zammit  
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Mercè Font  
Marc Fusté  
Oriol Casabella

# Area III TECHNOLOGIES AND EVALUATION

We started the year 2020 in the “business as usual” mode, with the excitement of coming back to work after a well-deserved Christmas break. With more than 30 researchers working in the Area, we all had big expectations for the year to come. Some were planning on finishing their thesis, others on finishing key experiments needed to complete a paper or a patent, projects moving towards implementing their planned experimental campaigns or starting their pilot plant activities. And all of this had to stop quite abruptly in early March when we had to face for the first time in our lives a global pandemic, still unknowing at that stage the profound impacts it will have in our daily life and in our society.

As researchers working in water and wastewater technologies, we often discuss new ways to enhance the resilience in our water systems and our cities to face emerging challenges. And maybe thanks to that we were able to adapt rapidly to the new situation, having the capacity to maintain most of our activities throughout this period of uncertainty and stress.

As a team we are very proud of the contribution of the Area's expertise to the design and development of a wastewater-based surveillance system for SARS-CoV-2 in Catalonia. Dr. Lluís Corominas and his team together with researchers from the Quality research Area and other Catalan research institutions used their expertise in sewer epidemiology and virus quantification to establish this surveillance system as an early warning to detect relevant changes in circulation of the SARS-CoV-2 virus in wastewater.



Despite suffering some unavoidable delays, research projects continued, resulting in many interesting outcomes and publications. In this sense, we would like to highlight an European Patent submitted by Dr. Pires and Prof. Jelena Radjenovic within the scope of the ground breaking research that is being carried out in the Starting Grant Project Electron4Water funded by the European Research Council. Also, two students arrived at the end of their PhD journeys during 2020. Lucia Gusmaroli and Federico Ferrari virtually defended their PhD thesis and moved to other institutions to continue their careers. And as some left, many new students, postdocs and technicians arrived. Among them, Veronica Rocasalva started at ICRA in October as a Research Technician supporting the research and administrative activities conducted in our Area. Together with Nuria Caceres and Carmen Gutiérrez, they form a team that provide support to the 3 Areas of Research at ICRA, greatly facilitating our day-to-day activities.

Finally, we would like to acknowledge the continuous support of our industry partners and public water agencies that are engaged in many of our ongoing research projects and that provide us with invaluable feedback.

Below you can find a more detailed explanation of the activities conducted within our three research lines during this challenging 2020.

## ▶ LINE III.1 WATER SUPPLY AND ADVANCED TREATMENT

The research line has two overarching themes, the development of novel processes and treatment trains, mostly focused on physicochemical treatments, and water quality management in these processes. These strategies are applied to increase water supply diversity by amending the quality of challenging traditional and alternative water sources contaminated mainly with organic pollutants but also inorganics such as nitrate.

In the scope of the ERC Starting Grant ELECTRON-4WATER led by ICREA professor Jelena Radjenovic, the following progress has been made:

- The first study on selective and rapid (electro)catalytic oxidation of sulfide to elemental sulfur using manganese oxide-coated electrodes has been published. Manganese oxide was discovered to have high catalytic activity for sulfide oxidation to sulfur, a reaction typically occurring in the nature (e.g., anoxic marine sediments). By polarizing an electrode at low anodic potentials, manganese oxide coating was continuously regenerated after reacting with sulfide, thus ensuring the anode stability and (electro)catalytic activity. This was the first study to demonstrate heterogeneous catalysis using Mn-oxides (Sergienko and Radjenovic, Applied Catalysis B Environmental, 2020). Ongoing work by the PhD student Natalia Sergienko is focused on patenting an Mn-oxide based electrode for sulfide removal and production of colloidal sulfur.
- An EU patent application was submitted entitled: “Method to prepare graphene coated sponges, sponges obtained thereof, electrodes obtained from such sponges and uses of the sponges for water treatment”. Graphene sponge electrodes have been successfully applied for the removal of different persistent organic contaminants, antibiotics and others, as well as for water disinfection. Currently the optimization of the structure of these graphene sponges by the incorporation of different atoms and 2D materials for defluorination of PFAS is under way. This work was conducted by Dr Luis Pires (post-doc fellow) and is currently the topic of several ongoing PhD thesis within the project (Giannis Florjan-Norra, Natalia Ormeño Cano, Nick Duinslaeger, Anna Segues Codina).

Also, as part of the Marie Curie ITN project Nowelties (coordinated by Mira Petrovic, ICRA AII), the PhD student Nikoletta Tsiarta (supervised by Wolfgang Gernjak, co-supervisor Lidija Ćurković, U. Zagreb) continued her PhD thesis on catalytic ozonation using modified ceramic membranes, with the

aim to achieve increase micropollutant degradation and decreased membrane fouling. Two more PhD students, Amit Kumar (co-supervised by Wolfgang Gernjak) and Camilo Sánchez Tobón (co-supervised by Jelena Radjenovic) commenced their respective PhD projects on plasma reactor development and Au/TiO<sub>2</sub>/graphene oxide photocatalyst synthesis in their primary host institutions and will commence working at ICRA in 2021.

Another PhD is being carried in collaboration with Wetsus in the Netherlands ([www.wetsus.nl](http://www.wetsus.nl)), where PhD student Nimmy George Kooror (principal supervisor, Wolfgang Gernjak, ICRA) aims to develop novel AOPs making use of the 185 nm and the 254 nm component simultaneously emitted by low pressure mercury lamps. Besides targeting an understanding of the chemistry of the process, this PhD project has a strong emphasis on computational fluid design modelling and reactor design as well. In 2020, two pilot plants were designed, built and have commenced operation at a drinking water production facility in the Netherlands.

In October 2020, COST Action 19110 PIAgri (“Plasma applications for smart and sustainable agriculture”) commenced, where Wolfgang Gernjak co-leads work group 4: “Plasma treatment of agricultural wastewater, growth media and production of plasma activated water”, whereby the first online work group meeting held in January 2021 reunited over 100 international experts in the field.

In October the newly awarded H2020 project commenced, which is led by Wolfgang Gernjak and Ignasi Rodríguez-Roda. iWAYS, funded under the EU H2020 programme, brings together 19 partners. The project will develop a set of technologies to increase water and energy efficiency in industry through three main solutions: exhaust condensation, water treatment and waste valorisation. iWAYS will consider alternative freshwater sources and will also develop robust technologies to reduce brine volumes and to recycle product water back to the manufacturing process, implementing principles of the circular economy. The main technology studied by ICRA is membrane distillation and its potential use in the steel manufacturing industry.

The water quality and supply management aspects within the research line include a strategic co-operation with the company s::can Messtechnik GmbH from Austria and its Spanish daughter company s::can Iberia S.L. Within this line Mireia Plà Castellana continued an Industrial Doctorate co-funded by the



Generalitat of Catalonia to work on chemometric methods for enabling contaminant detection using optical spectroscopic sensors.

The Agencia Estatal de Investigación (AEI) funds the INVEST project, that commenced in 2019. The aim of the project (PIs Wolfgang Gernjak and Lluís Corominas) is to establish a framework that can be used to make investment decisions to support attaining the implementation goals of the Water Framework Directive under different global change scenarios. Besides the PIs, Profs Ignasi Rodríguez-Roda (ICRA-UdG), Manel Poch (UdG) and Morgan Abily (ICRA, postdoctoral researcher) complete the core project team.

In 2020 the Catalan Water Agency funded the SUG-GEREIX project executed at ICRA by Wolfgang Gernjak, Joaquim Comas, and Mercé Font among others. The project is carried out in collaboration with EURECAT (coordinating institution), CETAO-UA and the Catalan Water Partnership, whereby one of ICRA's responsibilities is to develop a decision support system for the selection of appropriate treatment technology for the fit-for-purpose generation of reclaimed water. Knowledge acquired in this research line is also transferred to industry via consulting through consulting contracts and honorary roles, such as e.g., the participation of Wolfgang Gernjak in the expert panel counselling ACA on water reclamation in the Prat de Llobregat WWTP.

## ▶ LINE III.2 WASTEWATER TREATMENT, REUSE AND RESOURCE RECOVERY

Research conducted under this line aims to improve current technologies and develop novel tools for treating wastewater in the context of circular economy. The goal is not only achieving the desired treatment standards but also recovering the valuable resources wastewater contains such as energy, nutrients, and water. The technologies investigated are of application in centralized and decentralized facilities, with an increasing interest on including nature-based solutions within the context of wastewater treatment and resource recovery.

Achieving better treatment performance in terms of macropollutants and contaminants of emerging concern, recovering energy and nutrients and reducing the environmental impacts of the treatment facilities are the goals of this line. The experimental approach ranges from fundamental to applied research, with most of the projects involving strong participation from industry partners and water utilities.

The main activities focus on the following themes:

- Resource recovery from wastewater treatment
- Fate of emerging pollutants in conventional and advanced wastewater treatment technologies.
- Circular economy and nature-based solutions for optimal and safe closed water cycle in the Mediterranean region and in tourist facilities.

### RESOURCE RECOVERY FROM WASTEWATER TREATMENT.

Within this block of activities, a pilot plant based on an innovative electro dialysis system coupled with a transmembrane chemisorption was operated from January until July in the wastewater treatment plant (WWTP) of Girona. This pilot system is part of the ongoing project NEWBIES awarded within the call LIFE17 ENVINL, coordinated by WETSUS and led by Dr. Maite Pijuan and Dr. Jelena Radjenovic. The aim of the pilot plant was the recovery of from the digestate produced in the anaerobic digesters of the WWTP. The NEWBIES plant technology was based on electro dialysis (ED) and was comprised of 65 cell pairs of BPM/CEM membranes, coupled to two TMCS modules. The pilot was operated in the continuous and intermittent current mode, to investigate the impact of Donnan dialysis on the process performance in terms of ammonia recovery, membrane scaling and energy consumption. Results have demonstrated the feasibility of using ED and TMCS for selective extraction and recovery of ammonia from anaerobic digestate with a satisfactory  $\text{NH}_4\text{-N}$  product concentration and energy consumption. The pilot plant was moved to the Netherlands in July to proceed with the next stage of the project focused on  $\text{NH}_4\text{-N}$  recovery from urine.

The other activities within this topic have been focused on the anaerobic treatment of different wastewater streams aiming at biogas recovery. In October, Federico Ferrari defended his PhD thesis in the topic of municipal wastewater treatment via an anaerobic membrane bioreactor. His research demonstrated

the effectiveness of the anaerobic treatment of municipal wastewater at ambient temperature but also highlighted the importance of pre-concentrating the municipal wastewater via a forward osmosis membrane to enhance biogas recovery. Also, within the topic of biogas recovery from wastewater and in the frame of a Juan de la Cierva project, Soraya Zahedi has investigated the anaerobic treatment of different highly polluted industrial wastewater (WW) such as slaughterhouse WW and pig, poultry, and cattle manure. Anaerobic treatment from these concentrated streams offers an excellent opportunity for the recovery of methane from the organic content but also reduces the environmental risk of these wastewaters associated with the high presence of pharmaceutical compounds and antibiotic resistance genes.

In October 2020, Dr. Simon Guerrero started his Marie Curie individual fellowship (H2020-MSCA-IF) at ICRA to work with Dr. Maite Pijuan in the topic of novel anaerobic microbes to mitigate methane emissions from wastewater systems.

### FATE OF EMERGING POLLUTANTS IN CONVENTIONAL AND ADVANCED WASTEWATER TREATMENT TECHNOLOGIES.

The second research topic deals with organic micropollutants (pharmaceutical, endocrine disrupting compounds and Watch list compounds) to expand the knowledge of their removal and/or biodegradation mechanisms. Lucia Gusmaroli defended her thesis in May 2020 and tests were conducted with not sufficiently evaluated emerging compounds (e.g., Watch list compounds) in conventional activated sludge systems. Additional studies, in collaboration with the water quality area, were performed to evaluate the removal of specific micropollutants (metoprolol and metoprolol acid), combining biological processes (activated sludge or fungi) with UV/ $\text{H}_2\text{O}_2$ . Furthermore, a book chapter on the fate and removal of pharmaceuticals in CAS for water and sewage sludge reuse was elaborated by AIII.2 researchers (Marc Castaño and Gianluigi Buttiglieri).

As regards to advanced treatment technologies, a new research project, ANTARES (PID2019-110346RB-C22), funded by the Agencia Estatal de Investigación from the Spanish Government and led by Dr. Jelena Radjenovic and Dr. Maite Pijuan started in June 2020. This project is coordinated by the Chemical Engineering Department from the Universidade de Santiago de Compostela and aims at investigating the fate and transformation of a wide range of micropollutants and antibiotic resistance genes present in municipal wastewater under different treatment technologies. Within this project we are investigating the capabilities of a bio reduced graphene oxide an-

aerobic system towards the removal of certain micropollutants. The hypothesis that is being tested is that graphene oxide can be biologically reduced by anaerobic biomass acting as redox mediator and facilitating the direct interspecies electron transfer process, thus enhancing the removal of several micropollutants, which are difficult to be biodegraded under conventional anaerobic processes. During the second half of 2020 a pilot plant was set up and operated to achieve steady state conditions before applying the graphene oxide.

Also, in this line of research, the PhD student Michele Ponzelli (supervised by Dr. Jelena Radjenovic and Jurg Drewes) has continued his training as part of the Marie Curie ITN project Nowelties (coordinated by Mira Petrovic, ICRA AII) Michele has successfully demonstrated microbial reduction of GO to biologically reduced GO (bioRGO), and formation of a hydrogel-like sludge in anaerobic batch reactors. He discovered how bioRGO enhanced the transformation of some organic contaminants (e.g., iodinated contrast media), and had little effect on others that are susceptible to anaerobic biotransformation (e.g., antibiotics trimethoprim, sulfamethoxazole). Yet, even in the latter case, bioRGO impacted the fate of biotransformation products.

### NATURE-BASED SOLUTIONS AND CIRCULAR ECONOMY.

Following the achieved expertise on water reuse and nutrients recovery, the third research topic within this line is expanding its activities towards the circular economy concept and nature-based solutions with the HYDROUSA and the CLEaN-TOUR project, in the context of Mediterranean areas and tourist installations, and the COST action Circular City.

Regarding circular economy and nature-based solutions, the H2020 project HYDROUSA "Demonstration of water loops with innovative regenerative business models for the Mediterranean region" has been evaluating innovative, nature-based, water management solutions for Mediterranean islands and coastal areas for wastewater treatment and nutrient recovery, supplying fresh water from non-conventional water sources, also for agriculture purposes. The final aim is to establish the water-energy-food-employment nexus creating jobs, boosting the economy, and making sure that the community and the stakeholders are engaged. In this context a paper was published, in collaboration with Brunel University, on nature-based solutions as enablers of circularity in water systems, reviewing assessment methodologies, tools and indicators. In parallel, an exploratory sampling campaign of different water matrices from Greek islands was performed and analytical protocol for the analyses of selected micropollutants in crops (e.g., lettuce)

are being developed, in collaboration with the water quality area, in the framework of the PhD thesis of Marc Castaño.

Also, The RETOS project CLEaN-TOUR (2018-2021) "Circular economy to facilitate urban water reuse in a touristic city: centralized or decentralized?" is being conducted in collaboration with the AIII.3 line and in the framework of the PhD thesis of Esther Mendoza. The aim is to demonstrate the safety of regenerated water for irrigation and other uses thus making a step towards circular economy in touristic regions. It is analyzing centralized systems and decentralized systems (segregating different types of water) to address: (i) the elimination of organic microcontaminants (ii) the evaluation of possible risks of water reuse, and (iii) the difficulties to select the most suitable scenario (centralized or decentralized) with innovative treatment technologies such as forward osmosis membranes and hydroponic technologies for greywater treatment with edible plants. A hydroponic pilot plant has been developed in the premises of ICRA, to test crops production with greywater as well as organic micro-pollutants and heavy metal plant uptake.

We have also been working in collaboration with Prof. Manel Poch (LEQUIA-UdG) on the definition of Water 5.0, a new paradigm in the framework of the circular economy. Our vision is to go further than "just" aiming for direct and indirect water reuse, energy optimization, and recovery of nutrients, biopolymers or bio-solvents among others. First, we want to improve

the relationship between food, water and energy in cities promoting NBS but also urban agriculture with reclaimed water and nutrients recovered from urban solid and liquid waste. Second, we want to take advantage of the digital revolution to recover and reuse the information hidden in the large amounts of data generated to carry out more systemic water management and increase transparency towards citizens. The idea behind this approach is to develop more sustainable, resilient and democratic cities.

Also to be remarked that ICRA is also active in the Circular City (Implementing nature-based solutions for creating a resourceful circular city) COST action (2018-2022) with Gianluigi Buttiglieri as MC for Spain and other ICRA researchers involved. In this context, a book chapter was elaborated (by Gianluigi Buttiglieri and coauthored by several international expert in nature-based solutions) on the possibilities of nature-based and hybrid decentralized solutions for reclaimed water reuse, as well as a review paper of nature-based solutions for urban water management in European circular cities.

Finally, Dr. Ignasi Rodriguez-Roda coordinates the Working Group 3 ("Wastewater treatment. Technological solutions including emerging compounds. Reuse and desalination") from the Plataforma Tecnológica Española del Agua (PTEA, <http://www.plataformaagua.org>).

three of the city's neighbourhoods will be monitored in 2021. In 2020, the monitoring stations have been build and sensors installed. Mònica Escolà and Nicole Schröter (under the main supervision of Pablo Gago) have contributed to these achievements.

A team of researchers from AIII.3 (Dr. Neus Collado and Dr. Corominas) are coordinating with Dr. Carles Borrego and Dr. Laura Guerrero (from Qual area), the design and deployment of a wastewater-based surveillance system for SARS-CoV-2 in Catalonia. This surveillance serves as an early warning system to detect relevant changes in the circulation of the virus. The results are provided in an online platform ([sarsaigua.icra.cat](https://sarsaigua.icra.cat)) and discussed weekly with the health department of Catalonia and the Catalan Water Agency (ACA). A total of 56 WWTPs are sampled throughout the country which serve 193 municipalities, representing 80% of the Catalan population. The labs involved in the initiative are: i) the research group in Molecular Biology of Enteric Viruses (<https://is.gd/DfJvtY>), ii) the research group on Viruses, Bacteria and Protozoa of Interest in Public Health and Food Security (VirBaP, <https://is.gd/rNmGr1>) and iii) the EURECAT Center for Omic Sciences (<http://omicscentre.com>), located in Reus.

A web-viewer (<https://sarsaigua.icra.cat>) has been developed by EURECAT in collaboration with ICRA to collect and integrate the data generated by the labs and the metadata generated by the sampling.

The H2020 project "Leading Urban Water Management to its Digital Future" (DWC) (<https://www.digital-water.city/>) continued during 2020. The main objective of DWC is to create linkages between

the physical and digital world by developing 15 advanced digital solutions to address water-related challenges. The solutions are being tested and demonstrated in five major European cities to show how they can contribute to achieving three main objectives: improved water system performance, increased citizen involvement in urban water management and better protection of citizens' health. Traditionally there has been a lack of reliable data and information on the occurrence of CSO's. The AIII.3 contribution to DWC is led by Dr Gutiérrez and Dr Corominas with participation from Silvia Busquets; the team will deploy a network of low-cost sensors (SENVES, see description below) in the sewer systems of Sofia (Bulgaria) and Berlin (Germany) to improve knowledge on CSO emissions and develop operational strategies to minimise its effects. The solution provides a robust and straightforward method for CSO detection, reduces CAPEX and OPEX for CSO monitoring and allows utilities to monitor their extensive networks.

AIII.3 has been very active in the field of urban wastewater system digitalisation. The team, formed by Dr Lluís Corominas, Dr Oriol Gutiérrez, Sílvia Busquets, Lluís Bosch and Adrià Riu, has been working on three projects-actions that have successfully developed smart solutions to cope with the current and future needs of water utilities. Starting small, with the invention of low-cost combined-sewer-overflow detectors, then integrating those sensors in proactive management tools and finally working on their incorporation into the digitalisation of the urban water cycle. The following is a description of two of the main tools developed:

## ▶ LINE III.3 MODELLING AND MANAGEMENT SYSTEMS

The main focus of research line AIII.3 is on the development of tools and methodologies to support urban water system (UWS) management. Line III.3 seeks the integration of subsystems (e.g. sewer systems, wastewater treatment plants and receiving water bodies) and the planning of smart and sustainable cities.

The main activities focus on the following three themes:

- Digitalisation of the water sector
- Planning of sustainable cities including Nature-Based Solutions
- Integrated management of urban wastewater systems

### DIGITALISATION OF THE WATER SECTOR

AIII.3 established a cooperation with the Water Quality research area (Sara Rodriguez-Mozaz, Mira Petrovic, Carles Borrego and Pablo Gago) which will bring together technology and imagination to mine socio-economic information from different neighbourhoods through the chemical and microbiological analysis of their citizens' sewage, the so-called "sewage sociology". Lluís Corominas is leading the ICRA contribution on the H2020 SCOREwater project (<https://www.scorewater.eu/>), which aims at mining socio-economic information from sewage samples. SCOREwater relies on several complementary Catalan partners (ICRA, BCASA, s::can iberia, IERMB and Eurecat) who are collaborating on the Barcelona case-study, where



SENVES (Development of a low-cost sensor for combined sewer overflow monitoring). Combined sewer overflow (CSO) events produced in sewer systems during wet weather conditions are a threat for the receiving water bodies. Legislation obliges the monitoring of such events (i.e. in Spain, Royal Decree 1290/2012). In 2012, Dr Corominas, Dr Acuña and Dr Gutiérrez (during the EcoMaWat project) led the development of a new methodology which aims to characterise the occurrence and duration of CSO events using low-cost temperature sensors. The method has been patented and rigorously validated in 4 European cities. The cost of the proposed solution is five times lower than that of current technologies. The first prototype (called SENVES) of this low-cost method was later deployed and validated in the Gestor project. An enhancement of the prototype is now being deployed in the H2020 Digital Water City project (DWC) which will finally bring the new sensor to the market.

GESTOR (Decision support tool for the proactive management of sewer systems) finished in March 2020. Together with two companies (FACSA and ABM) T&E-ICRA developed the GESTOR tool which helps to predict potential sewer problems such as combined sewer overflows, infiltration/exfiltration or life-span reduction through corrosion, allowing us to detect/solve them before they become critical and even more costly. The tool was tested in the municipality of Peñíscola (Spain) and is ready to be applied in other sites. The GESTOR platform reduces the maintenance costs of urban water infrastructure management, and its proactive protection diminishes the risk of infrastructure failure. Despite being a recently created tool, several municipalities have enquired about its application, and FACSA is already using it in a municipality in Northern Spain.

### PLANNING OF SUSTAINABLE CITIES INCLUDING NATURE-BASED SOLUTIONS

All.3 cooperates with Al.3 in the Sanitation for and by Nature project (SANNAT) as part of the Science for Nature and People Partnership (SNAPP). The team is led by Dr Acuña, with contributions from Prof. Comas, Dr. Corominas and Mrs. Castañares. ICRA has been compiling scientific evidence on the use of nature-based solutions (NBS) in urban wastewater systems all around the world. ICRA is developing a web-based decision support system (DSS) based on expert knowledge and the collected scientific evidence, to provide recommendations on using NBS for sanitation. At the end of 2020, ICRA completed the first prototype of the web-based DSS (<https://snapp.icra.cat/>). During 2020, the DSS has also been preliminary validated

by experts. In 2021, this DSS will be further validated and extended with economic and environmental impact criteria under the recently awarded EU Green Deal MULTISOURCE project.

In 2020, All.3, in collaboration with the Resources and Ecosystems Area, has intensified its work on the H2020 project EdiCitNet (<http://www.edicitnet.com>), which aims to foster the systemic use of nature-based solutions for food production as a major step towards more sustainable, liveable and healthier cities. ICRA is leading the development of the tools (online catalogue and educational game supported by a database) to support public and private stakeholders in NBS learning and implementation. During 2020, ICRA researchers (Dr Castellar, Dr Pueyo, Dr Acuña, Dr Corominas, Dr Rodríguez-Roda and Dr Comas) have finalized the conceptualization and co-design of the tools and a first prototype of the toolbox is already available (<https://toolbox.edicitnet.com/>) since the end of 2020. The toolbox is currently being used for data collection of NBS for food production, called hereafter Edible City Solutions (ECS), among the cities worldwide. Furthermore, in 2020 the framework and functionalities of the first prototype for the Edible City Game, a serious game for participatory urban planning and scenario simulation of ECS benefits, have been completed. This game aspires to be a valuable contribution to designing the transition to more edible cities. This year, we have continued our contacts with NBS-sister projects to look for synergies and amplify the project's impact, also through the EU NBS taskforces.

### INTEGRATED MANAGEMENT OF URBAN WASTEWATER SYSTEMS

In the INVEST project, research professor Wolfgang Gernjak, and research scientist Lluís Corominas, are attempting to establish a framework that can be used to make investment decisions that contribute to achieving the implementation the Water Framework Directive goals under different global change scenarios. Prof. Ignasi Rodríguez-Roda (ICRA-UdG), Manel Poch (UdG) and Morgan Abily (ICRA, postdoctoral researcher) complete the core project team. In 2020 we have assessed surface water bodies (SWBs) dilution capacity across the European continent to identify most vulnerable areas using information from centralized European databases. SWBs' future dilution factor values are estimated based on representative concentration pathway scenarios impacts on rivers flow, and likely changes in European SWBs' ecological status foretold. This assessment allows understanding where in Europe investment is more relevant.

Within the CLEaN-TOUR Spanish Retos project, in 2020 a multicriteria decision-making tool to support the planning of water reuse networks in cities, including collection of wastewater or greywater, its treatment and the (re)distribution of the reclaimed water, has been initiated. This DSS will support the generation and assessment of the most adequate water reuse decentralized (or centralized) scenarios. Output data will include the optimal water reuse network as well as the change between current and future (water reuse) scenarios in terms of the number of inhabitants served, the nexus flows (drinking water savings and energy footprint) and the construction and operation costs. This tool is being developed in collaboration with the computer science research group BCDS (Broadband Communications and Distributed Systems) of the UdG. Josep Pueyo, Gianluigi Buttiglieri, Miquel Farreras, Lluís Corominas and Joaquim Comas (from ICRA) and David Martínez and Eusebi Calle (from UdG) form the interdisciplinary team working in this tool.

The development of the EcoAdvisor tool, an app for the integrated operation of wastewater treatment plants and freshwater ecosystems to maximize environmental benefits while minimising costs, has continued during 2020 thanks to the funding of the company "Aigües de Catalunya" (Global Omnium). At ICRA, the working team is composed by Dr Corominas, Dr Acuña, Mrs Castañares, Mr Bosch and Prof. Comas. EcoAdvisor offers "Aigües de Catalunya" an advantage in tenders for the management of UWWTUs. Three phases were programmed for EcoAdvisor, and two of them were successfully completed by the end of 2020. EcoAdvisor makes it possible to model different scenarios for a comprehensive range of WWTP treatments (i.e., primary treatment, nitrification, denitrification and phosphorus removal) and to evaluate how the discharge is affecting the receiving water body. The models that EcoAdvisor uses have been validated by expert knowledge and experimental campaigns in two real systems at catchment level.

In 2020, All.3 continued working on the development of an educational game in cooperation with GILAB (Universitat de Girona). Dr Corominas led the development of an educational game to educate primary school students about the urban water cycle (from the tap to freshwater ecosystems) in collaboration with GILAB (Universitat de Girona). The educational game was an output from the EcoMaWat project and now it is being expanded to incorporate new scenarios under the umbrella of the SCOREwater project.

Additionally, the SAD-nitrates, a Decision support

system to select the most suitable treatment technologies for nitrate removal in groundwaters, has been launched in 2020. This DSS was developed in cooperation with the Catalan Water Partnership and funded by the Catalan Water Agency (ACA). The DSS incorporates updated information on the most effective treatment technologies for nitrate removal and is freely available through the ACA website (<http://aca.gencat.cat>) to support local authorities dealing with polluted groundwaters. The project was led by Prof. Comas and the DSS was developed by Adrià Riu.

Finally, in 2020, two more projects funded by the Catalan Water Agency related to integrated management of water systems have been initiated: SUGGEREIX: Development of tools to support the implementation and water reuse, where a DSS for the selection of the most adequate water reuse scheme will be developed, and EESAM: Integration of ecological status and environmental services for the design and prioritization of management measures, where a DSS will be developed to analyse the impact of management strategies for improving the ecological status and assess ecosystem services. The working team for these two projects include Adrià Riu, Lluís Bosch, Wolfgang Gernjak, Mercè Font, Lluís Corominas, Gianluigi Buttiglieri, Ignasi Rodríguez-Roda and Joaquim Comas.



## TECHNOLOGY TRANSFER

Several activities were conducted to transfer the knowledge generated within our projects into the society:

- An European patent was submitted in October 2020 (EP20382879): "Method to prepare graphene coated sponges, sponges obtained thereof, electrodes obtained from such sponges and uses of the sponges for water treatment".

The patent was developed within the context of the ERC funded project Electron4Water led by the ICREA research professor Dr. Jelena Radjenovic. The patent describes the development of graphene sponge electrodes that are produced using a simple, low-cost, method, which have high electrocatalytic activity for the degradation of organic contaminants and in situ production of strong oxidants, and at the same time are completely inert to chloride. The fact that chlorine, chlorate and perchlorate production is omitted, resolves a major limitation of electrochemical water treatment – production of toxic chlorinated byproducts. Formation of chlorinated byproducts occurs at all other commercially available anode materials in the presence of chloride, which is encountered in all natural waters. Bottom-up synthesis enables easy incorporation of atomic dopants, 2D materials, and MXenes. Thus, it is possible to functionalize the graphene sur

face and tailor the electrodes for the removal of specific contaminants. A successful use of a flow-through electrochemical system equipped with the graphene sponge electrodes for the degradation of persistent organic contaminants (e.g., halogenated pollutants, antibiotics), defluorination of per- and poly-fluoroalkyl substances (PFASs) and disinfection of water are described in the patent.

- Use of the SCORE-CT platform for testing different chemicals to control hydrogen sulfide formation in sewer systems.

The Plantea installation of ICRA also counts with the SCORE-CT platform, a special pilot-scale equipment replicating sewer systems within our laboratories. This piece of equipment is highly interesting not only for odour-corrosion research purposes but also for testing the new generation of chemicals developed by various industries that aim to solve problems inherent to wastewater transport systems. During 2020, three different international companies, Trojan Technologies-USP Peroxide (USA-Canada), Envirosuite (Australia) and FACSA (Spain) have contracted our services to work with the SCORE-CT platform for testing and validating their products for sulfide control in sewers. The SCORE-CT platform is becoming the standard protocol for many water agencies to screen and test products effectiveness under completely controlled conditions, before their dosage at full scale, typically costly and unreliable.



## AIII- PHD DISSERTATIONS

Joana Castellar (Universitat Politècnica de Catalunya-UPC) WETWALL an innovative design concept for the treatment of urban wastewaters

Lucia Gusmaroli (Universitat de Girona), Anàlisi, presència i destí dels microcontaminants a les aigües residuals i al medi receptor

Federico Ferrari (Universitat de Girona) Combining forward osmosis and anaerobic membrane bioreactor technologies for raw municipal wastewater treatment

## VISITING STUDENTS

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Moraleda Martínez, Julia Maria  
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Pujol Coscolluela, Marta  
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 Univeritat de Girona (UDG)

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## VISITING SCIENTISTS

Barbeau, Benoit,  
 Polytechnique Montreal

## AIII – STAYS ABROAD

Gianluigi Buttiglieri at UNIVPM, Department of Materials, Environmental Sciences and Urban Planning, (Ancona, Italy) with Prof. Francesco Fatone and Dr Anna Laura Eusebi in the period 10th September - 8th October 2018. September - 8th October 2018.



# 04

## PUBLICATIONS & CONGRESSES

TOTAL PUBLICATIONS:  
**177**

# SCI PUBLICATIONS (153)

## (SCIENCE CITATION INDEX 2020)

(Publications ordered alphabetically)

Aguilar-Alarcón, P., Gonzalez, S.V., Simonsen, M.A., Borrero-Santiago, A.R., Sanchís, J., Meriac, A., Kolarevic, J., Asimakopoulos, A.G., Mikkelsen, Ø.

**Characterizing changes of dissolved organic matter composition with the use of distinct feeds in recirculating aquaculture systems via high-resolution mass spectrometry**  
(2020) *Science of the Total Environment*, 749, art. no. 142326, IF=6.551, Q1

Bilal, M., Barceló, D., Iqbal, H.M.N. **Nanostructured materials for harnessing the power of horseradish peroxidase for tailored environmental applications.**  
(2020) *Science of the Total Environment*, 749, art. no. 142360, IF=6.551, Q1

Song, C., Zhang, C., Zhang, S., Lin, H., Kim, Y., Ramakrishnan, M., Du, Y., Zhang, Y., Zheng, H., Barceló, D. **Thermochemical liquefaction of agricultural and forestry wastes into biofuels and chemicals from circular economy perspectives**  
(2020) *Science of the Total Environment*, 749, art. no. 141972, IF=6.551, Q1

C. Ávila, M.J. García-Galán, C.M. Borrego, S. Rodríguez-Mozaz, J. García and D. Barceló. **"New insights on the combined removal of antibiotics an ARGs in urban wastewater through the use of two configurations of vertical subsurface flow constructed wetlands"**. *Science of the Total Environment*, In press (2020), 142554. IF=6.551, Q1

Jaén-Gil, A., Ferrando-Climent, L., Ferrer, I., Thurman, E.M., Rodríguez-Mozaz, S., Barceló, D., Escudero-Oñate, C. **Sustainable microalgae-based technology for biotransformation of benzalkonium chloride in oil and gas produced water: A laboratory-scale study**  
(2020) *Science of the Total Environment*, 748, art. no. 141526, IF=6.551, Q1

Llorens, E., Ginebreda, A., la Farré, M., Insa, S., González-Trujillo, J.D., Munné, A., Solà, C., Flò, M., Villagrasa, M., Barceló, D., Sabater, S. **Occurrence of regulated pollutants in populated Mediterranean basins: Ecotoxicological risk and effects on biological quality**  
(2020) *Science of the Total Environment*, 747, art. no. 141224, IF=6.551, Q1

Carrascal, M., Abian, J., Ginebreda, A., Barceló, D. **Discovery of large molecules as new biomarkers in wastewater using environmental proteomics and suitable polymer probes**  
(2020) *Science of the Total Environment*, 747, art. no. 141145, IF=6.551, Q1

Menger, F., Gago-Ferrero, P., Wiberg, K., Ahrens, L. **Wide-scope screening of polar contaminants of concern in water: A critical review of liquid chromatography-high resolution mass spectrometry-based strategies**  
(2020) *Trends in Environmental Analytical Chemistry*, 28, art. no. e00102, IF=7.059, Q1

Franco, A.A., Arellano, J.M., Albendín, G., Rodríguez-Barroso, R., Zahedi, S., Quiroga, J.M., Coello, M.D. **Mapping microplastics in Cadiz (Spain): Occurrence of microplastics in municipal and industrial wastewaters**  
(2020) *Journal of Water Process Engineering*, 38, art. no. 101596, IF=3.465, Q1

Borrego, C., Sabater, S., Proia, L. **Lifestyle preferences drive the structure and diversity of bacterial and archaeal communities in a small riverine reservoir**  
(2020) *Scientific Reports*, 10 (1), art. no. 11288, IF=3.998, Q1

Radjenovic, J., Duinslaeger, N., Avval, S.S., Chaplin, B.P. **Facing the Challenge of Poly- And Perfluoroalkyl Substances in Water: Is Electrochemical Oxidation the Answer?**  
(2020) *Environmental Science and Technology*, 54 (23), pp. 14815-14829. IF=7.864, Q1

Senta, I., Rodríguez-Mozaz, S., Corominas, L., Petrovic, M. **Wastewater-based epidemiology to assess human exposure to personal care and household products – A review of biomarkers, analytical methods, and applications**  
(2020) *Trends in Environmental Analytical Chemistry*, 28, art. no. e00103, IF=7.059, Q1

Iroumé, A., Paredes, A., Garbarino, M., Morresi, D., Batalla, R.J. **Post-eruption morphological evolution and vegetation dynamics of the Blanco River, southern Chile**  
(2020) *Journal of South American Earth Sciences*, 104, art. no. 102809, IF=1.704, Q1

Khan, H., Laas, A., Marcé, R., Obrador, B. **Major Effects of Alkalinity on the Relationship Between Metabolism and Dissolved Inorganic Carbon Dynamics in Lakes**  
(2020) *Ecosystems*, 23 (8), pp. 1566-1580. IF=6.330, Q1

Karimi, R., Hallaji, S.M., Siami, S., Torabian, A., Aminzadeh, B., Eshtiaghi, N., Zahedi, S. **Synergy of combined free nitrous acid and Fenton technology in enhancing anaerobic digestion of actual sewage waste activated sludge**  
(2020) *Scientific Reports*, 10 (1), art. no. 5027, IF=3.998, Q1

Veyrand-Quirós, B., Gómez-Gil, B., Lomeli-Ortega, C.O., Escobedo-Fregoso, C., Millard, A.D., Tovar-Ramírez, D., Balcázar, J.L., Quiroz-Guzmán, E. **Use of bacteriophage vB\_Pd\_PDCC-1 as biological control agent of *Photobacterium damsela* subsp. *damsela* during hatching of longfin yellowtail (*Seriola rivoliana*) eggs**  
(2020) *Journal of Applied Microbiology*, 129 (6), pp. 1497-1510. IF=3.066, Q1

Söregård, M., Ahrens, L., Alygizakis, N., Jensen, P.E., Gago-Ferrero, P. **Non-target and suspect screening strategies for electro-dialytic soil remediation evaluation: Assessing changes in the molecular fingerprints and per-And polyfluoroalkyl substances (PFASs)**  
(2020) *Journal of Environmental Chemical Engineering*, 8 (6), art. no. 104437, IF=4.300, Q1

Araújo, C.V.M., Laissaoui, A., Silva, D.C.V.R., Ramos-Rodríguez, E., González-Ortegón, E., Espíndola, E.L.G., Baldó, F., Mena, F., Parra, G., Blasco, J., López-Doval, J., Sendra, M., Banni, M., Islam, M.A., Moreno-Garrido, I. **Not only toxic but repellent: What can organisms' responses tell us about contamination and what are the ecological consequences when they flee from an environment?**  
(2020) *Toxics*, 8 (4), art. no. 118, pp. 1-22. IF=0.786, Q1

Bogler, A., Packman, A., Furman, A., Gross, A., Kushmaro, A., Ronen, A., Dagot, C., Hill, C., Vaizel-Ohayon, D., Morgenroth, E., Bertuzzo, E., Wells, G., Kiperwas, H.R., Horn, H., Negev, I., Zucker, I., Bar-Or, I., Moran-Gilad, J., Balcazar, J.L., Bibby, K., Elimelech, M., Weisbrod, N., Nir, O., Sued, O., Gillor, O., Alvarez, P.J., Cramer, S., Arnon, S., Walker, S., Yaron, S., Nguyen, T.H., Berchenko, Y., Hu, Y., Ronen, Z., Bar-Zeev, E. **Rethinking wastewater risks and monitoring in light of the COVID-19 pandemic**  
(2020) *Nature Sustainability*, 3 (12), pp. 981-990. IF=12.080, Q1

Keller, P.S., Catalán, N., von Schiller, D., Grossart, H.-P., Koschorreck, M., Obrador, B., Frassl, M.A., Karakaya, N., Barros, N., Howitt, J.A., Mendoza-Lera, C., Pastor, A., Flaim, G., Aben, R., Riis, T., Arce, M.I., Onandia, G., Paranaíba, J.R., Linkhorst, A., del Campo, R., Amado, A.M., Cauvy-Fraunié, S., Brothers, S., Condon, J., Mendonça, R.F., Reverey, F., Rødm, E.-I., Datry, T., Roland, F., Laas, A., Obertegger, U., Park, J.-H., Wang, H., Kosten, S., Gómez, R., Feijóo, C., Eloşegi, A., Sánchez-Montoya, M.M., Finlayson, C.M., Melita, M., Oliveira Junior, E.S., Muniz, C.C., Gómez-Gener, L., Leigh, C., Zhang, Q., Marcé, R. **Global CO<sub>2</sub> emissions from dry inland waters share common drivers across ecosystems**  
(2020) *Nature Communications*, 11 (1), art. no. 2126, IF=12.121, Q1

Dulio, V., Koschorreck, J., van Bavel, B., van den Brink, P., Hollender, J., Munthe, J., Schlabach, M., Aalizadeh, R., Agerstrand, M., Ahrens, L., Allan, I., Alygizakis, N., Barceló, D., Bohlin-Nizzetto, P., Boutrop, S., Brack, W., Bressy, A., Christensen, J.H., Cirka, L., Covaci,

A., Derksen, A., Deviller, G., Dingemans, M.M.L., Engwall, M., Fatta-Kassinos, D., Gago-Ferrero, P., Hernández, F., Herzke, D., Hilscherová, K., Hollert, H., Junghans, M., Kasprzyk-Hordern, B., Keiter, S., Kools, S.A.E., Kruve, A., Lambropoulou, D., Lamoree, M., Leonards, P., Lopez, B., López de Alda, M., Lundy, L., Makovinská, J., Marigómez, I., Martin, J.W., McHugh, B., Miège, C., O'Toole, S., Perkola, N., Polesello, S., Posthuma, L., Rodríguez-Mozaz, S., Roessink, I., Rostkowski, P., Ruedel, H., Samanipour, S., Schulze, T., Schymanski, E.L., Sengl, M., Tarábek, P., Ten Hulscher, D., Thomaidis, N., Togola, A., Valsecchi, S., van Leeuwen, S., von der Ohe, P., Vorkamp, K., Vrana, B., Slobodnik, J.

**The NORMAN Association and the European Partnership for Chemicals Risk Assessment (PARC): let's cooperate!**  
(2020) *Environmental Sciences Europe*, 32 (1), art. no. 100, IF=5.394, Q1

Tuset, J., Vericat, D., Batalla, R.J. **Water and sediment budgets unveiling contrasting hydro-sedimentary patterns in a mountainous Mediterranean catchment**  
(2020) *Science of the Total Environment*, 745, art. no. 140884, IF=6.551, Q1

López, R., García, C., Vericat, D., Batalla, R.J. **Downstream changes of particle entrainment in a hydropeaked river**  
(2020) *Science of the Total Environment*, 745, art. no. 140952, IF=6.551, Q1

Poch, M., Garrido-Baserba, M., Corominas, L., Perelló-Moragues, A., Monclús, H., Cermerón-Romero, M., Melitas, N., Jiang, S.C., Rosso, D. **When the fourth water and digital revolution encountered COVID-19**  
(2020) *Science of the Total Environment*, 744, art. no. 140980, IF=6.551, Q1

Patrício Silva, A.L., Prata, J.C., Walker, T.R., Campos, D., Duarte, A.C., Soares, A.M.V.M., Barceló, D., Rocha-Santos, T. **Rethinking and optimising plastic waste management under COVID-19 pandemic: Policy solutions based on redesign and reduction of single-use plastics and personal protective equipment**  
(2020) *Science of the Total Environment*, 742, art. no. 140565, IF=6.551, Q1

De Castro-Català, N., Dolédec, S., Kalogianni, E., Skoulikidis, N.T., Paunovic, M., Vasiljević, B., Sabater, S., Tornés, E., Muñoz, I. **Unravelling the effects of multiple stressors on diatom and macroinvertebrate communities in European river basins using structural and functional approaches**  
(2020) *Science of the Total Environment*, 742, art. no. 140543, IF=6.551, Q1

Balcázar, J.L. **Implications of bacteriophages on the acquisition and spread of antibiotic resistance in the environment**  
(2020) *International Microbiology*, 23 (4), pp. 475-479. IF=1.833, Q3

Zahedi, S., Solera, R., Pérez, M. **An eco-friendly way to valorize winery wastewater and sewage sludge: Anaerobic co-digestion**  
(2020) Biomass and Bioenergy, 142, art. no. 105779, IF=3.551, Q1

Oliveira, B.B., Veigas, B., Carlos, F.F., Sánchez-Melsió, A., Balcázar, J.L., Borrego, C.M., Baptista, P.V. **Water safety screening via multiplex LAMP-Au-nanoprobe integrated approach**  
(2020) Science of the Total Environment, 741, art. no. 140447, IF=6.551, Q1

Majdi, N., Colls, M., Weiss, L., Acuña, V., Sabater, S., Traunspurger, W. **Duration and frequency of non-flow periods affect the abundance and diversity of stream meiofauna**  
(2020) Freshwater Biology, 65 (11), pp. 1906-1922. IF=3.835, Q1

Marano, R.B.M., Fernandes, T., Manaia, C.M., Nunes, O., Morrison, D., Berendonk, T.U., Kreuzinger, N., Telson, T., Corno, G., Fatta-Kassinos, D., Merlin, C., Topp, E., Jurkevitch, E., Henn, L., Scott, A., Heß, S., Slipko, K., Laht, M., Kisand, V., Di Cesare, A., Karaolia, P., Michael, S.G., Petre, A.L., Rosal, R., Pruden, A., Riquelme, V., Agüera, A., Esteban, B., Luczkiewicz, A., Kalinowska, A., Leonard, A., Gaze, W.H., Adegoke, A.A., Stenstrom, T.A., Pollice, A., Salerno, C., Schwermer, C.U., Krzeminski, P., Guilloteau, H., Donner, E., Drigo, B., Libralato, G., Guida, M., Bürgmann, H., Beck, K., Garelick, H., Tacão, M., Henriques, I., Martínez-Alcalá, I., Guillén-Navarro, J.M., Popowska, M., Piotrowska, M., Quintela-Balaja, M., Bunce, J.T., Polo-López, M.I., Nahim-Granados, S., Pons, M.-N., Milakovic, M., Udikovic-Kolic, N., Ory, J., Ousmane, T., Caballero, P., Oliver, A., Rodríguez-Mozaz, S., Balcázar, J.L., Jäger, T., Schwartz, T., Yang, Y., Zou, S., Lee, Y., Yoon, Y., Herzog, B., Mayrhofer, H., Prakash, O., Nimonkar, Y., Heath, E., Baraniak, A., Abreu-Silva, J., Choudhury, M., Munoz, L.P., Krizanovic, S., Brunetti, G., Maile-Moskowitz, A., Brown, C., Cytryn, E. **A global multinational survey of cefotaxime-resistant coliforms in urban wastewater treatment plants**  
(2020) Environment International, 144, art. no. 106035, IF=7.577, Q1

Zahedi, S., Martín, C., Solera, R., Pérez, M. **Evaluating the Effectiveness of Adding Chicken Manure in the Anaerobic Mesophilic Codigestion of Sewage Sludge and Wine Distillery Wastewater: Kinetic Modeling and Economic Approach**  
(2020) Energy and Fuels, 34 (10), pp. 12626-12633 IF=3.421, Q1

Schirinzi, G.F., Pedà, C., Battaglia, P., Laface, F., Galli, M., Bainsi, M., Consoli, P., Scotti, G., Esposito, V., Faggio, C., Farré, M., Barceló, D., Fossi, M.C., Andarolo, F., Romeo, T. **A new digestion approach for the extraction of microplastics from gastrointestinal tracts (GITs) of the common dolphinfish (Coryphaena hippurus) from the western Mediterranean Sea**  
(2020) Journal of Hazardous Materials, 397, art. no. 122794, IF=9.038, Q1

Garau, E., Vila-Subiros, J., Pueyo-Ros, J., Palom, A.R. **Where do ecosystem services come from? Assessing and mapping stakeholder perceptions on water ecosystem services in the muga river basin (catalonia, spain)**  
(2020) Land, 9 (10), art. no. 385, pp. 1-21. IF=0.717, Q2

López-Doval, J.C., Serra-Compte, A., Rodríguez-Mozaz, S., Barceló, D., Sabater, S. **Diet quality and NSAIDs promote changes in formation of prostaglandins by an aquatic invertebrate**  
(2020) Chemosphere, 257, art. no. 126892, IF=5.778, Q1

Salehin, S., Kulandaivelu, J.K., Rebosura, M., Jr., van der Kolk, O., Keller, J., Doederer, K., Gernjak, W., Donose, B.C., Yuan, Z., Pikaar, I. **Effects of aging of ferric-based drinking water sludge on its reactivity for sulfide and phosphate removal**  
(2020) Water Research, 184, art. no. 116179, IF=9.130, Q1

Odekanle, E.L., Dahunsi, S.O., Zahedi, S. **Anaerobic treatment of abattoir waste: Biogas production and correlation parameter in a batch reactor system**  
(2020) Journal of Water Process Engineering, 37, art. no. 101337, IF=3.465, Q1

Mortezaei, F., Royan, M., Allaf Noveirian, H., Babakhani, A., Alaie Kordghashlaghi, H., Balcázar, J.L. **In vitro assessment of potential probiotic characteristics of indigenous Lactococcus lactis and Weissella oryzae isolates from rainbow trout (Oncorhynchus mykiss Walbaum)**  
(2020) Journal of Applied Microbiology, 129 (4), pp. 1004-1019. IF=3.066, Q1

Barceló, D., Žonja, B., Ginebreda, A. **Toxicity tests in wastewater and drinking water treatment processes: A complementary assessment tool to be on your radar**  
(2020) Journal of Environmental Chemical Engineering, 8 (5), art. no. 104262, IF=4.300, Q1

Acuña, V., Bregoli, F., Font, C., Barceló, D., Corominas, L.L., Ginebreda, A., Petrovic, M., Rodríguez-Roda, I., Sabater, S., Marcé, R. **Management actions to mitigate the occurrence of pharmaceuticals in river networks in a global change context**  
(2020) Environment International, 143, art. no. 105993. IF=7.577, Q1

Agathokleous, E., Barceló, D., Tsatsakis, A., Calabrese, E.J. **Hydrocarbon-induced hormesis: 101 years of evidence at the margin?**  
(2020) Environmental Pollution, 265, art. no. 114846, IF=6.793, Q1

Mora-Sánchez, B., Balcázar, J.L., Pérez-Sánchez, T. **Effect of a novel postbiotic containing lactic acid bacteria on the intestinal microbiota and disease resistance of rainbow trout (Oncorhynchus mykiss)**  
(2020) Biotechnology Letters, 42 (10), pp. 1957-1962 IF=1.977, Q2

Blandin, G., Ferrari, F., Lesage, G., Le-Clech, P., Héran, M., Martínez-Lladó, X. **Forward osmosis as concentration process: Review of opportunities and challenges**  
(2020) Membranes, 10 (10), art. no. 284, pp. 1-40. IF=0.537, Q2

Santos, L.H.M.L.M., Maulvault, A.L., Jaén-Gil, A., Marques, A., Barceló, D., Rodríguez-Mozaz, S. **Insights on the metabolization of the antidepressant venlafaxine by meagre (Argyrosomus regius) using a combined target and suspect screening approach**  
(2020) Science of the Total Environment, 737, art. no. 140226, IF=6.551, Q1

Marteau, B., Gibbins, C., Vericat, D., Batalla, R.J. **Geomorphological response to system-scale river rehabilitation II: Main-stem channel adjustments following reconnection of an ephemeral tributary.**  
(2020) River Research and Applications, 36 (8), pp. 1472-1487. IF=1.916, Q1

Marteau, B., Gibbins, C., Vericat, D., Batalla, R.J. **Geomorphological response to system-scale river rehabilitation I: Sediment supply from a reconnected tributary**  
(2020) River Research and Applications, 36 (8), pp. 1488-1503. IF=1.916, Q1

Corominas, L., Byrne, D.M., Guest, J.S., Hospido, A., Roux, P., Shaw, A., Short, M.D. **The application of life cycle assessment (LCA) to wastewater treatment: A best practice guide and critical review**  
(2020) Water Research, 184, art. no. 116058, IF=9.130, Q1

Nika, C.E., Gusmaroli, L., Ghafourian, M., Atanasova, N., Buttiglieri, G., Katsou, E. **Nature-based solutions as enablers of circularity in water systems: A review on assessment methodologies, tools and indicators**  
(2020) Water Research, 183, art. no. 115988, IF=9.130, Q1

Bilal, M., Barceló, D., Iqbal, H.M.N. **Persistence, ecological risks, and oxidoreductases-assisted biocatalytic removal of triclosan from the aquatic environment**  
(2020) Science of the Total Environment, 735, art. no. 139194, IF=6.551, Q1

Pantarella, F., Lekunberri, I., Gagliardi, A., Venuto, G., Sánchez-Melsió, A., Fabiani, M., Balcázar, J.L., Schippa, S., De Giusti, M., Borrego, C., Solimini, A. **Effect of urban wastewater discharge on the abundance of antibiotic resistance genes and antibiotic-resistant escherichia coli in two Italian rivers**  
(2020) International Journal of Environmental Research and Public Health, 17 (18), art. no. 6813, pp. 1-13. IF=2.849, Q2

Freixa, A., Perujo, N., Langenheder, S., Romani, A.M. **River biofilms adapted to anthropogenic disturbances are more resistant to WWTP inputs**  
(2020) FEMS Microbiology Ecology, 96 (9), art. no. fiae152, IF=3.675, Q1

Llorca, M., Álvarez-Muñoz, D., Ábalos, M., Rodríguez-Mozaz, S., Santos, L.H.M.L.M., León, V.M., Campillo, J.A., Martínez-Gómez, C., Abad, E., Farré, M. **Microplastics in Mediterranean coastal area: toxicity and impact for the environment and human health**  
(2020) Trends in Environmental Analytical Chemistry, 27, art. no. e00090, IF=7.059, Q1

Bond, T., Chu, W., Von Gunten, U., Farré, M.J. **Themed issue on drinking water oxidation and disinfection processes**  
(2020) Environmental Science: Water Research and Technology, 6 (9), pp. 2252-2256. IF=3.449, Q1

Picó, Y., Barceló, D. **Pyrolysis gas chromatography-mass spectrometry in environmental analysis: Focus on organic matter and microplastics**  
(2020) TrAC - Trends in Analytical Chemistry, 130, art. no. 115964, IF=9.801, Q1

Orive, G., Lertxundi, U., Barcelo, D. **Early SARS-CoV-2 outbreak detection by sewage-based epidemiology**  
(2020) Science of the Total Environment, 732, art. no. 139298, IF=6.551, Q1

Villez, K., Vanrolleghem, P.A., Corominas, L. **A general-purpose method for Pareto optimal placement of flow rate and concentration sensors in networked systems – With application to wastewater treatment plants**  
(2020) Computers and Chemical Engineering, 139, art. no. 106880, IF=4.000, Q1

Petsch, D.K., dos Santos Bertoncin, A.P., Gentilin-Avanci, C., Favro, A., González Trujillo, J.D., Pinha, G.D. **High water flow velocity reduces beta diversity and leads to a distinct composition of Oligochaeta in Neotropical lotic ecosystems**  
(2020) Limnology, 21 (3), pp. 297-304. IF=2.458, Q2

González-Trujillo, J.D., Pedraza-Garzón, E., Donato-Rondon, J.C., Sabater, S. **Ecoregional Characteristics Drive the Distribution Patterns of Neotropical Stream Diatoms**  
(2020) Journal of Phycology, 56 (4), pp. 1053-1065. IF=2.328, Q1

Khalifa, O., Banat, F., Srinivasakannan, C., Radjenovic, J., Hasan, S.W. **Performance tests and removal mechanisms of aerated electrocoagulation in the treatment of oily wastewater**  
(2020) Journal of Water Process Engineering, 36, art. no. 101290, IF=3.465, Q1

Moura de Salles Pupo, M., Albahaca Oliva, J.M., Barrios Eguiluz, K.I., Salazar-Banda, G.R., Radjenovic, J. **Characterization and comparison of Ti/TiO<sub>2</sub>-NT/SnO<sub>2</sub>-SbBi, Ti/SnO<sub>2</sub>-SbBi and BDD anode for the removal of persistent iodinated contrast media (ICM)**  
(2020) Chemosphere, 253, art. no. 126701, IF=5.778, Q1

Mora-Sánchez, B., Pérez-Sánchez, T., Balcázar, J.L. **Phylogenetic analysis of intestinal microbiota reveals novel Mycoplasma phylotypes in salmonid species**  
(2020) Microbial Pathogenesis, 145, art. no. 104210, IF=2.914, Q2

Casas-Ruiz, J.P., Spencer, R.G.M., Guillemette, F., von Schiller, D., Obrador, B., Podgorski, D.C., Kellerman, A.M., Hartmann, J., Gómez-Gener, L., Sabater, S., Marcé, R. **Delineating the Continuum of Dissolved Organic Matter in Temperate River Networks** (2020) *Global Biogeochemical Cycles*, 34 (8), art. no. e2019GB006495, IF=4.608, Q1

Jaén-Gil, A., Farré, M.-J., Sánchez-Melsió, A., Serra-Compte, A., Barceló, D., Rodríguez-Mozaz, S. **Effect-Based Identification of Hazardous Antibiotic Transformation Products after Water Chlorination** (2020) *Environmental Science and Technology*, 54 (14), pp. 9062-9073. IF=7.864, Q1

Bivins, A., North, D., Ahmad, A., Ahmed, W., Alm, E., Been, F., Bhattacharya, P., Bijlsma, L., Boehm, A.B., Brown, J., Buttiglieri, G., Calabro, V., Carducci, A., Castiglioni, S., Cetecioglu Guro, Z., Chakraborty, S., Costa, F., Curcio, S., De Los Reyes, F.L., Delgado Vela, J., Farkas, K., Fernandez-Casi, X., Gerba, C., Gerrity, D., Girones, R., Gonzalez, R., Haramoto, E., Harris, A., Holden, P.A., Islam, M.T., Jones, D.L., Kasprzyk-Hordern, B., Kitajima, M., Kotlarz, N., Kumar, M., Kuroda, K., La Rosa, G., Malpei, F., Mautus, M., McLellan, S.L., Medema, G., Meschke, J.S., Mueller, J., Newton, R.J., Nilsson, D., Noble, R.T., Van Nuijs, A., Peccia, J., Perkins, T.A., Pickering, A.J., Rose, J., Sanchez, G., Smith, A., Stadler, L., Stauber, C., Thomas, K., Van Der Voorn, T., Wigginton, K., Zhu, K., Bibby, K. **Wastewater-Based Epidemiology: Global Collaborative to Maximize Contributions in the Fight against COVID-19** (2020) *Environmental Science and Technology*, 54 (13), pp. 7754-7757. IF=7.864, Q1

Balcazar, J.L., Borrego, J.J. **Fish and Shellfish Pathogens** (2020) *Journal of Applied Microbiology*, 129 (1), p. 2. IF=3.066, Q1

Mora-Sánchez, B., Fuertes, H., Balcázar, J.L., Pérez-Sánchez, T. **Effect of a multi-citrus extract-based feed additive on the survival of rainbow trout (*Oncorhynchus mykiss*) following challenge with *Lactococcus garvieae*** (2020) *Acta Veterinaria Scandinavica*, 62 (1), art. no. 38, IF=1.590, Q1

Čelić, M., Škrbić, B.D., Insa, S., Živančev, J., Gros, M., Petrović, M. **Occurrence and assessment of environmental risks of endocrine disrupting compounds in drinking, surface and wastewaters in Serbia** (2020) *Environmental Pollution*, 262, art. no. 114344, IF=6.793, Q1

Sbardella, L., Gala, I.V., Comas, J., Carbonell, S.M., Rodríguez-Roda, I., Gernjak, W. **Integrated assessment of sulfate-based AOPs for pharmaceutical active compound removal from wastewater** (2020) *Journal of Cleaner Production*, 260, art. no. 121014, IF=7.246, Q1

Rodríguez-Mozaz, S., Vaz-Moreira, I., Varela Della Giustina, S., Llorca, M., Barceló, D., Schubert, S., Berendonk, T.U., Michael-Kordatou, I., Fatta-Kassinos, D., Martinez, J.L., Elpers, C., Henriques, I., Jaeger, T., Schwartz, T., Paulshus, E., O'Sullivan, K., Pärnänen, K.M.M., Virta, M., Do, T.T., Walsh, F., Manaia, C.M. **Antibiotic residues in final effluents of European wastewater treatment plants and their impact on the aquatic environment** (2020) *Environment International*, 140, art. no. 105733, IF=7.577, Q1

Vanderkelen, I., van Lipzig, N.P.M., Lawrence, D.M., Droppers, B., Golub, M., Gosling, S.N., Janssen, A.B.G., Marcé, R., Schmied, H.M., Perroud, M., Pierson, D., Pokhrel, Y., Satoh, Y., Schewe, J., Seneviratne, S.I., Stepanenko, V.M., Tan, Z., Woolway, R.I., Thiery, W. **Global Heat Uptake by Inland Waters** (2020) *Geophysical Research Letters*, 47 (12), art. no. e2020GL087867, IF=4.497, Q1

Sergienko, N., Radjenovic, J. **Manganese oxide-based porous electrodes for rapid and selective (electro)catalytic removal and recovery of sulfide from wastewater** (2020) *Applied Catalysis B: Environmental*, 267, art. no. 118608, IF=16.683, Q1

Romero, F., Acuña, V., Sabater, S. **Multiple stressors determine community structure and estimated function of river biofilm bacteria** (2020) *Applied and Environmental Microbiology*, 86 (12), art. no. e00291-20, IF=4.016, Q1

Sanchís, J., Jaén-Gil, A., Gago-Ferrero, P., Munthali, E., Farré, M.J. **Characterization of organic matter by HRMS in surface waters: Effects of chlorination on molecular fingerprints and correlation with DBP formation potential** (2020) *Water Research*, 176, art. no. 115743, IF=9.130, Q1

Córdoba-Ariza, G., Rincón-Palau, K., Donato-R, J.C., González-Trujillo, J.D. **Spatio-temporal variation of the aquatic macroinvertebrates in La Lindosa, Colombian Guiana [Variación espacio-temporal de macroinvertebrados acuáticos en La Lindosa, Guayana Colombiana]** (2020) *Revista de Biología Tropical*, 68 (2), pp. 452-465. IF=0.446, Q2

Witteveen, N.H., Freixa, A., Sabater, S. **Local and regional environmental factors drive the spatial distribution of phototrophic biofilm assemblages in Mediterranean streams** (2020) *Hydrobiologia*, 847 (10), pp. 2321-2336. IF=2.385, Q1

Barrientos, G., Herrero, A., Iroumé, A., Mardones, O., Batalla, R.J. **Modelling the effects of changes in forest cover and climate on hydrology of headwater catchments in South-Central Chile** (2020) *Water (Switzerland)*, 12 (6), art. no. 1828, IF=0.657, Q1

Orive, G., Lertxundi, U., Barceló, D. **Do we really need to invoke heroic measures for early SARS-CoV-2 outbreak detection?**

(2020) *European Journal of Epidemiology*, 35 (6), pp. 613-614. IF=7.135, Q1

Hawkes, J.A., D'Andrilli, J., Agar, J.N., Barrow, M.P., Berg, S.M., Catalán, N., Chen, H., Chu, R.K., Cole, R.B., Dittmar, T., Gavard, R., Gleixner, G., Hatcher, P.G., He, C., Hess, N.J., Hutchins, R.H.S., Ijaz, A., Jones, H.E., Kew, W., Khaksari, M., Palacio Lozano, D.C., Lv, J., Mazzoleni, L.R., Noriega-Ortega, B.E., Osterholz, H., Radoman, N., Remucal, C.K., Schmitt, N.D., Schum, S.K., Shi, Q., Simon, C., Singer, G., Sleighter, R.L., Stubbins, A., Thomas, M.J., Tolic, N., Zhang, S., Zito, P., Podgorski, D.C. **An international laboratory comparison of dissolved organic matter composition by high resolution mass spectrometry: Are we getting the same answer?** (2020) *Limnology and Oceanography: Methods*, 18 (6), pp. 235-258. IF=2.458, Q2

Roccaro, P., Finocchiaro, R., Mamo, J., Farré, M.J. **Monitoring NDMA precursors throughout membrane-based advanced wastewater treatment processes by organic matter fluorescence** (2020) *Water Research*, 175, art. no. 115682, IF=9.130, Q1

Sauchelli Toran, M., D'Haese, A., Rodríguez-Roda, I., Gernjak, W. **Fouling propensity of novel TFC membranes with different osmotic and hydraulic pressure driving forces** (2020) *Water Research*, 175, art. no. 115657, IF=9.130, Q1

García-Galán, M.J., Arashiro, L., Santos, L.H.M.L.M., Insa, S., Rodríguez-Mozaz, S., Barceló, D., Ferrer, I., Garfí, M. **Fate of priority pharmaceuticals and their main metabolites and transformation products in microalgae-based wastewater treatment systems** (2020) *Journal of Hazardous Materials*, 390, art. no. 121771, IF=9.038, Q1

Santos-Clotas, E., Cabrera-Codony, A., Comas, J., Martín, M.J. **Biogas purification through membrane bioreactors: Experimental study on siloxane separation and biodegradation** (2020) *Separation and Purification Technology*, 238, art. no. 116440, IF=5.774, Q1

Salehin, S., Rebosura, M., Jr., Keller, J., Gernjak, W., Donose, B.C., Yuan, Z., Pikaar, I. **Recovery of in-sewer dosed iron from digested sludge at downstream treatment plants and its reuse potential** (2020) *Water Research*, 174, art. no. 115627, IF=9.130, Q1

Saldarriaga-Hernandez, S., Hernandez-Vargas, G., Iqbal, H.M.N., Barceló, D., Parra-Saldívar, R. **Bioremediation potential of *Sargassum* sp. biomass to tackle pollution in coastal ecosystems: Circular economy approach** (2020) *Science of the Total Environment*, 715, art. no. 136978, IF=6.551, Q1

Pérez-Sánchez, T., Mora-Sánchez, B., Vargas, A., Balcázar, J.L. **Changes in intestinal microbiota and disease resistance following dietary postbiotic supplementation in rainbow trout (*Oncorhynchus mykiss*)**

(2020) *Microbial Pathogenesis*, 142, art. no. 104060, IF=2.914, Q2

Bosch-Orea, C., Sanchís, J., Barceló, D., Farré, M. **Ultra-trace determination of domoic acid in the Ebro Delta estuary by SPE-HILIC-HRMS** (2020) *Analytical Methods*, 12 (15), pp. 1966-1974. IF=2.596, Q1

Garrido-Baserba, M., Corominas, L., Cortés, U., Rosso, D., Poch, M. **The Fourth-Revolution in the Water Sector Encounters the Digital Revolution** (2020) *Environmental science & technology*, 54 (8), pp. 4698-4705. IF=7.864, Q1

Gusmaroli, L., Mendoza, E., Petrovic, M., Buttiglieri, G. **How do WWTPs operational parameters affect the removal rates of EU Watch list compounds?** (2020) *Science of the Total Environment*, 714, art. no. 136773, IF=6.551, Q1

Schirinzi, G.F., Köck-Schulmeyer, M., Cabrera, M., González-Fernández, D., Hanke, G., Farré, M., Barceló, D. **Riverine anthropogenic litter load to the Mediterranean Sea near the metropolitan area of Barcelona, Spain** (2020) *Science of the Total Environment*, 714, art. no. 136807, IF=6.551, Q1

Pijuan, M., Ribera-Guardia, A., Balcázar, J.L., Micó, M.M., de la Torre, T. **Effect of COD on mainstream anammox: Evaluation of process performance, granule morphology and nitrous oxide production** (2020) *Science of the Total Environment*, 712, art. no. 136372, IF=6.551, Q1

Sanchís, J., Jiménez-Lamana, J., Abad, E., Szpunar, J., Farré, M. **Occurrence of Cerium-, Titanium-, and Silver-Bearing Nanoparticles in the Besòs and Ebro Rivers** (2020) *Environmental Science and Technology*, 54 (7), pp. 3969-3978. IF=7.864, Q1

Gago-Ferrero, P., Bletsou, A.A., Damalas, D.E., Aalizadeh, R., Alygizakis, N.A., Singer, H.P., Hollender, J., Thomaidis, N.S. **Wide-scope target screening of >2000 emerging contaminants in wastewater samples with UPLC-Q-ToF-HRMS/MS and smart evaluation of its performance through the validation of 195 selected representative analytes** (2020) *Journal of Hazardous Materials*, 387, art. no. 121712, IF=9.038, Q1

Compte-Port, S., Fillol, M., Gich, F., Borrego, C.M. **Metabolic versatility of freshwater sedimentary archaea feeding on different organic carbon sources** (2020) *PLoS ONE*, 15 (4), art. no. e0231238, IF=2.740, Q1



Acuña, V., Jorda-Capdevila, D., Vezza, P., De Girolamo, A.M., McClain, M.E., Stubbington, R., Pastor, A.V., Lamouroux, N., von Schiller, D., Munne, A., Detry, T. **Accounting for flow intermittency in environmental flows design** (2020) *Journal of Applied Ecology*, 57 (4), pp. 742-753. IF=5.840, Q1

Guzmán-Villanueva, L.T., Escobedo-Fregoso, C., Barajas-Sandoval, D.R., Gomez-Gil, B., Peña-Rodríguez, A., Martínez-Díaz, S.F., Balcázar, J.L., Quiroz-Guzmán, E. **Assessment of microbial dynamics and antioxidant enzyme gene expression following probiotic administration in farmed Pacific white shrimp (*Litopenaeus vannamei*)** (2020) *Aquaculture*, 519, art. no. 734907, IF=3.224, Q1

Rizzo, L., Gernjak, W., Krzeminski, P., Malato, S., McARDell, C.S., Perez, J.A.S., Schaar, H., Fatta-Kassinos, D. **Best available technologies and treatment trains to address current challenges in urban wastewater reuse for irrigation of crops in EU countries** (2020) *Science of the Total Environment*, 710, art. no. 136312, IF=6.551, Q1

Timoner, X., Colls, M., Salomón, S.M., Oliva, F., Acuña, V., Sabater, S. **Does biofilm origin matter? Biofilm responses to non-flow period in permanent and temporary streams** (2020) *Freshwater Biology*, 65 (3), pp. 514-523. IF=3.835, Q1

Groeneveld, M., Catalán, N., Attermeyer, K., Hawkes, J., Einarsdóttir, K., Kothawala, D., Bergquist, J., Tranvik, L. **Selective Adsorption of Terrestrial Dissolved Organic Matter to Inorganic Surfaces Along a Boreal Inland Water Continuum** (2020) *Journal of Geophysical Research: Biogeosciences*, 125 (3), art. no. e2019JG005236, IF=3.408, Q1

Béjar, M., Gibbins, C., Vericat, D., Batalla, R.J. **Influence of habitat heterogeneity and bed surface complexity on benthic invertebrate diversity in a gravel-bed river** (2020) *River Research and Applications*, 36 (3), pp. 465-479. IF=1.916, Q1

Pastor, A., Hernández-del Amo, E., Giménez-Grau, P., Fillol, M., Pereda, O., Flores, L., Sanpera-Calbet, I., Bravo, A.G., Martín, E.J., Poblador, S., Arroita, M., Rasines-Ladero, R., Ruiz, C., del Campo, R., Abril, M., Reyes, M., Casas-Ruiz, J.P., Fernández, D., de Castro-Català, N., Tornero, I., Palacin-Lizarbe, C., Arce, M.I., Mora-Gómez, J., Gómez-Gener, L., Monroy, S., Freixa, A., Lupon, A., María González-Ferreras, A., Estévez, E., Rodríguez-Lozano, P., Solagaistua, L., Rodríguez-Castillo, T., Aristi, I., Martínez, A., Catalán, N. **Early-Career Coordinated Distributed Experiments: Empowerment Through Collaboration** (2020) *Frontiers in Education*, 5, art. no. 13, IF= 0.698, Q3

Zhao, F., Yao, Y., Jiang, C., Shao, Y., Barceló, D., Ying, Y., Ping, J. **Self-reduction bimetallic nanoparticles on ultrathin MXene nanosheets as functional platform for pesticide sensing** (2020) *Journal of Hazardous Materials*, 384, art. no. 121358, IF=9.038, Q1

Gros, M., Ahrens, L., Levén, L., Koch, A., Dalahmeh, S., Ljung, E., Lundin, G., Jönsson, H., Eveborn, D., Wiberg, K. **Pharmaceuticals in source separated sanitation systems: Fecal sludge and blackwater treatment** (2020) *Science of the Total Environment*, 703, art. no. 135530, IF=6.551, Q1

Morera, S., Santana, M.V.E., Comas, J., Rigola, M., Corominas, L. **Evaluation of different practices to estimate construction inventories for life cycle assessment of small to medium wastewater treatment plants** (2020) *Journal of Cleaner Production*, 245, art. no. 118768, IF=7.246, Q1

Musacchio, A., Re, V., Mas-Pla, J., Sacchi, E. **EU Nitrates Directive, from theory to practice: Environmental effectiveness and influence of regional governance on its performance** (2020) *Ambio*, 49 (2), pp. 504-516. IF=4.778, Q1

Marti, E., Gros, M., Boy-Roura, M., Ovejero, J., Busquets, A.M., Colón, J., Petrovic, M., Ponsá, S. **Pharmaceuticals removal in an on-farm pig slurry treatment plant based on solid-liquid separation and nitrification-denitrification systems** (2020) *Waste Management*, 102, pp. 412-419. IF=5.448, Q1

He, D., Cheng, Y., Zeng, Y., Luo, H., Luo, K., Li, J., Pan, X., Barceló, D., Crittenden, J.C. **Synergistic activation of peroxymonosulfate and persulfate by ferrous ion and molybdenum disulfide for pollutant degradation: Theoretical and experimental studies** (2020) *Chemosphere*, 240, art. no. 124979, IF=5.778, Q1

Koschorreck, M., Downing, A.S., Hejzlar, J., Marcé, R., Laas, A., Arndt, W.G., Keller, P.S., Smolders, A.J.P., van Dijk, G., Kosten, S. **Hidden treasures: Human-made aquatic ecosystems harbour unexplored opportunities** (2020) *Ambio*, 49 (2), pp. 531-540. IF=4.778, Q1

Barceló, D., Kostianoy, A.G. **Series preface** (2020) *Handbook of Environmental Chemistry*, 97, pp. vii-viii. IF=0.194, Q3

Barceló, D. **Series editor's preface** (2020) *Comprehensive Analytical Chemistry*, 91, pp. xix-xx. IF=0.307, Q3

Barceló, D., Kostianoy, A.G. **Series preface** (2020) *Handbook of Environmental Chemistry*, 98, pp. vii-viii. IF=0.194, Q3

Barceló, D. **Microplastics analysis** (2020) *MethodsX*, 7, art. no. 100884, IF=0.381, Q2

Corominas, L., Gimeno, P., Constantino, C., Daldorph, P., Comas, J. **Can source control of pharmaceuticals decrease the investment needs in urban wastewater infrastructure?** (2020) *Journal of Hazardous Materials*, art. no. 124375, IF=9.038, Q1

Negm, A.M., Bouderbala, A., Chenchouni, H., Barceló, D. **Preface** (2020) *Handbook of Environmental Chemistry*, 97, pp. ix-x. IF=0.194, Q3

Barceló, D. **An environmental and health perspective for COVID-19 outbreak: Meteorology and air quality influence, sewage epidemiology indicator, hospitals disinfection, drug therapies and recommendations** (2020) *Journal of Environmental Chemical Engineering*, 8 (4), art. no. 104006, IF=4.300, Q1

Sanchís, J., Freixa, A., López-Doval, J.C., Santos, L.H.M.L.M., Sabater, S., Barceló, D., Abad, E., Farré, M. **Bioconcentration and bioaccumulation of C60 fullerene and C60 epoxide in biofilms and freshwater snails (*Radix* sp.)** (2020) *Environmental Research*, 180, art. no. 108715, IF=5.715, Q1

Onyshchenko, E., Blandin, G., Comas, J., Dvoretzky, A. **Influence of microalgae wastewater treatment culturing conditions on forward osmosis concentration process** (2020) *Environmental Science and Pollution Research*, 27 (2), pp. 1234-1245. IF=3.056, Q2

da Silva, J.J., da Silva, B.F., Stradiotto, N.R., Petrovic, M., Gago-Ferrero, P., Gros, M. **Pressurized Liquid Extraction (PLE) and QuEChERS evaluation for the analysis of antibiotics in agricultural soils** (2020) *MethodsX*, 7, art. no. 101171, IF=0.381, Q2

da Silva, J.J., da Silva, B.F., Stradiotto, N.R., Petrović, M., Gros, M., Gago-Ferrero, P. **Identification of organic contaminants in vinasse and in soil and groundwater from fertigated sugarcane crop areas using target and suspect screening strategies** (2020) *Science of the Total Environment*, art. no. 143237, IF=6.551, Q1

16. M. Köck-Schulmeyer, A. Ginebreda, M. Petrovic, M. Giulivo, O. Zaznar-Aleman, E. Eljarrat, J. Valle-Sistac, D. Molins-Delgado, M.S. Díaz-Cruz, L.S. Monllor-Alcaraz, N. Guillem-Argiles, E. Martínez, M.L. de Alda, M. Llorca, M. Farré, J.M. Peña, L. Mandarić, S. Pérez, B. Majone, A. Bellin, E. Kalogianni, N.Th. Skoulikidis, R. Milacic and D. Barceló. **"Priority and emerging organic microcontaminants in three Mediterranean river basins: Occurrence, spatial distribution, and identification of river basin specific pollutants"**. *Science of the Total Environment*, 754 (2020), 142344. IF=6.551, Q1

Kothawala, D.N., Kellerman, A.M., Catalán, N., Tranvik, L.J. **Organic Matter Degradation across Ecosystem Boundaries: The Need for a Unified Conceptualization** (2020) *Trends in Ecology and Evolution*, IF=14.764, Q1

Negm, A., Omran, E.-S.E., Barcelo, D. **Update, Conclusions, and Recommendations for "Assessment of Surface and Groundwater Resources in Algeria"** (2020) *Handbook of Environmental Chemistry*, 97, pp. 321-336. IF=0.194, Q3

Barceló, D., Kostianoy, A.G. **Series preface** (2020) *Handbook of Environmental Chemistry*, 96, pp. vii-viii. IF=0.194, Q3

Negm, A.M., Bouderbala, A., Chenchouni, H., Barceló, D. **Preface** (2020) *Handbook of Environmental Chemistry*, 98, pp. ix-xi. IF=0.194, Q3

Negm, A., Omran, E.-S.E., Barcelo, D. **Update, conclusions, and recommendations for water resources in algeria: Water quality, treatment, protection, and development** (2020) *Handbook of Environmental Chemistry*, 98, pp. 319-334. IF=0.194, Q3

Zelený, J., Mercado-Bettín, D. **Evaluation of ecological integrity in landscape based on remote sensing data** (2020) *Ecological Integrity in Science and Law*, pp. 161-173. IF=1.330, Q1

Béjar, M., Vericat, D., Palau, A., Batalla, R.J. **Hydrosedimentary dynamics of the Sant Llorenç de Montgai reservoir drawdown (Segre river) [Balance de agua y sedimentos durante el vaciado del embalse de Sant Llorenç de Montgai (Río segre)]** (2020) *Cuatrenario y Geomorfología*, 34 (1-2), pp. 63-80. IF=0.252, Q3

Escudero-Oñate, C., Rodríguez-Mozaz, S., Ferrando-Climent, L. **Tamoxifen: Occurrence, fate, transformation products, and non-conventional treatment technologies** (2020) *Fate and Effects of Anticancer Drugs in the Environment*, pp. 71-86. IF= 1.070, Q1

Vericat, D., Ville, F., Palau-Ibars, A., Batalla, R.J. **Effects of hydropeaking on bed mobility: Evidence from a Pyrenean river** (2020) *Water (Switzerland)*, 12 (1), art. no. 178, IF=0.657, Q1

Ekpe, O.D., Choo, G., Barceló, D., Oh, J.-E. **Introduction of emerging halogenated flame retardants in the environment** (2020) *Comprehensive Analytical Chemistry*, 88, pp. 1-39. IF=0.307, Q3

Farré, M.J., Insa, S., Lamb, A., Cojocariu, C., Gernjak, W. **Occurrence of: N-nitrosamines and their precursors in Spanish drinking water treatment plants and distribution systems** (2020) *Environmental Science: Water Research and Technology*, 6 (1), pp. 210-220. IF=3.449, Q1

González-Trujillo, J.D., Donato-Rondon, J.C., Muñoz, I., Sabater, S. **Historical processes constrain metacommunity structure by shaping different pools of invertebrate taxa within the Orinoco basin** (2020) *Diversity and Distributions*, 26 (1), pp. 49-61. IF=3.993, Q1

Andersson, M.G.I., Catalán, N., Rahman, Z., Tranvik, L.J., Lindström, E.S. **Effects of sterilization on dissolved organic carbon (DOC) composition and bacterial utilization of DOC from lakes** (2020) *Aquatic Microbial Ecology*, 82 (2), pp. 199-208. IF=1.841, Q1

Picó, Y., Farré, M., Barceló, D. **Quantitative profiling of perfluoroalkyl substances by ultrahigh-performance liquid chromatography and hybrid quadrupole time-of-flight mass spectrometry** (2020) *Analytical and Bioanalytical Chemistry*, 407 (15), 13 p. IF=3.637, Q1

Barceló, D., Kostianoy, A.G. **Series preface** (2020) *Handbook of Environmental Chemistry*, 104, pp. vii-viii. IF=0.194, Q3

Barceló, D., Kostianoy, A.G. **Series preface** (2020) *Handbook of Environmental Chemistry*, 87, pp. ix-x. IF=0.194, Q3

Barceló, D., Kostianoy, A.G. **Series Preface** (2020) *Handbook of Environmental Chemistry*, 91, pp. vii-viii. IF=0.194, Q3

Barceló, D., Kostianoy, A.G. **Series Preface** (2020) *Handbook of Environmental Chemistry*, 95, pp. vii-viii. IF=0.194, Q3

González-Trujillo, J.D., Saito, V.S., Petsch, D.K., Muñoz, I., Sabater, S. **Historical legacies and contemporary processes shape beta diversity in Neotropical montane streams** (2020) *Journal of Biogeography*, IF=3.723, Q1

Negm, A.M., Omran, E.-S.E., Bouderbala, A., Chenchouni, H., Barcelo, D. **Introduction to "water resources in algeria: Water quality, treatment, protection and development"** (2020) *Handbook of Environmental Chemistry*, 98, pp. 1-10. IF=0.194, Q3

Beghelli, F.G.S., Cetra, M., Marchese, M., López-Dovál, J.C., Rosa, A.H., Pompêo, M.L.M., Moschini-Carlos, V. **Taxonomic and non-taxonomic responses of benthic macroinvertebrates to metal toxicity in tropical reservoirs. The case of cantareira complex, São Paulo, Brazil** (2020) *Anais da Academia Brasileira de Ciências*, 92 (2), art. no. e20180962, IF=1.280, Q1

Barceló, D., Kostianoy, A.G. **Series preface** (2020) *Handbook of Environmental Chemistry*, 86, pp. ix-x. IF=0.194, Q3

Barceló, D., Kostianoy, A.G. **Series preface** (2020) *Handbook of Environmental Chemistry*, 88, pp. ix-x. IF=0.194, Q3

Negm, A.M., Omran, E.-S.E., Bouderbala, A., Chenchouni, H., Barcelo, D. **Introduction to "Water Resources in Algeria: Assessment of Surface and Groundwater Resources"** (2020) *Handbook of Environmental Chemistry*, 97, pp. 3-12. IF=0.194, Q3

Martínez-Morcillo, S., Rodríguez-Gil, J.L., Fernández-Rubio, J., Rodríguez-Mozaz, S., Míguez-Santiyán, M.P., Valdes, M.E., Barceló, D., Valcárcel, Y. **Presence of pharmaceutical compounds, levels of biochemical biomarkers in seafood tissues and risk assessment for human health: Results from a case study in North-Western Spain** (2020) *International Journal of Hygiene and Environmental Health*, 223 (1), pp. 10-21. IF=4.801, Q1

Vázquez-Tarrio, D., Piqué, G., Vericat, D., Batalla, R.J. **The active layer in gravel-bed rivers: An empirical appraisal** (2020) *Earth Surface Processes and Landforms*, IF=3.694, Q1

Sanchís, J., Gernjak, W., Munné, A., Catalán, N., Petrovic, M., Farré, M.J. **Fate of N-nitrosodimethylamine and its precursors during a wastewater reuse trial in the Llobregat River (Spain)** (2020) *Journal of Hazardous Materials*, art. no. 124346, IF=9.038, Q1

Botturi, A., Ozbayram, E.G., Tondera, K., Gilbert, N.I., Rouault, P., Caradot, N., Gutiérrez, O., Daneshgar, S., Frison, N., Akyol, Ç., Foglia, A., Eusebi, A.L., Fatone, F. **Combined sewer overflows: A critical review on best practice and innovative solutions to mitigate impacts on environment and human health** (2020) *Critical Reviews in Environmental Science and Technology*, IF=8.302, Q1

Brepols, C., Comas, J., Harmand, J., Heran, M., Robles, Á., Rodríguez-Roda, I., Ruano, M.V., Smets, I., Mannina, G. **Position paper - progress towards standards in integrated (aerobic) MBR modelling** (2020) *Water Science and Technology*, 81 (1), pp. 1-9. IF=1.638, Q2

Catalán, N., Pastor, A., Borrego, C.M., Casas-Ruiz, J.P., Hawkes, J.A., Gutiérrez, C., von Schiller, D., Marcé, R. **The relevance of environment vs. composition on dissolved organic matter degradation in freshwaters** (2020) *Limnology and Oceanography*, IF=2.458, Q2

Nagler, M., Praeg, N., Niedrist, G.H., Attermeyer, K., Catalán, N., Pilotto, F., Gutmann Roberts, C., Bors, C., Fenoglio, S., Colls, M., Cauvy-Fraunié, S., Doyle, B., Romero, F., Machalett, B., Fuss, T., Bednařík, A., Klaus, M., Gilbert, P., Lamonica, D., Nydahl, A.C., Romero González-Quijano, C., Thuile Bistarelli, L., Kenderov, L., Piano, E., Mor, J.-R., Evtimova, V., deEyto, E., Freixa, A., Rulík, M., Pegg, J., Herrero Ortega, S., Steinle, L., Bodmer, P. **Abundance and biogeography of methanogenic and methanotrophic microorganisms across European streams** (2020) *Journal of Biogeography*, IF=3.723, Q1

Eid EM, Galal TM, Shaltout KH, El-Sheikh, MA, Asaeda T, Alatar AA, Alfarhan AH, Alharthi A, Alshehri AMA, Picó Y, Barcelo D. **Biomonitoring potential of the native aquatic plant *Typha domingensis* by predicting heavy metal accumulation in the Egyptian Lake Burullus.** *Science of the Total Environment* 714 (2020) 136603 IF= 6.551, Q1

## BOOKS

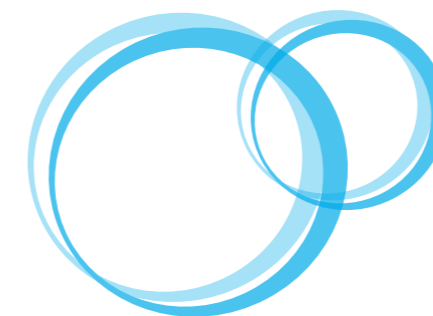
### PUBLISHED BOOKS (4)

Editor of the Book "Removal and Degradation of Pharmaceutically Active Compounds in Wastewater Treatment" Part of The Handbook of Environmental Chemistry series in Springer.

Manual d'anàlisi dels objectius de desenvolupament sostenible: Guia d'entitats de cooperació i medi ambient del sud de Catalunya (2020). Publicacions URV, 1st edition: 2020.

Abdelazim M. Negm, Abdelkader Bouderbala, Haroun Chenchouni and D. Barceló. "Water Resources in Algeria-Part II". Berlin, Germany, 2020. Springer Verlag editorial. *Handbook of Environmental Chemistry*, vol. 98.

Abdelazim M. Negm, Abdelkader Bouderbala, Haroun Chenchouni and D. Barceló. Título "Water Resources in Algeria-Part I" Berlin, Germany, 2020 Springer Verlag. *Handbook of Environmental Chemistry*, vol. 97



Leonard Wijaya, Mohammed Alyemeni, Parvaiz Ahmad, Ahmed Alfarhan, Damia Barcelo, Mohamed A. El-Sheikh, and Yolanda Pico **Ecotoxicological Effects of Ibuprofen on Plant Growth of *Vigna unguiculata* L.Plants** (2020) 9, 1473; doi:10.3390/plants9111473 IF= 2.762, Q

R. Sagaya Jansi, Ameer Khusro, Paul Agastian, Ahmed Alfarhan c, Naif Abdullah Al-Dhabi, Mariadhas Valan Arasu, Rajakrishnan Rajagopal, Damia Barcelo, Amal Al-Tamimi **Emerging paradigms of viral diseases and paramount role of natural resources as antiviral agents** *Science of the Total Environment* (2020), in press, doi.org/10.1016/j.scitotenv.2020.143539 IF= 6.551, Q1

### BOOKS CHAPTERS (11)

Maria José Farré and Wolfgang Gernjak. "Chapter 6: DBPs in Potable Water Reuse". Editor: Tarek Manasfi Jean-Luc Boudenne. Elsevier. In the book: Analysis, formation, and toxicity of disinfection byproducts in drinking water Volume 92 (ISBN: 9780444643438).

Elisabet Marti, Victoria Osorio, Marta Llorca, Lidia Paredes and Meritxell Gros\*. "Environmental risks of sewage sludge reuse in agriculture". Editor: Paola Verlicchi and Damia Barceló. Elsevier. In the book: Wastewater Treatment and Reuse-Lessons learned in Technological Developments and Management Issues (ISSN Book 6).

Sara Rodríguez-Mozaz, Albert Serra-Compte, Ruben Gil-Solsona, Diana Álvarez-Muñoz. Environmental metabolomics and xenometabolomics for the assessment of exposure to contaminant mixtures in "Environmental metabolomics" (2020) Elsevier. https://doi.org/10.1016/B978-0-12-818196-6.00010-8

Castaño-Trias, M., Brienza, M., Tomei, M.C., Buttiglieri, G. (2020). Fate and removal of pharmaceuticals in CAS for water and sewage sludge reuse. Pages 1-29. Chapter in the book: Removal and Degradation of Pharmaceutically Active Compounds in Wastewater Treatment, Hdb Env Chem.

Farré, M.J. and Gernjak, W. (2021). Chapter 6: DBPs in Potable Water Reuse. Editor: Tarek Manasfi and Jean-Luc Boudenne. In: Analysis, formation, and toxicity of disinfection byproducts in drinking water. Elsevier: Comprehensive Analytical Chemistry, Volume 92 (ISBN: 9780444643438).

Masi, F., Langergraber, G., Santoni M., Istenič, D., Atanasova, N. Buttiglieri, G. (2020). Possibilities of nature-based and hybrid decentralized solutions for reclaimed water reuse. *Advances in Chemical Pollution, Environmental Management and Protection*. Volume 5, 2020, Pages 145-187. Chapter in the book: *Wastewater Treatment and Reuse Present and Future Perspectives in Technological Developments and Management Issues*.

J. Radjenovic, L. Baptista-Pires. (2020). Electrochemical processes for the elimination of pharmaceutical compounds in contaminated waters, in volume *Removal and Degradation of Pharmaceutically Active Compounds in Wastewater Treatment*, Eds. S. Rodriguez-Mozaz, P. Blanquez Cano, M. Sarra Adroguer, *The Handbook of Environmental Chemistry*, Springer, Berlin.

Acuña V., Freixa A., Marcé R., Timoner X. 2020. Ecosystem metabolism in river networks and climate change. Chapter X. In: Jürgen Marxsen (ed.): *Climate Change and Microbial Ecology: Current Research and Future Trends*, 2nd ed., Caister Academic Press.

Freixa A, Acuña V, Gutiérrez M, Sanchís J, Santos LHM-LM, Rodriguez-Mozaz S, Farré M, Barceló D and Sabater S. Fullerenes Influence the Toxicity of Organic Micro-Contaminants to River Biofilms. In: Pesce, S., Martin-Laurent, F., Topp, E., Jean-Francois, G., eds. (2020). *Microbial Ecotoxicology*. Lausanne: Frontiers Media SA. doi: 10.3389/978-2-88963-881-9.

OD Ekpe, G. Choo, D. Barceló, and JE Oh. "Introduction of emerging halogenated flame retardants in the environment" Ed JE Oh in *Emerging Halogenated Flame Retardants in the Environment*, *Comprehensive Analytical Chemistry*. Amsterdam, 2020. Editorial Elsevier Vol. 88.

M. Farre and D. Barceló. "Microfluidic devices: biosensors" Ed Y. Pico in *Chemical Analysis of Food: Techniques and Applications*. London, 2020. Academic Press editorial, chapter 6.

## OTHER BOOKS AND JOURNALS (9)

Moura de Salles Pupo, M., Albahaca Oliva, J.M., Barrios Eguiluz, K.I., Salazar-Banda, G.R., Radjenovic, J. 2020. Characterization and comparison of Ti/TiO<sub>2</sub>-NT/SnO<sub>2</sub>-SbBi, Ti/SnO<sub>2</sub>-SbBi and BDD anode for the removal of persistent iodinated contrast media (ICM), *Chemosphere* 253: 126701.

Khalifa, O., Banata, F., Srinivasakannan, C., Radjenovic, J., Hasan, S.W. 2020. Performance tests and removal mechanisms of aerated electrocoagulation in the treatment of oily wastewater, *J. Water Process Eng.*, in press

Sergienko, N., Radjenovic, J. 2020. Manganese oxide-based porous electrodes for rapid and selective (electro)catalytic removal and recovery of sulfide from wastewater, *Appl. Catal. B. Environ.*, 267: 118608.

Mendoza, E, Comas J, Buttiglieri, G. (2020). CLEaN-TOUR: Reutilización de agua en instalaciones turísticas. *IDiAgua*, 34-37.

Palau Ibars, A., Rocaspana, Jové, R., Aparicio Manau, E., Batalla, R.J., Vericat Querol, D., Pedrocchi, V., Palau Nadal, A., Marín Vitalla, N. (†), García Escudero, A. (2020): Análisis de los efectos de las hidropuntas en ríos regulados: el caso de la CH Esterrri-Unarre (ENDESA) en el río Noguera Pallaresa (Lleida). In: Palau Ibars, A., Rocaspana Jové, E., Aparicio Manau, E. (eds.). *Legal deposit: D L 327-2020. ISBN: 978-84-09-19284-7. OFF-7 S.A., Lleida*

Damia Barcelo (2020) *Wastewater-Based Epidemiology to monitor COVID-19 outbreak: Present and future diagnostic methods to be in your radar*. *Case Studies in Chemical and Environmental Engineering*. Editorial Elsevier <https://doi.org/10.1016/j.cscee.2020.100042>

Ana L.P. Silva, Joana C. Prata, Armando C. Duarte, Amadeu M.V.M. Soares, Damia Barcelo, Teresa Rocha-Santos (2020) *Microplastics in landfill leachates: The need for reconnaissance studies and remediation technologies*. *Case Studies in Chemical and Environmental Engineering*. Editorial Elsevier. <https://doi.org/10.1016/j.cscee.2020.100072>

Xiuna Ren, Yue Sun, Zhaoyu Wang, Damia Barcelo Quan Wang, Zengqiang Zhang, Yuanye Zhang (2020) *Abundance and characteristics of microplastic in sewage sludge: A case study of Yangling, Shaanxi province, China*. *Case Studies in Chemical and Environmental Engineering*. Editorial Elsevier. <https://doi.org/10.1016/j.cscee.2020.100050>

Mario E. Barocio, Enrique Hidalgo-Vazquez, Yuna Kim, Laura Isabel Rodas-Zuluaga, Wei-Ning Chen, Damia Barcelo, Hafiz N.M. Iqbal, Roberto Parra-Saldívar, Carlos Castillo-Zacarias (2020) *Portable microfluidic devices for in-field detection of pharmaceutical residues in water: Recent outcomes and current technological situation – A short review*. *Case Studies in Chemical and Environmental Engineering*. Editorial Elsevier. <https://doi.org/10.1016/j.cscee.2020.100069>

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- **D. Barceló**, since 2017 Editor as well of *Methods X and Process Safety and Environmental Protection*.

- **D. Barceló**, Editor of three book series: *Comprehensive Analytical Chemistry, Elsevier*, *Advances in Chemical Pollution and Environmental Management and Protection, Academic Press- Elsevier* and *The Handbook of Environmental Chemistry from Springer*.

# PRESENTATION AT CONGRESSES

## ORAL PRESENTATIONS

**Castaño-Trias, M.,** Gusmaroli, L., Rodriguez-Mozaz, S., Buttiglieri G. 2020. Pharmaceutical active compounds in the environment and their transformation products: a hidden threat? The IV conference of pre-doctoral researchers of the UdG, Girona 13-16 June 2020.

**Kovoor George N.,** Wols B., Santoro D., Bell K., Martijn B., Kruithof J., Gernjak W. 2020. Developing a Chemical-Free AOP for the Removal of Micropollutants from Water and Wastewater, Adapting to Change: Considerations for Water Recycling and Desalination to Address Future Water Supply Challenges in the UK (Invited talk, 26 Feb, 2020, Brighton, United Kingdom).

**Mendoza, E.,** Blandin, G., Comas, J., Buttiglieri, G. 2020. Fertilizer-drawn forward osmosis for sustainable water reuse in touristic Mediterranean regions. The IV conference of pre-doctoral researchers of the UdG, Girona 13-16 June 2020.

**Mendoza, E.,** Comas, J., Buttiglieri, G., Blandin, G. 2020. Fertilizer-drawn forward osmosis for sustainable greywater reuse in touristic Mediterranean regions. Environmental Technology for impact conference. Wageningen. 2-5 June 2020.

**Norra G.,** Radjenovic J. 2020. RGO coated graphite granules as particle electrodes in 3D EC reactor for the reduction of persistent contaminants. Platform. The First International Workshop on Advanced Electrochemical Oxidation for Water Reuse, online conference.

**Norra G.,** Radjenovic J. 2020. Hybrid electrochemical-granular activated carbon (GAC) system for the removal of persistent organic contaminants from wastewater. Platform. The IV Conference of Pre-doctoral Researchers of the Universitat de Girona. Girona, Spain.

**Pijuan M.,** Rodriguez-Caballero A.\*, Ribera-Guardia A. 2020. Monitoring GHG emissions from WWTP: experiences and challenges of quantifying N<sub>2</sub>O and CH<sub>4</sub> in full-scale systems. IWA Nutrient Removal and Recovery virtual conference, 01-03 September.

**Radjenovic J.,** Sergienko N., Duinslaeger N., Florjan-Norra G., Baptista-Pires L. 2020. Electrochemi-

cal systems for the treatment of contaminated water: limitations, challenges and prospective. Invited talk. Annual Meeting of the International Society of Electrochemistry (ISE), online meeting.

**Radjenovic J.,** 2020. Future research directions of electrochemical water treatment systems. Invited talk and discussion leader. Next Generation Electrochemistry Workshop organized by the University of Illinois at Chicago, online webinar.

**Rodriguez-Roda, I.,** Comas, J., Buttiglieri, G., Poch, M. 2020. Water 5.0: a new paradigm in the framework of the circular economy. Closed cycles and the circular society. The power of Ecological Engineering, Wadenswil, Switzerland, 2-4 September 2020. Platform presentation and chairman (by Rodriguez-Roda, I).

**Zahedi S.,** Ferrari F., Blandin G., Balcazar JL., Pijuan M. 2020. Anaerobic treatment of forward osmosis concentrate obtained during water recovery from municipal wastewater. IWA Nutrient Removal and Recovery virtual conference, 01-03 September.

**Damià Barceló,** Ethel Eljarrat, Diana Alvarez-Muñoz, Sara Rodriguez-Mozaz & Antonio Marques. "Pharmaceuticals and other emerging contaminants in European seafood samples" SMART TECH for FOOD (ST4F) November 25th 2020.

**Batalla,** Ramon J. 2020. 'The Ebro River Basin: Environmental history and implications for sediment (dis)continuity'. Annual Conference ZAPYGAR Zone Atelier Pyrénées-Garonne, Centre National de la Recherche Scientifique. ENSAT, Toulouse, France

**Batalla,** Ramon J. 2020. 'Some insights into the Ebro', Shifting Shores Online Workshop; Paris, France.

**Marcé,** R. 2020. Keynote lecture "Forecasting lake water quality during extreme events across time-scales". Management of Extreme Events in Lakes and Catchments 14-15 Oct 2020, Virtual Symposium MANTEL-ITN.

**Mas-Pla, J.** 2020. Pros i contres dels diferents tipus de captacions en Aigües subterrànies. A "La gestió de l'aigua a Viladrau" – Setmana de la Natura – Ajuntament de Viladrau. 9 d'octubre de 2020.

**Damià Barceló,** "Microplastics pollution in coastal waters, rivers and soil: monitoring, assessment and remediation". DSFP- King Saud University-College of Science, Botany and Microbiology (KSU, Riyadh), February, 2020

**Damià Barceló,** "Microalgae-based technology for the removal of benzalkonium chloride in oil and gas produced water: Biotransformation and environmental effects". American Chemical Society Fall 2020 National Meeting and Exposition. Division of Environmental Chemistry (virtual) ( San Francisco, USA), August, 2020,

**Damià Barceló,** "Pharmaceuticals, CECs and Microplastics in European Seafood Samples and Coastal Waters". Smart Tech for Food Final Conference from FoodSamrtphone project (virtual), (Barcelona), November 2020

**Damià Barceló,** Macro- and Micro- Plastic Litter and Increased Covid-19 Based Plastic Pollution. Master of Inland Water Quality Assessment-UAM (virtual) (Madrid-Spain), Desember, 2020

## PATENTS/PILOT PLANTS

Note: Both patents were in force. From the 26/12/19 when the European one is dropped.

**Spanish Patent:** ES2490065.

**Title:** Sistema de monitorització de desbordaments en redes de tuberías.

**Application date:** 27/02/2013 - Grant date: 09/06/2015.

**Holder:** Fundació Institut Català de Recerca de l'aigua (ICRA).

**Inventors:** Oriol Gutiérrez García-Moreno; Lluís Corominas Tabares; Vicenç Acuña Salazar. **European patent application:** EP16382307 (Requested).

**Title:** Method for operating a membrane bioreactor of a water treatment system and corresponding membrane bioreactor and water treatment system.

**Holder:** Universitat de Girona and the Catalan Institute for Water Research (ICRA).

**Inventors:** Blandin, Gaetan, Rodríguez-Roda Layret, Ignasi, Comas i Matas, Joaquim.

**European patent application:** EP20382879.

**Title:** "Method to prepare graphene coated sponges, sponges obtained thereof, electrodes obtained from such sponges and uses of the sponges for water treatment.

**Holder:** Catalan Institute for Water Research (ICRA).

**Inventors:** Lluís Pires and Jelena Radjenovic.





# 05

## PROJECTS

- RESOURCES AND ECOSYSTEMS RESEARCH AREA**
- WATER QUALITY RESEARCH AREA**
- TECHNOLOGIES AND EVALUATION RESEARCH AREA**

## RESOURCES AND ECOSYSTEMS RESEARCH AREA

### PROJECT

#### SMIRES

#### Science and Management of Intermittent Rivers and Ephemeral Streams

Funding agency:	European Union - COST Action
Duration:	2015-2020
Coordination:	Institut national de recherche en sciences et technologies pour l'environnement et l'agriculture (IRSTEA)
Leader researcher:	Vicenç Acuña Salazar
Amount for ICRA:	€ 0.00

### PROJECT

#### MANTEL

#### Management of Climatic Extreme Events in Lakes Reservoirs for the Protection of Ecosystem

Funding agency:	EUROPEAN COMMISSION H2020 Research and Innovation Framework Program
Duration:	2017-2020
Coordination:	Centre for Freshwater and Environmental Studies (IRL)
Leader researcher:	Dr. Rafael Marcé
Amount for ICRA:	€ 238,872.96

### PROJECT

#### Qualitat, dinàmica i funció dels ecosistemes aquàtics continentals (ICRA-ENV)

Funding agency:	Agència de Gestió d'Ajuts Universitaris (AGAUR)
Duration:	2017-2021
Coordination:	Institut Català de Recerca de l'Aigua
Leader researcher:	Mira Petrovic
Amount for ICRA:	€ 60,216.00

### PROJECT

#### EcoAdvisor (EcoAdvisor for Wise Leadin Water Management)

Funding agency:	Aigües de Catalunya
Duration:	2018-2021
Coordination:	Aigües de Catalunya
Leader researcher:	Lluís Corominas
Amount for ICRA:	€ 80,000

### PROJECT

#### EdiCitNet - Edible City Solutions

Funding agency:	European Union's Horizon 2020 research and innovation programme under grant agreement No. 776665
Duration:	2018-2023
Coordination:	Humboldt Universitaet
Leader researcher:	Joaquim Comas
Amount for ICRA:	€ 389,780.00

### PROJECT

#### Intermitencia espacial y temporal del flujo en sistemas fluviales: efectos en la estructura, funcionamiento, y servicios ecosistémicos (Retos17\_SPACESTREAM)

Funding agency:	Ministerio de Economía y Competitividad (MINECO) and ERDF.
Duration:	2018-2021
Coordination:	Institut Català de Recerca de l'Aigua (ICRA)
Leader researcher:	Vicenç Acuña Salazar
Amount for ICRA:	€96,800

### PROJECT

#### Impacto de la contaminación de origen agrícola en la calidad hidroquímica (nitratos, antibióticos) y microbiológica (genes de resistencia)

Funding agency:	Agencia Estatal de Investigación (AEI), Ministerio de Ciencia, Innovación y Universidades (MICIU) y el Fondo Europeo de Desarrollo Regional (FEDER).
Duration:	2018-2021
Coordination:	Institut Català de Recerca de l'Aigua (ICRA)
Leader researcher:	Josep Mas Pla
Amount for ICRA:	€ 104,665

### PROJECT

#### Ajuts per a la contractació de personal investigador novell FI 2019

Funding agency:	Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR)
Duration:	2019-2020
Coordination:	Institut Català de Recerca de l'Aigua (ICRA)
Leader researcher:	Sergi Sabater
Amount for ICRA:	€ 20,402.72

### PROJECT

#### ACA\_TRAÇA (Traçabilitat de les fonts de substàncies prioritàries i contaminants emergents en trams fluvials rellevants, i mesures de millora en el sanejament urbà al Baix Llobregat)

Funding agency:	Agència Catalana de l'Aigua (ACA).
Duration:	2020-2022
Coordination:	Agència Catalana de l'Aigua (ACA)
Leader researcher:	Vicenç Acuña
Amount for ICRA:	€ 295,410

### PROJECT

#### Sanitation for and by Nature 2 NCEAS-SNAPP

Funding agency:	National Center for Ecological Analysis and Synthesis (NCEAS)
Duration:	2020-2020
Coordination:	Institut Català de Recerca de l'Aigua (ICRA)
Leader researcher:	Vicenç Acuña
Amount for ICRA:	€ 8,394

### PROJECT

#### Integració d'estat ecològic i serveis ambientals per al disseny i priorització de mesures de gestió (EESAM)

Funding agency:	Agència Catalana de l'Aigua (ACA)
Duration:	2020-2022
Coordination:	Institut Català de Recerca de l'Aigua (ICRA)
Leader researcher:	Vicenç Acuña
Amount for ICRA:	€ 127,422

### PROJECT

#### DRYvER Securing biodiversity, functional integrity and ecosystem services in DRYing rivER networks

Funding agency:	EUROPEAN COMMISSION
Duration:	2020-2024
Coordination:	Institut National de recherche pour l'agriculture, l'alimentation et l'environnement
Leader researcher:	Sergi Sabater
Amount for ICRA:	€ 136,541.25

### PROJECT

#### Ajuts per a la contractació de personal investigador novell FI 2020

Funding agency:	Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR)
Duration:	2020-2021
Coordination:	Institut Català de Recerca de l'Aigua (ICRA)
Leader researcher:	Sergi Sabater
Amount for ICRA:	€ 22,039.84

## WATER QUALITY RESEARCH AREA

### PROJECT

**Tecnologies i avaluació del cicle integral de l'aigua (ICRA-TECH)**

Funding agency:	Agència de Gestió d'Ajuts Universitaris (AGAUR)
Duration:	2017-2021
Coordination:	Institut Català de Recerca de l'Aigua (ICRA)
Leader researcher:	Ignasi Rodríguez-Roda Layret
Amount for ICRA:	€ 36,000.00

### PROJECT

**Qualitat, dinàmica i funció dels ecosistemes aquàtics continentals (ICRA-ENV)**

Funding agency:	Agència de Gestió d'Ajuts Universitaris (AGAUR)
Duration:	2017-2021
Coordination:	Institut Català de Recerca de l'Aigua (ICRA)
Leader researcher:	Mira Petrovic
Amount for ICRA:	€ 60,216.00

### PROJECT

**EFLUCOMP: recerca de tecnologies cost-eficients basades en processos de separació, biològics i altres processos innovadors per al tractament d'efluents complexos**

Funding agency:	ACCIÓ/ RIS3CAT, Generalitat de Catalunya - Fondo Europeo de Desarrollo Regional (FEDER)
Duration:	2017-2021
Coordination:	EURECAT-CTM Centre Tecnològic
Leader researcher:	Mira Petrovic
Amount for ICRA:	€ 42,230.02

### PROJECT

**PLAS\_MED: Microplásticos y microcontaminantes en la costa Mediterránea. Toxicidad e impacto ambiental y en la salud humana**

Funding agency:	Agencia Estatal de Investigación (AEI), Ministerio de Ciencia, Innovación y Universidades (MICIU) y el Fondo Europeo de Desarrollo Regional (FEDER)
Duration:	2018-2021
Coordination:	Institut Català de Recerca de l'Aigua (ICRA)
Leader researcher:	Sara Rodríguez Mozaz
Amount for ICRA:	€ 159,720.00

### PROJECT

**Circular economy to facilitate urban water reuse in a touristic city: centralized or decentralized? (CLEAN-TOUR)**

Funding agency:	Agencia Estatal de Investigación (AEI), Ministerio de Ciencia, Innovación y Universidades (MICIU) y el Fondo Europeo de Desarrollo Regional (FEDER)
Duration:	2018-2021
Coordination:	Institut Català de Recerca de l'Aigua (ICRA)
Leader researcher:	Joaquim Comas
Amount for ICRA:	€ 181,500.00

### PROJECT

**Qualitat, dinàmica i funció dels ecosistemes aquàtics continentals (ICRA-ENV)**

Funding agency:	Agència de Gestió d'Ajuts Universitaris (AGAUR)
Duration:	2017-2021
Coordination:	Institut Català de Recerca de l'Aigua (ICRA)
Leader researcher:	Mira Petrovic
Amount for ICRA:	€ 60,216.00

### PROJECT

**Ajuts per a la contractació de personal investigador novell FI 2019**

Funding agency:	Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR), Departament d'Universitats, Recerca i Societat de la Informació, Generalitat de Catalunya amb cofinançament del Fons Social Europeu (FSE)
Duration:	2019-2020
Coordination:	Institut Català de Recerca de l'Aigua (ICRA)
Leader researcher:	Sara Rodríguez Mozaz
Amount for ICRA:	€ 20.402.72

### PROJECT

**REWATERGY Sustainable Reactor Engineering for Applications on the Water-Energy Nexus**

Funding agency:	EUROPEAN COMMISSION
Duration:	2019-2023
Coordination:	Universidad Rey Juan Carlos
Leader researcher:	Sara Rodríguez
Amount for ICRA:	€ 0.00

### PROJECT

**SCHEME Sewage chemical information mining - development of a novel concept for the assessment of human exposure to pollutants through wastewater analysis**

Funding agency:	EUROPEAN COMMISSION H2020
Duration:	2019-2021
Coordination:	Institut Català de Recerca de l'Aigua (ICRA)
Leader researcher:	Ivan Senta
Amount for ICRA:	€ 160.932.48

### PROJECT

**ENVIROSTOME Exploring the contribution of bacteriophages to the emergence and spread of antibiotic resistance in environmental settings**

Funding agency:	EUROPEAN COMMISSION (REA)
Duration:	2019-2021
Coordination:	Institut Català de Recerca de l'Aigua (ICRA)
Leader researcher:	José Luís Balcázar
Amount for ICRA:	€ 170,121.60

### PROJECT

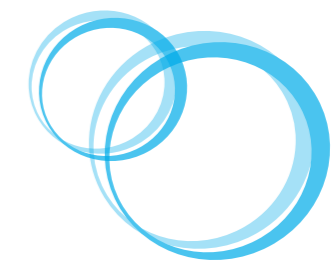
**BIOaccumulation of toxic contaminants in biofilms exposed to microPLASTics in aquatic mesocosms. (BioPlast)**

Funding agency:	AGAUR
Duration:	2019-2021
Coordination:	Institut Català de Recerca de l'Aigua (ICRA)
Leader researcher:	Sara Rodríguez Mozaz
Amount for ICRA:	€ 113,738.89

### PROJECT

**NOWELTIES: Joint PhD Laboratory for New Materials and Inventive Water Treatment Technologies. Harnessing resources effectively through innovation**

Funding agency:	EUROPEAN COMMISSION
Duration:	2019-2023
Coordination:	Institut Català de Recerca de l'Aigua (ICRA)
Leader researcher:	Mira Petrovic
Amount for ICRA:	€ 862,334.64



**PROJECT**

Contribution of bacteriophages to the spread of antibiotic resistance in the environment (SfAM)

Funding agency:	Society for Applied Microbiology (SfAM)
Duration:	2020-2022
Coordination:	Institut Català de Recerca de l'Aigua (ICRA)
Leader researcher:	José Luis Balcázar
Amount for ICRA:	€ 10,850.00

**PROJECT**

Ajuts per a la contractació de personal investigador novell FI 2020

Funding agency:	Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR), Departament d'Universitats, Recerca i Societat de la Informació, Generalitat de Catalunya amb cofinançament del Fons Social Europeu (FSE)
Duration:	2020-2021
Coordination:	Institut Català de Recerca de l'Aigua (ICRA)
Leader researcher:	Sara Rodríguez Mozaz
Amount for ICRA:	€ 20,774.97

**PROJECT**

**EMERGE**  
Evaluation, control and Mitigation of the EnviRonmental impacts of shippinG Emissions

Funding agency:	EUROPEAN COMMISSION H2020
Duration:	2020-2024
Coordination:	ILMATIETEN LAITOS, Finland
Leader researcher:	Mira Petrovic
Amount for ICRA:	€ 399,968.75

**PROJECT**

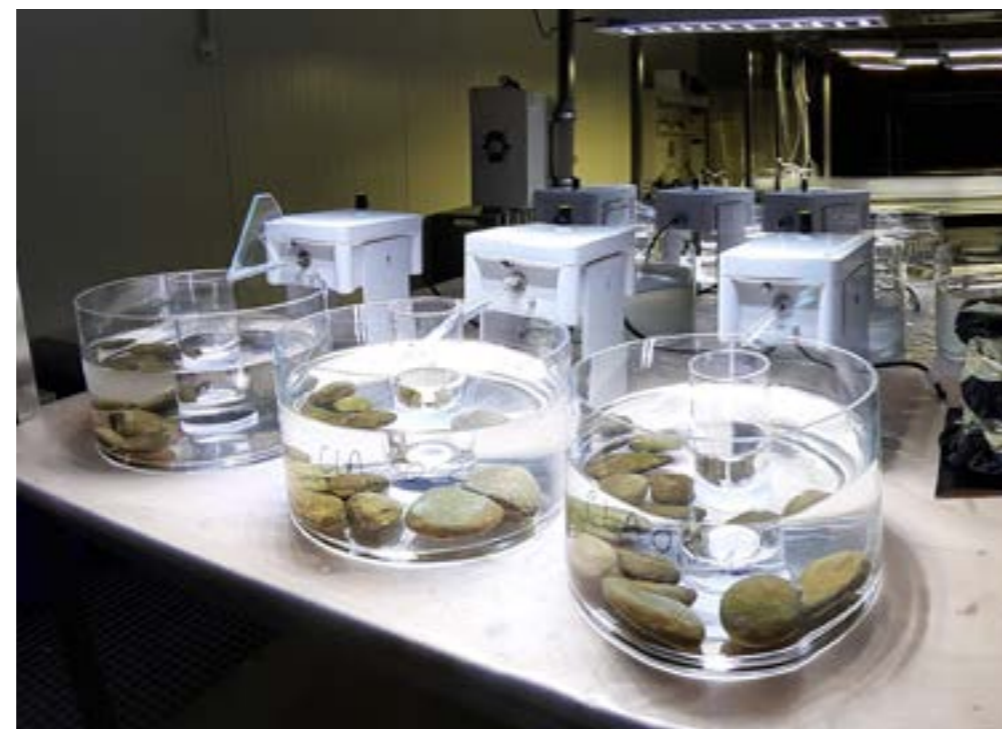
Dissemination of Antibiotic Resistance by Aquatic Birds: disentangling the contribution of microbes, bird ecology and anthropogenic pollution (DARABi)

Funding agency:	Agencia Estatal de Investigación (AEI), Ministerio de Ciencia, Innovación y Universidades (MICIU)
Duration:	2020-2023
Coordination:	Universidad de Sevilla
Leader researcher:	Carles Borrego More
Amount for ICRA:	€ 159,720.00

**PROJECT**

New tools for the evaluation of innovative water treatments at molecular level based on high resolution mass spectrometry and advanced statistical treatment (INNOTREAT)

Funding agency:	AGAUR-MSCA
Duration:	2020-2023
Coordination:	Institut Català de Recerca de l'Aigua (ICRA)
Leader researcher:	Mira Petrovic
Amount for ICRA:	€ 144,300.00



## TECHNOLOGIES AND EVALUATION RESEARCH AREA

**PROJECT**

DI17\_SCAN - Doctorat Industrial amb SCAN IBERIA (Mireia Plà Castellana)

Funding agency:	AGAUR
Duration:	2017-2021
Coordination:	Institut Català de Recerca de l'Aigua (ICRA)
Leader researcher:	Oriol Gutiérrez
Amount for ICRA:	€ 33,690.00

**PROJECT**

ELECTRON<sub>4</sub>WATER - Nanoelectrochemical systems (NES) for distributed water and wastewater treatment

Funding agency:	European Commission
Duration:	2017-2023
Coordination:	Institut Català de Recerca de l'Aigua (ICRA)
Leader researcher:	Jelena Radjenovic
Amount for ICRA:	€ 1,493,733.12

**PROJECT**

**WETSUS**

Funding agency:	WETSUS - ICRA
Duration:	2017-2020
Coordination:	Institut Català de Recerca de l'Aigua (ICRA)
Leader researcher:	Wolfgang Gernjak
Amount for ICRA:	€ 59,293.52

**PROJECT**

Tecnologies i avaluació del cicle integral de l'aigua (ICRA-TECH)

Funding agency:	Agència de Gestió d'Ajuts Universitaris (AGAUR)
Duration:	2017-2021
Coordination:	Institut Català de Recerca de l'Aigua (ICRA)
Leader researcher:	Ignasi Rodríguez-Roda Layret
Amount for ICRA:	€ 36,000.00

**PROJECT**

EFLUCOMP: RECERCA EN TECNOLOGIES COST-EFICIENTS BASADES EN PROCESSOS DE SEPARACIÓ, BIOLÒGICS I ALTRES PROCESSOS INNOVADORS PER AL TRACTAMENT D'EFLUENTS COMPLEXES

Funding agency:	ACCIÓ/ RIS <sub>3</sub> CAT, Generalitat de Catalunya - Fondo Europeo de Desarrollo Regional (FEDER)
Duration:	2017-2021
Coordination:	EURECAT-CTM Centre Tecnològic
Leader researcher:	Mira Petrovic
Amount for ICRA:	€ 42,230.02

**PROJECT**

Estudio de la utilización de rechazos de potabilización ricos en NO<sub>3</sub> para el control de olores, toxicidad y corrosión en redes de saneamiento.FACSA\_Nules

Funding agency:	FACSA
Duration:	2018-2020
Coordination:	FACSA
Leader researcher:	Oriol Gutiérrez
Amount for ICRA:	€ 20,201.00



**PROJECT****EcoAdvisor - (EcoAdvisor for Wise Leadin Water Management)**

Funding agency: Aigües de Catalunya

Duration: 2018-2021

Coordination: Aigües de Catalunya

Leader researcher: Lluís Corominas

Amount for ICRA: € 80,000.00

**PROJECT****life NEWBIES - Nitrogen Extraction from Water By an Innovative Electrochemical System**

Funding agency: LIFE programme of the European Union

Duration: 2018-2021

Coordination: WETSUS

Leader researcher: Maite Pijuan

Amount for ICRA: € 162,179.00

**PROJECT****CARBOLOCKDOWN**

Funding agency: Funding agency: CETAQUA

Duration: 2020-2021

Coordination: CETAQUA

Leader researcher: Maite Pijuan

Amount for ICRA: € 6,000.00

**PROJECT****SCOREwater: Smart City Observatories implement RESilient Water Management**

Funding agency: Call H2020-SC5-2018-2

Duration: 2019-2023

Coordination: IVL (Sweden)

Leader researcher: Lluís Corominas

Amount for ICRA: € 388,511.75

**PROJECT****ACA\_COVID-19**

Funding agency: Agència Catalana de l'Aigua (ACA)

Duration: 2020-2020

Coordination: Agència Catalana de l'Aigua (ACA)

Leader researcher: Carles Borrego

Amount for ICRA: € 39,300.00

**PROJECT****Xarxa de vigilància de SARS-CoV-2 en aigües residuals de Catalunya**

Funding agency: Agència Catalana de l'Aigua (ACA)

Duration: 2020-2020

Coordination: Agència Catalana de l'Aigua (ACA) - Agència de Salut Pública de Catalunya, Generalitat de Catalunya

Leader researcher: Carles Borrego

Amount for ICRA: € 39,300.00

**PROJECT****DESENVOLUPAMENT D'EINES PER AL SUPORT EN LA IMPLEMENTACIÓ I GESTIÓ DE LA REUTILITZACIÓ (SUGGEREIX)**

Funding agency: Agència Catalana de l'Aigua (ACA)

Duration: 2020-2022

Coordination: EURECAT (CTM)

Leader researcher: Wolfgang Gernjak

Amount for ICRA: € 65,606.85

**PROJECT****iWAYS - Innovative WATER recoverY Solutions through recycling of heat, materials and water across multiple sectors**

Funding agency: EUROPEAN COMISSION

Duration: 2020-2024

Coordination: UNIVERSITA DEGLI STUDI DI MODENA E REGGIO EMILIA

Leader researcher: Wolfgang Gernjak

Amount for ICRA: € 583,980.00

**PROJECT****Ajuts per a la contractació de personal investigador novell FI 2020**

Funding agency: Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR), Departament d'Universitats, Recerca i Societat de la Informació, Generalitat de Catalunya amb cofinançament del Fons Social Europeu (FSE)

Duration: 2020-2021

Coordination: ICRA

Leader researcher: Gianluigi Buttiglieri

Amount for ICRA: € 23,774.97

**PROJECT****Ajuts per a la contractació de personal investigador novell FI 2020**

Funding agency: Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR), Departament d'Universitats, Recerca i Societat de la Informació, Generalitat de Catalunya amb cofinançament del Fons Social Europeu (FSE)

Duration: 2020-2021

Coordination: ICRA

Leader researcher: Joaquim Comas Matas

Amount for ICRA: € 23,774.97

**PROJECT****Analysis of antibiotic resistance and micropollutants biotransformation: bioRGO-enhanced anaerobic MBR and elucidation of degradation products (ANTARES)**

Funding agency: Agencia Estatal de Investigación (AEI), Ministerio de Ciencia, Innovación y Universidades (MICIU)

Duration: 2020-2023

Coordination: Universidade de Santiago

Leader researcher: Jelena Radjenovic

Amount for ICRA: € 137,335.00





# 06

## CONTRACTS

TOTAL AMOUNT 2020:  
**€ 679,305.29**

**CONTRACT:**

NEIKER\_Antifungicos (Monitoreo del impacto agudo de la adición de antifúngicos en el control de l banda en Pinus radiata sobre los ecosistemas fluviales)

Contracting Entity: NEIKER

Duration: 2019-2020

Leader researcher: Sabater Cortes, Sergi

**CONTRACT:**

NILSA (evaluación de propuestas de mejora para los ríos receptores de efluentes de aguas residuales tratadas en la comunidad foral de navarra)

Contracting Entity: NILSA

Duration: 2019-2020

Leader researcher: Sabater Cortes, Sergi

**CONTRACT:**

EcoAdvisor (Desarrollo de una plataforma web y App para la asistencia a la operación EDARs, basada en criterios ambientales y ecosistémicos (EcoAdvisor for Wise Leadin Water Management)

Contracting Entity: Aigües de Catalunya

Duration: 2018-2020

Leader researcher: Corominas Tabares, Lluís

**CONTRACT:**

STARNIT (Seguimiento mediante herramientas de biología molecular FISH y pirosecuenciación de las poblaciones presentes en los reactores de nitrificación parcial y anammox en el proyecto STARNIT "Nueva estrategia de control de poblaciones basada en el FNA para procesos integrados de nitrificación parcial-Anammox")

Contracting Entity: ACCIONA AGUA S.A.

Duration: 2019-2020

Leader researcher: Pijuan Vilalta, Maite

**CONTRACT:**

NDMA\_Licitacio (Servicios de investigación, presencia y eliminación de precursores de NDMA en ETAP)

Contracting Entity: Canal de Isabel II S.A.

Duration: 2019 - 2022

Leader researcher: Farre Olalla, Maria Jose

**CONTRACT:**

TRAGSATEC\_licitacio (Servicio de Asesoramiento Experto Senior en Limnología Aplicada Para La Revisión de Las Condiciones de Referencia de Las Masas de Agua de La Categoría Ríos y Lagos)

Contracting Entity: TRAGSATEC

Duration: 2019-2023

Leader researcher: Sabater Cortes, Sergi

**CONTRACT:**

AUDITORIES ENAC (Auditories ENAC)

Contracting Entity: ENAC

Duration: 2015- until term

Leader researcher: Sabater Cortes, Sergi

**CONTRACT:**

FACSA\_Nules .Estudio de la utilización de rechazos de potabilización ricos en NO<sub>3</sub> para el control de olores, toxicidad y corrosión en redes de saneamiento

Contracting Entity: FACSA

Duration: 2018 -2020

Leader researcher: Gutierrez Garcia Moreno, Oriol

**CONTRACT:**

Sulfelox\_RU. Scientific collaboration between ICRA and Ryerson University (RU) to test the effectiveness of the Sulfelox product developed by RU

Contracting Entity: University Ryerson

Duration: 2019-2020

Leader researcher: Gutierrez Garcia Moreno, Oriol

**CONTRACT:**

CTFC\_Life\_ALNUS. Projecte de transferencia CTFC tasques projecte Life\_ALNUS

Contracting Entity: CTFC

Duration: 2020-2021

Leader researcher: Sabater Cortés, Sergi

**CONTRACT:**

CEC\_BESOSTORDERA. Consorci besos tordera CEC\_BESOSTORDERA

Contracting Entity: Consorci Besós Tordera

Duration: 2020-2021

Leader researcher: Rodriguez Roda Layret, Ignasi

**CONTRACT:**

ACCIONA\_Life\_DREAMER. Análisis de Ciclo de Vida (ACV) ambiental y de costes de un sistema de desalinización de alta conversión en agua de mar

Contracting Entity: ACCIONA AGUA S.A.U.

Duration: 2020

Leader researcher: Corominas Tabares, Lluís

**CONTRACT:**

ACA\_COVID-19. Programa de detecció anticipada COVID-19 en les aigües residuals urbanes a Catalunya: consultoria tècnica especialitzada per a la integritat i qualitat del procés.

Contracting Entity: Agencia Catalana de l'Aigua - ACA

Duration: 2020

Leader researcher: Borrego Morè, Carles  
Corominas Tabares, Lluís

**CONTRACT:**

ACA\_TRAÇA. Traçabilitat de les fonts de contaminació de substàncies prioritàries i contaminants emergents en trams fluvials rellevants, i mesures de millora en el sanejament urbà al Baix Llobregat

Contracting Entity: Agència Catalana de l'Aigua-ACA

Duration: 2020-2022

Leader researcher: Acuña Salazar, Vicenç

**CONTRACT:**

Cetaqua\_CARBOLOCKDOWN. Medición de emisiones directas de GEI en EDAR - CARBOLOCKDOWN

Contracting Entity: Cetaqua

Duration: 2020-2021

Leader researcher: Pijuan Vilalta, Maite





# 07

## AGREEMENTS

01/01/2020

**ICREA**

This agreement sets out the framework for joint working between ICREA and ICRA in relation to research proposals put forward by ICRA and approved by ICREA by means of the secondment of ICREA research personnel to ICRA.

02/01/2020

**Universitat de Girona**

Renewal of agreement for secondment for Research of Dr Sergi Sabater to ICRA for a period of four years.

02/01/2020

**Universitat de Girona**

Renewal of consent to management position of Dr Sergi Sabater as sub-director of ICRA.

13/01/2020

**PSIPW**

Scientific collaboration agreement with the Prince Sultan Abdulaziz International Prize for Water - PSIPW Saudi Arabia, for collaboration in relation to activity carried out in the framework of the ICRAPHE and HSMS conferences held in the course of 2020.

23/01/2020

**University of New South Wales**

Agreement for scientific collaboration and management of the patent for the 'Rend-cap device. Self-assembling membrane housing for low pressure water filtering applications' between UNSW-UDG-ICRA.

05/02/2020

**ISGlobal**

Agreement for the management and transport of samples as part of ERC Expo-Hum (ISGlobal).

27/02/2020

**PINT OF SCIENCE - Association for the popularisation of science**

Collaboration for the holding of PINT of SCIENCE - Spain 2020 (May 2020) events.

01/03/2020

**CSUC**

CSUC-ICRA agreement for the processing of personal data on the Research Portal of Catalonia.

01/03/2020

**CSUC**

Agreement to regulate the processing of personal data of ICRA researchers by CSUC in the context of the Research Portal of Catalonia (PCR) setting out the respective duties and obligations of the institutions.

03/03/2020

**Companyia Gral d'Aigües de Catalunya (General Water Company of Catalonia)**

Extension until 31/03/2021 of the agreement of 5 March 2018 between the institutions for the development of a web platform and APP for the operation of EDARS (Waste Water Purification Stations) in function of environmental and biodiversity principles.

11/03/2020

**Foundation of the J Gol University Institute for Primary Care Research (IDIAPJGol).**

The subject matter of this Agreement is the promotion of joint working and communication in science between the signatory institutions and, taking due account of the shared scientific interests and objectives of the institutions, in technology and culture, and the promotion and carrying on of research and knowledge transfer relating to water issues.

15/03/2020

**Foundation of the J Gol University Institute for Primary Care Research (IDIAPJGol).**

Under the Research Collaboration Agreement entered into by the Parties on 11 March 2020, IDIAPJGol, as directed by Dr IDIAPJGol is empowered to extract information from primary healthcare databases and to carry out statistical analysis as part of epidemiological studies. Sewage epidemiology has the potential to be a great source of additional information for epidemiological studies. PROJECT SCOREWATER

06/05/2020

**Costa Brava Consortium (CCB-ELA)**

Framework Collaboration Agreement providing a structure for and coordinating the activity carried out by ICRA and CCB in applied research projects, consultancy, information exchange and similar activity concerning the treatment, management and quality monitoring of water, and the promotion of the sustainability and environmental effectiveness of processes.

11/05/2020

**CCB- Girona Provincial Council**

The purpose of this framework collaboration agreement is to provide a structure for and to coordinate the activity carried out by ICRA and CCB in research projects, consultancy, and information exchange, in relation to the treatment, management and quality of water.

20/05/2020

**Università di Salerno**

Agreement with the University of Salerno entered into under the ERASMUS PROGRAMME: TRAINESHIP 2020-2025.

02/06/2020

**ACCIONA-AGUA (ACTION WATER)**

Service contract regulating collaboration between ACCIONA-AGUA and ICRA (Assessment and Technology Department) as contractor for the performance and implementation of the 'Life Dreamer: Demonstration Of An Environmentally-Friendly Desalination Systems Concept: Transforming Seawater Into Valuable Resources' research project.

22/06/2020

**CCB- SERVEIS MEDIAMBIENTALS SAU (CCB- ENVIRONMENTAL SERVICES LTD)**

This agreement regulates a study of the incidence of emerging contaminants in the environment in the context of the activity of the Besòs Tordera Consortium.

31/07/2020

**MATELCO**

Agreement and terms and conditions for the hire of a HACH FL 1500 flow monitor for one and a half months for demonstration purposes (starting 14/09/2020).

01/09/2020

**NEIKER**

This contract regulates the terms and conditions of the provision of services by ICRA in the context of the provision of antifungal agent impact monitoring services for the monitoring of Black Band disease in Monterrey pines in river ecosystems in counties affected by Dothistroma needle blight.

13/10/2020

**Central Subsupplies Commission - Gencat**

Collaboration agreement regulating the terms and conditions of participation by ICRA in the Central Goods and Services Procurement System of the Generalitat of Catalonia.

13/10/2020

**Technical University of Munich- Universitat de Girona**

Specific collaboration agreement for the carrying out of doctoral theses under the umbrella of the NOWELTIES project.

14/10/2020

**Ministry for Universities**

Agreement for the management of grants in the context of the subprogrammes for Training and Mobility in the National Programme for the Promotion of Talent and Employability under the National Scientific and Technical Research Plan 2017-2020.

27/11/2020

**Universitat de Barcelona**

Educational cooperation agreement for external academic practice of UB students at collaborating bodies.

03/12/2020

**AGAUR**

Specific agreement regulating the processing of personal data in the context of the competitive processes managed by AGAUR.

18/12/2020

**ACA - Competitive Tender CTN2oA0533 Lot 1**

Services Contract in the context of the Competitive Tender Technical Assistance Prior to the Drafting of the Management Plan and the Programme of Measures in the Third Cycle of Hydrological Planning. Lot 1: Analysis of the Scope for Improvement of Urban Cleaning and Studies of the Traceability of Sources of Pollution of Industrial Origin and Emerging Contaminants

30/12/2020

**NEIKER**

Twelve months' extension to the contract dated 1/09/2020 entered into with NEIKER that regulates the terms and conditions of the provision of services by ICRA in the context of the provision of antifungal agent impact monitoring services for the monitoring of Black Band disease in Monterrey pines in river ecosystems in counties affected by Dothistroma needle



# 08

## OTHER DISSEMINATION ACTIVITIES

08/01/2020

### ICRA took part in CWP's inaugural Water Talks on Microplastics

ICRA researcher Sara Rodríguez took part in the Catalan Water Partnership's (CWP) Water Talks, a new format of technical sessions to discuss technology, challenges and trends relevant to the water industry. Microplastics were the theme of the inaugural event. The session was held at the Universitat de Barcelona with the involvement of the University's Water Research Institute (IdRA) and brought together 60 people, including notably many researchers in the water field who are working on or have an interest in the study of microplastics.

Pieces of plastic, fibres and granules (microplastics) are classified as emerging contaminants. They are currently among the most significant and continue to grow. Microplastics generate considerable environmental impact, particularly when they reach continental or ocean waters. They have also been detected in wastewater and even drinking water.

The session was split into two parts, the first with presentations by organisations associated with the cluster such as the Dr Oliver Rodés Laboratory, Aqualia, Leitat and Aigües de Barcelona that set out the principal challenges in the analysis of microplastics, ways of reducing the risk associated with plastics, experience gained and ongoing projects, and the study of microplastics in drinking water. The second part was a roundtable with Sara Rodríguez and five researchers from universities and research centres that are members of CWP. UB, IDAEA-CSIC, EURECAT, ICTA-UAB, URV and ICRA. The main themes brought out were trends and future challenges in microplastics

21/01/2020

### International scientists are warning us about the actual and potential risks of emerging contaminants in water.

Every day, millions of people are supplied with drinking water that contains many contaminants, including contaminants from human and animal waste, pesticides, from wear and tear to water pipes and water infrastructure and maintenance failures. Population growth has led to growth in the use of products that contain large numbers of chemical compounds. In fact, 4,000 new substances are added to the official catalogue of chemical compounds every day. Because of the difficulty of doing so, emerging contaminants are generally not monitored, despite

the real possibility that they may adversely affect human health and ecosystems and despite the fact that they end up in wastewater.

A working group of European scientists flagged in a recently published document the need to deal with the progressive increase in levels of emerging contaminants in water and warned of the potential risks to human health. Similarly, they said that there needs to be an exhaustive review of current legislation in order to adopt proactive measures to quantify the increase in emerging contaminants and ensure the sustainability of the water cycle with water suitable for reuse, to the benefit of the environment and the general public.

The scientists, of internationally recognised standing in the field, formed a working groups coordinated by the Water Joint Programming Initiative (Water JPI) in order to review, identify loopholes and bring together existing knowledge on the behaviour of emerging contaminants in the environment... and their long-term impact on the health and lives of ecosystems and people.

As a result of this work, a report has just been published that provides a snapshot of current knowledge of emerging contaminants, existing detection methods and treatment options along with some key messages to continue to move towards a solution. The intention is for the report to stimulate debate and collaboration among all stakeholders to bring about the necessary change. To accompany the report, the working group provided a series of infographics distributed via social media to foster public debate about the problem of emerging contaminants.

"It is crucial to act and disseminate the knowledge to meet the challenge, informing decision-makers, law-makers and other stakeholders about recent scientific advances and innovations" said Dominique Darmendrail, coordinator of the Water JPI and the French Research Funding Agency, ANR.

Spain is leading the way in research into emerging contaminants. The Water JPI working group included Damià Barceló, Director of the Water Research Institute of Catalonia (ICRA), Javier Marugán, professor and researcher at the Universidad Rey Juan Carlos I and Ignasi Rodríguez-Roda, ICRA researcher and professor at the Universitat de Girona.

Among other examples from within Spain, a recent study carried out in collaboration between the Universidad Rey Juan Carlos I and the Universidad Politécnica de Madrid, the Universidade Catolica Portuguesa, FCC Aqualia and IDAEA-CSIC, published in the international journal Science of The Total Environment, analysed the elimination of antibiotic substances and antibiotic resistance genes in urban wastewater purification processes. The worked ca-

ried out at a purification plant allowed an assessment to be made of the large-scale use of different advanced treatment processes based on the use of UV light, both alone and in combination with oxidants such as hydrogen peroxide (oxygenated water) and peroxymonosulfate. The results showed the potential of those processes to eliminate both antibiotics and genes. However, the operating conditions for treatment have to be accurately optimised to achieve successful treatment whilst keeping water purification costs down.

The report is available on the Water JPI's website.

#### About Water JPI

The work of Water JPI is aimed at tackling the ambitious challenge of creating water systems for a sustainable economy in Europe and further afield. It uses a multidisciplinary approach that takes into account economic, environmental social and technical issues.

In March 2019, Water JPI had 23 full member countries and three observer countries, that in aggregate represent 88% of public sector investment in water resources. Eleven of them are contributing to the Knowledge Hub on Contaminants of Emerging Concern (KHCEC).

Water JPI has received finance from the European Union's Horizon 2020 Programme for Research, Technological Development and Demonstration under Grant Agreement 689271 (WaterWorks2015)

30/01/2020

### Official visit of Minister Àngels Chacón to ICRA.

Minister for Business and Knowledge, Àngels Chacón, this morning visited the H<sub>2</sub>O Building of the Catalan Institute for Water Research (ICRA) at the Universitat de Girona's Science and Technology Park.

Accompanied by Provincial Councillor for Business and Knowledge, Josep Planco, and the Rector of the Universitat de Girona, Jaouim Salvi, the Minister was welcomed by ICRA's management and its research team. In the course of the meeting, the Minister was given an overview of the type of research done at ICRA and the Institutes's successes domestically and internationally in the two years that it has existed.

Àngels Chacón then signed ICRA's Book of Honour and the meeting ended with a guided tour of the laboratories and pilot plant at ICRA's headquarters.



11/02/2020

### INTERNATIONAL DAY OF WOMEN AND GIRLS IN SCIENCE 2020

ICRA

The International Day of Women and Girls in Science is 11 February. It was introduced in 2015 by the UN under Resolution 70/474/Add.2.

The aim is to promote the full participation on equal terms of women and girls in education, training, employment and decision-making processes in the sciences, eliminate all discrimination against women, including in the field of education and employment, and overcome legal, economic, social and cultural barriers through science education policies and programming to encourage greater participation of women and girls and recognise their achievements.

The Day is part of Sustainable Development Goal Number 5 of Agenda 2030, the aim of which is to achieve gender equality and to empower all women and girls. According to a study carried out in 14 countries, the likelihood of female students completing an undergraduate or master's degree or a doctorate in a subject related to science is 18%, 8% and 2% respectively, whilst the probability for male students is 37%, 18% and 6%.

The gender gap in STEM – science, technology, engineering and maths – continues to exist worldwide.

ICRA did not want to miss the opportunity to remind everybody of these objectives.



12/02/2020

### Talk: 'Intuition and evidence in ecology: the legacy of Ramon Margalef for a world in change'

Barcelona

Talk: 'Intuition and evidence in ecology: the legacy of Ramon Margalef for a world in change', held by the Friends of UNESCO in Barcelona.

Talk given by Dr Sergi Sabater, a pupil of Ramon Margalef.

Professor in the Department of Ecology (1991-2001) at the Universitat de Barcelona.

From 2003, he was Professor of Ecology at the Universitat de Girona. Member of ICRA from 2009, of which he was to be Subdirector and head of the Resources and Ecosystems Department.

He has been joint editor of a number of books and has published more than 250 articles on ecology in international scientific journals and elsewhere. He has supervised 21 Doctoral theses. His research is focused on the ecology of river ecosystems, particularly the effects of climate change as it relates to water scarcity and excess nutrients, water system disruption and the presence of toxic substances.

14/02/2020

### Formation of ICRA Sustainability Committee.

People working at ICRA, mainly pre- and post-doctoral researchers, have formed the ICRA Sustainability Committee, which has been warmly welcomed by ICRA management.

The aim of the Committee is to try to ensure that our workplace is sustainable by drawing up, putting forward and implementing sustainability measures at the centre. The principal objective is to raise awareness of sustainability. As scientists, we believe that it is our duty to take on this responsibility.

The objective of the Committee is to make ICRA as a workplace 100% sustainable and carbon-free by 2050.

The Committee works on the identification of simple sustainable solutions for existing problems.

Objectives:

- To detect, provide information and raise awareness among ICRA's staff of the use of plastic, electricity, water, waste management, recycling,...
- To promote sustainable transport through carpooling, to promote cycling as a form of transport.
- To make the built environment more sustainable (climate control, water and electricity consumption)

- To hold regular meetings for all ICRA staff to give them information about ideas and progress

The current members of the Committee are:

- Giannis Florjan Norra – Pre-doctoral researcher
- Daniel Mercado – Post-doctoral researcher
- Didac Jorda – Post-doctoral researcher
- Duygu Tolunay – Pre-doctoral researcher
- Esther Mendoza Perdiguero – Pre-doctoral researcher
- Gianluigi Buttiglieri – Research scientist (RyC)
- Juan David Gonzalez – Pre-doctoral researcher
- Laura Castañares Pérez – Research Technician
- Michele Ponzelli – Pre-doctoral researcher
- Nick Duinslaeger – Pre-doctoral researcher
- Nikoletta Tsiarta – Pre-doctoral researcher
- Oriana Llanos – Pre-doctoral researcher
- Vicenç Acuña – Research Scientist

17/02/2020

### Doctoral Thesis Defence Joanna Castellar. WETWALL an innovative design concept for the treatment of urban wastewaters

Universitat Politècnica de Catalunya (UPC).

Joana Castellar, research technician at the Catalan Institute for water research (ICRA), presented her PhD thesis entitled "WETWALL an innovative design concept for the treatment of urban wastewaters

The defense of the PhD thesis took place 17th of February at the Universitat Politècnica de Catalunya (UPC).

Gianluigi Buttiglieri, research from the Catalan institute for water research (ICRA) was the president of the evaluation committee together with Pascal Mole from Irstea (France) and Ana Lacasta (UPC).

The PhD thesis obtained the mark of excellent cum laude.

The WETWALL proposes a unique ecotechnology for secondary wastewater treatment at an urban scale, which brings the novelty of a modular living wall hybrid flow based on the integration of two well established NBS: constructed wetlands and a modular living walls. In addition, the design includes circular economy principles by encouraging the reuse of local by-products as filtering substrates.

The development of the WETWALL design was supported by the National Council for Scientific and Technological Development (Brazil), UNESCO Chair on Sustainability and GICITED groups (Universitat Politècnica de Catalunya - Spain), DIOPMA group

(Universitat de Barcelona - Spain), Aarhus University (Denmark), research group GREA (Universitat de Lleida - Spain), Universitat Pompeu Fabra (Spain), Catalan Institute of Cork (Spain), Ytong S.a., Eixvered (Spain), Aldufreu associats (Spain, Viver tres turons (Spain)."

19/02/2020

### A study has shown that the Llobregat and Besòs rivers discharge approximately half a tonne of plastic into the sea every year

Recent research into the amount of floating litter at the mouths of the Llobregat and the Besòs, near the city of Barcelona, estimated that the two rivers discharge 0.4-0.6 tonnes of plastic into the sea each year.

The research was carried out by IDAEA-CSIC, ICRA, CEIMAR-INMAR-Universidad de Cádiz, European Commission-JRC and the Clean Countryside Association. It was carried out in the framework of project RIMMEL led by the European Commission's Joint Research Centre. It is a response to the need to quantify the volumes of floating litter discharged from continental waterways into the sea.

Given that the majority of marine waste comes from land, rivers are key to the quantification of the waste that ends up in the sea. The aim of the research was to gather as much data as possible, to create a statistical model of the most common floating litter to support the development of strategies to mitigate the problem of marine waste in the future.

Both rivers were sampled from October 2016 to September 2017. The method used was to observe the surface layer of water for 30-60 minutes each week from a raised position close to the mouth of the river. The aim was to identify and use an app specifically developed for the project to categorise pieces of floating litter equal to or greater than 2.5 cm (so-called macro litter), as classified in the list of items described in the Marine Strategy Framework Directive.

Over the whole year, 684 items were identified across both rivers that were classified in accordance with Project RIMMEL into the following categories: plastic, paper, metal, rubber, textiles and wood. The results were similar for the two rivers, and plastic was the most frequently observed category of floating litter: 67.7% in the Llobregat and 50.5% in the Besòs. The most frequent waste types were packaging, pieces of plastic, plastic bottles and plastic bags. Items that are consistent with the 17 rivers round the Mediterranean sampled under Project RIMMEL.

The results were obtained by extrapolating from



the width sampled to the whole width of the river and the sampling time was standardised to express the flow of classified waste per hour. It was estimated that approximately 0.4-0.6 tonnes of plastic are discharged in the course of a year by the two rivers into the Mediterranean.

Possible sources of the observed floating litter pollution are fundamentally towns and cities and leisure activities and, to a lesser extent, industry.

The data are important, but are still just an initial step. There is a need for continued research to identify the causes and sources of waste along the Llobregat and the Besòs and to apply different methodologies to provide alternative findings to set alongside the data provided by this study on floating macrolitter and to quantify non-floating litter found along the length of a river.

The research has been reported as 'Riverine anthropogenic litter load to the Mediterranean Sea near the metropolitan area of Barcelona, Spain' in the scientific journal *Science of the Total Environment*.

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21/02/2020

### Damià Barceló, ICRA's Director, is to be awarded an honorary degree by the Universitat de Lleida.

The Council of the Universitat de Lleida has approved Rector Jaume Puy's proposal to award an honorary doctorate to the Director of the Catalan Institute for Water Research (ICRA), Damià Barceló.

Damià Barceló has an honorary doctorate from the University of Ioannina (Greece). He was also awarded the Jaume I Environmental Protection Prize (2007); Saudi Arabia's Prince Sultan Bin Abdulaziz International Water Prize (2012) and the Recipharm International Environmental Prize (2012) awarded by a Europe-leading Swiss pharmaceutical manufacturer.

Damià Barceló will be sponsored by Professor Ramon J. Batalla of the Department of the Environment and Earth Sciences on 29 April at 6 pm at the Universitat de Lleida.

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27/02/2020

### NOWELTIES has been featured on Serbian television.

The NOWELTIES project, led by ICRA, the Institute of Physics and the Faculty of Technology and Metallurgy at the University of Belgrade, was featured in the Serbian television programme, Brainz TV. Two of NOWELTIES ESRs, Amit Kumar and Barbara Kalebić, were interviewed with their supervisors, Dr Puac, Dr Skoroc, Dr Rajic, and Dr Povrenovic.

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12/03/2020

### ICRA Seminar: Macrolide antibiotics in the environment - importance of comprehensive chemical characterization

Seminar on Macrolide antibiotics in the environment and the importance of comprehensive chemical characterisation led by Dr Ivan Senta, Marie Curie Research Fellow - Quality Area ICRA.

WHERE: Auditorium of ICRA (Science and Technology Park of the Universitat de Girona – Emili Grahit, 101 – 17003 Girona) DATE AND TIME: 12 March 2020, 10 am.

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27/04/2020

### Survey of use of single-use wipes and sanitisation habits during COVID-19 lockdown.

At the moment, we are spending more time at home and perhaps we have changed our habits and are using more personal hygiene products, which may have an impact on sewerage networks and the whole water cycle. To find out the actual effects of COVID-19 lockdown Consortium of the Barcelona Institute for Regional and Metropolitan Studies (IERMB), researchers at the Consortium of the Barcelona Institute for Regional and Metropolitan Studies with the support of the Catalan Institute for Water Research launched research home sanitisation habits and drew up a questionnaire for all residents of Catalonia over the age of 16.

The research was conducted in the framework of a European project SCOREwater focused on the management of wastewater and early incident detection.

In accordance with the Spanish Data Protection Act 2018, the personal data of participants will be processed solely and exclusively for the study. The data controller is the SCOREwater consortium. For further information on the processing of personal data or to exercise your rights, please contact SCOREwater.

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04/05/2020

### A global study led by ICRA, the Universitat de Barcelona and the Humboldt Centre for Environmental Research, lakes and reservoirs emit large amounts of CO<sub>2</sub> into the atmosphere when they dry up.

It is decades since scientists began to realise the key role of ecosystems in the regulation of atmospheric carbon dioxide concentrations. The pieces of this

giant puzzle as yet do not quite fit together and we are still finding new pieces to fit in. An international research project led by scientists from the Catalan Institute for Water Research (ICRA), the Universitat de Barcelona (UB), and the Humboldt Centre for Environmental Research (UFZ) has just announced a surprising finding that fits a piece into the puzzle: rivers, lakes and reservoirs emit large amounts of carbon dioxide into the atmosphere when they dry up. The finding was published today in the journal *Nature Communications*.

'It all began in 2012, during a clean-up campaign on the Fluvia river,' said Biel Obrador from the Department of Evolutionary Biology, Ecology and Environmental Sciences at the Universitat de Barcelona. Together with Rafa Marcé (ICRA) and Daniel von Schiller (Universitat de Barcelona), studied the release of greenhouse gases by small stretches of the river. 'It was summer and parts of the river had dried up. Out of curiosity, we decided to take some measurements in those areas,' explained Rafa Marcé. 'The results surprised us; we were expecting to see limited biological activity because of the lack of water in these areas, but they were releasing huge amounts of carbon dioxide. We wondered whether it could be the same in other ecosystems round the world and whether we were missing an important piece to understanding the regulation of atmospheric carbon dioxide by ecosystems,' said Matthia Koschorreck from UFZ.

To answer that question, they decided to let researchers worldwide know about their findings to put in place a programme of emissions measurement in dried up river beds round the world. 'Often, as researchers we are reluctant to share ideas about future projects, because competition in the world of scientific research is intense, which encourages secrecy,' explained Rafa Marcé. 'But in this case we were clear: nobody had data about carbon dioxide emissions from dried up sediment, so if we wanted to know whether it was a global issue, we had to share the idea with everybody who wanted to take part.' That was the birth of the DryFlux network. 'We used our international contacts to convince research teams to measure carbon dioxide emissions from the dried up beds of rivers, lakes and reservoirs following a shared protocol that was straightforward enough for everyone to be able to follow,' added Núria Catalán, now at the United States Geological Service, who led the drafting of the protocol. The response surpassed expectations. A total of twenty-four research teams from round the world decided to take part. They provided measurements from ecosystems on all the continents, except Antarctica. Daniel von Schiller explained that 'we were surprised to get such a positive response. Even though the methodology and equipment were

relatively accessible for a research team, fieldwork has considerable costs and each team had to bear its own costs, we didn't have the resources to cover all those expenses.'

The data obtained were analysed by Philipp Keller, doctoral researcher at the Department of Lake Research at UFZ and first named author of the study. 'We found significant carbon dioxide emissions from dry areas of fresh water ecosystems in all climatic zones,' said Keller. 'So it's truly a global phenomenon. If we add these emissions to existing estimates of global fresh water emissions, they go up by six per cent.' But what are the mechanisms underlying the release of carbon dioxide from dry sediments? 'The respiratory processes of micro-organisms,' said Philipp Keller. 'As yet we don't completely understand the underlying biological mechanisms, but it is clear that as humidity, temperature and organic matter rise, more carbon dioxide is released.' On the basis of the results of the study, the researchers concluded that the factors responsible for the release of carbon dioxide are essentially the same in all parts of the world. 'It's surprising that the sediment in a dried up mountain stream or a salt lagoon in a desert landscape respond in the same way to environmental factors like humidity and temperature, this suggests the presence of micro-organisms capable of adapting to extraordinarily diverse – and in some cases extreme – conditions,' explained Núria Catalán.

What do the results of the study mean, then, for the future assessment of the role of ecosystems in the regulation of atmospheric carbon dioxide? 'Our study has shown that there are still missing pieces in our understanding of the full carbon dioxide cycle on a planetary scale, because there are many small linkages that we need to understand if we want to predict how ecosystems are going to respond to current increases in atmospheric carbon dioxide,' said Biel Obrador, 'we hope that our work will help to ensure that dry areas of fresh water ecosystems are included in future calculations. With ongoing climate change and the impact of the human race, bodies of fresh water will dry out ever more frequently across significant areas of the planet, some of them permanently, like Central Asia's Aral Sea. That means that emissions from dry river and lake beds can only increase.' For Rafa Mercé 'this study has another message: competing is not the only, nor the best, way of doing research. Openly working together allows you to answer more ambitious questions. In these times, that is a lesson that we should all bear in mind.'

11/05/2020

**Damià Barceló, Director of ICRA, has published a critical review of the most recent COVID-19 international scientific literature from an environmental and public health perspective.**

Damià Barceló, founding Director of the Catalan Institute for Water Research (ICRA), one of the most globally cited Catalan scientists and recently awarded an Honorary Doctorate by the Universitat de Lleida (although the ceremony has yet to take place thanks to COVID-19), took advantage of lockdown to write and publish a balance sheet of the Coronavirus pandemic in the prestigious scientific journal *Journal of Environmental Chemical Engineering*.

The outcome is a profoundly insightful, critical and powerful article that summarises recent solutions and findings from studies by the author's peers from the five continents.

Going beyond the many contributions examined, Barceló's article is one of the first attempts to summarise and bring together the environmental and human health aspects of the management of COVID-19, in order to act as a multi-purpose reference, not just for scientists working in different disciplines, but also for social media and the general public. The structure of issues addressed is solid: the impact of weather (heat) and air quality on the transmission of the virus, the use of wastewater as an indicator of the scale of COVID-19 infection, analysis of existing hospital disinfection procedures and new, more eco-friendly technology and a description of available drug treatments pending the arrival of the so-longed-for vaccine.

There is one study (carried out in Wuhan) that supports the existence of an impact of weather (heat) on the transmission of COVID-19 and others against (carried out in 122 Chinese cities) and one carried out in Jakarta in which the weather, high mobility and the high density of the more than nine million inhabitants of the city led to the rapid spread of the virus.

Air quality, on the other hand, is unanimously recognised as a key factor behind the spread of COVID-19, both in the North of Italy, where infections due to air pollution-people are more frequent than person-to-person infections. A study in cities in Lombardy and Emilia Romagna indicated that air pollution made the defences of the respiratory and cardiovascular systems of the elderly more vulnerable.

Tobias/Querol's study also highlighted the immediate improvement in air quality following lockdown in Barcelona. And it agreed with Yaron Ogen's study on the correlation between nitrogen dioxide levels and mortality in 66 administrative regions in Italy, Spain, France and Germany. The methodology

of that study has been criticised, in contradiction with a similar study carried out in Taiwan.

Conversely, there is a degree of unanimity about the pollen factor as a firebreak for the flu and similar virus, thanks to a Dutch group with more than four years research into pollen and flu. That suggests a possible explanation for COVID-19's seasonality.

The Wastewater Epidemiology Indicator (WBE) has been pioneered by Christian Daughton, formerly a scientist at the US Environmental Protection Agency. Daughton has claimed that the underlying method is relevant not just for COVID-19 but also for future epidemics, because it allowed COVID-19 to first be detected in wastewater in the Netherlands, Australia and France. Other studies have also provided support for WBE and the need to reactively develop new tests to directly detect the virus in wastewater, because such tests are cheap, powerful tools to rapidly identify pathogens and determine the transmission of infections. They have been used with a large variety of infections such as malaria and other pathogens.

There are fully accredited safe techniques for the disinfection of hospitals and their staff and health workers, but new more environmentally friendly technologies are being trialled. At the same time, a study in Iran's largest hospital in March 2020 investigated the air in COVID-19 wards. Fortunately, all the samples collected were negative.

Available drug treatments are the antechamber to the hoped-for vaccine and range from antivirals, antimalarials and anti-inflammatories through, in China and India, a return to traditional plants to treat the virus, to the use of a number of clinical trials following protocols based on in vitro activity or limited clinical experience. No drug treatment has proven efficacy. The list is long: Chloroquine, Hydroxychloroquine, Lopinavir, Remdesivir, Favirapir, Azithromycin, Ivermectin, NSAIDs (non-steroidal anti-inflammatory drugs) and bronchodilators, while the vaccine is awaited.

The conclusions and recommendations arrived at by Dr Barceló can be summarised as follows. WBE can help to solve the acute problem of a lack of diagnostic tests and can be a quick, cheap way of alerting us to an outbreak of COVID-19. But WBE will always complement other tools and will not be an alternative to the essential PCR for the detection of COVID-19 in humans.

COVID-19 will be with us for some time. We now know much more than just a few months ago, but there is still a lot to be done to address this global threat. Future measures must include greater monitoring of the environment, both air and water, as well as the availability of the ELISA rapid biosensor in order to protect the general population and wastewater.

In Spain up to now, 15% of people infected with COVID-19 are doctors and healthcare workers. The

PPE (personal protective equipment) supply chain must be secure to reduce mortality. We need strategic plans for the global manufacture of, access to and protection and monitoring of supply chains in the face of inevitable cutbacks, cost increases and national stockpiling.

In summary, there is still much work to be done. This review helps not just scientists but also the general public who want to know a little more about the new and terrifying coronavirus that will be keeping us all busy for quite some time in the years to come.

29/05/2020

**Doctoral Thesis Defence of Lucia Gusmaroli: occurrence, fate and behaviour of emerging micropollutants in wastewater and the receiving environment**

On Monday 25 May, Lucia Gusmaroli defended her doctoral thesis 'Analysis, occurrence fate and behaviour of emerging micropollutants in wastewater and the receiving environment', directed by Dr Mira Petrovic (ICRA-ICREA) and Dr Gianluigi Buttiglieri (ICRA).

The presence of microcontaminants in the aquatic environment has caused great environmental concern. The European Union is reviewing its legislation to address the problem. A total of 17 emerging contaminants, candidates for inclusion in the priority substances list, have been added to the Watch List. All Member States must monitor them to gather data about their presence in fresh water.

The principal objective of Lucia Gusmaroli's thesis was to fill in the gaps in our knowledge of compounds on the Watch List (Decision EU 2015/495) at three levels: analysis, monitoring and elimination.

First, a method of analysis was developed based on SPE on line-UHPLC-MS/MS to simultaneously identify Watch List compounds both in fresh water and in wastewater (effluent and influent).

That method was used to monitor Watch List compounds in the Ebro delta, an area of great environmental and economic importance. The results showed that the extent of contamination in fresh water is not negligible, with total concentrations up to 2.39 mg/L. Pesticides were detected in all the fresh water samples and drugs were the category that caused the majority of pollution. Azithromycin and diclofenac were the compounds with the highest concentrations. The concentrations of the compounds investigated were above the set PNEC (predicted no-effect concentration) levels in the majority of samples.

At the same time, eight Watch List substances were studied in (bio)degradation experiments, with dual objectives of examining their elimination in conventional active mud systems and assessing the ope-

ration parameters for the WWPSs with the aim of improving rates of elimination. Maximum elimination was confirmed in aerobic conditions, at high temperatures (25°C), higher concentrations of biomass (5 g/L) and raised pH (7.5) and the parameters with greatest impact on rates of elimination were biomass concentration and redox conditions.

Generally speaking, the results presented in the thesis showed that Watch List substances are currently only partially eliminated in conventional treatment, leaving room for improvement. It should be noted that Watch List substances may be an environmental threat at the concentrations at which they occur, as confirmed by the results from monitoring.

19/06/2020

**Survey published to promote the harmonisation of terminology in Nature-Based Solutions (NBS)**

EdiCitNet and the Catalan Institute for Water Research (ICRA), with the support of COST ACTION Circular City, have drawn up a questionnaire with the aim of harmonising the terminology used for Nature-Based Solutions (NBS) within the scientific community. The questionnaire can be found at Oppla by following this link. There is more information there as well as the questionnaire itself that can be completed in 5-10 minutes.

The aim is to move towards a situation in which terminology ceases to be an issue for the dissemination of NBS and in which the scientific community all speaks the same nature-based language in the near future.

07/07/2020

**Damià Barceló took part in one of the first published worldwide critical reviews to look at the lethal effects of COVID-19 on laws against plastic pollution.**

Damià Barceló, Director of the Catalan Institute for Water Research (ICRA) one of the globally most cited Catalan scientists, recently nominated for an honorary doctorate from the Universitat de Lleida (ceremony delayed by COVID-19), took part in one of the first international studies into the effects of COVID-19 on the war on and laws against plastic pollution.

The study was published in the international journal *Science of the Total Environment*, under the title *Rethinking and optimising plastic waste management under COVID-19 pandemic: Policy solutions based on redesign and reduction of single-use plastics and personal protective equipment*. It was signed by a team of experts at the Universidade de Aveiro

(Portugal), Dalhousie University, Halifax (Canada) and ICRA, made up of Ana L. Patrício Silva, Joana C. Prata, Tony R. Walker, Diana Campos, Armando C. Duarte, Amadeu M.V.M. Soares, Damià Barceló and Teresa Rocha-Santos.

The study gives a reasoned summary of the current situation and existing laws on plastics and the development of public policy concerning the use of plastics and the production and management of waste during the pandemic. It recounts the principal international agreements (including the 2019 Brazil Convention; the UN Convention on the Law of the Sea, UNCLOS; the International Convention for the Prevention of Pollution from Ships, MARPOL; GESAMP and GPLM). It presents a very interesting map of the world showing the statutory limits in each country for Single-Use Plastics, adopted by the EU (Commission, Parliament and Council), the USA and in an overall total of 127 countries. And it has another map showing policies concerning prohibitions on plastic bag showing countries that have a ban or a tax. And there is a third map showing the obligatory use of face-coverings by country.

Some figures

Single-use plastics represented 46% of worldwide plastic waste in 2018. With COVID-19 that figure will go up significantly.

According to the WWF (World Wide Fund for Nature), a minimum of 10 million masks are being released into the environment every month: if only 1% of that waste is poorly managed – and in fact that figure could be at least ten times higher – that 1% represents some 30-40 tonnes of masks entering the environment every month at the least.

The higher amounts of plastic waste due to COVID-19 are being managed through landfill and incineration. That will lead to increases in greenhouse gas emissions and toxic substances.

Mask production in China increased by 450% in one month (from 20 million to 110 million in February 2020). The fabric those masks are made contains polypropylene and polyethylene that end up in microplastic microfibrils on ocean floors and in sediments.

Alongside increased production, there is an increase in the poor management to plastic waste with deadly effects on the causes of climate change.

Recommendations

The current COVID-19 pandemic has laid bare humanity's dependence on plastic as a material and the fragility of waste management and waste reduction systems. Pandemics are nothing new in the history of humankind so that the search for solutions must be a priority – now more than ever. And that requires collaboration between politics, industry and research.

Some existing laws that regulate plastics need to be actually implemented now more than ever. Du-

ring COVID-19, the use of single-use plastics and personal protective equipment has shot up and it is therefore urgent to rethink and redesign plastics (for example, the development of affordable solutions using environmentally friendly biological materials), and to improve recycling to ensure an appropriate end of life for those products. We need to produce reusable alternatives (for example for PPE) and the production of those alternatives needs financial incentives (in each relevant industry).

With public health the number one priority, the environmental implications of COVID-19 are still being overlooked. Even though the number of studies looking into the environmental impact of the COVID-19 pandemic (e.g., on air quality, carbon footprints) is growing every day, the extent of the physical 'impact' for plastic pollution during COVID-19 and what will happen long-term remain unclear.

The volume of waste generated as a result of COVID-19 is in fact a threat to current methods of waste management, and means that dispersal/pollution of/by plastics can represent very serious risks to environmental and human health alike. For that reason, it is imperative to increase monitoring (aquatic, terrestrial and air studies) of plastic waste post-COVID-19 worldwide. There should be support for the Citizen Science grassroots movement because it has a lot to offer this cause. Priority should also be given to studies looking at the destination, behaviour, degradability and the effects of PPE and its additives, that act as a potential medium for pathogens and have the capacity to absorb chemical contaminants. The production of plastic should be decoupled from fossil fuel resources such as the products of crude oil refining.

09/07/2020

### WEBINAR: HYDROUSA PROJECT

More than 100 people from across Europe attended a webinar as part of HYDROUSA held virtually on 9 July. The virtual seminar was organised by CWP, ICRA, the National Technical University of Athens and the Impact Hub Athens in order to publicise progress in HYDROUSA.

Sara Gabarrón, CWP Project Manager, opened the session laying out the agenda for the webinar and introducing the first speaker, the Project Coordinator of Simos Malamis, who kicked off the webinar with a presentation of what Hydrousa is and its objectives. Giulia Cipolletta and Francesco Fatone from the Marche Polytechnic University followed, explaining the legislation, the barriers and the opportunities of decentralised communities. They were followed by Patrik Karlsson from Alchemia-Nova Greece who presented an assessment of alternative water resources to rain and seawater.

Next, Fabio Masi from IRIDRA told the audience

about the implementation of water recovery solutions based on nature. Afterwards, Óscar Prado from AERIS presented on opportunities for harvesting energy from wastewater. Tarek El Arabi, from Helipolis University explained nutrient recycling: Fertilisation of an agroforestry field, followed by Zisis Tsiropoulos who presented on the digitisation of HYDROUSA services. The last presentation was given by Dimitris Kokkinakis from Impact Hub Athens about how to spread the word: a community of water allies. Before the end of the webinar, there was an interesting question and answer session moderated by Gianluigi Buttiglieri, ICRA researcher, in which all the speakers helped to address the audience's questions.

21/07/2020

### ICRA joins the working group created by the Regional Government of Catalonia to monitor the presence of Sars-CoV-2 in wastewater

The Departments of Territorial Planning and Sustainability and Public Health are leading a study that will periodically assess levels of the virus at the intakes of fifty-six water treatment plants that treat 80% of domestic wastewater.

The Government has been informed of the creation and mission of the monitoring group set up by ACA with the aim of establishing whether the SARS-CoV-2 virus is present at water treatment plants round Catalonia on the basis of testing of wastewater. This initiative, with an initial investment of €400,000, involves weekly and fortnightly at fifty-six water treatment plants in Catalonia. It is an additional tool for the Department of Public Health in the monitoring and oversight of the pandemic.

A total of thirty-four urban water treatment plants will be monitored weekly throughout the period, three will be monitored weekly in the summer, three weekly in the winter and the remaining sixteen will be monitored fortnightly. That will ensure that there are data from forty-five water treatment plants. The aim of the project is to detect genes and observe how they evolve at each plant, given that it has been shown that RNA from SARS-CoV-2 can be detected in wastewater between six and twenty-one days before the first cases are diagnosed.

The Catalan Water Agency (ACA) has launched the working group that includes experts from the world of science. The project can call on the knowledge and experience of the Catalan Institute for Water Research (ICRA), which is providing the secretariat for the group. Two specialist laboratories at the Universitat de Barcelona (the Molecular Biology of Enteric Viruses Laboratory and the Public Health and Food Safety group in the Protozoa, Bacteria and Virus Laboratory) are also represented along with

EURECAT. The working group is operating under the umbrella of SEWERS4COVID, an initiative of the European Commission.

Monitoring of 80% of wastewater

Catalonia currently has 527 water treatment plants that treat the wastewater of 97.1% of the population of Catalonia. It should be borne in mind, however, that thirty-five of those plants located in the most heavily populated areas of Catalonia treat 80% of all wastewater.

The programme will periodically (weekly or fortnightly depending on the plant) sample the intake water at fifty-six plants that treat urban wastewater across the whole country. Those fifty-six plants have been selected on the basis of criteria concerning the population served and geographic spread.

Fortnightly monitoring at sixteen treatment plants will be carried out in less heavily populated areas with lower risk of spread, whilst weekly sampling will be carried out in the most heavily populated areas with highest mobility. In some cases, sampling at coastal plants (in the summer) alternates with sampling at mountain plants (in the winter) on account of seasonal fluctuations in population.

The samples will be sent to the laboratories of Universitat de Barcelona and EURECAT for analysis. ICRA will be responsible for quality control and process integrity to ensure consistency of analysis protocols and ensure the reliability of any positive results. The results will be given to the Department of Public Health for analysis and review, as an additional tool to inform possible measures and actions through PROCICAT to control the pandemic.

The method to be used in the study is based on the scientific finding that virus in the population is reflected in genetic residues from the virus in wastewater. Although studies by the World Health Organisation show that the virus is not active at the inlet to WWPSs, the methods of analysis will allow it to be detected and measured, even before the emergence of clinical cases. That makes wastewater a very valuable aid in the early detection of new outbreaks and of the evolution and prevalence of the disease.

European Union database.

The Universitat de Barcelona, through its two research laboratories, EURECATA (Technology Centre of Catalonia) and ICRA will be responsible for coordinating and comparing results on the European and global stage through the European Commission's SEWERS4COVID. The intention is to create a space for European collaboration in epidemiological monitoring and public health with comparative data in order to facilitate coordinated measures and actions.

Monitoring Committee

Prior to the configuration of the project, an Expert

Coordination Committee was set up to discuss and weigh the value of setting up the project, likely problems and challenges and the choice of the right procedures. The Committee will remain active throughout the programme to monitor its development. The Expert Coordination Committee is made up of some thirty scientists who are experts in virology, epidemiology and genomics, wastewater laboratory experts and sewerage management and environmental monitoring experts. Its members are drawn from ACA, the Department of Public Health, ICRA, the Universitat de Barcelona, EURECAT, the Agbar-Abemica Centre of Genomic Regulation, Cetaqua, the Catalan Water Partnership (CWP) and the Barcelona Water Cycle (BCASA). Over the life of the programme, more participants and experts are expected to join.

30/07/2020

#### Doctoral thesis defence: Dissecting the assembly process of benthic communities from neotropical streams.

By: Juan David González-Trujillo

Thesis supervisors: Dr Sergi Sabater, Dr Isabel Muñoz and Dr Jhon Ch. Donato

Date: 30 July 2020 at 4 pm.

Defence by videoconference.

31/07/2020

#### Doctoral thesis defence: Biofilm Responses to Flow Intermittency in Mediterranean Rivers

Defence of the doctoral thesis "Biofilm Responses to Flow Intermittency in Mediterranean Rivers"

By: Miriam Colls

Thesis supervisors: Dr Vicenç Acuña and Dr Sergi Sabater

01/09/2020

#### ANTARES, a project concerning the transformation of antibiotics and their elimination from wastewater using emerging technology, is starting.

June saw the start of ANTARES at ICRA. ANTARES is a new line of research into 'Integrated analysis of the development of antibiotic resistance and routes of biotransformation of microcontaminants in innovative wastewater treatment technologies.'

The project is being coordinated by Universidade de Santiago de Compostella and the Catalan Institute

for Water Research (ICRA) and financed by the national government's Ministry of Science and Innovation, with a total budget of €365,000. It will last until May 2023. An ICRA research team led by Dr Jelena Radjenovic and Dr Maite Pijuan will research improvements to anaerobic decomposition of persistent contaminants in the presence of biologically reduced graphene oxide (bioRGO).

New anaerobic wastewater treatment technologies, such as anaerobic membrane bioreactors (AnMBR), have a number of advantages relative to aerobic muds, such as energy savings, production of biogas, resource recovery, reduced production of sludge and the capacity to degrade contaminants that persist in aerobic decomposition. However, anaerobic processes are marked by long start-up times, low rates of elimination and susceptibility to disruption due to organic overload, that are the result of the slow transfer of electrons between species (Interspecies Electron Transfer, IET) between fermenting bacteria and methanogenic archaea. It is known that the addition of non-biological conductors, such as granular activated carbon (GAC), speeds up methanogenesis as a result of the adhesion of bacteria to the surface of the AGC, which is used for electron exchange. The addition of bioRGO improves direct IET because of gelification and the secretion of active redox species by micro-organisms. The addition of bioRGO to an anaerobic community will be studied through determination of biochemical methane potential (BMP) on a discontinuous basis and in a pilot anaerobic membrane bioreactor (AnMBR). It is hoped that bioRGO will stimulate the flocculation of anaerobic sludges and so reduce accumulation on the membrane.

15/09/2020

#### 7th International Conference on Industrial and Hazardous Waste Management

15-18 Sept. CRETA

The 7th International Conference on Industrial and Hazardous Waste Management is going to be held from September 15th to September 18th, 2020, on the beautiful island of Crete, Greece.

CRETE 2020 is organized by the Technical University of Crete, the Università di Padua, the Hamburg University of Technology, as well as the Tsinghua University of Beijing.

25/09/2020

#### A study has looked at the relationship between the presence of emerging contaminants and the biological quality of Catalan rivers.

Research carried out by the Catalan Institute for Water Research (ICRA) and the Institute for Environmental Diagnosis and Water Studies - CSIC (IDAEA-CSIC), with the involvement of the Catalan Water Agency (ACA), looked into the presence of pollutants in a number of rivers in Catalonia and their effects on biological quality (invertebrates and algae). The presence of new pollutants (emerging contaminants), even at low levels, may be a source of environmental problems. That is why the European Commission has required them to be monitored. It should be borne in mind that there are three components in an assessment of the state of a river: physical-chemical quality (quality of the water in terms of nitrates, phosphates, TOC). Hydromorphological quality (continuity of flow, morphology) and biological quality (macroinvertebrates, diatoms and fish). Levels of those organisms can be affected by the presence of contaminants in the environment.

For this study, samples were taken at 89 control points on 16 rivers in Catalonia, including the Ebre and its tributaries, the Llobregat, the Ter, the Fluvià, the Muga, the Foix, the Francolí, the Besòs and the Tordera. The aim was to determine levels of emerging contaminants and their effects on biological communities under the Water Framework Directive (WFD).

Medicines – mainly antibiotics and anti-inflammatories, heavy metals such as nickel and pesticides such as Diuron – were detected in significant numbers of samples (80% of those taken). The greatest concentrations of pollutants were found in the rivers with the lowest dilution capacity, in which a large part of the flow comes almost exclusively from urban and/or industrial wastewater. Those rivers are often in areas of high population density (Llobregat and Foix in its middle and lower stretches, to give just two examples) and, to a lesser extent, in the higher courses of rivers like the Segre and the two Nogueras. Consequently, according to the research, they may trigger the loss of biological quality associated with macroinvertebrates (insects, crustaceans, molluscs, and others) in those stretches of river and of diatoms (principal group of river-dwelling algae).

No risk for drinking water

These contaminants do not present any risk for human health, since levels are within the legal ranges, and drinking water for human consumption is subject to purification to ensure that it is safe to drink. The research shows the need to carry out specific research into the ecological impact of these contaminants and promote their inclusion in European river basin management plans.

01/10/2020

#### Participation in the programme of SARS-CoV-2 Monitoring in wastewater in Catalonia.

A team of researchers from the Catalan Institute for

Water Research (ICRA) led the design and implementation of the SARS-CoV-2 monitoring network in wastewater in Catalonia. That monitoring will give early warning of significant changes in levels of the virus in water. The results will be provided via a web platform and discussed each week with Department of Public Health in Catalonia the Catalan Water Agency (ACA).

A total of 56 WWPSs will be sampled across the country. They serve 193 towns that are home to 80% of the population of Catalonia. Geographical balance is ensured by monitoring at least one WWPS in each administrative district. 36 WWPSs will be sampled weekly and 18 fortnightly. Every Tuesday, samples will be taken composed of 14 hours proportionate to the intake of each WWPS and they will immediately be sent to the three specialist laboratories for testing for SARS-CoV-2. The laboratories are the Molecular Biology of Enteric Viruses research group; the Virus, Bacteria and Protozoa of Relevant to Public Health and Food Safety Research Group (VirBaP) and the Biotechnology Department at the EURECAT Technology Centre, in Reus.

EURECAT has developed a web viewer, sarsaigua.icra.cat working with ICRA to gather and integrate the data generated by the laboratories and the metadata from the sampling. The platform allows the data to be visualised in various ways: first, an interactive map of Catalonia showing the levels of circulating virus, and alternatively, graphics and tables showing concentrations of different targets (N1, N2 and IP4) over time.

05/10/2020

#### ICRA RESEARCH NOWELTIES, a Joint Doctorate new materials and innovative water treatment technology Laboratory

NOWELTIES, led by ICRA, is a European Joint Doctorate (EJD) programme financed by the MSCA-Innovative Training Networks (ITN) H2020 programme. The main aim of NOWELTIES is to be a platform that provides opportunities for ground-breaking learning to educate the water treatment experts of the future. Its principal activity is a research programme made up of 14 individual research projects carried out by 14 doctoral researchers contracted by institutions in Spain (ICRA and the Universidade de Santiago de Compostella), Germany (University of Aachen and the Technical University of Munich), Croatia (Faculty of Chemical Engineering and Technology and Faculty of Mechanical Engineering and Naval Architecture of the University of Zagreb), Serbia (Faculty of Technology and Metallurgy of the University of Belgrade and the Physics Institute of the University of Belgrade) and Italy (Università de Ferrara). The research is focused on the development of innovative water treatment technologies (advanced biologi-

cal treatment, innovative oxidation processes, and hybrid systems) that can meet the treatment demands of a world of interconnected uses that arise from water cycles.

The programme brings together the experience of different institutions across Europe of current wastewater treatment problems, and makes the network a powerful tool for the development of new treatment technologies that are so urgently needed. The project does not just provide a broad scientific education to the 14 early stage researchers, it also challenges them to develop their capacity to adapt to new environments, increase their mastery of the language and broaden their cultural horizons, to make them into mature European researchers and citizens.

14/10/2020

### Doctoral thesis defence: Combining forward osmosis and anaerobic membrane bioreactor technologies for raw municipal wastewater treatment

By: Federico Ferrari

Thesis supervisors: Dr Maite Pijuan, Dr Soraya Zahedi and Dr Ignasi Rodríguez-Roda

Summary:

"In this thesis, different studies were performed to investigate the combination of FO for the pre-concentration of municipal WW with an anaerobic membrane bioreactor (AnMBR) for the production of biogas. Firstly, a lab-scale AnMBR was operated for 11 months treating synthetic WW that mimicked the concentrate from a FO process treating municipal WW with 80% water recovery. The effect of temperature on reactor performance was assessed at 34°C, 23°C, 17°C and 15°C mimicking the typical temperature seasonal variations of the sewage. The second chapter investigated for the first time at a pilot scale, the feasibility of concentrating real raw municipal WW using a submerged plate and frame FO module to reach 70% water recovery. In the third and last chapter, FO and AD technologies were coupled to compare the anaerobic treatment of municipal WW and that of concentrated WW at 25°C. First, biochemical methane production (BMP) tests were conducted with municipal WW and with two concentrated WW. Concentrated WW through FO proved to have higher methane production and higher specific methane production (SMP) but presented a longer lag phase probably due to the higher salinity present in the concentrated WW causing inhibition. Secondly, a continuous AnMBR was operated and showed similar COD removal efficiencies when treating municipal WW (at 12 and 8 hours hydraulic retention time (HRT)) and concentrated WW (at

24 and 12 hours HRT). Overall, results obtained in this thesis demonstrate the feasibility of combining both technologies to achieve a more sustainable treatment of WW and set up the basis for further investigations at a larger scale."

15/10/2020

### 16th annual workshop on emerging high-resolution mass spectrometry (HRMS) and LS-MS/MS APPLICATIONS IN ENVIRONMENTAL ANALYSIS AND FOOD SAFETY

15-16 October (Online Webinar)

ICRA and IDAEA-CSIC jointly hold these days every year. Because of the circumstances, this year it was held online. Dr Damià Barceló and Dr Mira Petrovic, are the people involved at ICRA.

29/10/2020

### Damià Barceló, ICRA's Director, is to be awarded an honorary degree by the Universidad de Almería

The Council Universidad de Almería, chaired by Rector Carmelo Rodríguez Torreblanca, on 20 October 2020, approved the nomination of Dr Damià Barceló Cullerés, Director of the Catalan Institute for Water Research (ICRA), to receive an Honorary Doctorate from the University of Almería, on proposal from the University's Department of Chemistry and Physics and Faculty of Experimental Science.

The grounds for the award notably include 'Dr Barceló's important research in the environmental field, in which he is a world leader in the detection and remediation of problems associated with contamination processes in the water cycle. He has taken part in research with Groups from the Universidad de Almería and in programmes for the exchange of researchers between CISC and the University.'

This award follows the Honorary Doctorate awarded by the Universitat de Lleida on 20 February 2020, for which the ceremony is yet to take place on account of the Covid-19 pandemic.

Dr Damià Barceló has an honorary doctorate from the University of Ioannina (Greece). He was also awarded the Jaime I Environmental Protection Prize (2007); Saudi Arabia's Prince Sultan Bin Abdulaziz International Water Prize (2012) and the Recipharm International Environmental Prize (2012) awarded by a Europe-leading Swiss pharmaceutical manufacturer.

07/12/2020

### ICRA is researching the role of aquatic birds in the spread of antibiotic resistance.

Antibiotic resistance (AR) has become a severe public health issue that affects people, animals and the environment. Despite all the knowledge that we have about the epidemiology of AR in a clinical environment and even in livestock, less well understood is the role of wild animals in the occurrence of AR and its spread between biomes.

To address that and to examine the prevalence of antibiotic resistance in different species of aquatic birds, the DARABi project has been set up, led by experts in environmental genomics and microbial ecology from the Catalan Institute for Water Research (ICRA) and experts in bird ecology and biomedicine from the Universidad de Sevilla.

The research is being carried out by examining the ecological relationships of birds (diet, how long they stay in one place and migratory routes) in habitats affected by different levels of anthropic pollution (landfills, recycling centres, natural spaces) and their capacity to travel long distances (migratory species vs sedentary species).

The ICRA team is especially interested in establishing the extent to which the different species of bird that are going to be studied (seagulls, storks, cranes and geese) are carriers of antibiotic resistant bacteria (ARB) and genes for resistance and to what extent those things are affected by pollution of their natural habitats.

There will also be different laboratory experiments to determine whether the birds contribute to the spread of antibiotic resistance in their environments through the introduction of antibiotic resistant bacteria in their dung.

DARABi will combine techniques that use cultures, metagenomics and genome sequencing to identify, quantify and characterise the resistome and the microbiome of the different species of bird in relation to their ecology and movement. It is hoped that the results from DARABi will allow the creation of better strategies to reduce the spread of antibiotic resistance in the environment and to mitigate its impact on global health.

15/12/2020

### Doctoral thesis defence: Target analysis and suspect screening of wastewater derived contaminants in receiving riverine and coastal areas and assessment of environmental risks

By: Mira Celic

Thesis supervisors: Dr Mira Petrovic and Dr Meritxe-Il Gros.

28/12/2020

### First edition of ICRA News published

This month saw the publication of the first edition of ICRA News, the bulletin of news and research being done at the Catalan Institute for Water Research.

The bulletin is published quarterly in three languages: Catalan, Spanish and English.

Take a look and, if you like it and you haven't subscribed yet, here is the link to do that.

Link to ICRA News no 1:

<https://mailchi.mp/degaf9f34684/icra-news-desembre-2020>

Link to subscribe:

<https://mailchi.mp/6d74dc936648/land-icra-news>

If you have already subscribed, and have not received your copy, please check your Junk folder and add comunicacio@icra.cat to your trusted senders list.

30/12/2020

### ICRA is going to take part in the Seasonal SARS-CoV-2 in Waste Water Monitoring Programme in Catalonia in 2021 and 2022.

The Regional Government has approved the setting up of the Seasonal SARS-CoV-2 in Waste Water Monitoring Programme in Catalonia for the period 2021-2022, extendable for three further years. It will be managed by the Secretariat for Public Health of the Department of Health and the Catalan Water Agency of the Department of Territorial Planning and Sustainability. And the analysis of water will be carried out by the Molecular Biology of Enteric Viruses Laboratory, the Viruses, Bacteria and Protozoa of Relevance to Public Health Laboratory, Eurecat's Center for Omics Sciences (COS) and the Catalan Institute for Water Research (ICRA).

The objective of the Programme is to quantitatively analyse viral particles in wastewater at wastewater purification stations (WWPS) in Catalonia to provide an additional indicator of the status of the Covid-19 pandemic and detect new outbreaks early. The Programme will allow us to find out more about patterns of circulation of the virus in different sampling areas and will provide information useful to determine preventive and monitoring measures for the management of the pandemic.

In the framework of the programme, samples will be collected every week or fortnight (depending on the site) of wastewater from the inlets of some 56 WWPSs spread across the country and will be conserved and refrigerated for transport to the laboratories that will analyse concentrations of the virus in wastewater. The results will be shown on a website where visitors will also be able to see a map with each WWPS tested and a colour scale showing the concentration band observed and the trend – up, down or stable.

The Programme has an annual budget of €947,430 drawn from the budgets of the two Departments involved, Health, and Territorial Planning and Sustainability.



# 09

## AWARDS

**Honorary and Guest Professor** Zhejiang A & F University, Hangzhou, China, to Dr. Damià Barceló for his scientific career devoted to environmental chemistry with the aim of solving different environmental problems in the field of water quality, in particular the development of methods for controlling organic pollution by so-called “emerging” contaminants (polar, surfactant, detergent), endocrine disruptors and pharmaceuticals, illicit drugs and carbon nanomaterials in waste and natural waters.

**Dr. Damià Barceló, director of the Catalan Institute of Water Research, appointed Doctor Honoris Causa of the Universidad de Almería,** at the proposal of the Department of Chemistry and Physics and of the Faculty of Experimental Sciences of the same university.

**Dr. Damià Barceló, director of the Catalan Institute for Water Research, named Doctor Honoris Causa of the Universitat de Lleida.** The proposal was made directly by the rector of UdL Dr Jaume Puy.



# 10

## FINANCING

### Contribution of the Regional Government of Catalonia

Ministry of Business and Knowledge (DECO)	€ 1,887,512.96
Catalan Water Agency (ACA)	€ 600,000.00
<u>Competitive projects</u>	
Regional Government of Catalonia	€ 225,429.39
Ministry of Economy and Competitiveness	€ 705,565.91
European Union	€ 1,345,911.68
<u>Transfer projects</u>	
Knowledge Transfer Technology (KTT)	€ 208,541.60
Financial income	€ 0.15
Other income	€ 12,712.39
<b>TOTAL INCOME</b>	<b>€4,985,674.08</b>

Universitat de Girona as ICRA Trustee annually consolidates its non-monetary contribution to ICRA from the transfer of the researchers assigned to its investigation, which is financially measured by the UdG in the amount of € 323,838.33 for 2020.

## 11

## ICRA IN THE NEWS & PRESS

The pandemic that started in March 2020 has also affected ICRA's external communications all year. There have been notably fewer press releases about the research carried on for ICRA's scientific community. Three press releases were issued, five fewer than the previous year and no press conferences were held. The press releases issued were about:

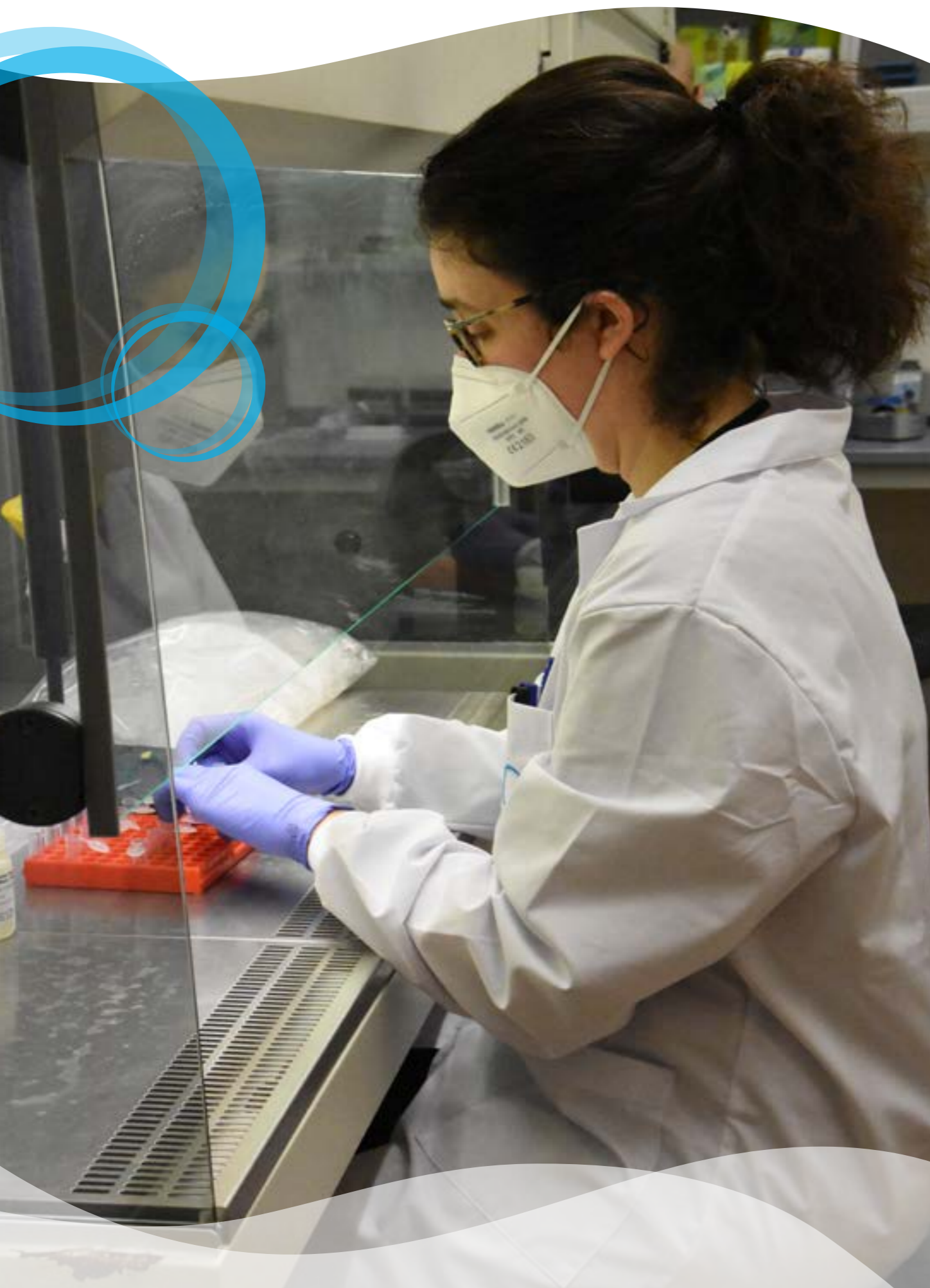
- Damià Barceló, Director of ICRA, has published a critical review of the most recent COVID-19 international scientific literature from an environmental and public health perspective.
- Damià Barceló took part in one of the first published worldwide critical reviews to look at the lethal effects of COVID-19 on laws against plastic pollution.
- Damià Barceló, ICRA's Director, is to be awarded an honorary degree by the Universidad de Almería.

However, the number of mentions in the media grew by 64% to 314 mentions (as against 204 mentions in 2019): 275 in digital media, 27 in print media, 4 on television and 8 on radio. The increase was due to ICRA's prominent role in different research projects into the monitoring of Covid-19 in wastewater. That was made possible by the commitment and availability of ICRA's research team in order to deal with interviews and statements requested by the media.

In 2020, ICRA continued to have an active presence on social media and in October it created an Instagram profile so as to inform the target audience (scientific community, institutions and general public) about what ICRA is doing and the research it is engaged in. Also in October, ICRA created a social media style guide to have a more active presence on platforms such as Twitter and Instagram. The guide was intended for people who are active on ICRA's social media profiles: heads of ICRA's Research Areas, research teams and the press office.

It should be noted that the involvement of ICRA's research teams in its social media profiles on platforms like Twitter means that ICRA is more active there. From November to December 2020 the number of tweets doubled and consequently so did the number of followers of the channel. In December 2020 the Twitter account (@icrawater) had 436 followers more than in the previous year to reach a total of 1804 followers, its posts were viewed a total of 652 times a day with 1806 likes and 671 retweets.

Another innovation in terms of communications has been the launch of the ICRA News electronic bulletin in December 2020. The new bulletin is intended to publicise the activities and research carried on by ICRA. It will come out quarterly in three languages: Catalan, Spanish and English.





[www.icra.cat](http://www.icra.cat)

Catalan Institute for Water Research

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