EDAR8
Environmental Dimensions of Antimicrobial Resistance
Brisbane, 2-7 August 2026

WORKSHOP OVERVIEW

Workshop Title	Persistence, dissemination and mitigation of ARGs in the environment: an evolutionary and ecological perspective
Facilitators and contributors Details of the individuals leading and contributing to the workshop, including: • Workshop facilitators • Guest speakers or contributors • Their roles in the session	Organizers: Dr Christophe Merlin (https://www.lcpme.ul.cnrs.fr/en/lcpme-2/; https://orcid.org/0000-0002-9261-5322) Dr Uli Klümper (https://fis.tu-dresden.de/portal/en/researchers/uli-klumper(afb885df-38f9-48dd-8a34-7c7075e18734).html) Dr Sotirios Vasileiadis (https://bio.uth.gr/en/professors-en/vasileiadis-sotirios-en/; https://orcid.org/0000-0002-2048-8192) Dr Eddie Cytryn (https://cytrynlab.wixsite.com/cytrynlab) Prof. Thomas Berendonk (https://tu-dresden.de/bu/umwelt/hydro/hydrobiologie) Prof. Celia Manaia (https://m.porto.ucp.pt/en/docentes-celia-manaia-en) Prof. Despo Fatta-Kassinos (https://www.ucy.ac.cy/directory/en/profile/dfatta
Background An overview of the context and rationale for the workshop, outlining the key issue, challenge, or opportunity it addresses, and why this topic is timely and relevant.	Anthropogenic sources such as treated and untreated sewage discharge large amounts of antibiotic-resistant bacteria (ARB) and associated genes (ARGs) into aquatic and terrestrial ecosystems. These receiving environments can act **(i)** as ARB and ARG reservoirs or conduits that can facilitate transmission to humans and animals, contributing to the global scope of AMR, or alternatively **(ii)** as natural barriers that mitigate their spread. To effectively understand and eventually mitigate AMR in these environments, it is essential to understand the rapid evolutionary, ecological and molecular processes governing resistance dynamics, especially at anthropogenic-environmental interfaces where ARB can persist or mobilize ARGs to native microbiomes, or alternatively dissipate due to biotic and abiotic interactions. Understanding these complex ecological interactions can lead to new approaches that apply nature-based solutions to mitigate AMR, focusing on natural biotic resistance of the receiving ecosystems rather than solely controlling AMR loads in the primary sources.
Workshop Aims A description of the purpose of the workshop and its intended focus. This section highlights what participants can expect to explore, learn, or develop during the session.	The goal of this workshop is to explore the underlying eco-evolutionary processes or molecular mechanisms that either constrain or promote AMR in anthropogenic/environmental interfaces. Generated knowledge will be valuable for the development of "nature-based" and "source control" solutions towards the mitigation of the environmental proliferation of AMR. Special attention will be given to adopting an environmental perspective to (i) avoid transposing classical in vitro-single cell approaches into unrelated real conditions, and (ii) identify environmental/ecological mechanisms of AMR persistence and dissemination in the complexity of the environment. A first output would be to identify and list natural barriers preventing AMR dissemination, or parameters leading to AMR ecological success. From this, it will be a matter of proposing leads for nature-based solutions to prevent AMR dissemination, and envisioning global experimental strategies to reach this goal.
Participant Takeaways A summary of what participants will gain from attending the workshop. This may include new knowledge, practical skills,	**Overview of takeaways** 1. Understanding of the environmental and evo-ecological processes (and underlying molecular mechanisms) that:

tools, frameworks, or shared resources, as well as any tangible outputs (e.g. ideas, draft materials, or collaborative outcomes).	a. Enable anthropogenically derived ARB and ARGs to persist and disseminate in and through the environment. b. Enable receiving (aquatic and terrestrial) environments and associated microbiomes to resist invasion and persistence of anthropogenically-derived ARB and ARGs. 2. Ranking of the relative importance of evo-ecological processes for AMR dynamics in individual ecosystems. 3. Understand how nature-based and source control solutions can mitigate AMR, and how these solutions can be optimized based on insights from evo-ecological processes discussed in stage 1. **Outputs** The workshop will be organized around focused talks, debates and group work oriented toward the design of innovative nature-based solutions while keeping an ecological perspective. In practical terms, the idea is to collectively envision ways to implement or facilitate natural barriers to AMR spread in environmental settings by utilizing or manipulating evo-ecological processes. The output of this think tank will be transposed into a white paper that will be shared with EDAR participants and beyond. In the best-case scenario, this will also be the opportunity to construct multidisciplinary consortia motivated to prepare proposals on this topic.
Expected Impact An outline of the broader value of the workshop, including how it may: • Influence research, policy, or practice • Support collaboration and knowledge exchange • Contribute to future work or ongoing initiatives	Several impacts are expected from this workshop: 1. **Knowledge:** Our understanding of AMR dissemination in the environment results from both, retrospective evidence showing increasing AMR prevalence in impacted ecosystems and, on a mechanistic point of view, from single cell-in vitro experiments with conclusions transposed into complex ecosystems. However, a number of studies highlight that evolutionary trajectories for AMR follow complex rules that are hardly predictable from single cell systems, which however define what is catalytically feasible. In this respect, the way environmental communities actively interfere with the propagation of AMR is not fully understood. The workshop will allow redrawing the outlines of natural barriers and facilitators of AMR dissemination in an environmental perspective. 2. **Collaboration:** The workshop will aggregate different fields of expertise with a common interest for the ecological perspective of AMR dissemination and the way to transpose knowledge in this field into practical impacts also driving technological/management development. This should set the basis of future collaborative work centred on nature-based solutions to mitigate AMR dissemination in the environment. 3. **Innovation:** Over the years, great efforts have been put on developing efficient technologies to limit pollution in the receiving environment, whether the AMR pollution itself or the pollution by confounding factors such as antibiotics, metals, pesticides, etc… However, (i) this kind of technology may not be affordable by all, and (ii) may not be implementable anywhere. Nature based-solution, in some instances, may represent alternatives taking advantage of local ecological processes resulting in barrier effects for AMR but also for all kinds of invaders including pathogens. The idea would be here to instil a scientific dynamics to identify and study locally adapted solutions, and bring innovative experimental set up (with proof of principle) to the public.
Who should attend? Information on the intended audience for the workshop, including: • Relevant backgrounds, sectors, or expertise • The level of participation expected (e.g. discussion, group work, problem-solving)	The workshop is primarily intended for scientists with a strong expertise or interest in environmental microbiology, ecology or environmental sciences, who will collectively contribute their insights (i) for untangling the complex ecological processes driving the fate of AMR in environmental ecosystems, and (ii) identify ecological processes that can be leveraged for targeted nature-based mitigation. The workshop is also open to (iii) a broad audience of scientists who wish to deepen their expertise, and (iv) stakeholders / policymakers who contribute with their knowhow when discussing the development and implementation of nature-based solutions and mitigation strategies in general.

	The workshop will be organized around two main activities. A first period will involve participants in short talks and/or debates centered on relevant ecological processes driving the fate of AMR in the environment, while the second period will be dedicated to work in groups focusing on ranking the relative contribution of these processes for specific environments.
Workshop Schedule and Duration A summary of the structure and flow of the workshop, including: • Key session components • Interactive or breakout activities	**<u>Schedule & duration</u>** The workshop is proposed to last 2 hours with two periods: one dedicated to short talks and collective debates, and a second dedicated to group work exploring and ranking the relative contribution of different ecological processes to AMR dynamics in different environments/ecosystems: **1. Introductory talk** to set the context, the aim and the rules of the workshop (5-10 min.) **2. First period - talks and debates** (45-50 min.): The session will alternate between sets of 4-5 minutes talks and small debates dedicated to defining cellular/ecological processes relevant for AMR spread in an environmental context (3 cycles of 18 minutes with 2 short talks and 1 short debate, each). The cycles will cover topics with 3 levels of complexity: • **Topic 1:** Molecular, single-cell processes (HGT, mutation, multiplication, death) in environmental conditions • **Topic 2:** Cell-community interactions (diversity, persistence, predation, competition) • **Topic 3:** Community-community interactions (invasion, coalescence, biotic resistance, resilience, dysbiosis). The 3 debate periods will be used to list the relevant biological/ecological processes to be further discussed in groups during the second hour. The debate will also be used by the organizers to keep the workshop focused, and prepare the working group activities. **3. Second period - group work** (45-50 min.): During the second period, people are split into groups of interest for a given environment or ecosystem or a case study (one per group). Each group work will: • continue elaborating on the list of relevant biological/ecological processes • rank the processes in order of importance for the given ecosystem • identify processes that can be tested/controlled in an environmental project • propose strategies how controlling the process can be implemented in nature-based mitigation strategies The selection of environments is not predefined, but may cover the following, and be explored through case studies by the groups: • Agroecosystems; • Aquaculture, aquaponics, fish, farming; • Rivers, lakes, surface hydrosystems; • Less human-affected ecosystems (forests, estuaries); • Extreme ecosystems (e.g. brine lakes and deep benthic, low temperature polar, desert, underground aquifers, hydrothermal vents…); • Climate change related ecosystems (e.g. permafrost); peatbogs; • Rehabilitated ecosystems (e.g. former mining areas); • Altered use ecosystems (e.g. artificial lakes); • Engineered ecosystems Depending on the composition of the audience groups can also be organized around case studies with sub-groups looking at the same situation - as i)

	scientists in AMR evolution, ii) engineers or scientists looking for solutions - what can be managed/what cannot etc; stakeholders and policy people, thinking of possible risks/monitoring/control. The case studies should close the loop on a One Health perspective. **4. Workshop end and Concluding remark** (5-10 min.)