

AQUATIC POLLUTANTS

RFI FUNDED PROJECTS BOOKLET

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Title of the project: Nanoenabled strategies to reduce the presence of contaminants of emergent concern in aquatic environments

Acronym and LOGO: AMROCE



AMROCE

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Abstract:

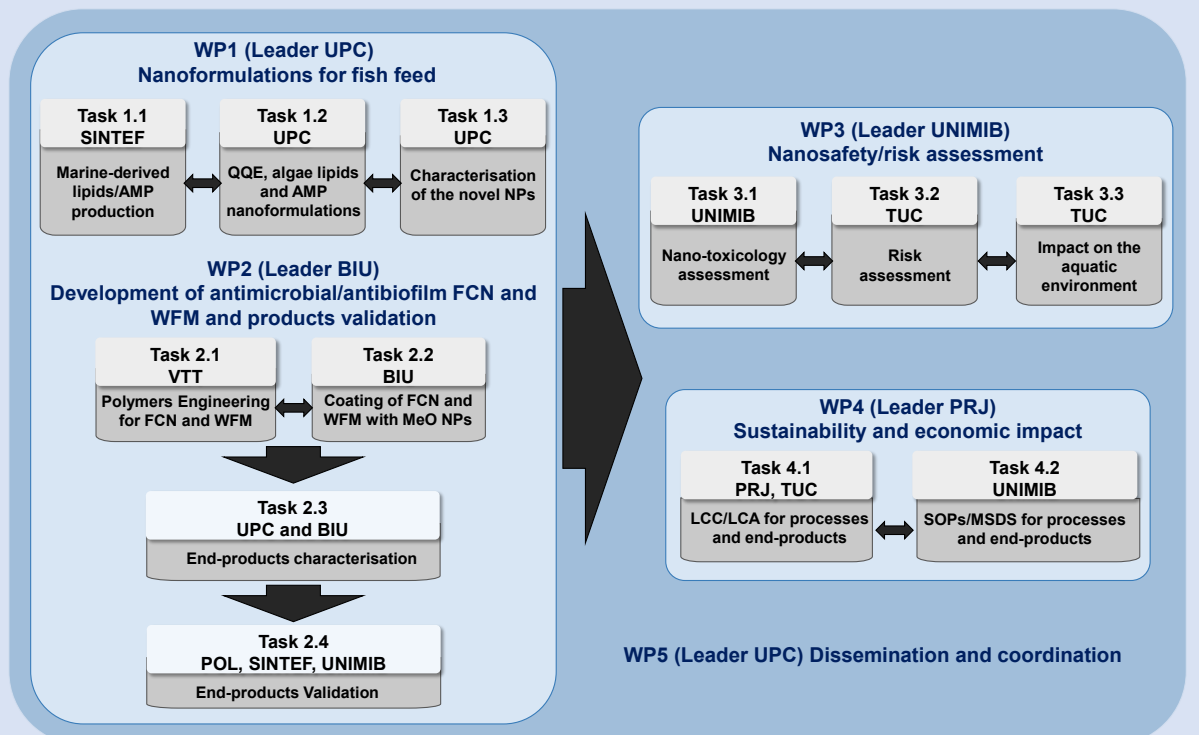
Contaminant of emerging concern (CECs) such as antibiotics, pathogens and antimicrobial resistant (AMR) bacteria in water bodies associated to intensive fish and inland animal farming, represent a great threat to the environment and human health. AMROCE aims at reducing antibiotic pollution and spread of AMR bacteria in the entire water cycle through a platform of novel antibiotic-free antimicrobial products. AMROCE will develop antimicrobial/antibiofilm fish cage nets and wastewater filtration membranes through polymer and surface nano-engineering. Marine-derived antimicrobial agents and antibiofilm enzymes will be nano-formulated as alternative to antibiotics for fish and animal feed supplement. Human and environmental nanosafety during the manufacturing and use of the novel nanotechnology-embedded products will be continuously evaluated to anticipate nanosafety issues

Keywords:

Antimicrobial resistant bacteria, antibiotic-free antimicrobials, CECs reduction, nano-coated materials, nano-formulated antimicrobials

Project structure (WPs description):

The duration of AMROCE project will be 36 months and the activities will be distributed in 5 WPs. **WP1** is dedicated to the development of nano-formulations assembling marine/algae-derived antimicrobial lipids and Antimicrobial lipids and peptides (AMP) with Quorum Quenching Enzymes (QQE), as stable additives for fish and animal feed with antibiofilm and bactericidal efficacies that prevent from bacterial infections. In **WP2**, bulk engineered or coated fish cage nets (FCN) and water filtration membranes (WFM) containing stable metal oxide nanoparticles (MeO NPs) with antimicrobial and antibiofilm activities will be generated. **WP3** will identify the parameters related to the safety of the nano-formulation process for both workers and users, considering not only the existing regulation, but also the gaps existing in the legislation and norms. In **WP4** the cost effectiveness and sustainability will be studied applying Life cycle assessment and costing (LCA/LCC) approaches to optimise the costs as well as the environmental and social impact of the novel technologies and products. **WP5** is dedicated to project management, communication and dissemination activities



AMROCE workflow, partners' interactions and complementarity

Outcomes and expected impact:

AMROCE will target the following key performance indicators:

- 20% competitiveness increase in fish and animal farming at EU level
- 80% reduction of CECs (antibiotics and AMR bacteria) and 80% reduction of AMR risk
- > 8 log reduction of the presence of bacteria in effluents from wastewater treatment plants
- 15% reduction of the operation costs of water filtration membranes
- 50% lower consumption of antibiotics in aquaculture and livestock
- ≥90% antifouling efficiency of fish cage nets and membranes and reduced cleaning costs.

The manufacturing of high quality and cost-efficient functional products will strengthen the technological competitiveness and promote a 20% growth of the European livestock and aquaculture industries. Novel antibiotic-free antimicrobial strategies will provide competitive advantages over the current remedial approaches for infection control in aquatic ecosystems. AMROCE aims at 80% reduction of CECs by tackling the polluting source - the livestock and aquaculture industries. Reducing by 50% the consumption of antibiotics in these industries, will decrease the antibiotic water contamination.

Current membrane processes in water treatment plants reduce bacterial contamination by up to 7 log while the novel WFM will achieve > 8 log bacterial elimination. Membrane cleaning due to biofouling represents 20% of the wastewater treatment cost and shortens by 50% the membrane lifetime. AMROCE WFM will reduce the biofouling by 80%, resulting in 15% decrease of the operation costs and 40% increased membrane durability.

AMROCE will alleviate by 90% the costs of biofouling in aquaculture. Additional cost burden related to reduced fish welfare by biofilm associated pathogens, low oxygen concentrations due to poor water exchange and increased stress during net changing, will be mitigated. Potential net failure and escapes, caused by drag and net deformation during cleaning, will be minimised.

List of deliverables expected:

Deliverable 1.1: Production of marine-derived lipids/AMP.

300 g of algae-derived antimicrobial lipids and peptides will be purified for further nano-formulation in Task 1.2 (SINTEF, Month 18)

Deliverable 1.2: Development of AMROCE feed supplements

500 g of fish feed supplements will be produced from nano-formulated algae-derived antimicrobial lipids and peptides and characterized for validation in Task 2.4 (UPC, M24)

Deliverable 2.1: Engineering of antimicrobial composites

10 kg of nano-enabled thermoplastic composites will be produced to generate antimicrobial and antibiofilm WFM and FCN in Task 2.1 (VTT, M30)

Deliverable 2.2: Production of antimicrobial MeO NPs

500 g of bactericidal and antibiofilm MeO NPs will be produced for functionalisation of FCN and WFM in Task 2.2 (BIU, M18)

Deliverable 2.3: Production of antimicrobial nano-enabled WFM

5 m² of MeO NPs embedded WFM will be produced for further characterization in task 2.3 (POL, M30)

Deliverable 2.4: Production of antimicrobial nano-enabled FCN

5 m² of MeO NPs embedded FCN will be produced for further characterization in task 2.3 (VTT, M30)

Deliverable 2.5: Characterization of AMROCE products

Nano-enabled WFM and FCN, and feed supplements will be characterized for their antimicrobial and antibiofilm efficacy (BIU, M33)

Deliverable 2.6: Validation of AMROCE products

Nano-enabled WFM and FCN, and feed supplements will be validated in exploitation scenarios (SINTEF, M36)

Deliverable 3.1: Nano-toxicology of AMROCE products

The nano-toxicology properties of nano-enabled WFM and FCN, and feed supplements will be reported (UNIMB, M36)

Deliverable 3.2: Risk management of the new products

The safety profile and risk management of the new products will be reported (TUC, M36)

Deliverable 3.3: Impact reduction of AMROCE products

Best practices for impact reduction of the new nano-enabled products will be defined (TUC, M36)

Deliverable 4.1: LCC/LCA of AMROCE products

LCC/LCA of the nano-enabling processes and end products will be reported (PRJ, M36)

Deliverable 4.2: Regulatory compliance of AMROCE

Compliance with standards and regulatory issues, and interactions with regulatory European bodies will be reported (PRJ, M36)

Deliverable 4.3: SOPs and information sheets

Safety-related SOPs and information sheets for workers and end-users will be developed (UNIMIB, M36)

Deliverable 5.1: AMROCE in social media

The outputs of AMROCE will be disseminated in social media (UPC, M03)

Deliverable 5.2: Dissemination Plan

A plan for dissemination of results will be elaborated (UPC, M06)

Deliverable 5.3: AMROCE web site

A project web site will be created (UPC, M06)

Deliverable 5.4: e-workshops organisation

Two e-workshops with stakeholders will be organised for dissemination of project results (SINTEF and VTT, M36)

Deliverable 5.5: Peer-reviewed scientific publications

At least 5 research articles in international peer-reviewed scientific journals will be published (All, M36)

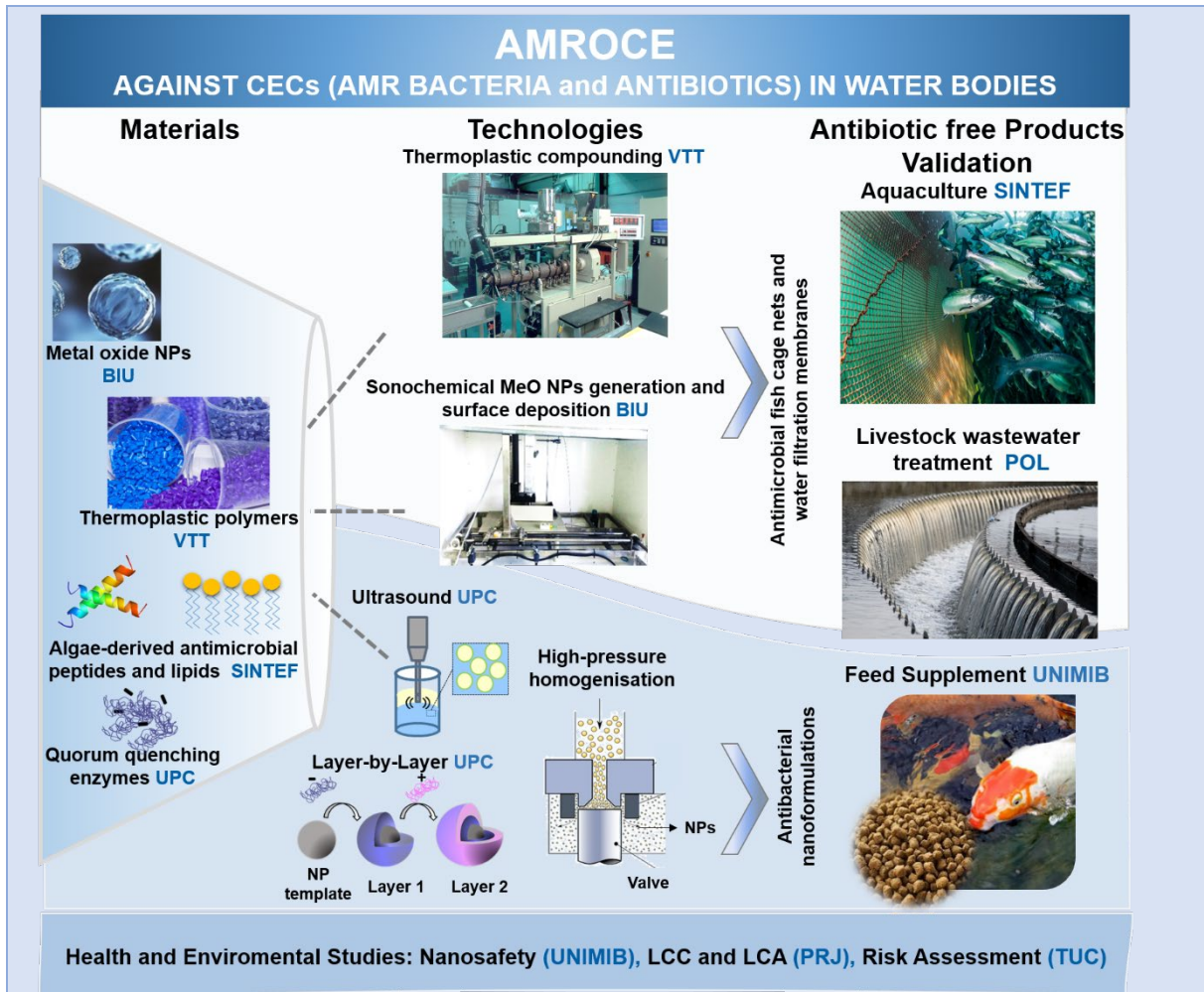
Deliverable 5.6: IPR management

IP management, exploitation and protection strategy will be reported (UPC, M36)

Funders of the project:

- Agencia Estatal de Investigación (AEI, Spain)
- Ministry of Health – Chief Scientist Office (CSO-MOH, Israel)
- The Research Council of Norway (RCN, Norway)
- Ministero dell'Università e della Ricerca (MUR, Italy)
- General Secretariat for Research & Technology (GSRT, Greece)
- Academy of Finland (AKA, Finland)
- National Centre for Research and Development (NCBR, Poland)

Representative Image of the project and Photo of the Research Team, if available:



AMROCE Project Layout

Contact person(s) for Communication and Dissemination activities (name and e-mail)

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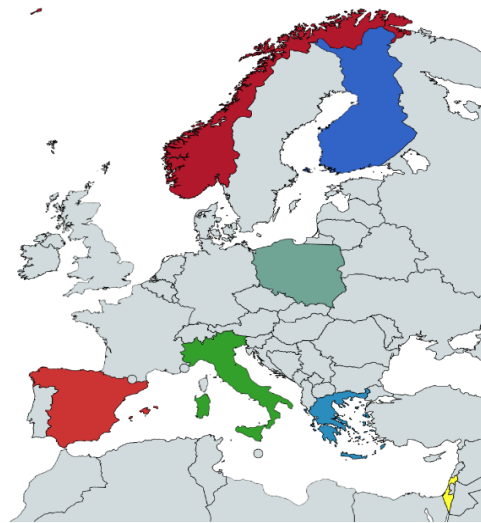
Contact person(s) for Open Access & Open Data activities (name and e-mail)

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Expected research results to communicate and disseminate (in very general terms)	Target groups for communication and dissemination activities:
1. Novel nano-formulation methodologies for quorum quenching enzymes, marine-derived lipids and Antimicrobial lipids and peptides	Scientific community, aquaculture and livestock related industries, pharmaceutical, personal care and cosmetic industries
2. Innovative nanocoating procedures of metal and metal oxide nanoparticles for fish cage nets(FCN) and water filtration membranes (WFM)	Scientific community, aquaculture, industrial filtration and water treatment companies
3. New approaches for identification and extraction of lipids and AMP from algae and other marine-derived species	Scientific community, aquaculture and livestock related industries, pharmaceutical, personal care and cosmetic industries
4. Procedures for the development of antimicrobial and antibiofilm thermoplastic polymer nanocomposites for FCN and WFM	Scientific community, aquaculture, industrial filtration and water treatment, food packaging, automotive, textiles, and construction among others
5. Nano-toxicology data on antimicrobial/antibiofilm NPs and NP-enabled products (FCN and WFM)	Scientific community, aquaculture and livestock related industries, pharmaceutical, personal care and cosmetic industries. Workers and consumers
6. Novel schemes to study the leaching effect of antimicrobials actives from the coatings using simulated conditions	Scientific community and public administration
7. Guidelines for sustainable nano-enabled products. Increased expertise for Life cycle assessment and costing in nanotechnologies	EU environmental companies, governmental and non-governmental organisations, standardisation and certification technical bodies
8. Antimicrobial and antibiofilm water filtration membranes containing metal nanoparticles.	Industrial filtration and water treatment companies
<p>Project studies location:</p> <p>AMROCE consortium is tailored to the project's needs and objectives. All research and development tasks are covered by the expertise of the consortium members, avoiding redundancy and overlapping in expertise. The composition of the consortium is based solely on in-depth analysis of the necessary "functions" to achieve the goals of the project. A clear workflow is established among the different partners with complementary functions</p>	

AMROCE consortium integrates partners from Norway, Italy, Greece and Spain, which represent almost 70% of European aquaculture production, while Spain, Poland and Greece are in the top 10 livestock populations in Europe. The geographical spread of the consortium will ensure optimum outreach of the project results, due to this geographically strategic collaboration of partners from different fields with pre-existent national or international cooperation networks. **SINTEF** and **VTT** closely collaborate with other Nordic universities, research institutes, industrial and societal partners under the framework of the Nordic Research and Innovation Program for Sustainable Aquaculture, from the NordForsk organisation. This hub gathers world-leading experts in microbiology, medical sciences, water management and environmental research enhancing collaborations within the sustainable blue bioeconomy. **PRJ** and **UNIMIB** cooperate in the EU NanoSafety Cluster that provides strategic directions in the development and implementation of Safety-by-design approach and sustainability. **UPC**, **BIU** and **UNIMIB** were involved in the H2020 PROTECT project that delivered pre-commercial lines for coating of medical devices, textiles and water treatment membranes, part of the European network for Pilot Production facilities (EPPN). **POL** is collaborating with industrial partners from Germany in a M-ERA.NET project developing filters for wastewater treatment. Partner **TUC** participates in the European Water Resources Association for cooperation in the field of water resources and in the Hellenic Water Association providing support to researchers and other professionals related to the design, construction and operation of water and wastewater management systems.

The geographical spread of the consortium will ensure that the project results reach the aquaculture and livestock industries in the entire Europe. Knowledge transfer to stakeholders will be promoted by **SINTEF** - one of the largest European research organisations, specialised in the development of innovative and sustainable technological solutions for the marine sector, **VTT** – one of the largest European research organisations, with a main research line in polymer bulk functionalization, **POL** – manufacturer of WFM for animal farms, and **PRJ** – a technological and business consultancy.



AMROCE geographical distribution

Policy context / project contribution to policies (National, European, International – UN SDGs):

Striving to reach good environmental status of the aquatic ecosystems in EU, the novel technological solutions of AMROCE for reduction of the antibiotic and AMR bacterial contamination will foster the implementation of the national and EU environmental policies in the aquaculture and livestock industries. LCA and Environmental Risk Assessment (ERA) will systematically monitor the progress within the ecological boundaries of the bio-economy. LCA/ERA data will provide reliable information to environment-oriented policy makers and tools, e.g. the EU Ecolabel, Product Environmental Footprint and Green Public Procurement. An improved approach to risk assessment based on hazard analysis in cooperation with the major stakeholder groups of the aquaculture industry and animal farming will be developed. Each operation will be discussed in detail, hazards will be assessed according to the existing environmental policies, risks associated with each task will be identified and evaluated and risk levels will be assigned. This approach will increase the likelihood for identifying possible new hazards and better assessing existing ones. This approach will result in a comprehensive list of hazards and propose best practices and concrete mitigating actions.

KEYWORDS

Water resources, Catchment scale water management, Environmental engineering, Wastewater treatment, Fresh water ecology, Risk Management, Freshwater Ecosystems, Marine Ecosystems, Human Health, Emerging Pollutants, Pathogens, Antimicrobial Resistance, Aquatic Ecosystems