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CORDIS Results Pack on

ocean plastics

A thematic collection of innovative EU-funded research results

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Sustainable and innovative solutions to tackle the plastics crisis in our oceans and seas



Research and Innovation

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Editorial

Sustainable and innovative solutions to tackle the plastics crisis in our oceans and seas

The prevalence of plastic in our rivers, seas and oceans has become an incredibly topical issue over the past few years with many raising the alarm about an impending environmental disaster. Yet plastics are a vital material in our modern society and play an important role in our daily lives.

This CORDIS Results Pack examines eight EU-funded projects that are taking on the challenge to find new, sustainable and achievable solutions to help us address, and ultimately overcome, this global problem.

Plastic – it's everywhere in our daily lives: around the food we eat, in the clothes we wear and the houses we live in. Due to its functionality, durability and low cost, plastic constitutes an essential ingredient of our modern life. But if not disposed of properly, plastic pollutes the environment causing substantial environmental and economic damages.

A pressing political priority...

Unfortunately, our oceans and seas are already heavily polluted with plastic, which can be found in even the remotest areas of the planet such as the Arctic. Every year, between 4.8 and 12.7 million tonnes of plastic end up in the ocean threatening marine life and causing damage to the economy. Plastic pollution in the ocean costs the EU up to EUR 690 million per year, resulting from beach and coastal clean-ups as well as negative impacts on the fishing and aquaculture industry.

Tackling this problem is a political priority of the European Union. In December 2018, the EU institutions reached a provisional agreement on measures to reduce marine litter at source through market restrictions, design and collection requirements and extending producer responsibilities, targeting the 10 plastics products most often found on beaches as well as abandoned fishing gear that together constitute around 70 % of all beach litter items. That agreement was based on the Single-use plastics proposal presented by the Commission in May 2018 as part of the world's first comprehensive Strategy for Plastics in a Circular Economy that will deliver on the Sustainable Development Goals.

... Needs robust research to underpin viable solutions

The EU is taking concrete political action to address this growing environmental crisis. Strong and robust research is required to ensure that policymaking is based on sound scientific evidence and to develop innovative solutions, solutions that reduce the amount of plastic waste, prevent its leakage into the seas and oceans and mitigate the effects of plastic on the environment. For 2018-2020, about EUR 100 million has been allocated under Horizon 2020 to projects directly related to the European Union's plastics strategy, adding to the EUR 250 million already spent on plastics-related projects under Horizon 2020 up to then.

Milk-based plastics to reduce environmental damages

The gesture seems inconsequential: filling the dishwasher or washing machine with a dose of detergent packed in soluble plastics. But what seems to disappear actually has a long-term negative impact on nature – one that could be solved with a proper biodegradable alternative.



© Lactips

With each year that passes, bioplastics keep snagging more market shares. But they are still marginal: they currently account for only around 1 % of Europe's total plastic production, and only further research and development can help overcome remaining barriers to a wider adoption.

In the context of growing concern over marine plastic pollution, one major such barrier is the lack of water solubility. Most attempts at creating water-soluble plastics have so far been relying on petrol-based polymers, while the Holy Grail could in fact have laid all this time in milk proteins.

Got milk proteins?

Lactips, a French SME built around the concept of building thermoplastic pellets from milk protein, is strongly investing in the production and commercialisation of their first applications. Judging by the EUR 3.7 million they raised in 2018, they are clearly onto something.

"Our product is the only thermoplastic based on sound and clean biomaterials (bio-sourced and biodegradable) in the world to be water-soluble at room temperature," says Jean-Antoine

Rochette, CEO of Lactips, the company behind the ECOLACTIFILM (A Water-Soluble Packaging to Unlock New Markets) project. "To produce it, we upgrade declassified milk's main protein called casein, which used to be destroyed, to create a processable polymer. Casein is renewable, biodegradable and compostable, and it allows for developing a bioplastic with no significant aquatic toxicity."

Ever noticed how detergent tablets for dishwashers are usually packed in soluble plastic packaging? Thanks to Lactips, this PVA-based soluble film which dissolves but doesn't biodegrade in water or in soil can be replaced with Ecolabel and Ecocert-certified milk protein-based plastics. Unlike PVA, whose aerobic biodegradation is limited to 13 % in 21 days in water, Lactips's alternative can reach almost 100 % biodegradation within 28 days.

Everything in our product was conceived with environmental impact in mind: from the sourcing of materials to the end of life of the product, including its production.

"Everything in our product was conceived with environmental impact in mind: from the sourcing of materials to the end of life of the product, including its production (a Life Cycle Analysis is currently in progress). Our temperature of transformation to make pellets is the only energy used over the whole life cycle, and this temperature is twice as low as that required for PVA transformation," Rochette explains.

To the market and beyond

Sales began in the last quarter of 2018, and Lactips and ULRICH-Natürlich have already agreed on a first set of orders. The German eco-friendly cleaning and care products manufacturer intends to use the patented technology for its dishwasher tablets. "To use Lactips is a great adventure. The advantage for us and the customers will be the plastic-free film, that doesn't put any poison into the water. So, the customers are also able to use tabs, packed in a healthy film, and don't need to worry about the ingredients," says Klaus Röhrle, Head of R&D at ULRICH-Natürlich.

Detergent tablet packaging is just an example of Lactips' potential. The company is already contemplating new markets such as construction, dyes, the textile industry, the agrochemical sector and the food market. Lactips plans to set up a 2 500 m^2 plant in its region soon, as part of its 100 % 'Made in France' strategy, and intends to further strengthen its production capacity.

"We are providing solutions to societal needs, protecting the planet, especially the oceans, as well as fulfilling the plastic industry's requirements. Born from patented scientific and technological expertise, our material combines social, environmental and economic benefits to lay the foundations of a virtuous industry," Rochette concludes.

PROJECT
ECOLACTIFILM – A Water-Soluble Packaging to Unlock New Markets

COORDINATED BY
Lactips in France

FUNDED UNDER
H2020-LEIT-ADVMANU, H2020-LEIT-ADVMAT, H2020-SME and H2020-LEIT-NANO

CORDIS FACTSHEET
cordis.europa.eu/project/id/766603

PROJECT WEBSITE
lactips.com

The truth about our exposure to chemical cocktails and its impact on our health

People across Europe and the world are starting to realise how much we don't know about the consequences of our seemingly constant exposure to chemical mixtures of all kinds. Research under the EuroMix project should help stakeholders close this gap over the years to come.



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EuroMix has been aiming to establish novel testing and assessment strategies for chemical mixtures found in humans, as well as the relevant tests and models to go alongside them.

The task was gargantuan. As Prof. Jacob van Klaveren, coordinator of the project on behalf of the Netherlands National Institute for Public Health and the Environment, underlines: "Prior to EuroMix, there was hardly any mechanism considering combined exposure to multiple chemicals via multiple exposure routes. This is hardly addressed in the current safety evaluation of chemicals, which is causing significant economical, societal and scientific concern."

Various human biomonitoring studies have already proved that people in Europe have a considerable number of man-made chemicals in their bodies, originating from multiple sources, including food and water intake and dermal contact. Most European regulations stipulate the need to consider the potential mixture effect in the future. Besides, animal testing is less and less in vogue, and new testing methods are required. For the EuroMix team, the question was simple: How do we translate this goodwill into effective action?

A new method for a pressing issue

"EuroMix considers many chemical classes for their effects on human health," says Prof. Van Klaveren. The team delivered a test strategy to generate the missing toxicity data needed to conduct future risk assessments. They tested a large number of chemicals and ran several case studies addressing exposure assessment affecting three adverse outcomes: liver steatosis, skeletal malformation and the endocrine system. Finally, they developed a novel risk modelling approach aligned with future needs in Europe and elsewhere.

Prior to EuroMix, there was hardly any mechanism considering combined exposure to multiple chemicals via multiple exposure routes.

"Our method starts with *in silico* modelling, to group chemicals into cumulative assessment groups in the absence of detailed toxicity data, and to set test priorities. From thereon, we use *in vitro* assays on the three adverse outcomes to investigate the appropriateness of assumptions related to dose addition as well as derive the relative toxicity of each chemical in a mixture. Results from *in vitro* testing are then compared with data from animal studies," Prof. Van Klaveren explains.

Although *in vitro* assays already allow for the generation of new hazard data on as yet untested chemicals, Prof. Van Klaveren stresses how their results need to be extrapolated from internal exposure concentrations to external doses before being used in mixture risk assessment. For this, the EuroMix team developed nine specific and one generic *in vitro* to *in vivo* (IVIVE) models.

Beyond the project

By the end of the project, the consortium will provide an open, web-based data and model platform. This platform includes: the results of *in silico* modelling; the *in vitro* test results and a modelling approach to derive relative potency factors; the IVIVE modelling approach; and the *in vivo* data.

A total of 11 Member States have already performed a dietary mixture exposure assessment using EuroMix data and models. Three case studies addressing multiple exposure routes of bisphenols and pesticides, along with a feasibility study on simultaneous exposure to pesticides, additives and contaminants regulated under different regulatory sectors, will soon be published.

For better or worse, chemicals have become an integrant part of our lives. And while there is still much we don't know about the consequences of this ubiquity on our health, EuroMix is certainly making headway.

PROJECT
EuroMix – A tiered strategy for risk assessment of mixtures of multiple chemicals

COORDINATED BY
The National Institute for Public Health and the Environment in the Netherlands

FUNDED UNDER
H2020-FOOD

CORDIS FACTSHEET
cordis.europa.eu/project/id/633172

PROJECT WEBSITE
euromixproject.eu

Unique bacteria can help reconcile plastics with nature

Imagine we could solve the world's plastic indigestion problem simply by taking oil-based plastics waste and processing it into a sustainable, biodegradable product. Too good to be true? Don't be so sure.

Many believe synthetic biology will be at the heart of the next technological revolution. Behind the oxymoron hides the design and construction of new, standardised biological parts and devices for various uses – one of which being a new generation of environment-friendly plastics. But as good as it sounds, this new bioplastics production era won't solve the problem of their oil-based counterparts already discharged in nature.

For those, members of the P4SB (From Plastic waste to Plastic value using Pseudomonas putida Synthetic Biology) consortium have a specific plan: a bioconversion of oil-based plastics into fully biodegradable ones, using deeply engineered, whole-cell bacterial catalysts derived from a bacterium known as *Pseudomonas putida*.

The depolymerisation of PET

"People like to think that plastics in nature will eventually be consumed by microbes, thereby 'dissolving' the environmental plastic crisis itself. But this will not happen overnight, as the rate of degradation in the environment is very, very slow," warns Dr Lars Blank, coordinator of P4SB on behalf of RWTH Aachen. "Using synthetic biology, however, we can create enzymes capable of degrading plastic and microbes using monomers as a carbon source. Our partner UFZ has identified such microbes, which can grow on the diamides originating from the isocyanates of digested polyurethane (PU, from your foam mattress or running shoe). This is really fascinating, as these molecules are known to be highly toxic."



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The consortium investigated several monomers constituting polyethylene terephthalate (PET, the material of your plastic water bottle) and PU, and showed that they could both be used to feed the microbes and produce a biodegradable plastic: polyhydroxyalkanoates (PHA) – a bio-polyester. In other words, the project has successfully led to the depolymerisation of PET and to some bonds in PU, and the subsequent production of PHA from resulting single monomers.

Currently the microbes perform best with PET, with which double digit grams per litre can be digested in 100 hours.

"Currently the microbes perform best with PET, with which double digit grams per litre can be digested in 100 hours. We can use PET flakes, degrade them with enzymes, feed microbes for growth and bioplastic production, and formulate that plastic into an end-user product. The technique works to some extent with PU too, and in the future all plastics with ester bonds should be a realistic target," says Dr Blank. Carbon-carbon bonds, however, have not yet been investigated.

Advancing towards full-scale rollout

P4SB technology is now somewhere between TRL 3 and 5, according to Dr Blank. Many aspects of the conversion process still need improvements, and its energy efficiency has yet to be evaluated. While it is expected to be energy-intensive compared to current market workflows, Dr Blank points out that, in a future where all energy will potentially be produced free of CO_2 emissions, this will not be a concern.

P4SB is set for completion in March 2019. After that, consortium members plan to keep developing their degrading enzymes, with for example potential applications in the textile industry. They are also in the process of answering a new H2020 call on the issue of mixed plastics waste. Meanwhile, the use of PET as a carbon source for the bio-polyester PHA is already in testing, and the consortium sees many opportunities ahead, including contributions to environment-friendly plastic production with the likes of mulch foils made of PHA.

Science-fiction enthusiasts who've read the novel 'Mutant 59: The Plastic Eater' where plastic-eating bacteria wreak havoc in the world can rest assured, too: "All catalytic steps are contained, so there is no possibility of this novel coming true," Dr Blank jokingly concludes.

PROJECT
P4SB – From Plastic waste to Plastic value using Pseudomonas putida Synthetic Biology

COORDINATED BY
RWTH Aachen University in Germany

FUNDED UNDER
H2020-LEIT-BIOTECH

CORDIS FACTSHEET
cordis.europa.eu/project/id/633962

PROJECT WEBSITE
p4sb.eu

Getting under the ocean's (microplastic) skin

With plastics production set to double within the next two decades, pollution of the ocean's sea-surface microlayer (SML) can only get worse. Thanks to research under the POSEIDOMM project, we now know a bit more about the devastating consequences of this pollution.

The extent of scientific, political and media coverage around sea and ocean plastic can barely hide an inescapable truth: At this point, we've hardly scratched the surface of all the chain reactions this plastic accumulation is setting off.

Let's take the SML. This 1 mm-thick barrier between water and the atmosphere – you could view it as the ocean's skin – may not look like much compared to the immensity of the world under it, but it is actually a key interface between the two environments. Major physical, chemical and biological exchanges take place in the SML, while the large variety of living organisms (fish eggs, larvae, bacteria, micro-invertebrates and algae) inhabiting it increasingly mix with plastics of low density.



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Upsetting the SML's delicate balance

"We know that natural organic matter, as well as anthropogenic contaminants, can be highly enriched up to a hundred times in the SML compared to the underlying water. What we did not know prior to our project, however, is how increases in microplastics and organic matter might influence each other and affect the important functions of the SML," explains Prof. Steven Loiselle, coordinator of POSEIDOMM (Photochemistry at the Ocean's Surface: Effects and Interactions of Dissolved Organic Matter with Microplastics) on behalf of the University of Siena.

Where scientific insight used to be scarce, POSEIDOMM investigated the effects of microplastics on the SML. The team explored their impact on the production of organic matter, the degradation of this organic matter as a potential net source of CO_2 in the atmosphere, as well as other microplastic-induced changes in the molecular composition of the SML. To get there, the consortium combined in-lab, controlled experiments (microPOSEIDOMM) on various water samples with a world-first large-scale *in situ* mesocosm experiment focusing on microplastics (mesoPOSEIDOMM).

A common observation from all our microcosm experiments was a significant reduction in oxygen concentration in treatments including microplastics, compared to 'control' samples.

According to Dr Luisa Galgani, principal investigator of the project, one of the most important findings of the project is how, "in the presence of microplastics in surface waters, the combined photochemical and microbial degradation of organic aggregates leads to further reduction in oxygen concentrations. In fact, a common observation from all our microcosm experiments was a significant reduction in oxygen concentration in treatments including microplastics, compared to 'control' samples."

These experiments suggest that marine microplastics act as localised hot spots for microbial activity. As this low-density plastic debris can remain on the sea-surface for a long time, this accumulation at the sea-surface may interfere with the SML's production, consumption and exchange of gases.

The need for further study

According to Dr Galgani, this has potential consequences for the ocean's respiration that need to be further studied. And while the results of the mesocosm study have yet to be published, the team says that they will further highlight the need for action and additional studies.

Speaking of future research, the consortium members are currently looking for new opportunities. They would like to focus these efforts on field quantification and monitoring, experimental studies on enrichment processes, and models of plastic residence time in the SML, as well as to push even further by exploring the effects of different types of plastics in a variety of aquatic environments – from riverbed sediments and soils to seawater and freshwater.

PROJECT
POSEIDOMM – Photochemistry at the Ocean's Surface: Effects and Interactions of Dissolved Organic Matter with Microplastics

COORDINATED BY
The University of Siena in Italy

FUNDED UNDER
H2020-MSCA-IF

CORDIS FACTSHEET
cordis.europa.eu/project/id/702747

PROJECT WEBSITE
poseidomm.eu

New 'Ocean Literacy' tools educate, while changing attitudes and behaviours

If marine issues are to involve everyone, one project knew it had to set its compass for horizons beyond the 'science education' of traditional ocean literacy, dropping anchor in lands with names like 'Blue Growth' to get all actors on-board.



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With the ocean beset by multiple challenges, such as climate change and plastics pollution, there is a concerted effort to increase ocean literacy (OL) to ensure the sustainability of marine ecosystems. OL encompasses awareness raising, capacity building and education about the ocean's functioning, health and relationship to human activities.

The EU-supported Respon-SEA-ble (Sustainable oceans: our collective responsibility, our common interest. Building on real-life knowledge systems for developing interactive and mutual learning media) project used participatory techniques (the living lab approach) to develop a range of OL products and interactive guidance for practitioners (a WebDocumentary), accessible

to interested parties including educators, businesses, trainers, policy makers and the media.

Information overboard?

Respon-SEA-ble reached clear conclusions about where to concentrate their efforts. "In many cases, there is too much information about the status of the marine ecosystem and too little about social and economic impacts. This is compounded by lack of clarity for targeted audiences about what action is most needed," says project coordinator Dr Olga Mashkina.

The project concluded that effective change comes from combining initiatives at different parts of the value chain, as evidenced by current efforts to ban microplastics in cosmetics. Additionally, the causes of many marine problems, such as plastics pollution, are actually land-based.

Respon-SEA-ble focussed on six thematic areas curated as 'key stories' – sustainable fisheries/aquaculture, marine renewable energies, eutrophication, maritime transport, sustainable tourism and microplastics – all contributing to marine ecosystems' health, connecting to existing policies and relevant to actors capable of driving change (e.g. policy makers, producers and consumers).

We have moved ocean literacy beyond schools and a purely scientific focus, making it inclusive, reminding everyone that we are all responsible!

These key stories illustrate current knowledge on the (direct and indirect) links between human activities and marine ecosystems, different types of information and mechanisms for sharing it (also identifying gaps) and constraints/opportunities in terms of practical actions and behaviour change.

The project created, tested and assessed a range of OL tools and products including: a series of games; short documentaries; cartoons; an IT platform for sharing marine knowledge with ferry passengers; an education module for children/schools and a training programme for fishermen.

"To ensure their effectiveness, the tools were co-designed with key stakeholders," says Dr Mashkina. "Additionally, we sought feedback on whether they made a difference to how users understood issues, felt about them and were ready to act."

The feedback so far has been positive, and analyses of assessment results are leading to recommendations for an interactive OL WebDoc platform which will be released at the end of the project (March 2019).

Lasting change

Project learning has led to specific suggestions to maximise opportunities in existing policies (such as the Marine Strategy Framework Directive), strengthening OL for different target groups. Specific attention has also been given to how OL could be embedded for regional seas by aligning with local sea conventions and activities, as well as contributing to Atlantic Ocean Research Cooperation, involving US/Canadian actors.

"We have moved ocean literacy beyond schools and a purely scientific focus, making it inclusive, reminding everyone that we are all responsible!" says Dr Mashkina. "Seeing OL attracting more attention through research calls, policy documents or international initiatives, makes us feel that our drop has already contributed to ripples of change."

PROJECT
Respon-SEA-ble - Sustainable oceans: our collective responsibility, our common interest. Building on real-life knowledge systems for developing interactive and mutual learning media

COORDINATED BY
ACTEON SARL in France

FUNDED UNDER
H2020-FOOD

CORDIS FACTSHEET
cordis.europa.eu/project/id/652643

PROJECT WEBSITE
responseable.eu

Harvester boats clean debris and toxic algae from polluted waters

Human activities generate quantities of waste which can contaminate the marine environment. SAILCLEAN aims to help reduce this, ensuring the Good Environmental Status of the seas.

Two of the biggest problems in ensuring we have clean oceans are marine litter (principally plastics) and eutrophication, which causes algal blooms. Both pose a threat to marine animals, as well as human health and livelihoods.

There does not yet exist an adequate full suite of solutions to address the challenge. What is needed is a solution that can bridge some of the current gaps, with the ability to harvest both litter and algae in hard-to-reach areas.



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Iceland's Technology Development Fund supported Asco Harvester to build a prototype waterborne harvester, Sigri 9057. With EU support, the company has started the design, build and development phase for full-scale cleaning boats. The SAILCLEAN (A complete solution for sea cleaning: marine litter removal and optimal algal bloom harvesting) project has tested its solution in the Atlantic Ocean, with promising results.

Tackling environmental, economic, health and aesthetic problems

SAILCLEAN conducted a feasibility study into a new boat fleet that could 'mow' toxic algae and marine litter (including plastics), especially in difficult areas such as fjords, open oceans or river canals – as well as sustainably harvest marine resources.

"The idea originally came from my family's work to improve seaweed harvesting. We realised we could tweak the technology to collect debris, unwanted algae and plastic, as well as clear flood areas," says Ms Anna Kristjansdottir, CEO of Asco Harvester and project coordinator.

The idea originally came from my family's work to improve seaweed harvesting. We realised we could tweak the technology to collect debris, unwanted algae and plastic, as well as clear flood areas.

The SAILCLEAN team undertook trials with their Sigri 9057 prototype which harvested seaweed (*ascophyllum nodosum*), in Iceland last year, managing to harvest up to 30 tonnes per tide, higher than expected. The boat, with its customised hull and floating system, proved stable, even when working in difficult conditions, such as bad weather.

One design feature, validated by testing, was the device's automatic, custom-made, twin conveyor belt system (for collection and packaging) placed on a hydraulic cylinder, which transports the captured material directly in sacks. Once full, the sacks are snipped shut and a switch releases them into the sea, where they are attached to one another, forming a floating chain, retrievable by another ship.

"The 1-3 tonne sacks offer high storage capacity, avoiding returns to port for unloading, and the conveyor belt enables continuous harvesting, with no interruptions, eliminating non-productive processing time," Kristjansdottir says.

Harvested seaweed can be dried or processed for fertilisers or food, while sea grass can be used for biodiesel, and toxic algae used as fertiliser, with plastics recycled.

Improvements to meet a growing problem

Worldwide, around 8 million tonnes of plastic enter the ocean annually – in densely populated areas as well as remote regions. Of the 5.25 trillion pieces of plastic debris in the ocean, 269 000 tonnes float on the surface, and 4 billion microfibres per km^2 contaminate the deep sea, wreaking havoc on marine wildlife, fisheries and tourism. Damage to marine ecosystems has been priced at at least EUR 8 billion.

The Harmful Algae Blooms (HABs), caused by anthropogenically-driven eutrophication (usually the release of nitrogen and phosphorous), lead to fish die-offs which jeopardise the fishing industry, as well as contaminated water supplies for populations. In the EU, the annual cost of cleaning up these blooms surpasses EUR 900 million, with a marked increase in the number of them reported over the last 25 years.

The SAILCLEAN team will now further improve the boat design based on the tests and discussions with stakeholders. "Modifications will strengthen our offer of safety, accessibility, efficiency and sustainable harvesting," affirms Kristjansdottir. "Customisation of the prototype into a product for our two target markets will incorporate the RECYCLE Model for plastics and debris collection and the BREED Model for sustainable algae harvesting."

PROJECT
SAILCLEAN – A complete solution for sea cleaning: marine litter removal and optimal algal bloom harvesting

COORDINATED BY
ASCO Harvester EHF in Iceland

FUNDED UNDER
H2020-Societal Challenges, H2020-SME and H2020-Industrial Leadership

CORDIS FACTSHEET
cordis.europa.eu/project/id/826061

PROJECT WEBSITE
ascoharvester.is

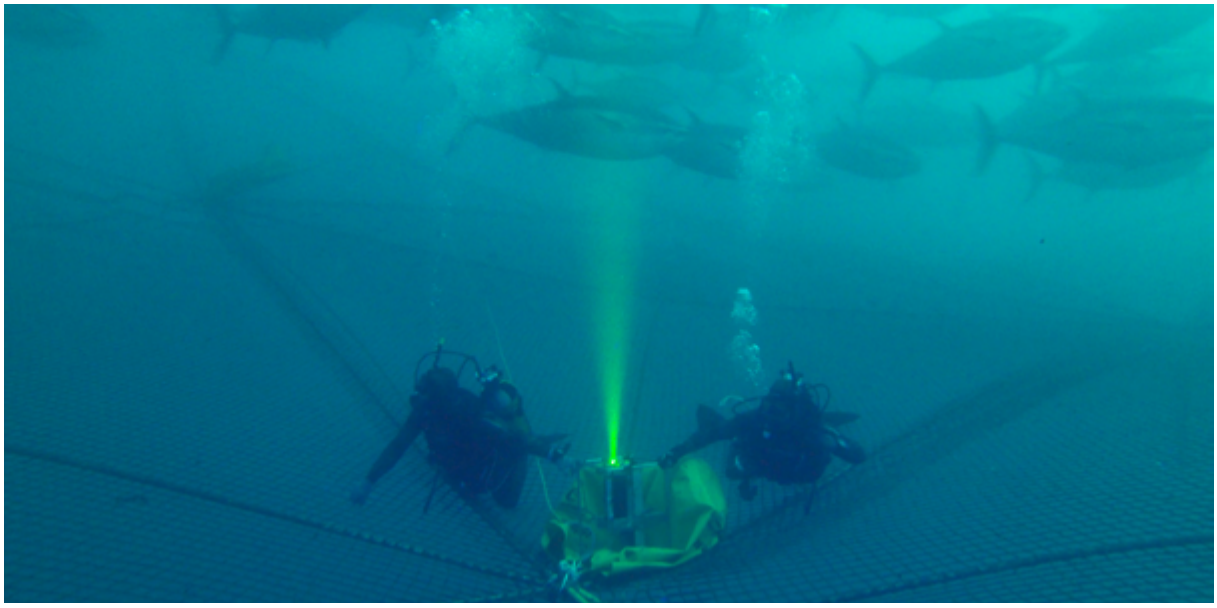
New underwater inspection camera uses 3D time-of-flight technology

When it comes to underwater surveillance, there is a gap between short-range, high-resolution conventional video and long-range, low-resolution sonar systems. UTOFIA has developed a compact and cost-effective underwater system to fill it.

Particles suspended in water can result in turbid environments, and being opaque in appearance they impair visibility. Fog is a familiar example of this phenomenon where small water droplets in the air make visibility challenging for both humans and imaging systems. When driving in fog, turning on headlights actually blinds drivers, creating a 'white-out' effect whereby the headlights are reflected back by the fog – known as backscatter.

The EU-supported UTOFIA (Underwater Time Of Flight Image Acquisition system) project tackled this imaging problem by emitting very short pulses of light, timed to match the shutter of a camera, as opposed to a continuous stream of light (as with the car headlights analogy).

UTOFIA developed prototypes for a commercial underwater inspection system using 3D 'time-of-flight' technology, of interest for marine science, public sector environmental monitoring, commercial fisheries/aquaculture stock assessment and subsea technologies, such as seabed mapping. In the long term, the systems could aid the autonomous functioning of subsea vehicles.



© UTOFIA

Generational improvements

Explaining the principles behind the UTOFIA technology, project coordinator Mr Jens Thielemann says, "As light travels at a constant speed, the light reflected from turbid environment particles returns to the camera before the light reflected from the objects under observation. Closing the shutter when light arrives from the murk, while opening it for the light's arrival from the objects, removes or reduces backscatter in the image."

Using this principle, the Pan-European team built their imaging system three times. Each time building on what had been learnt about the physical characteristics of the systems' components, the team honed their time-of-flight methodology, developing a more detailed understanding of how solid-state technologies operate when exposed to nanosecond-long events.

These efforts resulted in the system being reduced in size by a factor of six. Furthermore, the laser power increased by a factor of four and the precision of the 3D rendering increased to 10 times the original.

As there is a range of potential applications, the technology was trialled for a number of scenarios. For example, in Spain the camera was used to estimate biomass for the aquaculture industry, with the team satisfied with both the 3D data and the resulting images.

Before UTOFIA there was no full-field real-time 3D technology available with a range of several metres. Existing approaches either couldn't provide a full image (just a single line that was scanned) or could only provide an incomplete image with limited 3D viewing range (stereo).

Equally promising were the initial tests for close-range underwater navigation systems for remotely operated and autonomous underwater vehicles (ROVs/AUVs), an avenue with much potential. Good seabed images could, for instance, be used both for quantitative assessment of littering and pollution (useful for policymaking and enforcement), and also as input for cleanup efforts.

Perhaps the biggest potential lies in the automatic monitoring, quantitative assessment and characterisation (size, species and behaviour) of marine life.

Watch this space

Currently the team is working on the commercialisation of the technology through one of the project partners Subsea Tech, and anticipates making its first sales this year.

"Before UTOFIA there was no full-field real-time 3D technology available with a range of several metres. Existing approaches either couldn't provide a full image (just a single line that was scanned) or could only provide an incomplete image with limited 3D viewing range (stereo)," says Thielemann. "UTOFIA is also the first system to do range-gating using a CMOS array sensor, making it much more cost-effective."

To take the technology to the next level, the image processing algorithms will be further developed for the monitoring of aquaculture and fisheries. Towards this end, the team have secured funding for two follow-up projects, SMARTFISH and BIOSYS. There is even talk of taking the tech into outer space!

PROJECT
UTOFIA – Underwater Time Of Flight Image Acquisition system

COORDINATED BY
SINTEF AS in Norway

FUNDED UNDER
H2020-FOOD

CORDIS FACTSHEET
cordis.europa.eu/project/id/633098

Aquadrones remove, deliver and safely empty marine litter

If we continue to pollute the planet at current rates, the effects on marine ecosystems, potable water and ultimately human living standards will be stark. WasteShark (Marine Litter Prevention with Autonomous Water Drones) introduces a data-driven, complete waste capture and delivery solution, based on advanced robotics.



© RanMarine Technology BV

It has been estimated that marine litter costs the EU economy EUR 690 million per year, affecting mainly the tourism and fishery sectors. It is furthermore estimated that around 80 % of marine litter originates on land. Bearing in mind that once plastic reaches the ocean the vast majority of it ends up on the seabed or inside marine life, addressing the problem requires effective water-based capture alongside tackling it at source.

With EU support, RanMarine has added a new innovation to its suite of marine litter solutions. Their SharkPod allows aquadrones, known as WasteSharks, to autonomously deliver and empty waste, debris or biomass, from ports and inland waters, safely on shore.

The WasteSharks have a carrying capacity of 200 litres, with a buoyancy of 400 kg. Self-organising swarms can operate collectively and, using sensors, gather crucial environmental data while collecting garbage.

Robust and ravenous

"Our starting point with WasteShark was that there were already solutions for catching waterborne waste, but very few that can deliver it back to shore," says project coordinator Mr Richard Hardiman.

Once target areas are identified, the WasteShark aquadrones are deployed to collect the litter, which is stored in a basket below deck. An on-board algorithm detects when each drone is 'full', triggering its return to the SharkPod vessel to be emptied. It is here that the drones also recharge their batteries.

The aquadrones are able to work collectively as a swarm, making decisions based on interactions and shared knowledge. For example, if one drone is quickly filling up, an assumption can be made that that location is waste-dense, resulting in additional drones being deployed.

This information is logged for future correlation with similar weather or tidal conditions. "Having more knowledge about your environment makes decision making better. The hope is that as the aquadrones learn more about their environment, they become more efficient, resulting in faster capture of trash and ultimately cleaner waters," says Hardiman.

The aquadrones' ability to collect and collate data also means that measurements can be taken of anything from turbidity to oxygen/nitrogen levels or toxicity parameters. Longitudinal data-sets can then be used to create predictive models for phenomena such as algae blooms, fish die-offs, or toxicity dangerous to humans.

As they are intended for harsh environments, the aquadrones have to be robust, and so design was guided by the principle that fewer moving parts equates to fewer repairs and replacements. Technically the only moving parts are two thrusters.

Predictive and proactive solutions

Currently RanMarine are selling WasteSharks in two formats, Class A and Class B. Class A is a remote-controlled unit driven by a land-based operator and used solely to collect and remove biomass. Class B is a data and sensor-enabled unit with mission planning ability, whereby the aquadrones can course-set or manage a particular area for cleaning. RanMarine is seeing demand for both units and is already shipping globally.

Having more knowledge about your environment makes decision making better. The hope is that as the drones learn more about their environment, they become more efficient, resulting in faster capture of trash and ultimately cleaner waters.

The team are now working to further fine-tune their products. "We remain passionate about using technology to improve our environment. We are getting closer to a predictive model of where trash collects in water, along with the development of evermore efficient methods for removing it," says Hardiman.

PROJECT
WasteShark – Marine Litter Prevention with Autonomous Water Drones

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RESEARCH*EU MAGAZINE ISSUE 79

Helping the 5 in 10 000: Innovative therapies against rare diseases

In this issue of Research*eu magazine, we showcase innovative EU-funded research in developing new treatments for several rare diseases on the occasion of Rare Disease Day, observed annually on the last day of February. There are over 6 000 rare diseases that affect over 300 million people worldwide, with between 27 million and 36 million in Europe alone – find out how this research is working tirelessly to help patients live longer, happier and more fulfilling lives.



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