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#107

NOVEMBER 2021

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SPECIAL FEATURE
SQUARING THE ARCTIC CIRCLE:
PROTECTING AND
PRESERVING EARTH'S
FAR NORTH

Editorial

Arctic bees, the smell of babies, batteries made of dirt

Welcome to this month's Research*eu magazine

The last of Europe's summer warmth is dwindling away and we're preparing ourselves for the cold winter ahead. As you read this, your editor is likely to be spending the last of the daylight each evening cutting and stacking firewood.

A cleaner and more environmentally friendly source of heat, like an electric oil-filled radiator, would be preferable. But the ancient wiring in this even more ancient house cannot support such modern conveniences. For now, I have to make do with a tiny wood-fired stove and the mountain of scrap wood accumulated by the previous tenant.

Despite the dropping temperatures, winter in the northern hemisphere is not what it used to be. Nowhere is this more recognisable than in the Arctic, which is warming at twice the rate of the rest of the world.

The changes this entails will not be confined to the Arctic. Open water across the top of the world will invite new trade routes and geopolitical wrangling, retreating ice will provoke a scramble for natural resources animal and mineral, and geophysical processes that turn on the axis of the Earth, now destabilised, will impact on the climate of Europe and the rest of the planet.

The EU has a responsibility to the Arctic, its people, and its ecology, not least through the interests of its three Arctic Member States. The coal, gas, oil – and wood – that Europeans burn to keep warm

each winter is just one contributor to the Arctic's steady decline, nowhere more clearly evidenced than by the black soot from our chimneys that dusts the ice cap.

Last month, the EU strengthened its engagement for a peaceful, sustainable and prosperous Arctic, bolstered against the impacts of climate change, in the shared interest of the entire world. In this issue's Special Section, we focus on the Arctic research that underpins the action needed to meet these ambitions.

But our view is not confined to the top of the world. As always, **Life After** provides us with the chance to catch up on a past project, and we find out how Bird Control Group's laser-powered deterrent is keeping another type of frequent flyer safe. Meanwhile, our **Project of the Month** discovers how **Safeguard** captured worldwide interest in saving wild bees – as well as other less celebrated pollinators.

With that, it's time for me to go and sharpen my hatchet. As always, if you have any queries, questions or suggestions (but hopefully never a complaint), please feel free to drop us a line at editorial@cordis.europa.eu.

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Turtledoves can carry bad tidings for sparrows – and humans

The coronavirus pandemic has emphasised that emerging infectious diseases with a wildlife reservoir pose a major challenge to global health. A better understanding of West Nile virus disease dynamics is crucial to the development of effective control strategies.

The presence of West Nile virus (WNV) in Europe has been known for decades. WNV, hosted in birds, is the number one cause of viral encephalitis worldwide. In the early 2000s it was clear that the virus was endemic in several countries of Europe, including Italy and Spain.

From 2011 to 2019, 3 549 human cases were detected in Europe, with a peak of cases in 2018. Currently it is expanding north with new cases reported in Germany in 2018 and the Netherlands in 2020. The EU's WNV tracker shows its spread.

In the summer of 2020 Spain experienced an outbreak of WNV, representing the biggest outbreak of a mosquito-borne disease in Spain since malaria was eradicated in 1964. TransWNV (A transcriptomic approach to understand the avian genetic susceptibility to West Nile Virus infection) sought to gain a better understanding of the dynamics of how WNV spreads by identifying how different bird species respond to infection.

“When looking at these numbers it is important to consider that 80% of infected people are asymptomatic, 20% develop some form of symptoms, and a much smaller percentage of 1-2% develop severe disease. So, the number of people exposed to the virus is much larger,” explains principal researcher María José Ruiz-López.

Based at Seville's Doñana Biological Station, part of the Spanish National Research Council, Ruiz-López was supported by a Marie Skłodowska-Curie Individual Fellowship.

MESSAGES EMBEDDED IN DNA

Gene expression is a tightly regulated process that allows us to respond to changing conditions. The expression of certain genes is turned on and off, or increases or decreases, when the individual needs to respond to different conditions.



“*When looking at these numbers, it is important to consider that 80% of infected people are asymptomatic.*”

“Studying what genes are more or less expressed, or even turned on and off, helps us understand how the organism is responding to changing situations,” adds Ruiz-López.

The TransWNV project focused on transcription and the transcriptome, the set of all RNA in an individual or organ. “By analysing the transcriptome, we can identify which genes are being expressed and in what amount,” explains Ruiz-López.

The project first identified genes using the mRNA sequence, then counted the copies of each mRNA. They then compared the data across samples derived from birds that were either infected or not infected with WNV.

“If a gene is not present in some samples and it is present in others, it can be assumed that it is being turned off/on. If a gene has many copies in some samples and very few copies in others, it can also be assumed that its expression changes under certain conditions, in this case being infected or not,” says Ruiz-López.

As she explains: “In this study, by comparing the transcriptomes of individuals infected by WNV and individuals not infected by WNV, we can understand which genes are being activated to respond to the infection.”

A VALUABLE PIECE OF THE PUZZLE

The project established that three birds had different susceptibility to WNV: sparrows may die, while European turtle doves and quail were asymptomatic carriers. “This was confirmed by the gene expression data, where we found expression of different genes involved in different phases of the immune response,” Ruiz-López notes.

Understanding the dynamics of infection in different species and gaining information about which species are more likely to be reservoirs, can help in identifying areas where the risk of infection to humans is higher.

“WNV epidemiology is very complicated, and it also depends on the mosquito species present, and other environmental factors. The best way to reduce the spillover into humans is to prevent mosquitoes from breeding in populated areas, along with adequate surveillance in high-risk areas to reduce transmission,” says Ruiz-López.

TRANSWNV

- Coordinated by the Spanish National Research Council in Spain
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/795537

HEALTH

Wearable robots provide extra muscle for children

Neurological disorders such as cerebral palsy may cause chronic loss of mobility. To address the limitations of existing neurorehabilitation devices, European researchers have developed the first wearable robotic exoskeleton for children suffering from problems with walking.

Progressive muscle weakness due to neurological or neuromuscular disorders causes patients to lose their autonomy with obvious psychosocial implications.

Conventionally, rehabilitation sessions are used to maintain a given physical health but are not enough to restore muscle function. As such, there is an imminent need for a device that can be used by patients suffering



© Marsi Bionics

from neuromuscular disorders in everyday activities to enable them to walk effortlessly.

A MODULAR GAIT EXOSKELETON

The EU-funded MARSİ (Disruptive technologies for effectively rehabilitating chronic ambulatory disability) project has developed the first paediatric exoskeleton for patients suffering from neuromuscular disorders. The ATLAS 2030 is the first wearable paediatric gait exoskeleton to enter the European market. "It is a robotic device that can be worn by children who are unable to walk and improves their mobility and quality of life," explains project coordinator and CEO of Marsi Bionics, Elena Garcia.

The exoskeleton embraces the child's body from trunk to feet, and its artificial muscles operate in parallel to the user's muscles, to complement lost strength. It uses hundreds of sensorial receptors and AI to understand the movement intention of kids who in essence command the device to move. The patented ARES technology makes the exoskeleton adaptive to the musculoskeletal complexity of neurological diseases (modular and compliant).

ATLAS 2030 can also be employed by therapists as a rehabilitation tool and has already received CE marking as a medical device to be used in clinical settings. Young patients may receive therapy twice a week with the exoskeleton in the form of game playing that involves using the upper limbs, trunk and head.

“ It is a robotic device that can be worn by children who are unable to walk and improves their mobility and quality of life. ”

Clinical results so far in patients suffering from spinal muscular atrophy and cerebral palsy are impressive, demonstrating a clear improvement in muscle strength, muscle tone and spasticity reduction. In addition, it offers kids the autonomy they need in everyday life to eat by themselves and pay attention in school. Importantly, this impacts their psychological as well as physical state.

EXOSKELETON ADVANTAGES AND PROSPECTS

"We have successfully addressed societal needs by bridging the gap with research," notes Garcia. MARSİ has provided a healthcare device superior to existing stationary or non-powered exoskeletons that do not provide spatial mobility.

Given that neurological diseases account for 35% of direct healthcare costs, the ATLAS 2030 constitutes a neurorehabilitation approach that is expected to delay spinal cord surgery and reduce hospitalisation costs. Overall, by prolonging ambulation it will improve the quality of life of millions of children worldwide and extend their life expectancy.

"We are improving the medical exoskeleton technology and extending its application to new groups of patients, adults and the elderly," adds Garcia. A first prototype of a completely novel concept of exoskeleton, STELO, has already been patented. It constitutes a fully reconfigurable device that adapts to any patient and disease. Garcia and partners have applied for an EIC Accelerator grant to advance its arrival on the market.

MARSİ

- Coordinated by Marsi Bionics in Spain
- Funded under Horizon 2020-HEALTH, Horizon 2020-LEIT-ICT and Horizon 2020-SME
- cordis.europa.eu/project/id/784498
- Project website: marsibionics.com
- ▶ bit.ly/MARSİ-video

Blood flow: opening the taps on our supply of stem cells

As well as life-saving cancer treatments, stem cells offer new approaches to curing genetic diseases. Learning how to mass-produce them is a crucial step in realising their potential.

Every year, over 30 000 patients in Europe receive stem cell transplants. However, as with all transplants, there is a persistent shortage of suitable donors. The project UNEXPECTED (Uncovering targets for ex vivo expansion of hematopoietic stem cells to enhance cell therapies of blood disorders), supported by the European Research Council, tackled this longstanding issue by investigating how stem cells can be grown outside of the human body.

As well as a treatment for blood cancers, stem cell transplantation is becoming a more sophisticated therapy, says project coordinator Jonas Larsson. “With gene editing there are possibilities to correct genetic diseases via stem cells. If you can correct at the level of a stem cell you might correct the whole system.”

However, to be a successful and sustainable therapeutic, we need to be able to multiply our available stocks of stem cells. This is a problem as stem cells grown in culture quickly mature and differentiate, losing their beneficial stem cell properties.

“This is the real challenge. Stem cells have enormous potential when transplanted, but the minute they are in a culture dish they begin to lose it,” adds Larsson. Working with a team of researchers at Lund University, Larsson hoped to identify the key regulatory networks that keep stem cells in an undifferentiated state.

GENE SCREEN

To find out what these might be, Larsson and his colleagues exposed clusters of stem cells to virus particles carrying gene inhibitors powered by RNAi and CRISPR. Each virus particle infected one cell, targeting a single gene, and left a telltale molecular tag.

“The screening tool is simple in a way, since the default pathway for these cells is to differentiate,” explains

Larsson. “All we need to do is look for cells that did not differentiate, and see what the genetic perturbation was that allowed the cell to maintain potency.”

The process identified over a dozen genes of interest whose expression or silencing may help stem cells resist differentiation. For those that were part of known signalling pathways, Larsson and his team turned to off-the-shelf pharmaceutical inhibitors that could perturb the activity of the gene.

The ultimate goal is not to edit the stem cell genes, but to formulate a protocol that will keep stem cells from differentiating in culture. These pharmaceutical agents are then rinsed off the cells before they are implanted.



“Stem cells have enormous potential when transplanted, but the minute they are in a culture dish they begin to lose it.”

To guarantee they maintained their potential, Larsson also transplanted the cultured stem cells into mice. “Surface markers on stem cells indicate their potency, but the perfect test is to show they can regenerate blood in a transplanted individual,” he says.

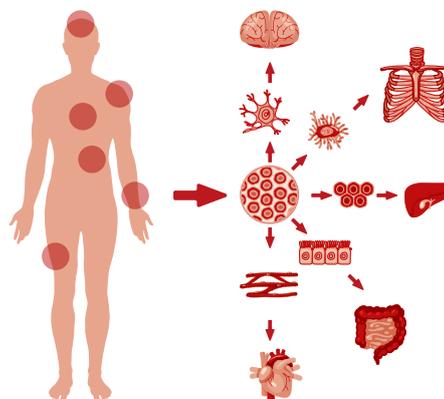
CANCER CLUES

The results gained by Larsson and his colleagues have been promising so far, and the group has published several papers on the research. The team identified several genes that prevent stem cells growing in culture, which can be overridden by pharmaceutical inhibitors.

The work also identified the role of several genes in tumour cells. “An expanding stem cell is to some degree equivalent to a cancer cell, both have an unlimited potential to grow, so some of these genes are crucially important in cancers, particularly blood cancers,” notes Larsson. “This was not part of the original aim, but is a very exciting consequence.”

Larsson is now assessing several of the targets the team have identified in more rigorous terms, to see if they can safely go to clinical trials. The group has also identified several unique identifiers from the RNAi screens that they hope to commercialise.

Every year, over **30 000** patients in Europe receive **stem cell transplants**



UNEXPECTED

- Hosted by Lund University in Sweden
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/648894

OCEAN ENERGY: PROMISING NEW TECHNOLOGIES TO HELP EUROPE ACHIEVE ITS CLIMATE GOALS

As Europe invests significantly in its transition to carbon neutrality over the coming decades, the oceans offer enormous potential as a source of clean, green energy. Innovative demonstrations of ocean energy technology across Europe, led by inspired and idealistic SMEs, offer an exciting opportunity for green investors. Often overlooked, these technologies should be considered as a viable long-term form of renewable energy, alongside their more widely known solar and wind cousins.

Horizon 2020 has been active in providing support to projects that further the reliability and robustness of ocean energy technologies, drive ocean energy toward cost-competitiveness, and clearly demonstrate its market potential.

To find out more, browse, download or order a physical copy of the Results Pack here: cordis.europa.eu/article/id/422014





Tracing the scientific contribution of female alchemists

The medieval and Renaissance era is rich in allusions to alchemy and studies have analysed its impact on male writers such as John Donne and Andrew Marvell. Now an EU study has looked at the writing of female alchemists to gain a more inclusive picture.

Turning base metal to gold, finding the elixir of life: alchemy has inspired literature throughout the ages. In the mid 1990s academics reconstructed a Renaissance British male alchemical literary tradition, but their research was published before the study of early modern women's writing was established as a field.

Over the last few decades, feminist scholars have rediscovered 16th and 17th century female-authored works in print and manuscript. We can now use this rediscovered corpus of women's writing to create a more expansive and inclusive understanding of early modern alchemical literary cultures.

The current drive to encourage women into science benefits from a historical perspective: scientific engagement is not only a male phenomenon, there are notable female contributions to the history of science.

HEARING THE FORGOTTEN VOICES

The WALCHEMY (Early Modern Women and Alchemy, 1550-1700) project brings to the fore the voices of these forgotten writers and reveals the diverse roles of female alchemists of the period.

"The female alchemist takes on different guises in the writings of these women: she is a medical practitioner and distiller, a religious meditator, a female poet-maker, a female friend, patroness, a transformative widow-poet, and spiritual visionary," explains principal investigator Sajed Chowdhury, based at Leiden University in the Netherlands.

Chowdhury, who received support through the EU's Marie Skłodowska-Curie Actions programme, says, "Medicine and theology were accepted concerns for many literate early modern women, and alchemy's cross-fertilisation between the medicinal and the spiritual facilitated women's involvement with it."

He offers Grace Mildmay (c. 1552-1620) as an example of why their role is important to understand. "Women like Mildmay were practising medical and spiritual alchemy in their households and local areas. If we are to gain a more accurate and inclusive understanding of Renaissance scientific, medical and spiritual cultures, then we must reintegrate into that history the identity and practices of the female alchemist."

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RECONSTRUCTING THE HISTORY OF THE FEMALE ALCHEMIST

The project resulted in the first in-depth study, a monograph titled: 'Women Writers and Alchemy in Early Modern Britain', currently under peer review. "The 12 early modern women writers discussed in the monograph used alchemical discourse, I argue, to foreground the transformative physical, spiritual and intellectual agency of the female chemical practitioner," Chowdhury comments.

The monograph considers works by 12 women from a variety of different backgrounds, including: the elite gentlewoman, Lady Grace Mildmay (c. 1552-1620); the daughter of a court musician, Aemilia Lanyer (1569-1645); the Republican, Lucy Hutchinson (1620-1681); and the Protestant dissenting religious leader, Jane Lead (1624-1704).

By analysing the writings of these women alongside one another, Chowdhury reconstructed a hitherto forgotten female alchemical literary culture which does not place the male chemical practitioner at its centre but brings to the fore the authority of the female alchemist.

Chowdhury poured over records in the Northamptonshire Record Office which houses some of Grace Mildmay's handwritten scientific papers.

"These manuscript papers document Mildmay's medical and chemical practices. Although Grace Mildmay was an

elite woman, textual evidence survives to suggest that she was practising medicine and chemistry in a cross-class environment. In one extant letter addressed to Mildmay's housekeeper, Bess, for example, Mildmay instructs Bess on how to concoct a healing balm," adds Chowdhury.

THE ALCHEMICAL NATURE OF LITERATURE

One of the ways in which scientific discourse and literary discourse overlapped in the Renaissance was through alchemy. Alchemy is cited in both scientific texts and literary works.

In 'An Apology for Poetry or The Defence of Poesy' (printed in 1595), Sir Philip Sidney describes the poet as an alchemist because of his capacity to turn brass into gold. In 'The Art of English Poesy' (printed in 1589), George Puttenham compares the poet to an alchemical healer.

"But for Sidney and Puttenham the poet-chemist is exclusively male. My monograph explores how women writers constructed the identity of the female chemical practitioner and female alchemical author," Chowdhury explains.

WALCHEMY

- Coordinated by Leiden University in the Netherlands
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/839419

SOCIETY

Saviour, villain, agent, victim? Untangling the relationship between migrant and smuggler

People smuggling – what roles do solidarity and cooperation play? And who are the facilitators? To get a better understanding of this significant societal dynamic, the MAPS project set out to answer these and other questions.

As the summer weather improves so the numbers of boats carrying migrants across the Mediterranean mounts. According to the UNHCR, the United Nations

refugee agency, in 2021 alone at least 896 migrants had died, or had been reported missing as of mid July. EU support to projects such as MAPS (Migrants And People

Smugglers: A Comparative Study of Smuggling Networks in the Eastern Mediterranean and the Central American corridors) helps to gain a clearer picture of the dynamics behind the statistics.

“What I tried to figure out was why millions of people kept entrusting their lives to people who were depicted as the very embodiment of evil by mainstream media,” says Luigi Achilli, principal investigator on the MAPS project which was hosted by the European University Institute in Italy.

Motivated by the circulation of this pejorative view in the media and general discourse, Achilli researched irregular migration to Europe, first, and then to the United States. His goal was to document what being a smuggler entails for the actors at the very centre of this unfolding drama.

“It all began with a question: are human smugglers motivated by anything other than greed and disregard for human life?”

A MORE NUANCED RELATIONSHIP

For most of his research respondents – both smugglers and migrants – human smuggling was not just about profiteering. “Criminal networks can be exploitative while simultaneously being embedded within ethnic networks and local economies, which are grounded in deep notions of solidarity and reciprocity,” notes Achilli.

A striking example comes from one of his subjects, called Mahdi, whose imperative to leave Syria required him to work as a ‘guide’ in Turkey for the very smuggling organisation that helped him and his family to leave the country.

“When I first met him, Mahdi was a young man in his early 20s. He and his smugglers came from the same village in Syria,” he adds.

During the first 2 years following the outbreak of the Syrian civil war, the village became the scene of fierce armed clashes between different armed groups. The intense fighting deprived the village of basic commodities and made it impossible to get supplies from surrounding areas.

As Achilli explains, “The resulting hunger, disease and high death rate caused by this situation led Mahdi to contact a smuggler who agreed to bring his family to Europe upon the condition that he work with him and his group in order to pay the smuggling fee.”



Achilli’s research highlights challenging questions: was the smuggler a reckless exploiter who capitalised on Mahdi’s vulnerability or a saviour who rescued him and his family from a situation of immediate danger there where official protection channels failed? And what about Mahdi himself? Was he a passive victim of a criminal network or a skilful agent who bypassed structural constraints?

“The point of my research was to problematise simplistic categorisations such as ‘criminals’ and ‘victims’ by looking at the complex dynamics behind human smuggling.”

PATTERNS OF PEOPLE SMUGGLING IN THE MEDITERRANEAN AND THE AMERICAS

Between 2017 and 2021, with the support of the EU’s Marie Skłodowska-Curie Actions programme, Achilli carried out ethnographic research. This was largely based on interviews and, to a lesser extent, participant observation with Syrian refugees and smugglers themselves in California, Greece, Jordan, Lebanon, Mexico and Turkey. “I was based at San Diego State University (SDSU), located in close proximity to the American/Mexican border and renowned for being a centre of excellence on migratory trends from Central America,” notes Achilli.

He found human smuggling held strong social and moral significance for both migrants and smugglers. Despite assumptions of deceit and deception, trust and cooperation seemed to be the rule more than the exception in the interaction between migrants and those behind their journeys.

“Where exploitation occurred among migrants and asylum seekers, this was more often the consequence of their protracted condition of deprivation and irregularity than the precise criminal intents of mafia-like organisations. This is exemplified by the situation of many refugees from Syria. Their need to support their families back in Syria considerably increased their vulnerability and the likelihood of their working in dangerous and exploitative conditions, or of getting involved in smuggling networks to enhance their own mobility.”

“It all began with a question: are human smugglers motivated by anything other than greed and disregard for human life?”

FROM INTERVIEWEES TO POLICY BRIEFS

MAPS has addressed knowledge gaps by examining the perspectives of irregular migrants, smugglers, authorities and local communities simultaneously, comparatively and over time.

The result is in-depth, empirical insight into the phenomenon to evaluate the relative success/failure of related migration control/asylum management policies. These are set out in publications such as the papers ‘Beyond legality and illegality: Palestinian informal networks and the ethno-political facilitation of irregular

migration from Syria’ and ‘Waiting for the Smuggler: Tales Across the Border’. A book, ‘2021 Global Human Smuggling’, is due to be published in January 2022.

This is all the more important because the eastern Mediterranean route and the central American corridors are evolving rapidly, raising serious policy and humanitarian concerns. “In terms of its potential impact on European policy objectives, the project can inform policies that are aimed at managing irregular migration and the fight against human smuggling,” Achilli adds.

MAPS

- Coordinated by the European University Institute in Italy
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/752144

SOCIETY

The lessons sport offers young people, on and off the pitch

We may be tempted to consider sports as a catalyst for universal values and learning experiences, but these can in fact vary considerably from one athlete to another. The Learn2 project brings about a more refined understanding of learning experiences in sport that considers the learner’s identity, gender, values and sociocultural environment.

Sport has many virtues, not least of which is its learning value. But what is learning in the context of sport exactly? If you had to ask this question as you enjoyed a nice dinner with a group of friends, chances are you would get as many different answers as there are people around the table. Some would refer to motor learning, others to various life skills such as fairness, discipline, perseverance, respect or team spirit.

So, which is it you might ask? Well you’re in luck, because Tatiana Ryba, senior researcher at the University of Jyväskylä, and Marie Skłodowska-Curie fellow Noora Ronkainen have recently jumped through hoops to answer this question. “This is a very pertinent research field for high-performance young athletes who combine sport and education/vocational training. By developing an existential theoretical framework of informal learning

in sport, we could support them in their personal development, provide an alternative interpretation to ‘life skills’, and ultimately facilitate athletes’ transition into the labour market and society at large once their sporting career is over,” Ryba explains.

Thanks to funding under the Marie Skłodowska-Curie Actions project Learn2 (Learning and Being in Sport: A Phenomenological Investigation), Ronkainen and Ryba were able to explore the structures of learning experiences in sport. They started by conducting interviews of young athletes. “The Learn2 study was designed as a part of the longitudinal research ‘Winning in the Long Run: towards a psychosocial sustainability of dual careers’. It investigated talented student-athletes’ development, dual career construction, and life design over 4 years as they attended



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elite sport high schools in Finland. Each participant had already been interviewed five times before Learn2 was kicked off, which means that we could use extensive life stories considering all changes they went through from one interview to another,” says Ryba.

With all this data, the team could theorise and study empirically the real learning experiences of young athletes, and Ronkainen was eventually able to conceptualise a framework for existential learning in sport that goes beyond the instrumental life skills discourse. The team also paid attention to cultural assumptions about gender, to define how they drive inequalities and differences in resources for learning and development.

THE IMPORTANCE OF INFORMAL LEARNING

Overall, project findings indicate that Positive Youth Development (PYD) through sport and life skills discourses dominate current understandings about learning in sport. But it all changed when the participants’ busy schedules

“If we think of life as time and energy, when there is no time for self-care to reflect on why I am doing what I’m doing, then routine will likely prevail.”

were interrupted by an unexpected challenging task or an interview question that disrupted dominant cultural narratives. “We obtained powerful insights into informal learning in sport. We could also show how access to counter-stories allows young people to build narrative resources which they can then use to avoid finalising their identities and lives”, Ronkainen notes. “This is not to suggest that young people do not have agency and are not already manoeuvring among various discourses. However, if we think of life as time and energy, when there is no time for self-care to reflect on why I am doing what I’m doing (Is this congruent with the person I aspire to be?), then routine will likely prevail,” Ryba adds.

With the project now completed, Ryba, Ronkainen and the rest of the team hope their findings will be used to generate better knowledge and policies. These could tackle, among other things, sustainable and ethical talent development in sport, future employability, and adaptability of talented sportswomen and sportsmen.

LEARN2

- Coordinated by the University of Jyväskylä in Finland
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/792172
- Project website: bit.ly/Learn2-project

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How do we comprehend the inexplicable or the unobservable? From magic tricks to quantum physics, tune in to Episode 8 of the **CORDIScovery** podcast which explores our drive to understand the world.

→ bit.ly/CORDIScovery_Episode_8





Transforming glass from inert shell to living skin

An EU-funded project offers an innovative solution that turns buildings into smart, sustainable and healthy ecosystems.

Aesthetically appealing and versatile, the use of glass in the building sector continues to grow in popularity. This presents a key challenge for the EU when it comes to achieving their objectives of increasing the number of nearly zero-energy buildings and becoming climate-neutral by 2050. This is because glass is largely an energy-inefficient material as a lot of heat goes in and out through it, resulting in energy loss as well as a poor indoor climate.

In the EU-funded GlasSkin (The GlasSkin Project: empowering every window in the world) project, PHYSEE – a research and development company – set out to address these concerns with SmartSkin, their smart window solution. “The project was designed to realise our ambition of changing glass from

inert shell to living skin by incorporating our patented coating, solar and sensor technology in 100% transparent insulated glass units,” notes Willem Kesteloo, project coordinator. Thanks to this solution, windows become an energy source instead of an energy sink, offering a payback time instead of remaining an expensive cost.

A CLOSER LOOK AT SMARTSKIN

“We found that currently the market wants two things. First, the most healthy, comfortable, productive and smart environment to work and live in,” explains Kesteloo. The second is to have an energy-neutral or energy-positive building. However, these



“The project was designed to realise our ambition of changing glass from inert shell to living skin by incorporating our patented coating, solar and sensor technology in 100% transparent insulated glass units.”

two needs do not align currently. This is because offering more comfort usually involves using more energy.

The SmartSkin solution adapts to the internal and external environment, optimising natural light, heat/cold and air to achieve the desired indoor climate. It can reduce the energy consumption of a building by up to 30% without compromising on design or comfort. “With our latest machine learning algorithms, we can actually offer the perfect marriage between a healthy environment and energy-positive building,” adds Kesteloo.

BREAKING INTO THE GLASS INDUSTRY

In GlasSkin, PHYSEE further developed their technology to bring it to the level where its performance significantly outweighs the costs for their stakeholders, making it ready for international scale-up eventually. The SmartSkin windows were successfully installed in several pilots throughout the Netherlands and have been certified with the EN 1279 certification by the glass manufacturing partner NSG Pilkington. “Despite experiencing delays due to

the COVID-19 pandemic, we were also successful in entering into official SmartSkin partnerships with two of the four largest global glass manufacturers and have many projects in the pipeline that want to implement the technology,” says Kesteloo.

Looking towards the future, PHYSEE’s product roadmap will focus on improving their current IoT and solar technologies integrated in windows as well as other facade applications in buildings such as blinds, natural ventilation and artificial lighting. This improved product offering is called SENSE, and SmartSkin is a crucial part of it.

Kesteloo concludes: “We are also very keen to apply for the Enhanced European Innovation Council pilot to keep our momentum as we are very much driven by our sense of urgency. If we indeed want to have the European building stock meet the required energy efficiency levels, there is a lot of work to be done, and we aim to play our part.”

GLASSKIN

- Coordinated by PHYSEE Group in the Netherlands
- Funded under Horizon 2020-Societal Challenges, Horizon 2020-SME and Horizon 2020-LEIT
- cordis.europa.eu/project/id/829448
- Project website: bit.ly/GlasSkin

ENERGY

Plugging smart parts into the future energy grid

The power infrastructure of tomorrow requires highly sophisticated, deeply connected and automated energy grids – so-called smart grids. The CONNECT project has demonstrated novel solutions across Europe.

Intelligent technologies are crucial for all parts of a power system – from generation, transmission and distribution, to consumption. The result is a more responsive, efficient and environmentally friendly system. The initiative CONNECT

(Innovative smart components, modules and appliances for a truly connected, efficient and secure smart grid) has achieved significant peak demand reduction by integrating



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photovoltaics and battery storage to reduce dependency on primary energy sources, therefore reducing the CO₂ footprint.

SMART AND EFFICIENT POWER TO THE PEOPLE

“In four CONNECT use cases throughout Europe – Germany, Italy, the Netherlands and Spain, bidirectional converters achieved up to 98.5% efficiency,” says Holger Schmidt, CONNECT project coordinator. Bidirectional energy flows optimise distributed generation, such as photovoltaic panels on building roofs. “Even small efficiency improvements have a huge impact due to the high power involved, up to 300 kW,” he explains.

CONNECT smart energy management was able to reduce the power demand, especially in peak demand periods. Strategies included effective load scheduling, smart use

of energy storage and efficient utilisation of renewable energy sources matching demand and supply.

The CONNECT communication infrastructure achieves the highest level of communication security (end to end) and, at the same time, interoperability at high and scalable data rates. This provides the vital basis for realisation of both the optimal utilisation of converters and the execution of energy management procedures.

ENERGY FLOW CONTROL AT A ‘PARK AND RIDE’ IN THE NETHERLANDS

CONNECT showcased controllable energy flow at the Transferium in ‘s-Hertogenbosch, the Netherlands. Where energy-conscious commuters and shoppers leave their cars and continue their journey with public transport or bike, the focus was on grid optimisation and stabilisation in a real-life microgrid infrastructure for electric vehicle charging.

Peak power reduction through load scheduling was demonstrated through the cooperative interaction of the subsystem photovoltaics, battery system, fast charging for buses and slow chargers for cars. Measurements showed that the overall system can reduce the active power taken from the main grid (particularly by the new 100-300 kW fast high-power bus charger) during charging intervals.

A battery setpoint, which can be optimised for different kinds of grid services, is therefore effective in following the charger

“ In four CONNECT use cases throughout Europe – Germany, Italy, the Netherlands and Spain, bidirectional converters achieved up to 98.5% efficiency. ”

demands and its effect on the grid connection. "Our data suggest that it's feasible to achieve at least 50% power reduction if stationary battery converters combined with PV are added to complement the microgrid," Schmidt notes.

COOPERATIVE ENERGY MANAGEMENT

For monitoring energy demand control, CONNECT looked at a group of buildings in Poblenou, Barcelona. Two residential buildings, two schools, a civic centre and an office building with diverse power consumption profiles were monitored throughout the seasons – in summer, a weekday and weekend, as well as a winter weekday and weekend.

Demand reduction, the percentage of the total power use apart from the main grid, ranged from 32% up to an impressive 71%, while during peak demand hours, the demand reduction ranged from 34% to 46%. Schmidt explains: "The

high reduction was achieved during summer days as power generated from photovoltaics was at its greatest."

The future for CONNECT work is bright, and partners will exploit the achieved results at component and subsystem level, for example by integrating the achievements to improve products or generating new ones. "Second, building on the CONNECT results, we were able to develop the follow-up proposal PROGRESSUS, also EU-funded, which started in April 2020 and will run for 3 years," concludes Schmidt.

CONNECT

- Coordinated by Infineon Technologies in Germany
- Funded under Horizon 2020-LEIT-ICT
- cordis.europa.eu/project/id/737434
- Project website: connect-ecsel.eu

ENERGY

Batteries made of soil could offer dirt cheap green energy

Fusing technology and nature offers innovative solutions to improve quality of life. It drives the shift towards a greener future, where sustainability is the central axis and technology the main tool for achieving it.



We've had the industrial revolution and the digital revolution, but now it's time for the biotech revolution. When most people hear the word biotech, they think about the pharmaceutical industry, but biotech can help shape the future of the world.

Imagine a world where everything from streetlights in major cities to agricultural technology runs 100% on nature, without ever harming it.

GREEN ELECTRICITY FROM PLANTS

The EU-funded project BIOO Panel (Green Electricity from plants' photosynthesis) joined the green movement by developing an alternative energy source. This is achieved

through bioelectrochemical batteries that exploit plant-microbial fuel cells to generate electricity by means of electrochemically active bacteria that consume organic matter naturally present in soil and produced by plants during their life cycle.

“The Bioo Panel is a biological battery capable of producing electricity by feeding on natural soil and using plants to maintain the ecosystem without damaging it. We profit from specific organic substances naturally transported by water, being able to obtain energy from soil terrains and others,” explains Pablo Vidarte, CEO and founder of Bioo and project coordinator. Unlike other biological batteries, these panels are uniquely adapted to the external impact of the environment, providing an optimal atmosphere to the natural microorganisms living in it and ensuring 24/7 energy output throughout the year.

Over the years, Bioo’s research and development team have created 11 different energy sources/batteries, all with different characteristics and focuses, including energy generation, improved terrain resilience and cost-efficiency. The Bioo Panel is a 30x30 cm panel that can be placed below the surface of a natural environment (for example a yard, garden or park) to generate electricity. Currently, its power usage is focused on obtaining energy for powering self-irrigation systems, but in the future it is expected to be applied to power light points in parks and gardens.

NEW ENERGY SOURCE REVOLUTION

Vidarte elaborates: “We have successfully produced scalable and industrially replicable biological batteries. We’ve seen a variety of problems globally with this issue, ranging from cost to difficulty to maintain. However, our cost-efficient biological batteries are adaptable to the environment versus others that are just adapted to

“ *The Bioo Panel is a biological battery capable of producing electricity by feeding on natural soil and using plants to maintain the ecosystem without damaging it.* ”

wastewater treatments and not designed to deal with harsh environments.”

Bioo has achieved a presence in the market and worldwide recognition for its Bioo Panel. The European Parliament named Bioo the most innovative company in Europe, and it was included in the 30 Under 30 Europe 2017 Forbes list.

The company’s next financing round of EUR 1.5 million invites global venture capitalists and investors to join the new energy source revolution. “In addition to Bioo Panel, we’ve also created Bioo Living Installations, which transforms plants into biological switches to activate music, lights and even screens all from nature,” concludes Vidarte.

BIOO PANEL

- Coordinated by Arkyne Technologies in Spain
- Funded under Horizon 2020-ENVIRONMENT and Horizon 2020-SME
- cordis.europa.eu/project/id/767678
- Project website: biootech.com
- ▶ bit.ly/BIOO_Panel_video



A race to save the world's wild pollinators

The plight of honeybees has captured the public's imagination, but the reality is that many wild pollinators are in decline. Wild bees, butterflies, beetles, flies and other insects play an important role in ecosystems but are under pressure from habitat loss, pesticides and climate change.



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“We are in a critical stage of human disruption to the ecosystem, and we urgently need to reverse this trend.”

The overall picture is complex, and little is known about how these stressors interact, or how to address the drop in biodiversity. The Safeguard (Safeguarding European wild pollinators) project is a 4-year programme which aims to fill in the gaps, compiling all the available data on wild pollinators while carrying out new field experiments to understand the complex interplay of individual drivers of pollinator decline.

“As scientists we aim to understand what the causes and consequences of pollinator decline are, and then use this evidence to implement and test interventions to protect and restore pollinator diversity,” says project coordinator Ingolf Steffan-Dewenter.

The professor of Animal Ecology at the University of Würzburg in Germany is an avid beekeeper, a hobby which sparked his early passion for pollinators. Interest in this field has increased dramatically in the last two decades, he explains: “When I did my first research on pollinators, the topic was not mainstream. That has changed completely, with the general public, policymakers and businesses all seeking ways to help our wild pollinators.”

The EUR 7.9 million project brings together 22 partners from 14 countries across Europe, as well as three institutions in China, underscoring the global interest in tackling the issue. “We are in a critical stage of human disruption to

the ecosystem, and we urgently need to reverse this trend,” adds Steffan-Dewenter.

As well as building a comprehensive knowledge base on pollinators, Safeguard will carry out field trials to quantify the impacts of different interventions. “A major advantage of an EU project like this is that we can develop common designs, and implement these in different ecosystems and climatic regions, so that we have targeted solutions to global challenges,” he says. The resulting data will be used to predict pollinator responses to untested combinations of pressures and interventions.

By the end of the project in 2025, Safeguard will provide a variety of cutting-edge tools and indicators to inform environmental policy at a national, European and global level. “We will work to raise the general awareness of pressing biodiversity issues, and the major challenges we face in our current situation,” concludes Steffan-Dewenter.

SAFEGUARD

- Coordinated by the Julius-Maximilians-Universität Würzburg in Germany
- Funded under Horizon 2020-ENVIRONMENT
- cordis.europa.eu/project/id/101003476
- Project website: safeguard.biozentrum.uni-wuerzburg.de

If you are interested in having your project featured in 'Project of the Month' in an upcoming issue, please send us an email to editorial@cordis.europa.eu and tell us why!



Shining a light on an age-old mystery

A widely used technique for dating archaeological and geological sites suffers from an unexplained discrepancy in its measurements. The RELOS project sought to build a less empirical methodology.

Luminescence dating is used to estimate the amount of time that has passed since grains of a mineral such as quartz were last exposed to daylight. It is an essential technique for dating geological and archaeological sites, and can date material as old as 500 000 years.

However, the measurements contain a degree of variability, the reasons for which are not understood. The project RELOS (Reducing empiricism in luminescence geochronology: Understanding the origins of luminescence from individual sand grains), which was supported by the European Research Council, set out to uncover the sources of this uncertainty. "This is a big unknown we think needs to be addressed," says project coordinator Jan-Pieter Buylaert. "In lab experiments, even if we give exactly the same radiation dose to each grain, we still see an unexplained dispersion in the apparent stored charge."

In practice, post hoc justifications by the practitioner are often used to dismiss or explain dispersed results, imbuing luminescence dating with a degree of subjectivity. By identifying the source of the dispersion, Buylaert and his colleagues at the Technical University of Denmark hoped to make the process more robust.

RADIOACTIVE DECAY

When mineral grains are buried, they gradually accumulate energy from exposure to natural radioactivity in the surrounding matrix. This energy is stored as charge trapped in defects in the crystal structure of the mineral.

When the grains are exposed to a bright light, both in nature and in the laboratory, the charge is freed, and the stored energy released as photons. This luminescence



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Luminescence dating can date material as old as 500 000 years



allows researchers to quantify the time the grains have been buried.

One of the key assumptions in calculating the rate of charge storage is that the grains remain electrically neutral. However, the RELOS project found that there is a significant build-up of charge imbalance, with some grains charging negatively, and others positively.

“It is the combination of the size of the grain and the range of the radiation that causes this,” explains Buylaert. “But although we could see this effect experimentally, we were unable to make the link to the dispersion observed in natural dose distributions.”

A second hypothesis suggested that the size, distribution and geometry of individual grains affect how the energy absorbed from radiation is distributed amongst the grains, and therefore the rate at which charge accumulates in one mineral grain compared to another. Buylaert’s team built complex mathematical models to account for this.

“The problem will not go away.”

DATING LOESS

During the course of the project, Buylaert and his colleagues also set out to develop a curve for luminescence response to dose in nature, by measuring grains recovered from the Quaternary terrestrial reference site in the Chinese Loess Plateau. Here, dust has been accumulating at a steady rate for millions of years, and the age of different strata can be cross-checked using signals such as palaeomagnetism (pole reversal) and Milankovitch cycles.

Unfortunately, this proved not to be possible. “We found many metres of sediment eroded – jumps in ages down the section of many tens of thousands of years. This meant we could not develop a dose response curve at this site, but we were able to link these age gaps to regional and global climate phenomena,” adds Buylaert. These findings were published in ‘Nature Communications’.

Buylaert says the geometry models developed under the project will aid his new project on human migration in Central Asia: “The problem will not go away, and we will take any opportunity that arises to reopen our investigations.”

RELOS

- Hosted by the Technical University of Denmark in Denmark
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/639904

CLIMATE CHANGE AND ENVIRONMENT

Heat transfer theory explains sudden cold snaps

Accurate predictions of when fog and frost will form are difficult to make, but researchers in the Netherlands found the answer is blowing in the wind.

The evening boundary layer is an important weather phenomenon that can trap cool air near the ground

surface, developing into frost or fog in the morning. A better understanding of this process can improve

weather forecasts, potentially saving farmers millions of euro in crop damage and making road and air travel safer.

The EU-funded COAT (Collapse Of Atmospheric Turbulence) project investigated the conditions driving the evolution of the evening boundary layer. “At night, the ground surface cools and creates a pool of cold air 50 to 200 m deep,” explains Bas van de Wiel, principal investigator on COAT. “This cold air is heavy, and will stratify.”

If there is little wind, this static layer of cold air continues to accumulate, eventually producing fog and frost. However, sufficient turbulence can carry away the colder air, preventing fog and frost.

This unpredictable nature of the evening boundary layer confounds climate models, producing errors of up to 5 degrees Celsius in forecasts for cold periods. “For that reason, we looked at what causes this collapse of turbulence, when all air mixing disappears,” says van de Wiel.

FEEDBACK LOOP

With his colleagues at Delft University of Technology in the Netherlands, van de Wiel modelled the heat exchange between ground and air. Paved surfaces such as roads and streets hold more heat than grass, keeping night temperatures higher.

However, even the heat lost from unpaved surfaces is eventually replenished from below. This allowed van de Wiel and his colleagues to quantify the total amount of expected heat loss.

Using this figure, they could determine the wind speed needed to deliver enough warm air that fog or frost do not

“*The results were so good, temperatures were up 3 to 5 degrees, harvest increased 100%.*”

form. “We calculated that at windspeeds lower than 3 m/s at nose height, the system collapses,” he adds. “The flow can only transfer a set amount of heat, and if the surface is cooling at a higher rate, you get a positive feedback loop.”

The model was validated in three stages. First, the team performed a direct numerical simulation at a high computational power, building the system from first principles. Secondly, they used a weather forecast model with some assumptions built in to see if the predictions were correct. Finally, the model was applied to real-world weather to see if it was accurate.

“The predictions still hold very well, here,” says van de Wiel. “We can be confident the theory is valid and that we solved the problem of collapse of atmospheric turbulence.” The model highlights that soil conditions, distance to urban areas and distance to water are key factors in the formation of fog.

BEARING FRUIT

The research is already being put into practice. As well as improving weather and climate predictions, van de Wiel’s research showed that air movement is a powerful tool against frost formation. A related project used large ventilators to circulate air in fruit orchards, to great success.

“The results were so good, temperatures were up 3 to 5 degrees, harvest increased 100%; we could perfectly show that harvest increased closer to the wind machine,” notes van de Wiel.

COAT was supported by the European Research Council. “This funding helped enormously, you have the freedom and opportunity to really be creative with it,” he adds. “Some funding just pays for the researcher’s salary, but science is much more than that.”

COAT

- Hosted by Delft University of Technology in the Netherlands
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/648666





SPECIAL FEATURE

SQUARING THE ARCTIC CIRCLE: PROTECTING AND PRESERVING EARTH'S FAR NORTH

Editorial

“Nothing more wonderfully beautiful can exist than the Arctic night. It is dreamland, painted in the imagination’s most delicate tints; it is colour etherealised.” – Fridtjof Nansen, polar explorer

Back in 2019, your editor was trying to catch a ride on a ship. This was no ordinary sea voyage: the *Polarstern*, a German research icebreaker, planned to sail to the Arctic, where it would tether itself to an ice floe. Then, as the sea froze around it, the ship and its passengers – engineers, researchers and a scattering of journalists – would be carried through the long Arctic winter with the drifting ice, eventually expelled into the Fram Strait come spring.

I am only one in a long history of people who have felt drawn to the Arctic and its mysteries. Since time immemorial, it has been a place of myth and magic. The Ancient Greeks imagined a temperate paradise above the north winds, ruled by giants called Hyperboreans. Even today, the North Pole serves as the location of Santa’s workshop, staffed by elves.

While an undeniably harsh landscape, the Arctic is by no means a wasteland. It is a province with rich ecological, cultural and geophysical significance. Yet days are numbered for its illusive inhabitants, and their real-world compatriots. The sea ice minimum is retreating at around 13% per decade, and less than 5% of the ice that remains is the thick, multi-year variety. We are likely to see ice-free Arctic summers within our lifetime. This has dramatic consequences for those that live there, and for the rest of us.

The EU recently published a new Arctic Strategy, reiterating its intent to protect the Arctic’s environment and biodiversity, reduce EU-sourced pollution in the region, and support the inclusive and sustainable development of the area.

Key to all of this is a better understanding of the Arctic: its climate, its flora and fauna, and its people. This Special section features seven EU-funded projects that focus on Arctic science. These include collaborative projects such as INTERACT, which brought 1 000 scientists to the polar north and gave its name to a new resident there, work to boost Earth observation data, research on the cultural identity and representation of the Arctic, and investigations into the consequences of a warming Arctic, both in the polar region and beyond.

In the end, the *Polarstern* made its journey to the frozen north, but without me. I still hope that one day I might be able to visit the Arctic myself. I just hope that there is still some ice left to see.

We look forward to receiving your feedback. You can send questions or suggestions to editorial@cordis.europa.eu.

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Arctic science holds the key for more accurate weather predictions in Europe

The EU-funded APPLICATE project has shed new light on the strength of the link between Arctic and midlatitude weather and climate. Its work contributes to more accurate forecasts, including of extreme weather events.

From deadly floods in Belgium and Germany to devastating fires in Greece and California, extreme weather in large areas of the northern hemisphere dominated headlines throughout the summer.

How can we improve our ability to forecast and prepare for such phenomena? By turning our attention to the Arctic, say researchers.

“A focus on the Arctic is important because the changes taking place there due to climate change – the retreat of sea ice, warming seas and atmosphere – have the potential to influence weather and climate in the midlatitudes,” explains Thomas Jung, climate scientist at the Alfred Wegener Institute’s Helmholtz Centre for Polar and Marine Research.

Jung coordinated the project APPLICATE (Advanced Prediction in Polar regions and beyond: Modelling, observing system design and Linkages associated with Arctic Climate change), which brought together partners across Europe to improve our understanding of these linkages and deliver the capacity for effectively enhancing predictions for the polar region and beyond.

FILLING IN THE GAPS

The team developed a number of important approaches enabling more accurate forecasts, including those of extreme events.

Advanced climate modelling played an important role. This involved taking stock of existing observation systems for various modelling applications, establishing the performance of these models and designing improved models based on thorough comparisons with observations.

APPLICATE also carried out a gap analysis to identify shortcomings in the existing observation systems and assessed how much forecasts could be improved by filling in these gaps.



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“One of the main take-home messages from the experiments is that a lot can be gained by making more effective use of existing observations,” Jung says.

The lower atmosphere, including the air-ice-ocean interface, which is known to play a pivotal role in weather and climate prediction, was a key focus of model improvements. Advancing the representation of the atmospheric boundary layer including clouds, sea ice and snow, for example, contributed to improving operational prediction of near-surface weather parameters such as temperature and rain.

Satellite data was a key source of information driving these advances. Existing and new Earth observation of parameters such as sea ice thickness and ice drift directly fed into model assessment and development efforts.

EARLY WARNING

The project team carried out a number of case studies to explore how these predictions could be used for real-world problems. For instance, they examined the risk and impacts of heavy rainfall in Svalbard during autumn and winter.

For the archipelago located between mainland Norway and the North Pole, such weather events could become a major challenge in a rapidly warming world.

“Extreme precipitation events can trigger landslides and slush avalanches, often followed by freezing conditions impacting ground ice formation, which can require closing of roads and

“ *A focus on the Arctic is important because the changes taking place there have the potential to influence weather and climate in the midlatitudes.* ”

airports, affecting population mobility and reducing income from tourism,” Jung adds. Such events can also starve wild reindeer by blocking access to food resources.

The study of events involving heavy rain over recent winters enabled the project to identify the weather patterns responsible and to predict the likelihood of such events on 2-week to 2-month timescales. The team could thereby make a direct contribution to creating an early warning system and improving the population’s preparedness.

To help APPLICATE’s results inform future research, a set of key resources will remain accessible on public repositories, including the APPLICATE Data Portal, Zenodo and Google Scholar.

APPLICATE

- Coordinated by the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research in Germany
- Funded under Horizon 2020-FOOD and Horizon 2020-ENVIRONMENT
- cordis.europa.eu/project/id/727862
- Project website: applycate-h2020.eu
- ▶ bit.ly/APPLICATE_video

The vast collective effort to track change across the Arctic

Observing the Earth from space is not enough to provide us with the data we need to understand, predict and manage the momentous environmental changes affecting the Arctic region. The INTAROS project is helping us piece together the bigger picture by collecting and connecting local evidence.

The world took note when rain fell on Greenland's icy summit this summer for the first time since records began in 1950. With climate 'firsts' now a regular occurrence, data enabling us to track and analyse these changes is becoming a vital resource for humanity.

This is particularly significant in the Arctic, where the climate crisis is already triggering deep changes with global impact such as rising sea levels and changing weather patterns.

To fill in the gaps and make better use of available data, the EU-funded INTAROS (Integrated Arctic observation system) project is working to develop an integrated Arctic observation system for atmosphere, ocean and terrestrial science.

Their research focuses on local observation, which complements satellite monitoring of the environment by delivering the physical and empirical evidence required to check, refine and interpret remote sensing data.

Project coordinator Stein Sandven explains: "Sea ice decline in the Arctic has been documented through satellite observation for over 40 years. By providing *in situ* measurements of aspects such as temperature, salinity and thickness, we help to create better algorithms and contribute to making more reliable predictions about future decline."

DATA FOR DAILY LIFE

His team from the Nansen Environmental and Remote Sensing Center (NERSC) worked with partners to create an inventory of existing observation systems and data. These include projects from across the globe, and also local communities in the Arctic who monitor the natural resources they need for their livelihoods.

"For instance, fishermen in Greenland record information on catches in a database. Data on increasing or decreasing fish stocks is then shared with local government to determine fishing quotas," Sandven says.



This is a two-way process: while the information collected by local communities feeds into the new integrated system, the project is also making additional data available for their use.

MORE DOTS TO CONNECT

One of INTAROS' key achievements is the development of new solutions filling important gaps in the existing observation systems.

A network of drifting buoys was deployed across the central Arctic to collect data about sea ice such as temperature, air pressure and thickness, which is then transmitted via satellite.

The team uses bottom-anchored moorings to collect oceanographic, acoustic, biological and geochemical data under the sea ice. As the data cannot be transmitted under the sea, the moorings are collected after 1 or 2 years in operation.

Other examples include automated instruments installed on ships travelling across the Arctic, and automated stations collecting atmosphere and cryosphere data on the Greenland ice sheet.

“*By providing in situ measurements of aspects such as temperature, salinity and thickness, we help to create better algorithms.*”

“Deploying additional instruments in the Arctic is important: the Greenland ice sheet alone covers an area of over 1.7 million sq. km,” Sandven notes. “You need to have a certain network of stations to collect enough data.”

ONLINE ACCESS

All data collected is made available free of charge through the project's iAOS web portal for a variety of uses. Target audiences include local communities, national agencies, climate researchers and data scientists.

The EU's large Earth observation programme Copernicus currently faces a considerable *in situ* data deficit in the Arctic. Increasing the amount of data made available through INTAROS – by ensuring its regular distribution in standard formats – will turn the project's database into a key resource for a number of Copernicus services.



The Greenland ice sheet covers an area of **1.7 million km²**

INTAROS

- Coordinated by the Nansen Environmental and Remote Sensing Center in Norway
- Funded under Horizon 2020-ENVIRONMENT and Horizon 2020-FOOD
- cordis.europa.eu/project/id/727890
- Project website: intaros.eu
- ▶ bit.ly/INTAROS_video

A new buzz: bumblebee species among discoveries enabled by Arctic research portal

An EU-funded network connecting 89 research stations across the Arctic opens a window onto the Far North for a global audience – and the door to amazing discoveries like new Arctic species.

Environmental change affecting the Arctic may seem remote to many of us, but its impact is felt worldwide. As a vast and sparsely populated area, the infrastructure available for observing these changes is limited compared to other latitudes.

The EU-funded project INTERACT (International Network for Terrestrial Research and Monitoring in the Arctic) is working to improve this capacity and promote better scientific research on environmental change in the Arctic. It also hopes to raise awareness globally about what's at stake.

“INTERACT has been able to send more than 1 000 scientists to the field, resulting in a lot of important research,” says project coordinator Margareta Johansson from Lund University in Sweden.

UNPRECEDENTED ACCESS

One example is the discovery of a new bumblebee species that was named after the project. *Bombus interacti* was identified by a Belgian-led group of researchers, who were able to use the Toolik Field Station in Alaska thanks to the project.

INTERACT provides access to 53 Arctic research stations, together creating an unprecedented portal to the Arctic.

This includes transnational access to facilities for selected user groups such as external researchers, work carried out at Arctic facilities by local staff upon request of external teams, as well as virtual access to stations' databases for all.



“INTERACT has been able to send more than 1 000 scientists to the field.”

“We reach out to everyone, from school kids to university students, scientists, policymakers and the general public,” Johansson adds.

INTERACT also helps to improve the existing infrastructure through mutual learning. The Station Managers Forum connects 89 terrestrial research stations. Anything from ensuring safety when doing field work to minimising the stations’ environmental footprint is discussed here, Johansson explains.

MAKING A DIFFERENCE

With stations monitoring the environment in all these different locations, the network provides important information on ongoing changes with significant societal impact.

Climate change is, of course, at the top of the list.

INTERACT helps to make data for climate action widely available by detecting hidden resources. These are records of environmental change that are not part of conventional

data gathering, such as private photographs, landscape paintings, captains’ logbooks and historical maps.

The project collects such records and applies artificial intelligence to turn them into data that can be used for climate research purposes. By documenting extreme weather events, INTERACT contributes to monitoring their many consequences – for instance for biodiversity – and to improving awareness of these processes.

It also works to document and reduce pollution. “INTERACT identifies emerging pollutants and their impact and develops a new monitoring protocol that can be used at research stations,” Johansson notes.

Other key societal challenges the project helps to address include reducing barriers to communication and transport, developing more sustainable tourism and reaching out to the next generation.

The team developed an interactive e-book with illustrated stories providing an immersive experience of what’s going on in the Arctic. To guarantee INTERACT’s legacy, the team has created a non-profit organisation to secure the long-term sustainability of the network.

INTERACT

- Coordinated by Lund University in Sweden
- Funded under Horizon 2020-INFRA
- cordis.europa.eu/project/id/730938
- Project website: eu-interact.org

From resource to reserve: the evolving identity of the polar regions

Polar regions are typically depicted as fragile habitats and ecosystems in need of protection and careful management. But this view is quite recent. The GRETPOL project demonstrates how attitudes to the Arctic vary with time, political context and cultural differences.

The idea of environmental protection in the polar regions wasn’t always about protecting vulnerable environments from people. In the 1940s and 1950s, the United States was more concerned with protecting fragile people from

harsh environments. Although this view persists today, it was progressively enriched with concerns over gas and oil exploration, excessive hunting, tracked vehicles and mineral exploitation.

Peder Roberts, associate professor of Modern History at the University of Stavanger in Norway and researcher at the KTH Royal Institute of Technology in Sweden, says researchers have only scratched the surface of what is in fact a highly intricate web of evolving perspectives and narratives.

“There’s a great deal new to be discovered just by expanding the scope of available material. This is why, with European Research Council funding under the project GRETPOL (Greening the Poles: Science, the Environment, and the Creation of the Modern Arctic and Antarctic), I have been bringing in anthropologists and political scientists capable of working in languages from Finnish to Japanese and from Russian to Spanish. This allowed us to uncover many unknown stories and perspectives on polar environments that go way beyond Anglophone narratives,” he explains.

Roberts had two key questions in mind for his project. The first was to ask what the different political and cultural meanings of environmental concerns from 1945 to 1991 were. The second was to ask to what extent these stories were of change, or of continuity, and why.

“It’s clear that we can identify some moments of important change,” says Roberts. “We see these in the late 1960s and early 1970s when the Arctic was swept up in the global emergence of environmentalism, in the 1980s when [Soviet leader Mikhail] Gorbachev’s reforms opened up new possibilities for Arctic environmental cooperation, and when debates over global economic justice joined with environmental concerns resulted in major changes in the environmental governance of Antarctica.”

These changes were sometimes very rapid, he adds, citing Norway’s legalisation of polar bear hunting in the 1960s before switching tack and taking the lead in a convention to ban such hunting by 1973.

NO EASY ANSWERS

The extent of GRETPOL’s findings is broad. Researcher Tayana Arakcha came across a corruption scandal involving the Japanese yakuza as she researched the Soviet Antarctic krill fishery, as well as past beliefs that krill had aphrodisiac qualities. Dmitry Arzyutov’s research reveals how Soviet researchers made sense of woolly mammoth remains, which included descriptions of what thawed and cooked mammoth tastes like.

In further work, Roberts approached the role played by colonialism in our views of polar regions, and whether this concept could be applied to animals, the rise of Indigenous

“ *We should remain very sceptical about claims that any kind of development is inevitable or natural.* ”

political movements, and even the significance of the word ‘development’.

As he explains: “We’ve been struck, but not surprised, by the consistent sense among governments, bureaucrats, businesses, and much of the broader public that the exploitation of polar resources was inevitable. The question was whether development should be orderly or disorderly. How we went from such views to moratoriums on resource extraction in the Antarctic shows how we should remain very sceptical about claims that any kind of development is inevitable or natural.”

We shouldn’t underestimate how quickly attitudes can change. As Roberts concludes: “GRETPOL ultimately doesn’t have easy answers on how to address the climate crisis, but it does make clear that environmental management is not just about picking the best course from the scientifically-informed options available. Defining what constitutes an environmental problem is a matter not just of knowledge, but of the power to say what counts as a problem, and for whom.”

GRETPOL

- Hosted by the KTH Royal Institute of Technology in Sweden
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/716211



Visual library sheds new light on Arctic history

It's always enlightening to see the village or city you live in as it was long before you were born. For people living in the Arctic however, this is very difficult if not downright impossible. The ARCVIS project aimed to right this wrong by digging into archives from the 19th century.



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It has become difficult to view the Arctic through a prism that doesn't involve melting ice caps, starving polar bears and threats of unbridled natural resource exploitation. The fact that these lands have a history and people of their own is often an afterthought, if it's even considered at all.

With the project ARCVIS (Arctic Visible: Picturing Indigenous Communities in the Nineteenth-Century Western Arctic), Eavan O'Dochartaigh wanted to cast a new light on these regions. Despite COVID-19 and all the technical difficulties it posed, she managed to compile an online collection of archive sketches, engravings, lithographs and photographs, which will provide a better understanding of the region's history and culture.

Why did you see a need to re-explore the history of local Arctic communities? What did you hope to uncover?

Eavan O'Dochartaigh: The dominant and enduring imaginary of the Arctic is of a space devoid of people, and yet in my doctoral research I kept coming across visual representations of Indigenous Arctic peoples (such as Inuit, Chukchi, Yup'ik, Iñupiat and Inuvialuit) in pencil sketches, watercolours and other media such as photographs, engravings and lithographs. I had expected my PhD

thesis to focus more on depictions of ice, seascapes and landscapes and I realised there was a need for further research there. I hoped to uncover representations of people in archival collections that were not well known – particularly those in the pre-photographic era – and to map the geographical origins of the representations.

How did COVID-19 make this more difficult?

The pandemic hit in the first year of my project and made it impossible to access items in archival collections that do not have all their material online. I think there is often a perception now that everything is available digitally. In reality, archival repositories do not necessarily have the resources to make their collections freely available online. There is also a lot of 'hidden' material in archives. For example, illustrations in personal diaries may not be catalogued individually. As I could not travel to, or even order, material from archives, I had to focus on collections that had large amounts of relevant material online. Examples include the polar art collection of the Scott Polar Research Institute's museum and the collections of Library and Archives Canada.

Did you have to reassess the goals of your research as a result?

The pandemic meant that I couldn't take the project in the planned direction. For example, I had planned to carry out archival research at various institutions. Travelling to these institutions was then of course impossible and as many of them were completely closed it was not even possible to order material. I was fortunate enough to be offered a book contract by Cambridge University Press during the pandemic which enabled me to channel Marie Skłodowska-Curie Actions (MSCA) funding into this research. With the support of my project officer, I have been able to use these funds for image permissions and professional photography.

Most importantly, it meant that I could use otherwise unspent funding to make the project book gold open access, meaning that it will be freely available online. The book focuses on the visual culture of mid 19th century British naval expeditions to the Arctic and is based on my



Eavan O'Dochartaigh
ARCVIS MSCA fellow
© Eavan O'Dochartaigh

“ *The Arctic is more than just an empty, icy space. So much of the focus today is on melting ice that the people who live in these regions are often forgotten.* ”

PhD thesis. The work I did during the MSCA fellowship was important in shaping revisions to the manuscript.

Are there any photographs that stand out for you?

There is one picture I feel particularly strongly about. It's a portrait of a Yup'ik woman from Alaska created in 1851 and located in the museum archives of the Scott Polar Research Institute. There are many features about this portrait of Koutoküdluk that mark it out as significant and it is quite unusual in the context of Arctic exploration. The woman is named and the portrait is quite sensitively done. The marks and blemishes that overlay the painting show that it was handled repeatedly and suggest that the woman had a significant impact on the maker of the portrait.

Another striking picture is a portrait of an 'explorer' by a Chukchi artist. It shows the subject as rather helpless, in contrast to the images we usually see that show a more heroic type associated with Arctic exploration.

What sort of lasting impact will this project have?

I have collected a significant amount of data on representations of Indigenous peoples in the western Arctic and I plan to publish this data on an online platform

over the coming months. The platform will gather data from different archival repositories around the world that are not always easily findable or accessible, particularly for people who live in the Arctic. I think the most important outcome will be the geographic display of this data, enabling people who live in the Arctic today to see visual records of people from their own region taken in the 19th century.

How will this research challenge the common view of these communities?

I hope that it will make people realise that the Arctic is more than just an empty, icy space. So much of the focus today is on melting ice that the people who live in these regions are often forgotten.

What comes next?

I have just started an Irish Research Council Postdoctoral Fellowship at the National University of Ireland, Galway, which provides me with the opportunity to build on my research. Besides consolidating and publishing the data I have gathered, I am now interested in images of the Arctic which challenge our preconceptions, particularly those that show a complex and biodiverse region. Both the work done during the MSCA fellowship and the current fellowship will come together in a second book on visual representations in the 19th century Arctic.

ARCVIS

- Coordinated by Umeå University in Sweden
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/839477
- Project website: arcviz.omeka.net

The sleeping giants of the global carbon cycle

The greenhouse gases we release into the atmosphere are the tip of the global warming iceberg. The release of methane from thawing permafrost is likely to become a significant issue over coming decades. The CC-TOP project explored its potential impact.

The melting of Arctic ice will pour more than just fresh water into our oceans. Greenhouse gases such as methane trapped

in permafrost will also break free, a fact that complicates global warming predictions. We still don't know how much of

“ This may be a sneak peek of what is in store for current climate change. ”

these gases will evaporate into the atmosphere, when, and how this will affect the current climate.

That's where CC-TOP (Cryosphere-Carbon on Top of the Earth (CC-Top): Decreasing Uncertainties of Thawing Permafrost and Collapsing Methane Hydrates in the Arctic) can make a difference. After 5 years of intensive European Research Council funded research, Örjan Gustafsson has managed to uncover precious information on what he calls the “sleeping giants in the global carbon cycle.”

“We are now closer to scientifically sound predictions for future releases of methane over the coming decades and centuries,” says Gustafsson, a professor at the Department of Environmental Science at Stockholm University. “CC-TOP tells us more about carbon-climate coupling and methane hydrates, specifically for permafrost on land, along the coastline and in the subsea.”

Gustafsson and his team pursued these giants in the distant East Siberian Arctic Ocean. They could do so thanks to advanced molecular and isotopic fingerprinting of the sources and fluxes of organic matter, as well as of the methane released from thawing permafrost.

“We notably developed triple-isotope source forensics for massive releases of methane over the East Siberian Arctic Shelf – the world's largest coastal sea. With these, we can provide high-precision measurements of the stable isotopes of carbon, hydrogen and natural abundance radiocarbon,” explains Gustafsson.



Over the past decades, subsea permafrost has been thawing at a rate 10 times faster than land-based permafrost



This method helped Gustafsson's team ascertain what proportion of the escaping methane comes from biogenic near-surface sources, thawing subsea permafrost, and deep reservoirs of thermogenic methane penetrating up through the thawing permafrost.

NEW KNOWLEDGE OF SUBSEA PERMAFROST

The project resulted in well over 30 papers, eight of which were published in high-impact journals such as 'Science', 'PNAS' and 'Nature'. Moreover, it compiled the first open-science database dedicated to the distribution and sources of carbon in all Arctic Ocean sediments.

Project studies on past rapid warming periods have found a correlation between massive permafrost carbon releases and rapid increases in atmospheric CO₂. As Gustafsson points out: “This suggests that the existing paradigm of ocean venting carbon may need to be complemented by a remobilisation of terrestrial carbon/methane. This may be a sneak peek of what is in store for current climate change.”

It also provides new knowledge on subsea permafrost. “Our studies show that the permafrost that's currently underneath the shallow shelf ocean has recently reached the thaw point. Over the past decades, it has been thawing at a rate 10 times faster than land-based permafrost,” adds Gustafsson.

He continues: “Observations of methane emissions hotspots in the Laptev Sea also revealed that the dominant source of methane there is a deep thermogenic pool. This suggests that there can be rapid release of such preformed methane.”

Thanks to isotope source apportionment of black carbon aerosol particles around the Arctic rim, which estimates

the contribution of pollution sources such as diesel engines and wood burning, the team even provided a scientific underpinning for targeting dominant emissions sources in mitigation measures.

CC-TOP's international network remains very active. Several major international expeditions on both Russian and Swedish research vessels and icebreakers are planned, and Gustafsson hopes to put together another ERC proposal soon. As he underlines: "The project's findings inspire us

to step up and bend the curves on climate change. The current decade will be critical if we are to win this fight."

CC-TOP

- Hosted by Stockholm University in Sweden
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/695331
- Project website: aces.su.se/research/projects/cc-top

Tracing a major Arctic export: oceanic carbon

On top of thawing permafrost, melting sea ice and swelling rivers, climate change is likely to wreak havoc on the Arctic carbon cycle. An EU-funded project is exploring new methods for tracing carbon from the Arctic to the Atlantic Ocean, and assessing the impact of these dynamics.

The organic compounds that represent the leftovers of life fill the ocean basins and form one of the Earth's largest carbon reservoirs. Changes to their concentration and distribution could have a major impact on the global carbon cycle, which regulates our climate.

Surrounded by large land masses, the Arctic Ocean is rich in such compounds. Much of this carbon is exported to the

North Atlantic through the Fram Strait between Greenland and Spitsbergen.

Rising temperatures in the Arctic region are likely to increase carbon input: thawing permafrost has the potential to release vast amounts of carbon from Arctic soils, which contain 50% of global soil carbon.



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“*We expect to see significant changes in fluxes from the Arctic to the Atlantic Ocean.*”

The CarbEx (Tracing carbon exchanges/fluxes between Arctic and Atlantic basins) project, undertaken with the support of the Marie Skłodowska-Curie Actions programme, set out to measure and understand the dynamics of the Arctic carbon flow.

DETECTING FUTURE CHANGE

“The Arctic Ocean receives a disproportionately high amount of dissolved organic matter compared to other oceans as it is surrounded by large Arctic rivers,” explains CarbEx project host Colin Stedmon.

Together with his team from the National Institute of Aquatic Resources at the Technical University of Denmark, which hosts the project, and in close collaboration with the Fram Strait Arctic Outflow Observatory, he developed a method for tracing dissolved organic carbon through the Fram Strait, the passage between Greenland and Svalbard.

The new approach proposed by the CarbEx team uses data collected from moorings in this strait to quantify Arctic carbon exports. The goal is to combine this data with satellite Earth observation measurements.

By determining the relationship between the optical properties of carbon – how the molecules absorb and emit light – and the origins of the water observed in the surface of the Arctic Ocean, they were able to develop an algorithm capable of detecting seasonal and annual fluctuations in Arctic carbon export, and establish a baseline to detect future change.

“We now have an approach to quantify how carbon exports vary from one year to the next,” says Rafael Gonçalves-Araujo, CarbEx’s principal investigator. “We

expect to see significant changes in fluxes from the Arctic to the Atlantic Ocean in the coming years as the Arctic temperature, melt water contribution and dissolved organic matter supply by rivers increase.”

NEW PERSPECTIVES

One of the key advantages of the new method is that carbon exports can be estimated based on data obtained from platforms that are not specifically focused on biogeochemical properties, opening new perspectives for increasing our understanding of the Arctic carbon cycle.

The researchers also used so-called ice-tethered profilers to retrieve information regarding the origins and circulation of Arctic surface waters. “Such autonomous platforms can provide continual measurements, under the ice, in very remote regions, such as the central Arctic Ocean,” Stedmon notes.

This approach could potentially also be used to separate freshwater contributions from sea-ice melt, river discharge and the Pacific Ocean. The data collected through CarbEx will continue to be updated via Norwegian and Danish research projects and observation programmes, helping to document future changes in the Arctic carbon export.

“We are also analysing the data to assess whether there are variations in the composition of the dissolved organic matter, which may reflect changes in the overall Arctic circulation driven by climate change,” Gonçalves-Araujo adds.

CARBEX

- Coordinated by the Technical University of Denmark
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/839311



Add fish for a more sustainable approach to aquaculture

By creating an ecosystem of different species of marine life, researchers aim to help reduce aquaculture's environmental impact while also increasing productivity.

Aquaculture has the potential to be one of the most environmentally sustainable ways of producing food and protein. However, to reach this potential, more work is needed.

In part, this is due to the fact that the current aquaculture model is monoculture-based, meaning fish waste is released directly into the water. Due to the high concentration of fish being reared in the typical aquaculture farm, this waste can add up, causing potentially harmful effects to these sensitive environments.

But the EU-funded IMPAQT (Intelligent management system for integrated multi-trophic aquaculture) project aims to change this. Using the Integrated Multi-Trophic Aquaculture (IMTA) model, the project is taking an ecosystem approach to sustainable aquaculture.

“IMTA thinks about aquaculture as an ecosystem that combines different species growing and interacting in the same space,” says Frank Kane, a researcher at Ireland’s Marine Institute and IMPAQT project coordinator. “With this approach, what was previously considered waste, such as excess fish feed, becomes a co-product that can



be used as a source of food or nutrition for other species like shellfish and seaweed.”

PRECISION AQUACULTURE

Using an intelligent management platform that incorporates novel sensors, data sources, and autonomous monitoring capabilities, researchers demonstrated the eco-efficiency, reduced environmental impact, and circular economy benefits of IMTA-enabled aquaculture operations.

“The IMPAQT technology platform is an innovative tool for managing an IMTA farm,” explains Kane. “Through analytics and decision support functionalities, it helps users boost production, assess food quality, and make informed decisions about animal welfare and environmental protection.”

The platform was tested at five pilot sites across Europe and one in China. One of the key outcomes of the work was concrete evidence of how IMTA can minimise an aquaculture farm’s risk of eutrophication – the process where a body of water becomes progressively enriched with minerals and nutrients. These nutrients can result in dense algal growth and degradation of water conditions for other species.

“We also showed how IMTA can increase a site’s biomass, both directly by offering an additional crop, as well as indirectly by leveraging the synergies found between species,” adds Kane.

THE IMTA MODEL

Based on these findings, the project developed an IMTA blueprint that aquaculture farmers and regulators can use to estimate the many environmental and economic benefits of transitioning to the model.

The project has developed an online training course on IMTA and precision aquaculture, hosted on the Open

“ *Our model thinks about aquaculture as an ecosystem that combines different species growing and interacting in the same space.* ”

University’s ‘OpenLearn Create’ platform. The findings also helped researchers fine-tune the technology platform, components of which are now being advanced towards commercialisation.

“The project has progressed the techniques for low trophic and integrated multi-trophic aquaculture, which will be utilised by the sector as the transition to the IMTA model for aquaculture continues,” concludes Kane. “The novel and innovative technologies developed within the project will help the sector manage their systems efficiently and sustainably.”

The project’s partners continue to communicate with policymakers and national regulators to present the benefits of IMTA and encourage a legislative change to facilitate its implementation at the local and European levels. More so, several partners are working to further develop the techniques and methods tested during the IMPAQT project through such EU-funded initiatives as the ASTRAL, UNITED and 5G-HEART projects.

IMPAQT

- Coordinated by the Marine Institute in Ireland
- Funded under Horizon 2020-FOOD
- cordis.europa.eu/project/id/774109
- Project website: impaqtproject.eu
- ▶ bit.ly/IMPAQT_video

Tree rings reveal a forest's vulnerability to drought

Drought events associated with climate change reduce tree growth and prompt tree mortality episodes, impacting globally and severely on forest ecosystems. The resilience of trees to the impact of drought will be decisive in the maintenance of functioning ecosystems.

Studying tree resilience is key to forecasting whether trees species will adapt, shift their ranges or become extinct after the rapid environmental changes predicted by most climatic models.

Because the effect of drought on tree growth can affect tree survival, and hence timber productivity and forest conservation, it is crucial to assess how climate change can be mitigated by identifying early signals associated with tree mortality to improve forest management. The EU-funded TreEsilience (Global patterns of intraspecific variation in tree resilience to drought) project has been analysing these signals to gain a better understanding of the impact of climate change.

"Drought affects tree growth differently among and within populations; thus, identifying those provenances or individual trees more resilient might increase the success of future management and conservation practices," explains Lucía DeSoto, principal investigator of the TreEsilience project.

With the support of the Marie Skłodowska-Curie Actions programme, DeSoto found that trees which died during

water shortages were less resilient to previous non-lethal droughts, relative to coexisting surviving trees of the same species within the same populations.

"This key result is evidence of the link between mortality risk and the previous observed differences in drought resilience strategies that can be reflected in tree ring growth," she says.

A NEW WAY OF ASSESSING POTENTIAL RESILIENCE

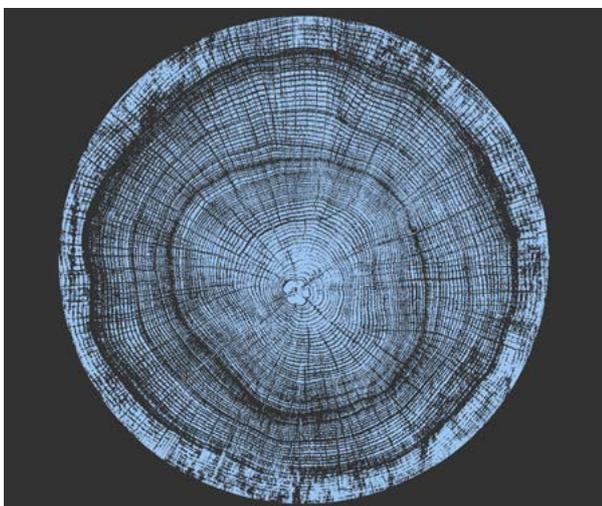
To DeSoto's knowledge, the project is the first to evaluate the direct links between resilience to drought and future mortality risk, "Mainly because it is difficult to empirically evaluate both resilience and mortality on the same individual tree."

The novelty is using tree ring data that allows a retrospective quantification of drought effects at annual resolution for numerous individuals, populations and species.

The team, based at the Spanish National Research Council in Almería, used two databases: the International Tree Ring Data Bank (ITRDB) and the tree width growth-mortality (TRW-mortality) database.

The ITRDB consists of 172 054 tree ring series found in 4 438 locations. The TRW-mortality database gathers tree ring data for 2 970 dead and 4 224 living trees from 190 sites, across 36 species, where mortality was mainly induced by stress, such as drought.

"Both databases gathered tree ring data mostly from conifers and from the temperate, Mediterranean and boreal ecosystems of the northern hemisphere. We acknowledge that the spatial coverage of our data set is limited, although it still covers large variation in geographic and climatic conditions within these regions," adds DeSoto.



Since water availability and temperature affect tree performance, tree populations from suitable climates are expected to have higher growth rates that can be measured in tree rings with annual resolution.

This gives researchers an insight into potentially stressful events. As DeSoto explains: “The tree ring data of each species was combined with ‘climate suitability’. Climate suitability is obtained with species distribution modelling that models the abiotic niche for every species. This makes it possible to characterise water conditions for populations and describe gradients of the environmental conditions for the species range.”

PUTTING THE INFORMATION TO GOOD USE

From the work she has done, DeSoto feels it is clear species distribution models should take into account that the response to climate is not homogeneous across the whole distribution range of a certain tree species.

The project’s findings will be fed into the species distribution models to identify hot spots and vulnerable tree species for conservation purposes, along with

“*Identifying those provenances or individual trees more resilient might increase the success of future management and conservation practices.*”

higher-resilience tree provenances suitable for more efficient afforestation.

“We would like to develop a protocol for the selection of trees which have less chance of overcoming future droughts, as candidates for harvesting. This would follow an assisted forest evolution.”

The project is now on the lookout for practitioners, policymakers and stakeholders who would be willing to use and assess the viability of the protocol.

TREESILIENCE

- Coordinated by the Spanish National Research Council in Spain
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/797188

FOOD AND NATURAL RESOURCES

Quiet roots could protect crops from cyst nematodes

New research aims to develop a natural alternative to pesticides for protecting crops against cyst nematode parasites, by silencing the chemical signals that encourage their eggs to hatch.

Nematodes are a type of roundworm that ranges in size from just a fraction of a millimetre to over 8 metres long and that lives in both water and soil. With an estimated 20 000 known species, they also have the distinction of being the most abundant animal on earth.

Unfortunately, many of these species are parasites and, as such, pose a threat to insects, plants and animals. Take for example the 75 species of cyst nematodes, which are responsible for causing a number of plant diseases. As some of these diseases cause significant crop loss, cyst nematodes are a significant risk to global food security.

Traditionally, these pests have been controlled using pesticides. But, with many pesticides being restricted for environmental reasons, new solutions are desperately needed.

Answering this need is the EU-funded project NemHatch (Unlocking mechanisms of cyst Nematode Hatching for sustainable cyst nematode control).

“Our goal is to develop a natural method to stop cyst nematodes from destroying crops,” says Lemeng Dong, a researcher at the University of Amsterdam and NemHatch project coordinator.

“ Our goal is to develop a natural method to stop cyst nematodes from destroying crops. ”

MANIPULATING THE HATCHING SIGNAL

As their name suggests, cyst nematodes lay their eggs in cysts. When the eggs hatch, they migrate through the host plant's roots. The nematodes then find an initial feeding cell into which they inject complex mixtures of effectors. These modify the host cell's metabolism, ultimately causing the plant's cell wall to break down. This in turn diverts the plant's nutrients to the nematodes, allowing the worms to live but causing the plant to die.

The NemHatch project, which received support from the Marie Skłodowska-Curie Actions programme, seeks to disrupt the signalling molecules, also called hatching stimulants, that cause the eggs to hatch in the first place.

“Hatching stimulants are chemical signals produced by the host plant that awaken the dormant nematodes that then infect the plant,” explains Dong. “By manipulating this signal, we aim to stop the eggs from hatching and, in doing so, prevent the plant from becoming infected.”

IDENTIFYING WHICH PLANTS ARE AFFECTED

Although still a work in progress, the project has already achieved several important results. This includes a new ultra-sensitive analytical method for detecting the hatching stimulant, called solanoeclipin A (SolA), in the root exudate of single potato plants.

Nematodes – with an estimated 20 000 known species, are the most abundant animal on earth



“Using this method, I was able to successfully demonstrate the substantial natural variation in SolA production in cultivated potato genotypes,” remarks Dong.

Researchers also detected SolA in about 20% of over 300 wild potato species. “This suggests that there must be other hatching stimulants in play,” adds Dong.

Other important outcomes include the identification of an intersecting genetic locus in chromosome 2 and the discovery that hatching stimulant production is regulated by nitrogen starvation.

As a result of Dong's research, we are now able to detect and quantify the SolA hatching stimulant in root exudate from a single plant. This finding played a large role in helping her secure a permanent position at the University of Amsterdam, where she will continue her work identifying the genes responsible for hatching stimulant production.

“This project resulted in a reliable detection method and a unique scientific position on the topic – one that I plan to build on as I continue my work in the below-ground chemical communication of plants,” says Dong.

Dong shares all her findings and work on plant metabolism and chemical communication at the Metabolism Lab.

NEMHATCH

- Coordinated by the University of Amsterdam in the Netherlands
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/793795
- Project website: bit.ly/NemHatch_project



An innovative, sustainable ink for printing digital porcelain

With the support of EU funding, one Italian company is developing a sustainable, water-based ink for the growing digital porcelain tile market.

Even a field as old as ceramics isn't immune from the digital revolution. Whereas in the past the ceramic tiles and decor used in building and construction projects got their colours and patterns through glazing, today this is being done digitally.

Called digital or technical porcelain, these tiles are digitally printed using high-resolution patterns that mimic such textures as stone, wood and even fabric. Unfortunately, the standard ink used in the printing process has a rather substantial carbon footprint.

This is where Metco comes in. With the support of the EU-funded ECO-INK (Eco-innovative water-based inks for the ceramic sectors) project, the Italian stoneware and porcelain tiles decor company has developed a sustainable ink specifically for the digital porcelain tile market.

"Our new water-based inks, which are dissolved in water, eliminate the use of organic solvents and, by doing so, reduce the ink's carbon footprint and level of toxicity," says Metco CEO and ECO-INK project manager Graziano Vignali.

A MORE SUSTAINABLE INK

Traditionally, digital porcelain tiles are coloured using an ink based on micronised pigments suspended in an organic solvent. This ink is sprayed onto the tile surface using a process that is very similar to a deskjet printer. To ensure that the ink holds to the surface, a glass grid must be applied to the tile.

ECO-INK, on the other hand, replaces this organic solvent with water, which is non-toxic. Furthermore, unlike organic-based inks, ECO-INK can penetrate the tile's surface, eliminating the need for an additional layer of protection. The result is a more efficient – and sustainable – production process.

"ECO-INK is a new colour formula that represents the most solid and resistant surface ever produced in the ceramic industry," adds Vignali.

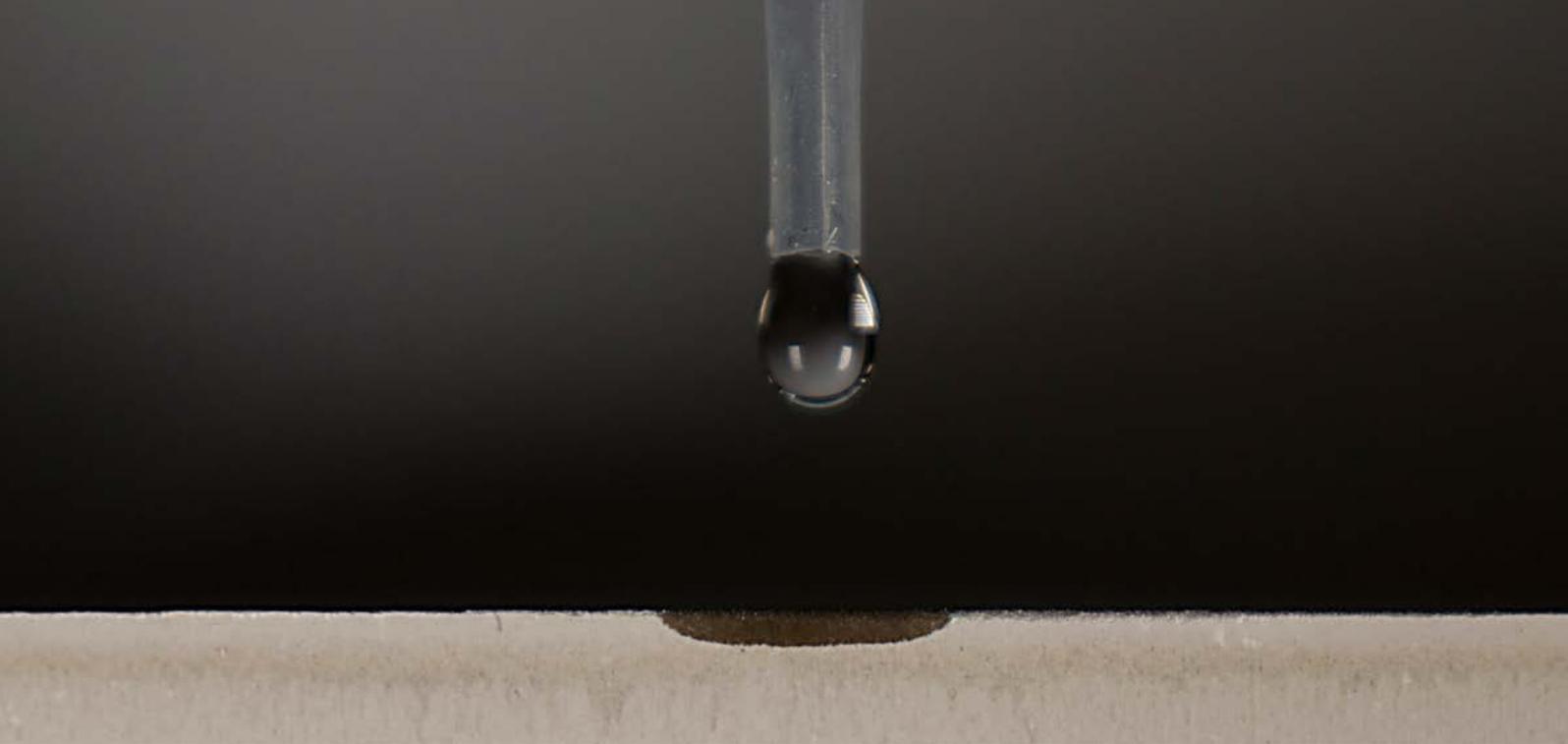
Of course, getting to this point was anything but easy. For instance, one of the first challenges that Metco had to overcome was ensuring that the water-based ink was compatible with the various electronic components used in digital printing. Another challenge was finding the right chemical compositions needed to create the six standard colours used in printing.

"We addressed each of these challenges, amongst others, by conducting hundreds of tests and trials in our firing kiln," remarks Vignali. "As a result, our colour collection is almost final, and our initial prototypes have proved to be viable from both a technical and an aesthetic point of view."

READY TO DISRUPT THE CERAMIC MARKET

Thanks to the support of the EU funding, ECO-INK is one step closer to hitting the international market. "We are very proud of the fact that, in just 3 years, we successfully developed something both new and revolutionary," says Metco sales and marketing manager Claudio Casolari. "Now we're ready to take it to market and disrupt the ceramic production sector."

“Our new water-based inks, which are dissolved in water, eliminate the use of organic solvents and, by doing so, reduce the ink's carbon footprint and level of toxicity.”



Metco is currently conducting market tests with several early adopters before moving into the production phase. The company is also ramping up its marketing and promotional efforts.

“With many people using the COVID-19 lockdowns as an opportunity to do home improvement projects, demand for quality, sustainable ceramics is on the rise,” concludes Casolari. “We are happy to report that ECO-INK is now well-positioned to meet this demand.”

ECO-INK

- Coordinated by Metco in Italy
- Funded under Horizon 2020-Societal Challenges, Horizon 2020-SME and Horizon 2020-LEIT
- cordis.europa.eu/project/id/822144
- Project website: metcoitalia.com/en/eco-ink

INDUSTRIAL TECHNOLOGIES

The ultra-clean water making a splash in the semiconductor industry

Microchip miniaturisation is accompanied by shrinking distances between conductive threads – now less than 10 nm – making it easier for tiny particles lodged between them to create shorts. EU-funded equipment presents a unique, eco-friendly way to get rid of these contaminants.

Nanoelectronics technologies have advanced at mind-boggling speed, facilitating ever-closer packing of components on chips and enormous memory capacity. However, this has increased the risk of impurities reducing yield rate and thus profitability. Chips processed in high-tech clean rooms are each rinsed about 100 times during

manufacturing. The European semiconductor manufacturer NXP (formerly Philips) requires about 30 million l/day.

Advanced processes to produce ultra-pure water (UPW) have difficulty removing particles smaller than 20 nm, let alone less than 10. As chips decrease in size, these

“*LastRinse is the only system to completely remove sub-20 nm nanoparticles in UPW, an absolute necessity for future profitable advances in nanoelectronics.*”

nanoparticles become more problematic. Their presence increases the likelihood that chips are scrapped, incurring significant waste of natural resources, time and money. Thus, improving water purity while reducing energy and water consumption, raw material waste and cost is critical to continued chip miniaturisation and European industry competitiveness. The EU-funded project ULTRAWAT (Ultrapure Water Technology – nanoparticle free water for the advanced nanoelectronics industry enabling further miniaturization of electronic devices) has a solution that is the culmination of decades-long work to address these challenges.

PURE GENIUS

Forty years ago, the Swedish company Scarab developed a pilot plant for desalination using its patented water treatment technology. Surprisingly, the water was extraordinarily pure. It seemed destined for a starring role in the semiconductor industry whose increasingly dense packing suggested a coming need. Ambitious research and development efforts began at Sandia National Laboratories in the United States after which Scarab and its spin-off Xzero began focusing on UPW for microchip manufacturing.

Since 2010, Xzero’s demonstration unit in Stockholm has been removing pharmaceutical residues from municipal wastewater, purifying flue gas condensate from power plants and more. Horizon 2020 funding of ULTRAWAT enabled the complete redesign of core equipment, enhancing efficiency and lowering costs.

Miriam Åslin, CEO of Xzero and ULTRAWAT project coordinator, explains: “Current state-of-the-art UPW production systems use about 10 steps. Xzero’s LastRinse equipment uses two, including our proprietary process to remove all non-volatiles by vaporising and condensing the water molecules while leaving the rest in the feed water. In addition, it uses waste heat instead of electricity to power the separation process.” This simpler and more efficient process enabled the development of a compact on-demand point-of-use system, minimising contamination risks, and simplifying maintenance and repair. Testing is in progress and commercial systems should be hitting the market in 2023.

A CIRCULAR MINI-ECONOMY

ULTRAWAT exceeded all expectations with their integrated wastewater treatment and resource recovery system to isolate all contaminants. Circular Water Technologies AB will offer the zero liquid discharge circular water treatment system for the semiconductor industry. In cooperation with imec, Xzero also initiated the ‘Resource Recovery’ project aimed at recovering valuable components like rare earth metals from semiconductor wastewater. Finally, given the obstacles associated with COVID-19, a small system was developed to send to interested potential customers. It will be sold as lab equipment by Type1water AB.

LastRinse can be integrated into existing water purification plants without disturbance or downtime or implemented in new ones. Aapo Sääsk, chairman of the Board of Xzero, concludes: “LastRinse is the only system to completely remove sub-20 nm nanoparticles in UPW, an absolute necessity for future profitable advances in nanoelectronics. Xzero will be a critical enabler for growth in the European nanoelectronics industry, freeing it from dependence on American and Asian manufacturers and driving home-grown innovation.”

For Xzero – the movie, see the video.

ULTRAWAT

- Coordinated by Xzero in Sweden
- Funded under Horizon 2020-Societal Challenges, Horizon 2020-SME and Horizon 2020-LEIT
- cordis.europa.eu/project/id/811908
- Project website: xzero.se
- ▶ bit.ly/Xzero-video





Can Virtual Reality shift our perspective on issues like climate change and immigration?

This question was at the heart of the PersVR project, which aimed to explore the power of persuasion of 360° Virtual Reality narratives. The results of their empirical study could very well change the way developers and journalists look at Virtual Reality as a means to tell convincing stories.

Across the world, Virtual Reality (VR) is being praised for the feeling of immersion it provides. It is indeed the closest engineers and developers have been to blurring the lines between what's real and what's virtual. But what's this immersion worth exactly? Can it change the way we perceive the real world or make us change our mind about something? And if so, does it fare better

than a movie or documentary would in this regard? As surprising as it may sound, we don't know for certain.

As VR technology evolves and the realm of possibility expands, the PersVR (Unraveling the persuasive power of 360°-video Virtual Reality narratives) project arrives just in time to clear this matter up. The project specifically focuses



on 360° video VR narratives to find out whether they can influence viewers' opinions on two fundamental issues faced by humanity: climate change and immigration.

"The issues of climate change and refugees often feel far away from us. We may hear about or even see images of poor quality of life in migrant camps or the Arctic melting, but eventually as we turn off our TV or close our newspaper, things become increasingly abstract and less emotionally grasping. The trouble is that we need to take on these challenges now and raising citizen awareness is a key ingredient to timely action," says Tilo Hartmann, professor of Virtual Reality and Communication at VU Amsterdam.

The rationale behind PersVR is simple. If VR is better placed than traditional media to bridge the psychological distance gap associated with these two problems, then perhaps actual empirical data will help justify investment in this technology.

THE POWER OF NARRATIVE VR

"VR has the power to make things very concrete," Hartmann explains. "You can see the Arctic melting right in front of your eyes or be in the middle of a bushfire, which makes you a direct witness of these events. PersVR really is about seeing how VR can be used to make the best of both worlds: the strong narratives brought by good journalism, and the immersion brought by a VR headset. We want to integrate these two mechanisms and see how they perform together, which has never been done under other VR-related studies."

To gather empirical insight, Hartmann and Marie Skłodowska-Curie fellow Miguel Barreda used existing 360° video clips on climate change and immigration. In the latter case, they picked 'Clouds over Sidra' – a critically

“*PersVR really is about seeing how VR can be used to make the best of both worlds: the strong narratives brought by good journalism, and the immersion brought by a VR headset.*”

acclaimed 360° web VR film focusing on the Syrian refugee crisis co-produced by VRSE and the United Nations. In this movie, watchers get to know Sidra, a 12-year-old girl who takes them to visit the Za'atari Refugee Camp and follow her daily life.

"The empirical study was delayed due to COVID-19, but the idea is to show these videos to different groups in different formats as well as induce different states of immersion to vary the witnessing effect," Hartmann adds. "Subjects won't initially know what the test is about: they will fill in a survey after the VR experience, and we will measure their physiological parameters as they watch the video clips." By the end of the experiment, Hartmann and Barreda should have a better sense of how narrative VR experiences really impact participants.

The project is currently on hold but work will resume post-lockdown, probably after summer 2021. In the meantime, the team has been studying the use of VR technology as an alternative to courses using video call software, and their findings are already sparking interest in various universities.

PERSVR

- Coordinated by VU Amsterdam in the Netherlands
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/838427



Still curious? In Episode 7 of **CORDIScovery**, Abigail Acton joins three space scientists to discuss Europe's celestial ambitions, from lunar bases to the search for life on Titan. Stream or download now:

→ bit.ly/CORDIScovery_Solar-system



New tech to stream high-quality video without sapping your data

With demand for video streaming services growing fast, the current internet bandwidth is struggling to cope. ENHANCEplayer allows broadcasters to stream smaller files, enabling users' own devices to upscale the video resolution to higher quality.

Video streaming over the internet, either as video on demand for existing content or live streaming for events, is a boom industry. Yet, high-quality streaming is not universally available, with some lacking the broadband connections needed. The cost of mobile internet is also prohibitive for many, with one study finding that cost stops almost 50% of people with 4G network access globally using smartphones for the internet.

The EU-supported project ENHANCEplayer (An Artificial Intelligence Enhancing Video Quality Locally to Limit Internet Traffic Tied to Video Streaming) set out to reduce the infrastructure load caused by sending lower resolution/lower bit rate videos over the internet with the receiving video player enabled to upscale quality.

“Whereas traditional approaches increase the encoding efficiency of video, risking incompatibilities with older hardware, we started with the quality of the viewer experience, not technical metrics,” explains Ely Loew, the project coordinator.

NEURAL NETWORK ENHANCEMENT

Project consortium members Artomatix and THEO Technologies shared their technological infrastructures to develop a prototype solution. ENHANCEplayer's starting point was that the minimum video resolution needed for broadcasters is 540 p for mobile devices.

Artomatix hypothesised that their super-resolution technology could be optimised for a variety of devices and prove fast enough to upscale video frame resolution in real time, 25-30 frames per second. THEO Technologies redesigned its universal video player, ‘THEOplayer’, to include Artomatix's upscaling modules.

The resulting ENHANCEplayer prototype works by training a neural network with two versions of a series of images



– a source resolution, 360 p for example, and a target resolution, say 720 p. The model then adds pixels to the 360 p version so that it matches the 720 p image in quality.

To further test the system, the project created a custom proof of concept model for videos sent by broadcaster partners – VRT in Belgium, NPO in the Netherlands and RTP in Portugal.

The first success was streaming a 360 p video with its resolution increased to 540 p for an iPhone 11. “At that moment, all doubts about the technology disappeared. Our enthusiasm was bolstered with broadcast tests and surveyed viewers who confirmed the upscaled video quality,” says Loew.

This breakthrough was made possible because the iPhone 11 has new neural network chips that can run

“We estimate that the hardware and browser infrastructure needed to handle the neural network models for resolution upscaling in real time is 1 to 2 years away.”

machine learning. These chips are becoming more prominent in new mobile devices.

Despite the newest Android phones also having neural network chips, their architecture slowed down the processing of individual video frames disabling the model from running in real time.

“So, currently, this technology is dependent on hardware,” observes Loew.

EXPANDED OPPORTUNITIES

According to one survey, the global over-the-top services market is projected to grow from USD 81.6 billion in 2019 to USD 156.9 billion by 2024, with a projected fourfold increase in bandwidth consumption between 2017 and 2022. The live video streaming portion is projected to grow by a factor of 15.

By reducing the bandwidth needed, ENHANCEplayer minimises strain on communication infrastructure, while

reducing energy consumption. It also increases access for those denied it for technical or cost reasons, such as rural communities and developing countries. Additionally, it opens up opportunities for content generated by non-professionals using basic equipment.

Along with reviewing options for Android hardware capabilities, the team are now working on web browser viewing. “We estimate that the hardware and browser infrastructure needed to handle the neural network models for resolution upscaling in real time is 1 to 2 years away,” adds Loew.

The team are also looking at a range of future directions including integrating upscaling into a video codec or as part of a video display device, such as a TV, or enabling partial upscaling for older devices.

ENHANCEPLAYER

- Coordinated by Artomatix in Ireland
- Funded under Horizon 2020-Societal Challenges and Horizon 2020-LEIT
- cordis.europa.eu/project/id/831109
- Project website: artomatix.com/enhance-that

DIGITAL ECONOMY

Intelligent robots can learn to recycle hazardous hardware

For robots to dismantle discarded electrical and electronic appliances for recycling, they need the ‘intelligence’ to cope with unfamiliar hardware variants.

Although robots are still far from matching human dexterity, they are beginning to be used for dismantling discarded electromechanical and electronic appliances for recycling, an activity that can be hazardous for humans.

But robots are programmed to execute tasks within a limited repetitive range. Now the EU-funded IMAGINE (Robots Understanding Their Actions by Imagining Their Effects) project has developed an intelligent system to

enable a robot to ‘understand’ how to disassemble a device it has not encountered before.

Even a small device can have hundreds of screws, which can be laborious to manually take apart, explains project coordinator Justus Piater, head of the Digital Science Center at the University of Innsbruck, Austria. “As a result, whenever these expensive recycling procedures arise, in practice recycling just doesn’t happen.”



These items end up disposed of in ways that pose a risk to health and the environment, he adds.

The 4-year project enhances a robot's capabilities by improving adaptability, perception and autonomous decision-making by combining machine learning with physics-based simulations of what the robot is likely to encounter with a device.

"Our biggest breakthrough is the highly integrative aspect of the system where it partially or fully disassembles objects it has never seen before, in a way that could not have been planned or programmed from scratch because the information was just not there," says Piater.

INTELLIGENT SYSTEM

A major novelty is that the system can trigger physical simulation to predict the usefulness of certain actions, Piater explains. "If you can estimate this in advance, then you can gather experience and statistics that describe the utility of those actions so that, next time around, it can help you make a better decision. The system learns from this," he remarks.

Physics-based simulation generates and visualises objects and their interaction with the environment. Camera images of a device are analysed to detect opportunities for action, known as 'affordances', which can include unscrewing, levering, pushing away and turning, shaking and so on.

“ Our biggest breakthrough is the highly integrative aspect of the system where it partially or fully disassembles objects it has never seen before. ”

Perceptual capabilities, like detecting or recognising objects or estimating the position and orientation of parts, were enhanced by the IMAGINE team. They also developed new screwhead detection systems, specific affordance detectors and detectors for wiring inside electronic devices. "We have state-of-the-art perceptual, especially visual perception, capabilities and we developed specific new functionality," Piater notes.

INNOVATIVE PLANNING

A sophisticated multifunctional robotic gripper with a built-in tool changer was specially designed for disassembling small electronic devices. The demonstrator system was trained to dismantle computer hard drives and can also handle some types of graphical processing unit.

"We let the robot perform the entire operation many times and analysed the state before and after and let the robot learn from that experience," Piater says.

"A special planning system was developed to decide what action to take next, not only by choosing one of the affordances to act upon, but also by looking at the future and coming up with as much of a plan as possible," Piater adds. This can be based on simulated and real interaction.

Existing planners are formulated mathematically to construct a complete plan or no plan at all. "If they cannot get to the goal then they have no way of figuring out whether any action would be useful. But the planner developed by the IMAGINE team knows how to make progress even if it cannot produce a full plan, just like humans would do," he explains.

IMAGINE

- Coordinated by the University of Innsbruck in Austria
- Funded under Horizon 2020-LEIT-ICT
- cordis.europa.eu/project/id/731761
- Project website: imagine-h2020.eu



LIFE AFTER...

Catching up with BIRD RELEASE: Sky's the limit for bird-banishing laser

*Previously Research*eu highlighted the exciting work of BIRD RELEASE, a project developing smart laser technology to harmlessly deter birds from agricultural sites like fields and orchards. One year on, we catch up with Steinar Henskes, founder of the company behind the technology, Bird Control BV.*



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Flocks of birds can destroy up to 25 % of harvested areas, both by eating the crops and by trampling young seedlings. The BIRD RELEASE (REpelLEnt Auto-SystEm) project focused on advancing the commercialisation of AVIX Autonomic bird deterrent system. This can decrease bird nuisance by more than 70 %, offering customers increased safety, profitability and sustainability.

The device at the heart of the AVIX system contains a camera which constantly scans a protected area. When birds appear, software automatically recognises whether they are a threat to the site, and if so, flashes a laser which startles the bird, causing it to flee. The device drastically reduces bird mortality by removing the need for nets and pesticides.

Since the advent of the EU-funded project, Bird Control BV, based in the Netherlands, has continued to develop its technology and expand its customer

base. They now count more than 8 000 users across more than 100 countries, mostly focused on agricultural users in North America and Australia.

But it has grown beyond simply protecting farmland, and the company has also installed devices at offshore oil and gas platforms. "Those locations are always a challenge," says Henskes. "Our technicians need special training to access the site, and you need to bring everything you think you might need. As our technicians put it: 'At sea, there is no hardware store around the corner'." He adds that future versions of the AVIX system will boast enhanced weatherproofing to better resist the harsh maritime conditions.

The company also carried out a case study at Chicago Executive Airport in the United States. Members of the airport's wildlife control team (employed by partner Wild Goose Chase) used a handheld version of the AVIX to more precisely manage birds

near the runways. "You can imagine scaring away sitting birds while aircraft are landing is not always a good idea," says Henskes. "You could scare away the birds into the aircraft path. Therefore the human element is important to make judgements on when to scare birds and when not to scare them."

Now, Bird Control BV are advancing the connectivity and manufacturing efficiency of their system by removing the need for a physical SIM card and instead using a worldwide eSIM solution. Henskes adds: "EU funding was crucial to develop our second-generation laser system, and propelled our company from start-up to scale-up!"

BIRD RELEASE

- Coordinated by the Bird Control Group in the Netherlands
- Funded under Horizon 2020-FOOD and Horizon 2020-SME
- cordis.europa.eu/project/id/766610
- Project website: birdcontrolgroup.com



Steinar Henskes
BIRD RELEASE project coordinator and founder of Bird Control BV
© Steinar Henskes

“EU funding propelled our company from start-up to scale-up!”



SECURITY

The secret robot armies fighting to undermine democracy

Governments and special interest groups are using networks of automated accounts on social media to sow dissent, spread disinformation and subvert their opponents.

Funded through a European Research Council (ERC) grant, the COMPROP (Computational Propaganda: Investigating the Impact of Algorithms and Bots on Political Discourse in Europe) project set out to investigate networks of automated social media accounts, and their role in shaping public opinion.

Researchers led by principal investigator Philip Howard produced a codified definition of ‘junk news’ that referred to deliberately produced misleading, deceptive and incorrect propaganda purporting to be real news. The team then examined millions of posts on social media to see how these messages were produced and disseminated.

Though initially focused on Twitter, the team at the University of Oxford’s Programme on Democracy and Technology found computational propaganda – algorithms put to work for a political agenda – on Facebook, Instagram, Telegram, YouTube, and even dating app Tinder.

“We didn’t expect over the course of the project the problem would grow as bad as it did,” notes Howard. “We can see

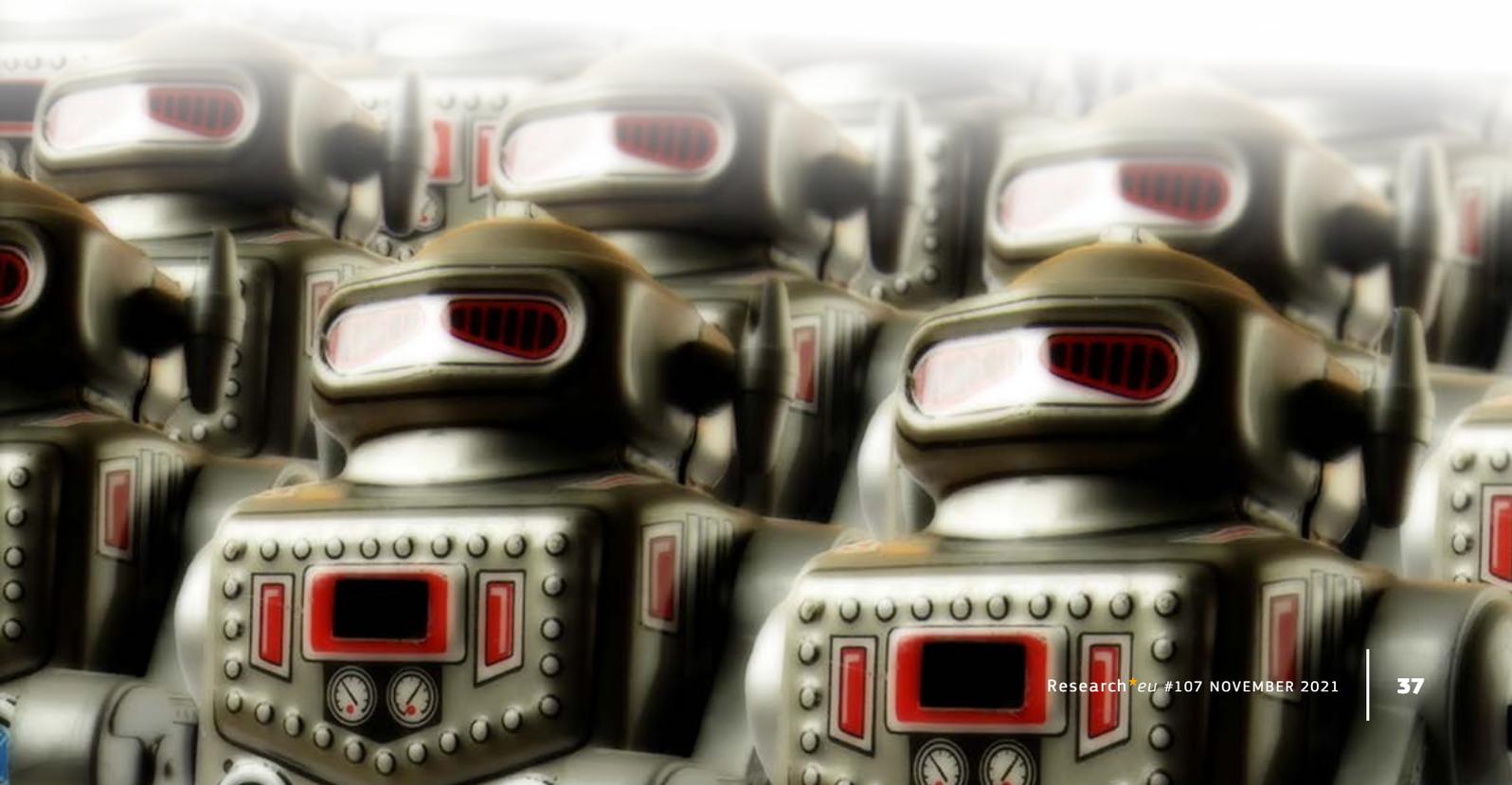
how some governments, lobbyists, the far right and white supremacists all use these to manipulate democracies.”

The COMPROP project focused heavily on COVID misinformation, which Howard notes came chiefly from three sources: Russian media, Chinese media, and American president Donald Trump. While Trump’s disinformation was tied to domestic American politics, Russia and China pushed three broad themes intended for foreign audiences.

“The first was that democracy can’t help us, elected leaders are too weak to make decisions,” says Howard. “The second message was that Russian or Chinese scientists were going to get the vaccine first, and the third was that Russia or China was leading on humanitarian assistance efforts.”

UNDER THE INFLUENCE

These misinformation campaigns predate the COVID-19 pandemic, however. “When Malaysia Airlines Flight 17 was shot down over Ukraine, there were multiple ridiculous



stories of what transpired – that democracy advocates shot it down, that American troops shot it down, that a lost tank from WWII came out of the forest and shot it down,” adds Howard. By laying out multiple conflicting stories, authoritarian regimes prevent their citizens from knowing which narrative to respond to.

This strategy was eventually turned outward, to undermine social movements and destabilise foreign nations. “Sometimes campaigns are about a specific crisis or person, but often the goal is to undermine trust in courts, police, journalism, science, or government at large,” explains Howard.

He adds that the target audience for these bots is perhaps only 10–20% of the population, typically disaffected, conservative-leaning adults who are politically active. In a highly polarised country, swaying 10% of the electorate can have a resounding impact.

Howard explains that these campaigns are particularly bad for the role of women and minorities in public life: “Feminists, female journalists, and female politicians get a nasty form of attack and disinformation on social media. It’s much easier to drive a woman out of public life than a man.”

GOVERNMENT INTERVENTION

Howard says more effort is needed to contain these propaganda networks. “We’re past the point of self-regulation

by industry. If tech firms stepped up, and governments imposed fines on politicians who commission these programmes, that set of initiatives would go a long way.”

Yet even identifying which social media accounts are automated has proven difficult. “One bot writer in Germany said his team would read our methodology papers and adjust their algorithms to just below our catchment,” remarks Howard. “We were in a sort of dialogue with these programmers.”

The group were also awarded a proof of concept grant to develop the Junk News Aggregator, a tool which interactively displays articles from unreliable sources as they spread on Facebook.

Howard and his team are now focused on how machine learning technology will power a new generation of computational propaganda. “If someone can take your social media feed and behavioural data, and come up with political messages you’ll respond to, they’ll do that,” he concludes. “This is the next great threat.”

COMPROP

- Hosted by the University of Oxford in the United Kingdom
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/648311
- Project website: demtech.oii.ox.ac.uk

SECURITY

New tools to help organisations become cyber-aware

Following an increase in homeworking, organisations are more vulnerable to cyberattacks than ever before. A new cybersecurity training initiative aims to mitigate this risk through practical knowledge and hands-on practice.

Too many companies make the mistake of seeing cybersecurity as an ‘IT problem’. But nothing could be further from the truth. “A phishing email sent to an employee and a click of a mouse is all it takes to give a hacker a direct path to an organisation’s network,”

explains Rodrigo Diaz-Rodriguez, head of the Atos Cybersecurity Unit.

According to Diaz-Rodriguez, training is crucial to helping organisations become cyber-aware. “With the

“ *A phishing email sent to an employee and a click of a mouse is all it takes to give a hacker a direct path to an organisation’s network.* ”

COVID-19 pandemic bringing an increase in homeworking, companies are now particularly vulnerable to malicious cyberattacks,” he says. “As such, the need for effective cybersecurity training is more pressing than ever.”

Meeting this need is the EU-funded project CYBERWISER.EU (Civil Cyber Range Platform for a novel approach to cybersecurity threats simulation and professional training). “From teaching employees to strengthen their password to helping system administrators implement comprehensive protection strategies, CYBERWISER.EU helps organisations mitigate their risk of a cyberattack,” adds Diaz-Rodriguez.

HANDS-ON EXPERIENCE

The main aim of the project is to increase an organisation’s capacity to address advanced cyberthreats. “We do this by providing tailored and efficient training that addresses the specific needs of professionals while also raising the organisation’s awareness about cybersecurity,” remarks Diaz-Rodriguez.

All 22 courses are delivered via the project’s user-friendly cyber range platform. The platform leverages state-of-the-art methodologies and tools and uses a combination of theory and practice to help an organisation develop a robust cyber response and decision-making processes. Courses are comprised of a variety of presentations, audio content, quizzes and hands-on exercises.

“One of the platform’s most popular features is the opportunity to use our cyberattack simulator,” explains Diaz-Rodriguez. “By playing the role of ‘defender’ or ‘attacker’, participants get hands-on practice with responding to a cyberattack and a unique understanding of how they work.”

Diaz-Rodriguez adds that courses are available for all skill levels. “CYBERWISER.EU is completely flexible and customisable, meaning it can be tailored to meet your organisation’s unique needs – and budget,” he notes.



“Whether your staff have little to no knowledge of cybersecurity or you are an advanced IT team looking to enhance your cybersecurity capabilities, CYBERWISER.EU has a solution for you.”

TOWARDS COMMERCIALISATION

During trial runs in the transport, academia and energy sectors, CYBERWISER.EU provided training to more than 500 individuals from over 20 institutions. Based on this success, the project team is currently preparing to make the training commercially available.

“Our idea is to develop a modular offering that allows users to access training on specific skills and topics, including malware, spoofing, phishing scams, spam emails, SQL injection, and password cracking,” says Diaz-Rodriguez.

The project has received expressions of interest from 41 organisations, with 146 users already using a beta version of the commercial platform via a free trial offer.

CYBERWISER.EU

- Coordinated by Atos in Spain
- Funded under Horizon 2020-SECURITY
- cordis.europa.eu/project/id/786668
- Project website: cyberwiser.eu
- ▶ bit.ly/CIBERWISEREU_video



Quantum simulations uncover exotic electron behaviour in extreme magnetic fields

The ultrapowerful magnetic fields surrounding white dwarfs can cause electrons that make up chemical bonds to behave in unfamiliar ways. New computational methods provide a first glimpse of the spectral and chemical properties of elements in magnetic fields 100 to 1 000 times stronger than those created on Earth.

Magnetic fields in white dwarfs can reach around 100 000 T, whopping numbers impossible to replicate in the laboratory. Detailed theoretical understanding of strong fields and computational machinery that can handle them feed back into the computational accuracy of weak field behaviour that is vital in boosting not only scientific research but also real-world applications.

“Magnetic fields created in the laboratories are weak enough to affect chemical bonds in small molecules. However, there is a size effect mechanism that associates the impact of strong fields on small molecules to that of much weaker fields on larger molecules,” explains Erik Tellgren, coordinator of MAGSPEC (Spectra of Molecules in Strong Magnetic Fields) – a project funded under the Marie Skłodowska-Curie Actions programme.

ELECTRON DYNAMICS IN CONSTANT AND VARYING MAGNETIC FIELDS

“Chemistry and molecular physics can dramatically differ in the presence of a strong magnetic field. Electronic states can change their character. We successfully developed computational chemistry methods to study excited states and emission spectrum characteristics,” notes Tellgren. The team derived working equations that extend the functionality of LONDON, a software package that uses Gaussian London-type atomic orbitals to simulate molecular systems in strong magnetic fields.

Researchers have also used their code to simulate the electron excited states in small molecules subject to either constant (uniform) or varying magnetic fields. “Magnetic fields that vary in space could give rise to exotic phenomena that mimic the effects of special relativity,” adds Tellgren. “Study results show how a changing magnetic field causes spin-orbit interaction, a relativistic interaction of the electron spin with its motion.”

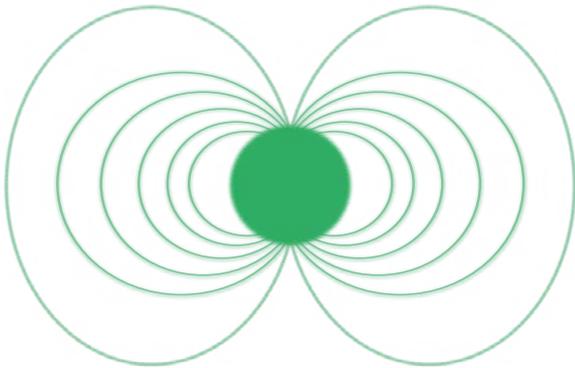
ELECTRONS BREAKING THE LAWS OF KNOWN CHEMISTRY

Researchers adapted a model known as Hartree-Fock theory to describe electron ground states, and adapted the random phase approximation to strong magnetic fields to describe excited states.

Results showed that when the field strength increased, the ground states changed from closed-shell singlets to states of higher multiplicity. Excited states were found to be more sensitive to magnetic field changes. Polar molecules like lithium hydride subject to weaker fields were more prone to change their electronic state.

An intriguing mechanism that could be verified is that a non-uniform magnetic field induces non-collinear spin densities, meaning that the spin direction varies over space to align with the local magnetic field. If only magnetic field effects were present, this alignment would have been perfect. But since the electrons interact with each other and the atomic

Magnetic fields in white dwarfs can reach around 100 000 Tesla, whopping numbers impossible to replicate in the laboratory



nuclei, the actual alignment is a complicated competition between magnetic forces and chemical effects.

The magnetic forces also break symmetries that typically apply for electron spins. A consequence is that transitions between the ground and excited states that are normally forbidden, because of incompatible spin symmetries, are now allowed. Researchers also studied how non-uniform

magnetic fields induce an exotic property known as a toroidal dipole moment in the ground state and studied the relative contributions from spin and orbital motion.

Extending the project's original scope, researchers sought to adapt and refine one of the most popular computational methods – density functional theory – for molecules in strong magnetic fields.

“Our research offers tantalising glimpses of the exotic chemistry of atoms and molecules in strong magnetic fields, while they provide a stress test for quantum chemistry. Further understanding of how strong magnetic fields affect atoms and small molecules could also help interpret the magnetic spectra of white dwarfs and uncover possible new chemical bonds that do not occur on Earth,” concludes Tellgren.

MAGSPEC

- Coordinated by the University of Oslo in Norway
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/745336

FUNDAMENTAL RESEARCH

Atomic clocks made of shattered zircon crystals can date asteroid impacts

When dating an impact crater, does the age indicate the moment of impact, and related devastation, or does it record cooling of the crater up to hundreds of thousands of years later? New research has managed to separate the two events and accurately date the point of impact.

The Chicxulub impact structure in the Yucatán Peninsula, Mexico, formed 66 million years ago and triggered the Cretaceous–Palaeogene mass extinction in which three quarters of life on Earth was wiped out.

This is the one well-established example of a cause–effect relationship between an impact and a mass extinction, but the possibility remains that other large impacts may have triggered other extinctions.

Accurate and precise dating of large craters can contribute to our understanding of the relationship between impacts and mass extinction events.

The EU-funded project Crater Chron (Understanding the role of impact cratering in Earth's evolution through state-of-the-art geochronology) has taken advantage of recent advances in our understanding of how the mineral zircon ($ZrSiO_4$) can record the age of an impact event, offering a better understanding of when the impact occurred and what resulted.

In the Cretaceous–Palaeogene mass extinction, **66 million years ago**, three quarters of life on Earth was wiped out



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“We managed to establish a relatively standard routine for determining the age of an impact event,” says principal investigator Gavin Kenny, based at Sweden’s Royal Museum of Natural History. Kenny was supported by a Marie Skłodowska-Curie Individual Fellowship.

One of the breakthroughs in the project came from integrating new zircon uranium-lead (U-Pb) data with previously published data from another dating technique, argon-argon, or Ar/Ar, dating.

As Kenny explains, “Ar/Ar dating is a powerful tool in dating impacts, and it was important to show that the two techniques can complement each other in order to give a more complete history of an impact event and the cooling of an impact crater tens to hundreds of thousands of years after the impact.”

COMBINING TECHNIQUES FOR A CLEARER PICTURE

Studying the 23 kilometre-wide Lappajärvi impact crater in Finland, the project showed that shocked zircon appears to more closely record the age of the impact event, while Ar/Ar dating records the cooling of the crater.

“Understanding whether one has dated the actual impact event, or the later cooling of the structure, is important if one wants to correlate impacts with other important events in Earth’s past, such as mass extinctions,” Kenny adds.

Zircon that has been shocked by the extreme pressures and temperatures unique to impact events deforms in a number of ways. One way is to recrystallise.

A pre-impact zircon grain, which might initially be approximately 100 micrometres (0.1 millimetre) in size, can recrystallise into a cluster of hundreds or thousands of subgrains. This process expels lead from the original crystal

and effectively resets the uranium-lead clock to the time of the impact.

High-spatial-resolution techniques can be applied to analyse the recrystallised parts of the zircon grain, so that the date of the impact can be identified.

THE IMPACT’S IMPACT

Improved dating can also indicate a possible temporal overlap with an extinction event that can be investigated further, and define which sedimentary successions may host a record of an impact and its possible effects on the biosphere.

“Dating an impact is usually a good first step in the process of testing whether a given impact structure may be related to a given extinction event,” Kenny notes.

“We concluded that the approximately 80 km in diameter Morokweng impact structure in South Africa formed a few million years before the Jurassic–Cretaceous boundary. Previous studies had suggested a possible overlap of the geological boundary and impact, but dating of the boundary by other researchers in recent years and the impact structure now indicate that they did not coincide and thus cannot have been related.”

LUNAR SECRETS

In the course of the work, Crater Chron investigated the effects of extreme pressures and temperatures on other minerals, such as apatite. Understanding how apatite responds to an impact is important in understanding the history of the Moon and inner solar system, because apatite is much more common than zircon in rocks on the Moon.

“Studies that date impacts and volcanic activity on the Moon use apatite, so it is important in understanding how impacts may have affected its uranium-lead clock,” explains Kenny.

CRATER CHRON

- Coordinated by the Royal Museum of Natural History in Sweden
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/792030
- Project website: bit.ly/Crater_Chon_website



AGENDA

JANUARY – FEBRUARY 2022

VIENNA, AUSTRIA
Advanced course 4 – Connectivity in
Environmental Science
→ bit.ly/EU_ICONN

**1 → 31
JAN**

**17 → 19
JAN**

BUDAPEST, HUNGARY
HiPEAC 2022
→ bit.ly/EU_HIPEAC

**24
JAN**

INTERNATIONAL
Day of Education

**18 → 19
FEB**

MUNICH, GERMANY
1st PILLARS Conference on Education,
Skills, and Worker Retraining
→ bit.ly/EU_PILLARS

**22 → 25
FEB**

INNSBRUCK, AUSTRIA & ONLINE
6th HBP Student Conference on
Interdisciplinary Brain Research
→ bit.ly/EU_BRAINPROJECT

**11
FEB**

INTERNATIONAL
Day of Women and Girls in Science

**31 JAN →
4 FEB**

DRESDEN, GERMANY
ENVRI Week 2022

An annual event dedicated to Environmental Research Infrastructures during the runtime of the ENVRI-FAIR project, ENVRI week hosts ENVRI-FAIR project-related sessions as well as other sessions targeting different groups of stakeholders.

→ bit.ly/EU_ENVRI

Whilst at the time of writing all of these events were scheduled to take place, we advise all of our readers to regularly check the status of each event due to the continued uncertainty caused by the novel coronavirus epidemic in Europe – events may be cancelled, rescheduled or reformulated (e.g. switched to being a digital event only) at any time.

RESULTS PACK ON DIGITAL CULTURAL HERITAGE – SECOND EDITION

A priceless Dutch Golden Age painting, a ruined Roman Forum surrounded by olive groves on a sleepy Mediterranean hillside or a more modern audiovisual masterpiece of the 20th century, our cultural heritage can be easily and/or permanently damaged or, in the worst-case scenario, even destroyed. In this comprehensively updated Results Pack, we feature 16 EU-funded projects that have developed numerous digital innovations that will help to ensure the preservation of Europe's precious cultural heritage.



Check out the Pack here:
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