

ÉMERGENCE(S)

KEY EVENTS IN RESEARCH AT THE UPPA

(N°8 - DECEMBER 2020)



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Graphics and layout:

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Photo credits:

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Print run:

2500 exemplaires

Distribution:

Direction de la recherche et de la valorisation (DRV) de l'UPPA

Legal deposit:

numéro ISSN 2426-1084

Émergence(s) can be downloaded at:<http://www.univ-pau.fr/emergences>**Université de Pau et des Pays de l'Adour:**

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ÉDITORIAL



What a year it's been!

Students, professors, researchers, administrative staff, technicians... 2020 is a year that has marked us all, in both our personal and professional lives. We've had to learn to adjust, invent new ways of working, get to grips with new communication tools and explore new and unprecedented learning methods. And all this took a good deal of ingenuity! I would like to take the opportunity to congratulate all the teams for their incredible capacity to adapt. Despite lockdown, closure of the laboratories and all the challenges we had to face – sometimes at the last minute – they not only succeeded in staying the course, they also helped our university continue to grow.

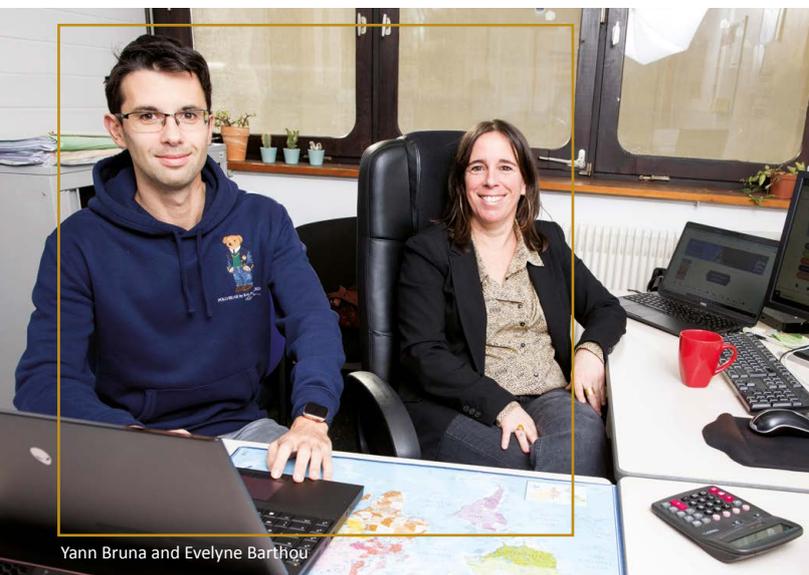
UPPA effectively maintained its quest for excellence by accompanying its PhD students, recruiting a number of talents, continuing to open high-level expertise chairs, creating two new laboratories in social sciences and humanities and strengthening ties with prestigious industrial and academic partners such as the University of California, Berkeley. The research results and stories presented in this magazine are evidence of the enthusiasm that drives our teams, now more than ever, and of the UPPA's global outreach.

The UPPA also achieved another step change by obtaining the "European Universities" label, one of the flagship initiatives of the European Union whose aim is to build a European space for education and research. To succeed in this major endeavour, we joined forces with five other universities – Turin, Saragossa, Timisoara, Beria, and Savoie Mont Blanc – as part of an alliance called UNITA. This unprecedented project heralds the creation of an inter-university campus that will be a real plus for both our students and our researchers.

Obtaining the HRS4R [Human Resources Strategy for Researchers] label was another success at the European scale; this gives added value to the establishments that have signed the European Charter for Researchers. These two labels should enhance the appeal of our university, making it a place to be for researchers from all over the world. As I am now coming to the end of my term as President, I would like to thank you for all the excellent results obtained and to reiterate my confidence in the capacity of the UPPA's community to meet the challenges ahead!

Mohamed Amara

President of the Université de Pau et des Pays de l'Adour



Yann Bruna and Evelyne Barthou

Transicovid Lockdown: a reflection of our society

Evelyne Barthou, a Doctor in sociology and a lecturer at the Université de Pau et des Pays de l'Adour in the Passages laboratory, has been conducting a major survey on people's experience of and feelings about the health crisis.

How did the effects of the health crisis catch your interest?

It was my colleague's idea, Gaëlle Deletraz, a study engineer at the Passages laboratory, to start working on the effects of the first lockdown. We first studied people's relationships with space and time, how they manage their personal and professional lives, and the place of ICT in their daily routine. We joined up with Yann Bruna, who is also a lecturer-researcher at the UPPA, and our work led us to draw up a questionnaire that we published online and distributed in the field, targeting priority neighbourhoods in order to obtain a representative sample. From April 1st to May 15th 2020, 8,412 people took the time to answer more than a hundred open and closed questions. That alone was a sign that people needed to talk.

What lessons can be drawn?

The summary of the first results can be found online. It appears that the lockdown was a positive experience for most people; some of them even mention "a magical interlude". A closer look though, reveals the tensions and disparities in the French society according to sex, age, level of income and place of residence. For example, 18- to 25-year-olds are the age group with the greatest anxieties. People with the highest incomes are those who coped the best with the situation during this period. Of course, it's much easier to balance out family and professional lives when living in a large apartment with a place where you can "get away from it all" sometimes. The results of this first questionnaire made us want to take things further. This is the aim of the TRANSICOVID research programme financed by the Conseil Régional of Nouvelle-Aquitaine and kicked off in July last year.

What are the next steps?

Since July, we have been distributing a second questionnaire focusing on the post-lockdown period this time and on forecasts of the situation after the health crisis, with sections on employment, the ecological transition, and the digital transition. More specific questions, devised by researchers of the Centre for the Theoretical Analysis and Processing of economic data [CATT] of the UPPA, address the transformation of socio-ecological systems in relation to pro-social behaviours. We will then consider a third questionnaire as well as semi-structured interviews to measure the impact of time on people's feelings and views as regards this crisis.



Big Data to tackle Covid-19

A professor at the Laboratory for mathematics and their applications (LMAP) in Pau, Benoit Liquet is taking part in an international study on patients suffering from Covid-19 placed in intensive care.

Benoit Liquet is not a doctor, but he's a wizard with numbers. As a brilliant statistician, he joined the COVID-19 Critical Care consortium, a global alliance of health professionals and researchers focused on identifying the most efficient treatments for the most severely affected patients. The project focuses more particularly on patients suffering from acute respiratory distress syndrome receiving Extracorporeal Membrane Oxygenation (ECMO).

The study was kicked off in January 2020 and its aim is to describe the severity of the respiratory failure, the technical characteristics and duration of the ECMO, the complications and patients' survival.

For this purpose, the consortium collects thousands of pieces of information from more than 200 hospitals in about 50 countries each day. Medical data from over 3,100 patients have been painstakingly compiled in a huge database.

"My job consists mainly in harmonising the data collected worldwide and finding a statistical method to process the missing elements," sums up Benoit Liquet. A crucial task that should enable health professionals to share their experience, learn from one another, reach a consensus on the best way of treating patients and thereby improve clinical practices

> www.covid-critical.com

Reading the future in wastewater

Thierry Pigot, a professor at the UPPA specialised in water treatment, has been using his skills to contribute to the fight against Covid-19.

As a researcher at the Institute of analytical sciences and physical chemistry for the environment and materials (IPREM) and the Director of the Research federation on aquatic environments and resources (MIRA), Thierry Pigot took part in implementing a system to monitor wastewater entering water treatment plants on the Basque coast. Because Covid-19 can be detected in the faeces of people who have been contaminated several days before symptoms appear, this initiative helps to save a precious amount of time in the fight against the pandemic.

For several years now, Thierry Pigot has been contributing to the development of a process to treat (DesinFIX project financed by the Côte Basque-Adour conurbation) or reuse (Safe-Reuse project, E2S UPPA/Kemira) wastewater. The key of the method is the use of performic acid, a disinfectant that decomposes in less than 30 minutes without generating any by-products apart from water and carbon dioxide. The oxidising agent is environmentally-friendly and has the advantage of being almost as effective as ultraviolet treatment while costing 10 times less. The technology has been deployed in Biarritz since 2014 and is used by the SIAAP (Public sanitation service of Île-de-France) with the objective of making the Seine safe for swimming before the 2024 Olympic Games.





Structural colour through self-assembly (spontaneous by evaporation of an aqueous solution) of second-generation microgels.



Microgels ith super-powers

The IPREM is developing a new generation of microgels with amazing properties, opening the door to a myriad of applications in the health and cosmetics sectors.

For the average person, microgels don't mean much. But these colloidal particles composed of a network of polymers swollen in a solvent have astounding properties that are a godsend for academics and industrials. "Microgels are substances that act a bit like tiny sponges that can contain up to 95% water; they can swell or contract under the effect of a stimulus, which can be acidity or a specific temperature," explains Laurent Billon in simple terms. He is the deputy director of the Institute of analytical sciences and physical chemistry for the environment and materials (IPREM). This unique property can be used to encapsulate or shed molecules. When water evaporates for example, microgels spread over the epidermis, form a resistant and elastic adhesive film that can be used to gradually and slowly diffuse an active ingredient contained in the initial composition into the skin. A bit like a transdermal patch, the key difference being that microgels are much more discreet than a cream or transparent gel.



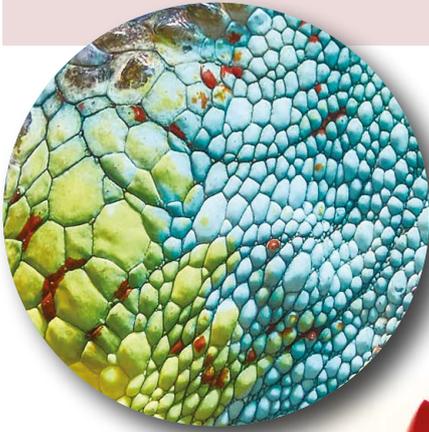
Laurent Billon

Biomim'week 2020

A specialist in bio-inspired materials, Laurent Billon was one of the key speakers at the Biomim'week 2020, a major event for biomimetics and inspired innovations organised by the Cité des sciences et de l'industrie in Paris. The researcher-lecturer seized the opportunity to present the European project eSCALED (European school on artificial leaf: electrodes & devices), which he has been coordinating since 2018, to the general public. It is an ambitious research programme which aims at designing an artificial leaf system based on the principle of photosynthesis; its purpose will be to produce hydrogen or raw materials in a stable and storable chemical form.

> <https://biomimexpo.com>





Applications in cosmetics

So, since 2011, the IPREM has been working in partnership with LVMH (Christian Dior) to synthesise biocompatible microgels for skin applications. Two patents devoted to the encapsulation and shedding of cosmetic agents were filed in 2015 and 2016. A third was filed in 2019 and concerned the development of bio-inspired materials capable of generating physical colours without pigments or dyes that could be incorporated into make-up such as lipsticks and foundations. (This partnership with the world's leading producer of luxury goods was taken a step further when a new partnership agreement was signed with URGO, associating researchers from the UPPA's Laboratory for the study of rheology and adhesion of wound dressings for medical applications (LERAM). This research also led to two new patents in 2019.

Advantages in the fight against cancer

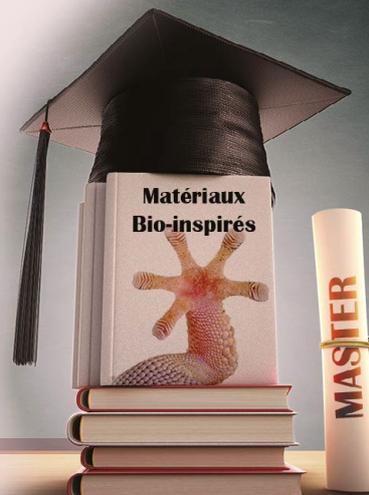
A further stage was reached when the IPREM was contacted by the Stanford University School of Medicine (California) to develop a new generation of microgels that could be used in the health sector for treating mouth cancer.

"The main challenge here is to enhance the adhesive properties of the microgels in a humid environment in order to increase their dwell time on cellular lesions and thus improve growth-factor shedding," specifies Laurent Billon. To meet this technological challenge, the teams of the IPREM had the idea of drawing inspiration from mussels which produce dopamine to cling to rocks under water. This research already resulted in a patent with the United States in 2020. More recently, the IPREM also got together with the Toulouse-based start-up Genoskin in order to develop a new generation of microgels, biodegradable this time. These research projects not only contribute to helping the UPPA earn renown for the excellence of its work on microgels, they are also proof that the university continues to gain momentum in the field of biomimetism.

A new Master's degree on bio-inspired materials

In 2020, the Université de Pau et des Pays de l'Adour introduced a new Master's degree, the only one of its kind in France, giving students the possibility to explore living systems in order to develop new materials. Called BIM for BioInspired Materials and placed under the responsibility of Corinne Nardin and Laurent Billon, the degree should eventually include the future excellence hub on marine biomimetics due to be built on the Basque coast. Open to third-year students in biology, chemistry, and physics & materials, the course is taught entirely in English and offers students the opportunity to draw inspiration from nature through a biomimetic approach. This multi- and transdisciplinary approach draws on fundamental science and materials engineering. It is based on the exploration and understanding of living organisms and ecosystems in order to develop environmentally-friendly bio-inspired materials. Eight students entered the course in 2020, four of them from foreign universities.

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Xavier Arnauld de Sartre

TREE

« It's up to us to be proactive! »

Here we meet with Xavier Arnauld de Sartre, a geographer and research director at the CNRS. He is the initiator of the project to create the mixed research unit TREE (Energy and environmental transitions) on 1st January 2021.

How did TREE start out?

Economists, legal experts in public and private law, geographers, sociologists, and so on. Forty or so researchers in social sciences from different laboratories at the UPPA, had been working for a long time, but in a rather unstructured manner, on common issues related to the energy and environmental transitions. It was time for us to join forces to work more efficiently, all the more so that the UPPA had planned to restructure its SSH [Social sciences and humanities] college. So when the CNRS suggested the idea of creating a transdisciplinary mixed research unit focused on societal issues, we immediately said yes.

What are the objectives?

One question sums up what is at stake: how can society be fostered to embark upon the energy and environmental transitions? The aim of our research is to answer this question by focusing on: governance, more particularly the regulation of transitions as well as the legal and economic aspects; innovation, by reflecting on the best way of accompanying those who deserve it; and the mobilisation of our territories.

It is up to us to be proactive, have our own research agenda and kick off projects without waiting to be consulted!

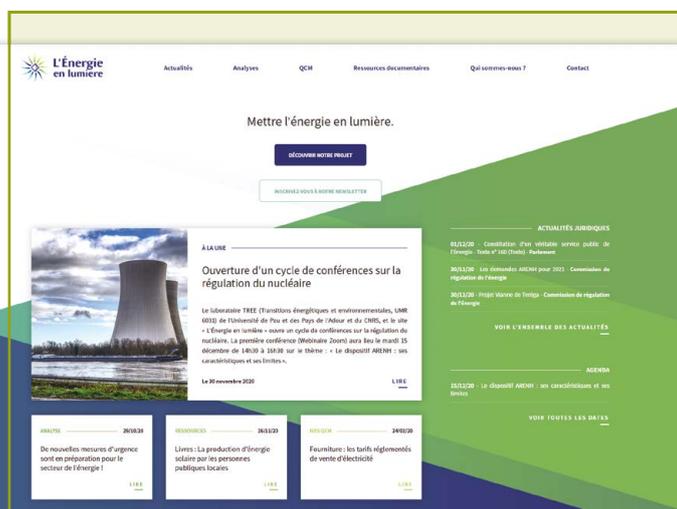
What method do you use?

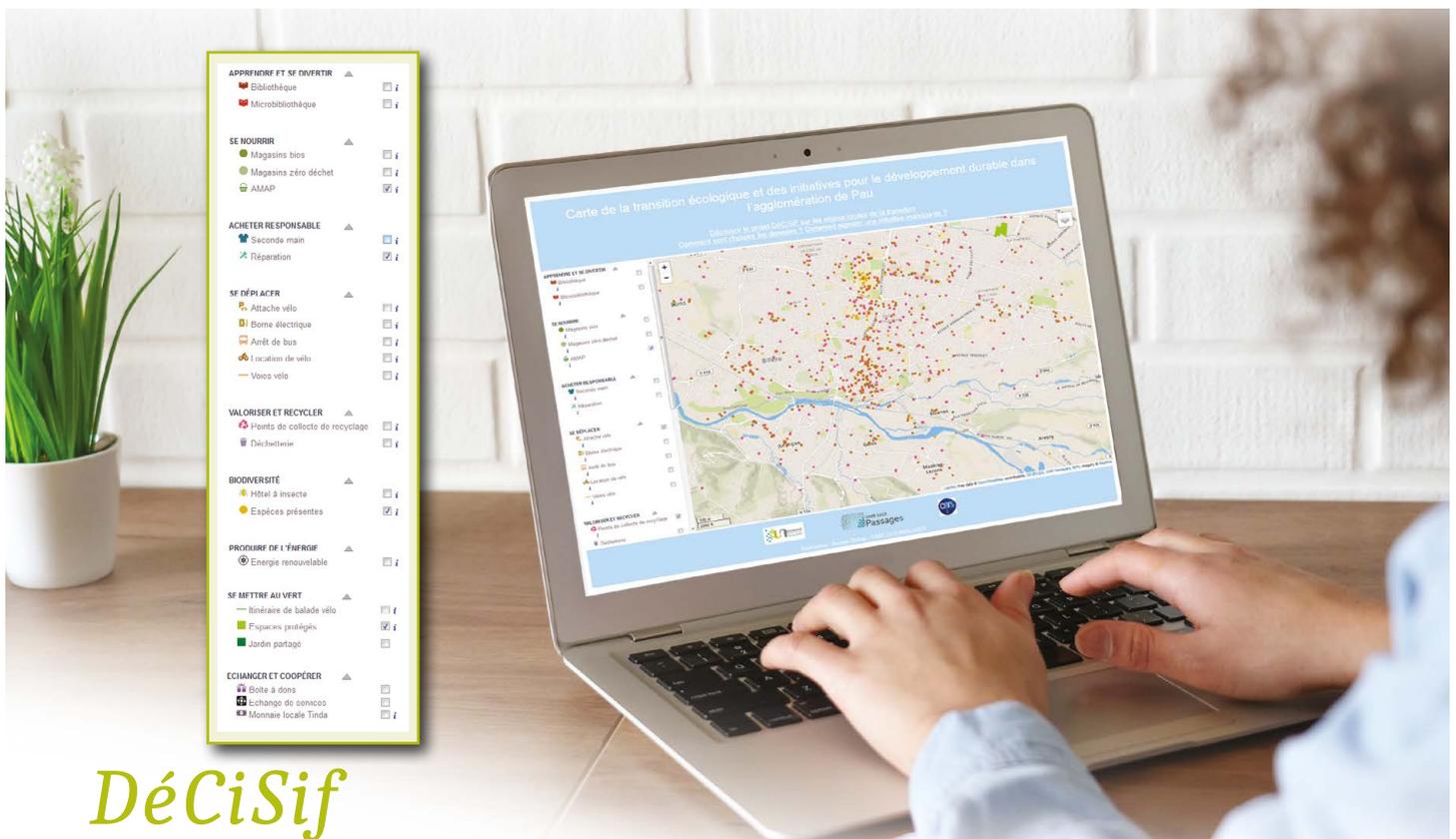
The objective is to encourage interdisciplinarity between all fields, to see that the researchers move away from their fundamentals and open up to other disciplines. I'm thinking, for instance, of hydrogen production using photovoltaic energy at household scale. Of course, it's a technological challenge but it also raises societal questions that must be answered for the project to be accepted by everyone: what are the expectations, what social reorganisation is needed, what economic model, what legal support, and so on. We have a rightful place in this debate.

A site dedicated to energy law

The energy world is in turmoil. International and national regulations and laws are piling up. There is an increasing number of disputes, raising new legal issues every day. The objective of *Energie en Lumière* is precisely to present and explain the stakes of the energy transition as comprehensively and as simply as possible. This new site, managed by Stéphane Andrieu who is fascinated by energy-related issues, and Louis de Fontenelle, a lecturer in public law at the UPPA, will also serve to showcase the activities and results of the university laboratories.

> <https://energie-en-lumiere.fr>





DéCiSif

The ecological transition: everybody's business

A lecturer in geography, Christine Bouisset coordinates the research programme, DéCiSif (The challenges of the transition at local scale: decision-makers and citizens in an urban environment with weak signals).

"The idea of the DéCiSif project was born from a discussion with the people in charge of the climate action plan for the Pau Béarn Pyrénées conurbation," recalls Christine Bouisset, a geographer at the UPPA. "They were telling us how difficult it was to get the general public, their colleagues and the elected representatives on board. They were lacking the appropriate tools and methods of action to lift what we call the social barrier regarding the appropriation of the ecological, economic and social transition." This led Christine Bouisset to kick off a research programme at the scale of the Pau conurbation, an area renowned for its quality of life, where at a first glance, the environmental challenges are less noticeable than elsewhere. The conurbation, the technological centre for the environment and risk management (APESA) and the Pau association for environmental education (Ecocène) immediately rallied around the approach financed by the ecological transition agency (ADEME).

A comprehensive map

The project is due to end in 2021. A team of twenty people is working on it, including eight researchers from the UPPA, sociologists and geographers. The first step was to list everything in the area that could be considered as being part of the ecological transition before drawing up a free-access interactive map (OpenStreetMap). *"Shops, electrical terminals, bus stops, shared gardens, insect hotels, and so on. We tried to list and locate all the existing initiatives,"* Christine Bouisset tells us. It was a lengthy and exhaustive process, and mobilised a lot of people in the field. The task at hand measured up to the challenges: providing a snapshot of the ecological transition, and creating a tool to valorise the players involved plus an educational device. The second stage was to analyse public policies and involved dissecting the environmental policies carried out in a dozen or so French conurbations of roughly the same size as Pau. What governance? What

levers? What obstacles? Etc. Among other things, the researchers observed that most conurbations give priority to mitigation policies rather than adaptation policies.

Raise awareness rather than try to reason

The last focus of the project was to ask the local population about how they perceived ecological challenges. From autumn 2018 to summer 2019, 90 people were questioned in 76 semi-structured interviews. It appeared that citizens often get the impression of being drowned in complicated and contradictory information. They end up feeling lost and not knowing what to believe. *"Eloquent speeches are all very well, but they are meaningless without elements of daily life to back them up,"* concludes Christine Bouisset, thus highlighting the importance of appealing to people's sensitivity rather than their rationale.

> <https://decisif.hypotheses.org>



EnSuTe

A technological and societal challenge

The EnSuTe hub brings together researchers from sciences and technologies and researchers in social sciences; their joint work focuses on the energy independence of a territory. An unprecedented approach, full of promise.

Let us picture a territory like a tree. The trunk would represent the motorway, the branches the more minor roads, and the leaves would be the houses. By taking the allegory even further, dwellings would be in charge of producing the energy necessary for the entire territory, just like leaves do when they transform the sun's energy. This metaphor provides the backdrop for the new thematic hub EnSuTe (bio-inspired Energy Sustainable and Independent Territories) kicked off by the UPPA in 2021. "EnSuTe is based on the idea that artificial photosynthesis may, one day, enable each inhabitant to store and redistribute the energy s/he will have produced as green hydrogen," explains Laurent Billon. "Like in a tree, we would all be energetically dependent on one another."

This visionary project not only requires maturing artificial photosynthesis technologies, but also examining the legal, societal and economic aspects. Developing a renewable, carbon-neutral energy is one thing,

but producing green hydrogen and using it as a real and lasting solution is a different challenge altogether – just as essential though – that citizens, economic operators and political players need to take on board. It's a challenge that can be overcome nonetheless, provided that the competencies and views of the different researchers are combined in a holistic approach. This is the solution chosen by the EnSuTe hub.

Coordinated by the legal expert Louis de Fontenelle and the chemist Laurent Billon, EnSuTe brings together three research laboratories (IPREM, LMAP, TREE) and a mixed service unit (DMEX) of the UPPA, all working on sciences and technologies and social sciences, as well as four international universities (Canada, Spain and Germany).

The hub is composed of polymer specialists and mathematicians working alongside legal experts, economists, sociologists and so on. In other words, a real talent pool working towards the energy transition.

What is "green" hydrogen?

Several technological sectors produce hydrogen. The main one, generally used in the industry, extracts hydrogen from fossil energies such as natural gas, coal and biomass. The second sector produces hydrogen by water electrolysis. Although this process does not emit any greenhouse gases, it still needs electricity to work. This is why the researchers of the UPPA are exploring a third possibility: the production of "green" hydrogen through artificial synthesis, i.e. purely from light and water. This assuredly sustainable solution is likely to offer an alternative to fossil energies in the longer term.



Legal transitions

« This laboratory is a place of convergence »

Three questions to Denys de Béchillon, manager of the new IFTJ laboratory (Federative research institute for legal transitions).



Denys de Béchillon

Why “Legal transitions”?

The creation of this laboratory goes hand in hand with that of the TREE UMR, focused on the energy and environmental transitions, to which many of our legal expert colleagues belong. Leaving by the wayside 15 or so lecturers-researchers whose interests lay more in public law, private law and criminal science was out of the question. It was definitely in their interest to join forces in a dedicated structure in order to maintain the visibility and image of excellence of the UPPA's law section.

How is it organised?

The laboratory comprises two hubs. The first, called the Centre for Research into criminal and penitentiary law [CRJ2P], steered by Jean-Paul Céré, is composed of the former criminal law and criminology team. The researchers are still fully autonomous. The second hub, headed by Marc Azavant, gathers together all the fundamental rights experts, i.e. the general practitioners from PDP (Pau public law) and the CRAJ (Centre for research and legal analysis). Moreover, we are giving ourselves a year to reflect on a possible integration of the European documentation and research centre (CDRE) as the third pillar of this fundamentally federative outfit.

What is your vision of research?

I'm convinced that researchers must feel free to dig where they want to. This laboratory must be a place of convergence, of harmonious coexistence, a space for personal development. It must enable everyone to invent, look for and develop initiatives. The thirst for knowledge must come from the researchers themselves. That's the only way that research in social sciences can work. I'm particularly keen for young researchers to take on responsibilities, for them to feel good. In short, for them to be happy at university!

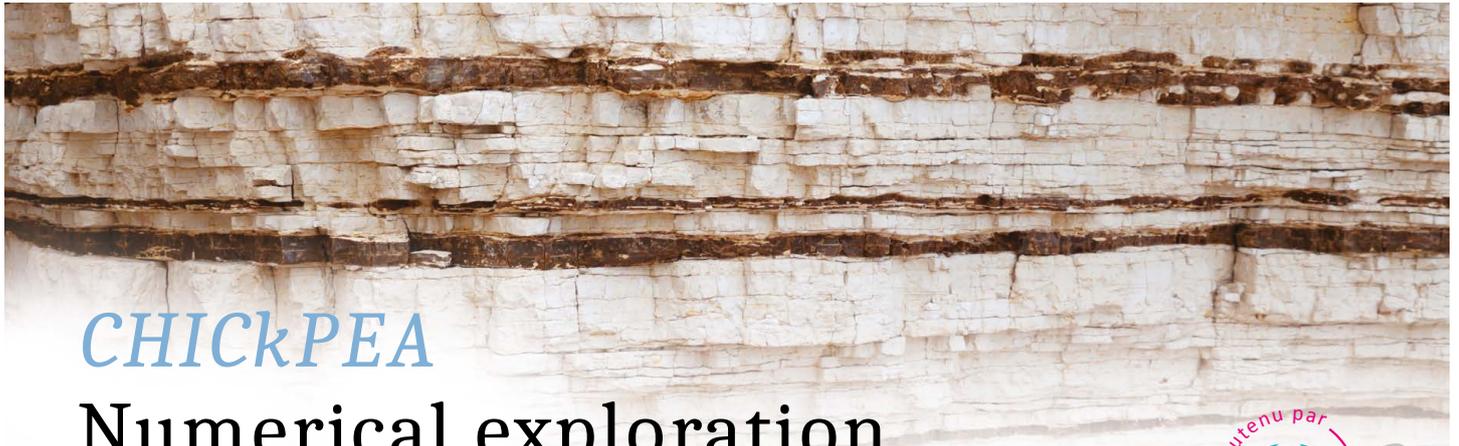
Experts in criminal and custodial justice

As a result of the creation of the IFTJ laboratory, the criminal law and criminology team is becoming a Centre for research on criminal and penitentiary law (CRJ2P). The director, Jean-Paul Céré, intends to make the most of this to further enhance the visibility and international dimension of his teams. The main research focuses include “Criminal law and literature”, “Criminal law and health” and “Penology”. This last theme, which concerns sentencing procedures and sentence enforcement (secure and open custody), is one of the UPPA's areas of expertise, recognised both in France and internationally. The CRJ2P does not shy away from exploring new subjects too, like road traffic law, which in 2018 led to the creation of a new degree, the only one of its kind in France.



Géraldine Bachoué-Pedrouzo Director of the CDRE

Géraldine Bachoué-Pedrouzo is a lecturer in public law at the UPPA and specialised in European and international law. She was elected Head of the Centre for European documentation and research (CDRE). She took over from Professor Henri Labayle, the founder of this research laboratory, which is located on the Nive campus in Bayonne. The lab develops in-depth scientific research on European and cross-border subjects.



CHICKPEA

Numerical exploration of porous media



The mathematicians and geophysicists of UPPA are joining forces to develop new numerical models designed to improve imaging of the Earth's natural resources.

Geophysical prospection methods are used to obtain detailed maps of the subsurface. One of the techniques consists in propagating seismic, or electromagnetic, waves through the ground then analysing the waves reflected at depth and recorded at the surface. It is based on the principle that seismic waves are disturbed as they reach the geological layers and travel through the different media; it is then possible to characterise the materials the waves pass through and map the subsurface structures. Seismic imaging has been used for many years to explore and produce natural resources but has its limitations in certain complex media. Porous materials like carbonates are the most difficult to characterise. This is where the researchers of the UPPA come in.

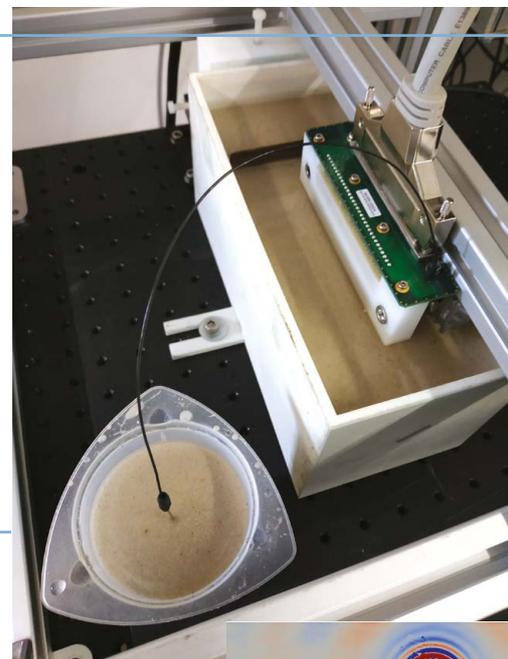
From the field to numerical simulation

The CHICKPEA (CHAracterization of Conducting Poro-elastic media using Experimental and advanced numericAl methods) project – funded by the Nouvelle-Aquitaine region and E2S UPPA as part of its actions in favour of scientific challenges – was kicked off in January 2018. Its aim is to improve image accuracy by developing models and new numerical methods to simulate the propagation of seismic and electromagnetic waves in porous media. The following results are expected: the development of an experimental protocol to better understand wave propagation in porous rocks, the creation of software to simulate seismic and electromagnetic waves and the design of a device able to characterise porous media in the laboratory based on knowledge of the seismic or electromagnetic fields recorded.

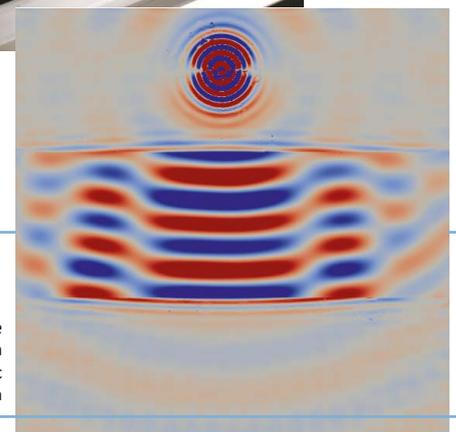
At the crossroads between mathematics and geosciences

CHICKPEA stands out from other projects through the scope of the issues addressed and its intrinsically interdisciplinary approach. “We are at the crossroads between mathematics and geosciences,” the project manager, H el ene Barucq, remarks. She is a Research director at the Inria and the head of the Magique-3D project team (UPPA/CNRS/Inria). “We need to combine the experience of geophysicists specialised in seismic waves and the competencies of mathematicians to design numerical tools and complex algorithms on a case-by-case basis.” To

overcome this challenge, the project can count on H el ene Barucq, Julien Diaz and Ha Pham, who all belong to the Laboratory for mathematics and their applications in Pau (LMAP), and Daniel Brito, a geophysicist from the Laboratory for complex fluids and their reservoirs (LFCR). The Bordeaux-based federative platform for research on computer science and mathematics (PlaFRIM) will also be contributing with its expertise, and several supercomputers will be used too.



LFCR experimental protocol



Simulation of a wave propagating through a stratified poroelastic medium

Gas hydrates

A fine discovery indeed!

A multidisciplinary team of researchers from the UPPA and the Ecole des Ponts is inventing a new method to measure the mechanical properties of gas hydrates.

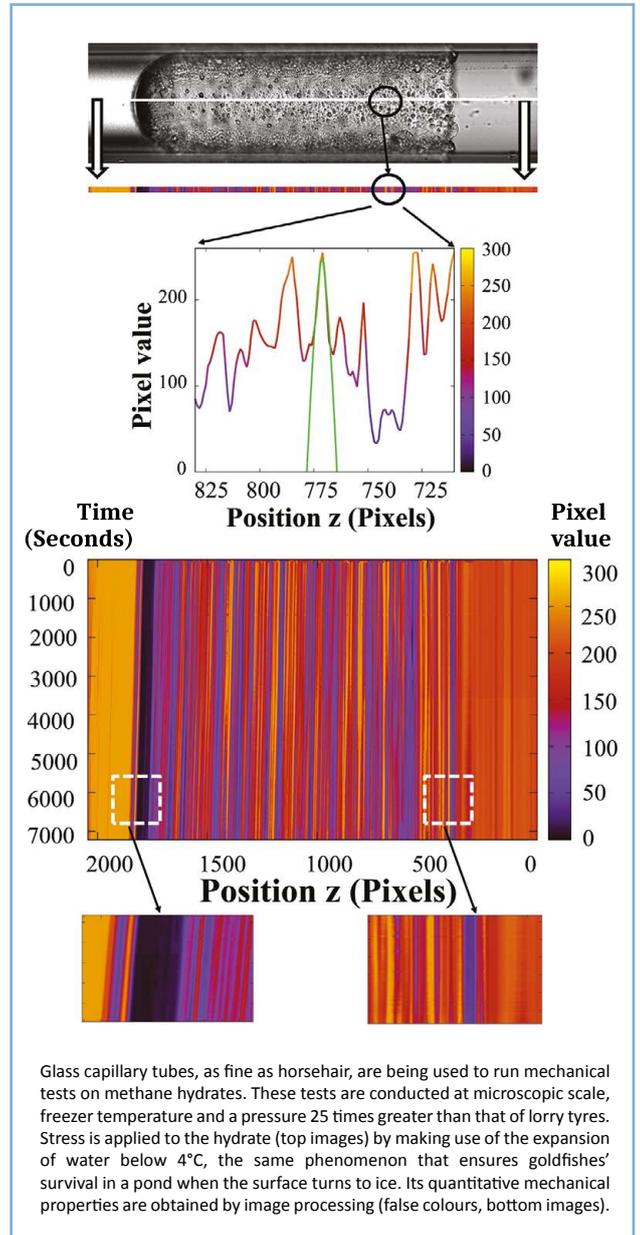
On the 6th of July 2020, publication of the work carried out by Dyhia Atig, Daniel Broseta, Ross Brown and Jean-Michel Pereira in the Nature Communications review caused quite a sensation. The first two researchers belong to the Laboratory of complex fluids and their reservoirs (LFCR), the third to the Institute of analytical sciences and physical chemistry for the environment and materials (IPREM) and the fourth to the Navier laboratory of the Ecole des Ponts. Together they invented an original method, contactless and very inexpensive, to measure the mechanical properties of gas hydrates under a microscope. It was a rather unexpected discovery, made as part of a research project funded by the ANR on the mechanical behaviour of sediments contained in gas hydrates (HYDRE).

Like ice on fire

A result of the crystallisation of a mixture of water and methane, methane hydrate is a solid compound that looks like an ordinary block of ice. But the resemblance ends there, as methane hydrates are flammable. The Internet is actually full of spectacular videos showing gas hydrates on fire. Although they are commonly found in the pores of marine sediments and permafrost soils, they remain difficult to study. They only form under certain temperature and pressure conditions, where heavy, costly and secure equipment is required. The researchers of the HYDRE project, for example, were working on the formation of methane hydrates at -25°C and 150 bars. And then Dyhia Atig came into the picture...

The virtues of capillary tubes

Recruited as a PhD student by the LFCR, the young woman studied methane hydrate in glass capillary tubes, in a system designed in the laboratory, composed of minute tubes able to withstand high pressures, very inexpensive and observable under the microscope. She wondered why methane hydrates always fractured when heated at the end of an experiment; she understood the cause – expansion or contraction of the water according to temperature – and used the discovery to submit the hydrates to a controlled level of stress. *“A highly elegant discovery, which draws on the mundane properties of water!”* enthuses Ross Brown, an expert in microscopy. And which also opens up a whole new range of possibilities. *“The use of capillary tubes offers a new experimental approach in other fields: fluids, materials and even micro-organisms in difficult conditions,”* he adds. Is it necessary to mention that the thesis defended by Dyhia Atig in November 2019 won the approval of the jury hands down?



Hannelore Derluyn takes the place of honour



A graduate in civil engineering from the Catholic University of Louvain and from the Federal Polytechnic School of Zurich, and now a CNRS research fellow at the IPRA-LFCR of the UPPA, Hannelore Derluyn won the bronze medal at the CNRS 2020 competition. The distinction recognises her work on the damage caused to porous rocks by salt crystallisation.



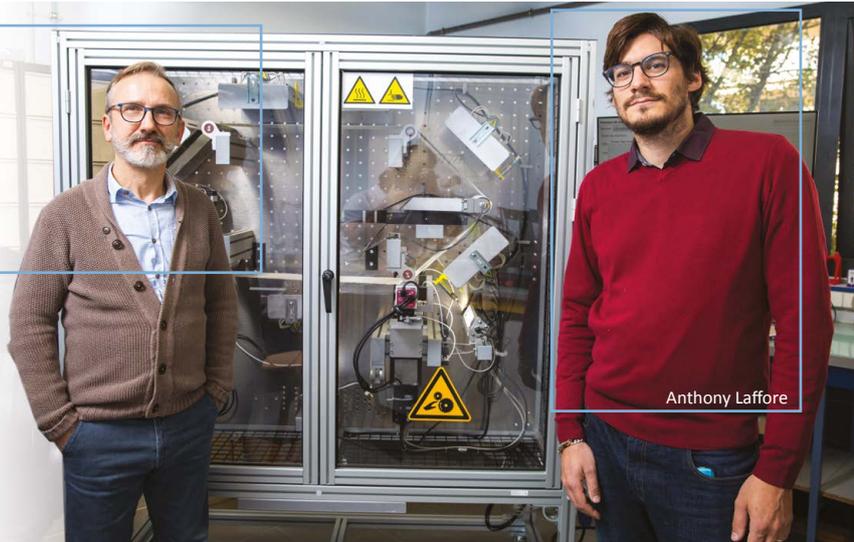


LERAM

When the UPPA tends URGO's wounds

Researchers of the LERAM common laboratory have developed a tool able to detect defective adhesive tape during manufacturing in URGO plants.

Francis Ehrenfeld



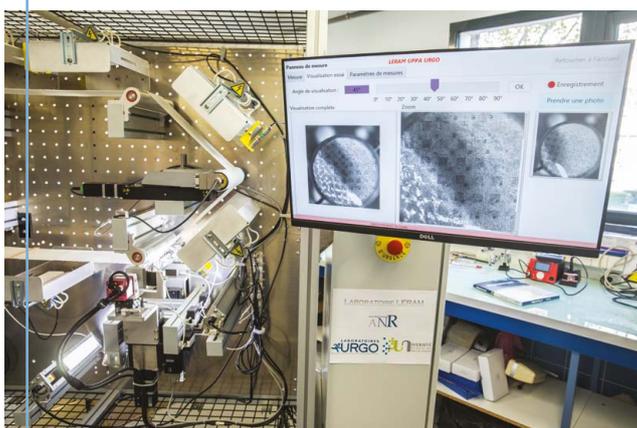
Anthony Laffore



CAO, a design-aid tool for the test bench



A series of sensors to develop and control



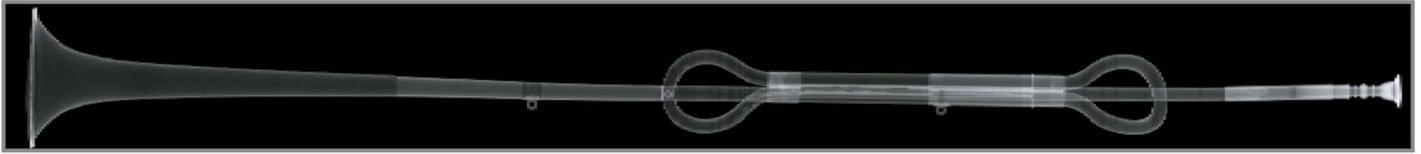
The operator can monitor the behaviour of the tape in real time

Making an ordinary sticking plaster is no mean feat, as URGO, the second European manufacturer of plasters, is well aware. Before they end up wound around your finger, plasters are made from huge rolls of adhesive tape, several kilometres long, that rotate at high speed on automated production lines. To check the quality of the tape, a sample is taken over a period defined by URGO. In the line of sight: the adhesive parameter. The slightest defect is a no-go. If the adhesive properties do not correspond exactly to commercial specifications, if the tape sticks too much or not enough, the machine is stopped immediately, and part of the production is lost. It was to counter these losses, that the URGO research teams decided to call on the researchers of the IPREM in Pau with whom they have been sharing the LERAM (Laboratory for the study of rheology and adhesion of wound dressings for medical applications) since 2013.

A patent and an operating permit

Christophe Derail, the Director of the LERAM, Francis Ehrenfeld and Anthony Laffore, both instrumentation engineers at the IPREM, got down to work straight away. They came up with the idea of an innovative tool to measure the adhesive parameter almost in real time, without it being necessary to slow down or stop the production line. This is called online measurement.

"For this purpose," Christophe Derail explains *"we designed a roll that brushes against the adhesive tape over the period defined by URGO. When it rotates, the roll generates a slight stress on the moving adhesive tape. By measuring the stress on contact with the adhesive tape by means of judiciously positioned sensors, we obtain extremely precise information on the properties of adhesion. Coupled with an optical device designed to corroborate the results of the analysis, the technique is 100% effective for detecting any discrepancies, in other words adhesion defects."* A real stroke of genius, which reduces the amount of tape wasted while helping to save production time; it could also turn out to be a very valuable development tool. The first test bench was built and successfully tested in the laboratory, and the second is to be installed very soon on URGO's premises. As a result of this research, an international patent was filed and an operating permit for the technology was signed with the industrial group. Innovation is in the air, at the UPPA and at URGO



Tomographie par rayons X d'un instrument conservé au Musée de la Musique de Paris. La reconstruction de sa perce (forme intérieure) permet de modéliser son comportement acoustique.



Magique-3D

Unravelling the mysteries of instrument making

A research fellow in applied mathematics at the Inria, Juliette Chabassier is working on characterising, modelling and simulating wind instruments.

Is it possible to discriminate a good wind instrument from a bad one? Is it possible to anticipate the sound an instrument will make before it is even made? Are we capable of virtually restoring antique instruments? These questions form the main focuses of research of Juliette Chabassier and her colleagues from Magique-3D, the project team of the Inria (National institute for research in computer science and automation) specialised in the study of wave propagation, and from the LMAP (Laboratory for mathematics and their applications in Pau). An inevitably multidisciplinary approach, both experimental and theoretical, related to instrument making and museums, the teaching of music professions and digital research.

In a wind instrument, the sound is produced by the vibrations of the air column coupled with an exciter: the musician's lips in the case of brass instruments, and the bevel or reed in the case of woodwind instruments. The idea was to apply and adapt material characterisation techniques, used in terrestrial imaging for example, to musical acoustics. The aim of

this innovative approach is to characterise each instrument to model and simulate the sounds produced. The only damper is related to the human aspect: the researchers must factor in the musician's gestures, as well as the listener's appraisal of the sound and subjective experience.

The very first software program called OpenWind**, for computing and predicting instruments' behaviour, has been developed since February 2019. Beyond the academic aspect, the work of the Magique-3D team – related to museums and the teaching of music professions – could lead manufacturers to improve the quality of their instruments and to virtually resurrect certain cultural heritage treasures that are in danger of being lost forever.

* In partnership with the S3AM (Sound systems and signals: audio/acoustics, instruments) team of the IRCAM (Institute for Research and Coordination in Acoustics/Music)

** <https://openwind.gitlabpages.inria.fr/web>

Louis 14.0 - At the frontier of art and sciences



Supported by the Inria, the Louis 14.0 project is introduced as musical and theatrical show that portrays the daily life of Louis XIV through the eyes of the women around him. It's actually much more than that.

The show is interspersed with fun and interactive presentations during which questions are asked about the instruments, how they work, the nature of musical sound, and so on. "In partnership with the musical ensemble Les Précieuses, we thought up a show that would enable the general public to understand how mathematical models can be used to create software capable of synthesising the sounds of musical instruments in real time. Of particular note is the sound of an ancient harpsichord, computed by software, that addresses the notion of virtual restoration," says Juliette Chabassier.

The researcher of Magique-3D is an accomplished oboist and one of the musicians present on stage.

> <https://project.inria.fr/louis14point0>

IPREM

A team from the IMT School of Mines of Alès joins the IPREM

The research team on the interactions of materials with their environment (RIME) of the IMT School of Mines of Alès was integrated into the Institute of analytical sciences and physical chemistry for the environment and materials (IPREM) on 1st January 2020.

The UPPA and the IMT School of Mines of Alès go back a long way, to the nineties in fact. The RIME team of the IMT School of Mines of Alès is based at the heart of the Helioparc technohub in Pau and has enjoyed a unique relationship with the IPREM for many years. The EMVOL project (2019-2022, financed by the Nouvelle-Aquitaine region), which focuses on the footprint of volatile substances to develop applications in the agri-food sector, is just one example of the many successful ventures they have carried out together. On 1st January 2020, a new milestone was reached when the RIME team members were integrated into the IPREM, thereby making the IMT School of Mines a secondary trustee of the institute.

"We wanted to foster closer ties in order to create a more formal framework for our partnerships," says Valérie Desauziers, a professor at the IMT Mines Alès and the manager of the RIME team. "We now share a scientific project and we will be able to position ourselves on much bigger projects where we have a good deal of competencies to leverage. For my team, it's also an opportunity to benefit from the scientific excellence, visibility and recognition of the IPREM."

There is no lack of synergies. On the one hand, the RIME team has cutting-edge competencies in the fields of air quality, the psycho-sensorial properties of materials and their environmental impact (lifecycle analysis). On the other hand, the IPREM offers its high-level expertise and scientific instrumentation systems for the analysis and characterisation of materials. The integration will undoubtedly open up new research opportunities, particularly in the field of emerging pollutants and their environmental and health impacts.



Jean-Serge Bidoret, Nathalie Costarramone, Hélène Garay, Joana Beigbeder, Chloé Gourdon, Marine Reyrolle, Hervé Plaisance, Valérie Desauziers



IPREM

Creation of LabCom So Ph'AIR

The IMT School of Mines of Alès and M2i Development – the research centre of the M2i Life Sciences group based in Lacq – have founded the common laboratory So Ph'AIR (Solutions for Pheromones Analysis in Air). Five years of scientific cooperation led to this partnership between the two entities, which foster competence- and objective-based synergies. On the one hand, M2i is the market leader in the sector of pheromones for the biological protection of plants and crops as an alternative to pesticides. On the other hand, the IMT School of Mines of Alès is specialised in the development of methods to sample and analyse traces of volatile and semi-volatile organic compounds in the air and at the air/material interface.

The aim of the research and development programme is to better understand how pheromones diffuse in the air as they are key elements in the development of biocontrol solutions.



EDELAB

A tool to detect language disorders in Basque

The research center on Basque language and texts (IKER) coordinates an original project on language disorders in bilingual Basque-speaking children, from 4 to 8 years old.

Almost 5% of children are concerned by developmental language disorders in French. Fortunately, professionals have effective methods to help them to overcome their difficulties. But, Basque-speaking children are not so lucky. There are simply no tools available to detect and treat language disorders in Basque, neither in the French Basque country, nor in the Autonomous Basque Community, despite Basque being an official language there. The situation is all the more problematic that Basque is an isolated language which differs from any other through its syntax, its grammar, its vocabulary and its wide range of dialects.

"Without knowing the reference standards, it is difficult to diagnose markers of deviance in bilingual or multilingual children," Mariei Pourquoié observes. She is a post-doc researcher in psycholinguistics at the IKER laboratory and contributes to the EDELAB

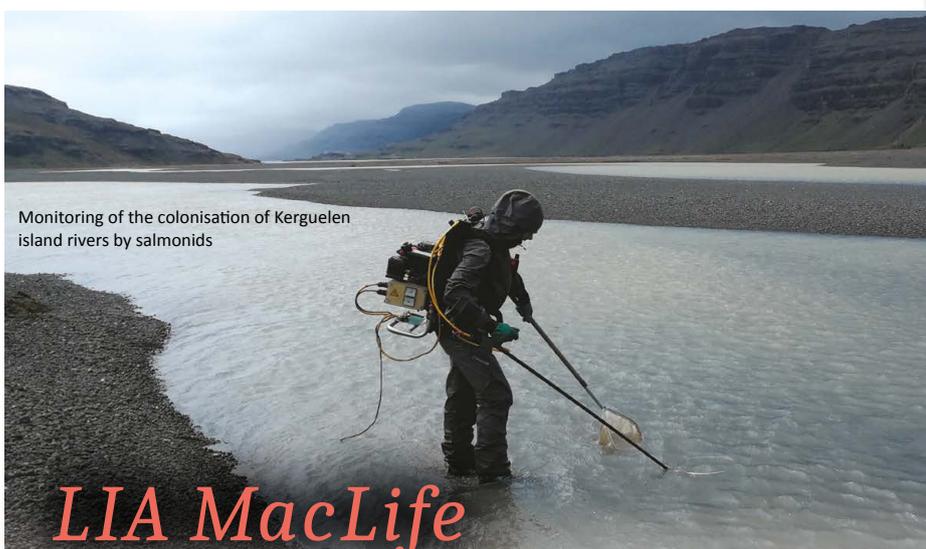
project (evaluation of development in Basque-speakers and polyglots). The objective is to define standards for the phonological, lexical and morphosyntactic development of bilingual Basque-speaking children aged 4 to 8.

Coordinated by Urtzi Etxeberria, the Director of IKER, EDELAB is backed by the Nouvelle-Aquitaine region and the GEROA foundation. Maria-José Ezeizabarrena from the ELEBILAB research centre (Spanish University of the Basque Country (UPV/EHU)), is also taking part in the work. An experimental study has already been run with 30 children registered in an immersion class in the Pyrénées-Atlantiques. In the longer term, a standardised tool to detect and diagnose language disorders will be made available to Basque-speaking speech therapists. The data gathered will also fuel research on cognitive science.

Where it all began... HIPIE !

HIPIE (Hizkuntza Patologiaren Ikerketa Euskaraz eta eleaniztunengan - Research on language disorders in Basque and in polyglots) is a research group devoted to the study of language disorders in Basque and in a multilingual environment. Open and accessible to everyone, it comprises thirty or so participants including researchers, speech therapists and teachers.

At the origin of the EDELAB project, the HIPIE network was created in May 2015 as part of the Nouveaux commanditaires sciences (New science sponsors) research programme under the mediation of the Atelier des Jours à Venir. The aim of this programme of the Fondation de France is to *"guide and encourage the non-scientific communities to strike up dialogue with researchers and co-create open-ended questions."*



Monitoring of the colonisation of Kerguelen island rivers by salmonids



Experimental channels in the Sierra Nevada, Aquatic research Laboratory, University of California.

LIA MacLife

Les organismes aquatiques face au changement climatique

The UPPA, the INRAe, the Californian University of Berkeley and the Spanish University of the Basque Country (UPV/EHU) have joined forces to better understand the capacities of aquatic ecosystems to adapt to extreme climatic events.



Mathieu Buoro

Sea trout sampling campaign in the Kerguelen islands.



Mathieu Buoro (ECOBIOP), Nicolas Jeannot (INRAE U3E), Etienne Prévost (ECOBIOP) Annual campaign to capture and mark juvenile Atlantic salmon in the river Scorff (Morbihan) as part of a long-term programme to monitor the population. Thanks to this, the populations' responses to environmental changes can be studied.

It goes without saying that we are not all equal when it comes to global warming. Researchers in behavioural ecology and the biology of fish populations (Ecobiop), the mixed research unit of the UPPA and the National institute for research on agriculture, food and the environment (INRAe), are studying the impacts of extreme events on migratory fish. More specifically, they are looking at the adaptation, resistance and resilience capacities of salmonids, from gene to population levels. "As they evolved, aquatic organisms, including migratory fish, put in place remarkable adaptation processes and mechanisms to adjust to changing environments. We would like to determine whether these processes will enable them to cope with the fast-occurring present and future changes, and particularly with extreme events such as flooding and low water in freshwater environments," says Mathieu Buoro, a research fellow at the INRAe. The capacity of certain organisms to adapt to climatic hazards can also be observed in marine environments. Intrigued and keen to compare his results and widen his scope of research, the biologist from the Aquapôle in Saint-Pée-sur-Nivelle, quite naturally decided to seek out professor Stephanie Carlson, who had taken him on as a post-doctoral student in her laboratory at the University of California, Berkeley.

An international associated laboratory

Aquatic ecosystems in California are effectively strongly impacted by climate change and extreme events. Stephanie Carlson, joined by her colleague Albert Ruhi from the Freshwater ecology group, integrate into their research elements of behavioural, demographic and community ecology, from population to ecosystem scales. Their work is eminently complementary to that of Ecobiop. Together, they are carrying out a "no walls" laboratory project that also includes a team from the University of the Basque Country (Stream Ecology Group), specialised in the functioning of aquatic ecosystems. Called MacLife (MANagement and CLimate Impacts on Freshwater Ecosystems), this new international associated laboratory is due to be opened in 2021 and will have five years to better understand how biodiversity, at different levels of biological organisation, is an adaptive network that favours the stability, resilience and adaptation of aquatic ecosystems and organisms having to deal with rapid changes in the environment. A real lesson in life.





COMFLUENCE

An international Chair with Brésil

The UPPA and the Federal University of Rio de Janeiro (UFRJ) are considering the creation of an international chair on complex fluids in partnership with Petrobras and Total.

COMFLUENCE, for “COMplex FLUIDs: towards thermo-physical properties comprehensions ENhancement” is the name of the international chair between the UPPA, the UFRJ, Petrobras and Total that is due to be kicked off very soon. A professor in Pau in the Laboratory of complex fluids and their reservoirs (LFCR), Jean-Luc Daridon is the man behind the project. The objective is to work on oils trapped under layers of salt buried at depths of 5,000 to 7,000 meters off the Brazilian coast in the South Atlantic. They are known as pre-salt fields. *“These reservoirs are very difficult to produce, both due to the pressure that can reach 1,000 bars and to the presence of up to 60% CO₂ in the fluid,”* Jean-Luc Daridon explains. *“The challenge is to design recovery projects that make use of the properties of CO₂ in order*

to facilitate the displacement of oil in the reservoir towards the well. ” In practice, operations consist in injecting the necessary quantity of CO₂ to push oil towards the surface. But it’s a very delicate process. Beyond a certain threshold, as more and more CO₂ is mixed with the fluid, bitumen starts to form making it impossible to recover the oil. The objective of the Chair is therefore to develop specific tools to find out more about the characteristics of these fluids upstream. The LFCR has already succeeded in developing cameras with special lenses able to film the CO₂ bubbles in the oil, quite an achievement when you consider the opacity of the fluid. The next steps will involve running molecular simulations then building models and algorithms in partnership with the Brazilian researchers.

Gas bubbles in a totally opaque reservoir fluid at high pressure, made observable by the use of optical methods under high pressure in SWIR light developed at the LFCR.

The CATT

helping the European Parliament

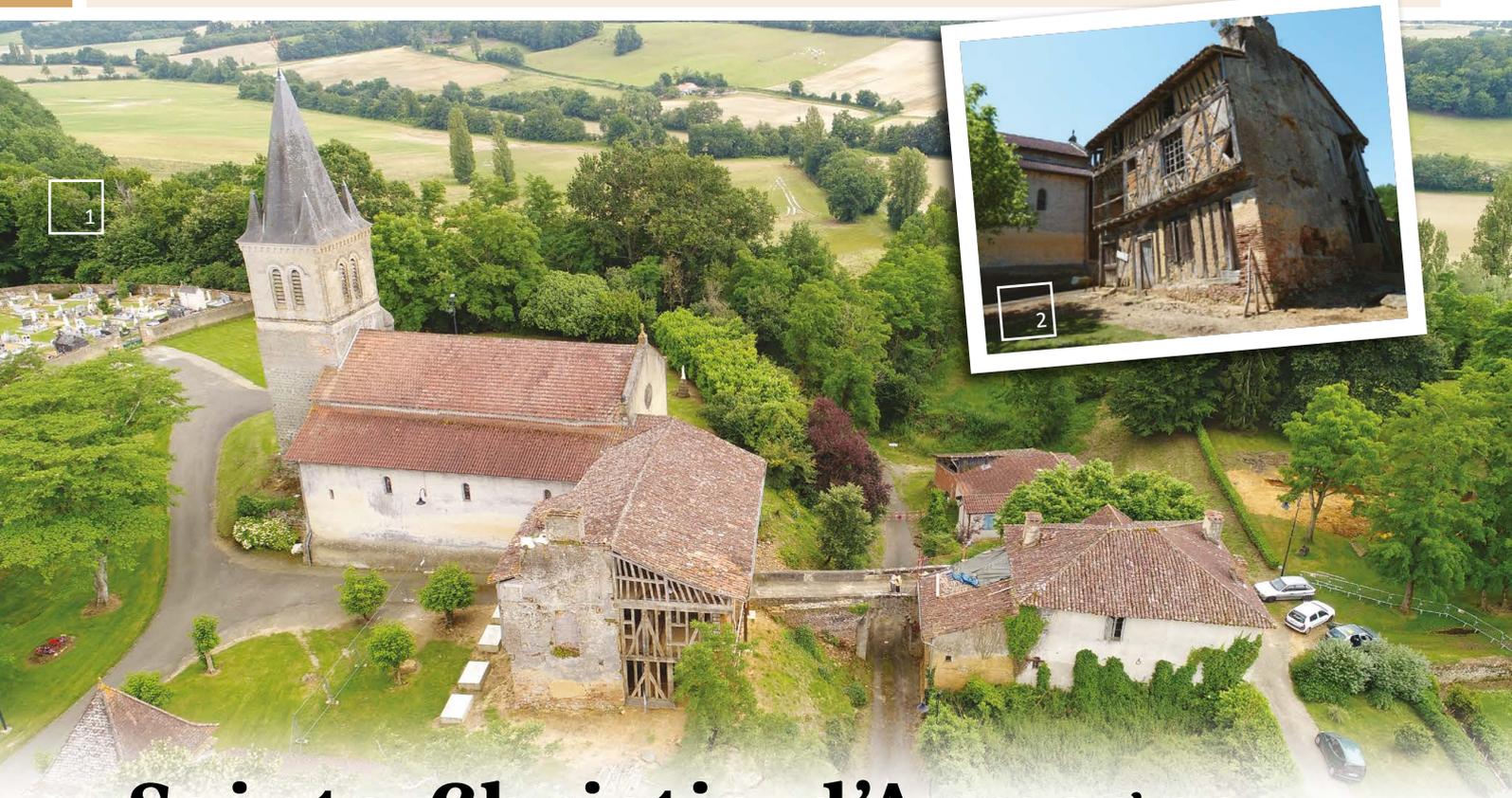
The centre for economic research of the UPPA has been selected by the European Parliament to conduct surveys within its areas of expertise, i.e. budget, taxation, etc.



The European think tank CEPS (Centre for European Policy Studies) is at the head of a large consortium that includes the Centre for the Theoretical Analysis and Processing of economic data (CATT) of the UPPA, the Jacques Delors institute, the CSE COE (Central and Southern Europe Centre Of Excellence), the EPC (European Policy Centre) and the IEEP (Institute for European Environmental Policy). The winner of a call for tenders of the European Parliament in 2020, the consortium is now in charge of running studies on various EU-related topics for the next four years.

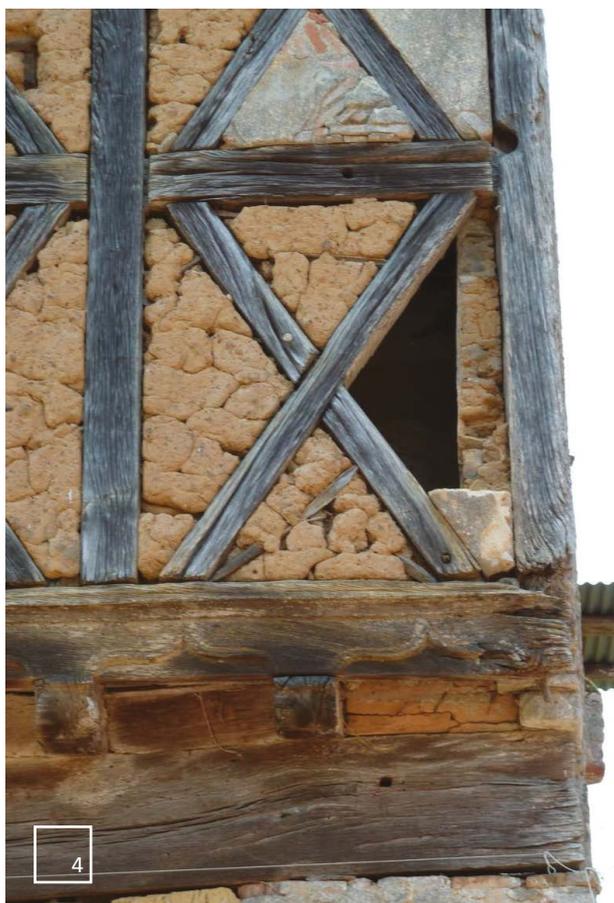
“The consortium members split up the different studies according to the subjects addressed and each of their specialities,” explains Jacques Le Cacheux, a professor at the CATT. *“Our research centre, for example, will not be working on subjects like agriculture or the pension entitlements of the European Deputies. We will however, intervene whenever the European Parliament requires an advanced expert assessment in an area that falls within our competencies.”*

Jacques Le Cacheux and Fabien Candau, also a lecturer-researcher at the CATT, have been called on by European organisations in the past. The two UPPA professors are specialised in the economic aspects of European integration as well as environmental taxation and economics and have already published several studies for the European Parliament and Commission. Five years ago, for example, Brussels had asked the researchers of the CATT to work on the reform of the European Union’s budget. Now – maybe more than ever before – there is no shortage of topics. What with Brexit, financing of the EU post-Covid recovery plan and the taxation of multinationals, the CATT is likely to have its work cut out until 2024.



Sainte-Christie-d'Armagnac, living history

Since 2017, Alain Champagne, a lecturer in medieval archaeology at the UPPA, has been the manager of a collective research project on the history of the town of Sainte-Christie-d'Armagnac in the Gers.



“A Gersois village with exceptional listed heritage”, the Mairie of Sainte-Christie-d'Armagnac is proud to announce on the homepage of its website. Located on a hill overlooking the Midouzon and Roux valleys, at the crossroads between Aire-sur-L'Adour, Condom, Mont-de-Marsan and Auch, the small Gersois town is effectively the home of astonishing medieval structures dotted around its parish church, that have piqued the curiosity of inhabitants and researchers for many years. Under the leadership of Alain Champagne, a medieval archaeologist at the ITEM laboratory (Identities, territories, expression, mobility), a team composed of archaeologists, historians, an architect, a topographer and an expert in metal furniture are now striving to unravel the mysteries of these structures. Financed by the DRAC, the Occitanie region and the Mairie, the collective research project kicked off in 2017 will continue until 2022.

An unusual site

The site explored is composed of a sizeable feudal motte built between the 11th and the 13th centuries, a church, probably including parts of old 11th- or 12th-century fossilised buildings, and at least one 11th- or 12th- century tower, two sections of ramparts made of raw earth, exceptionally preserved on elevated ground, a dovecote and a half-timbered house called Castet by the inhabitants. The central part, a courtyard surrounded by the church and the seigneurial house protected by moats, was the site of a village composed of houses until the beginning of the modern age. “The whole heritage site is quite unusual in terms of its layout,” says Alain Champagne. “It’s still difficult to determine the relative chronology. The site is more complex than it first seems. The house and the ramparts, which were listed in 2016, are only the tip of the iceberg so to speak.”



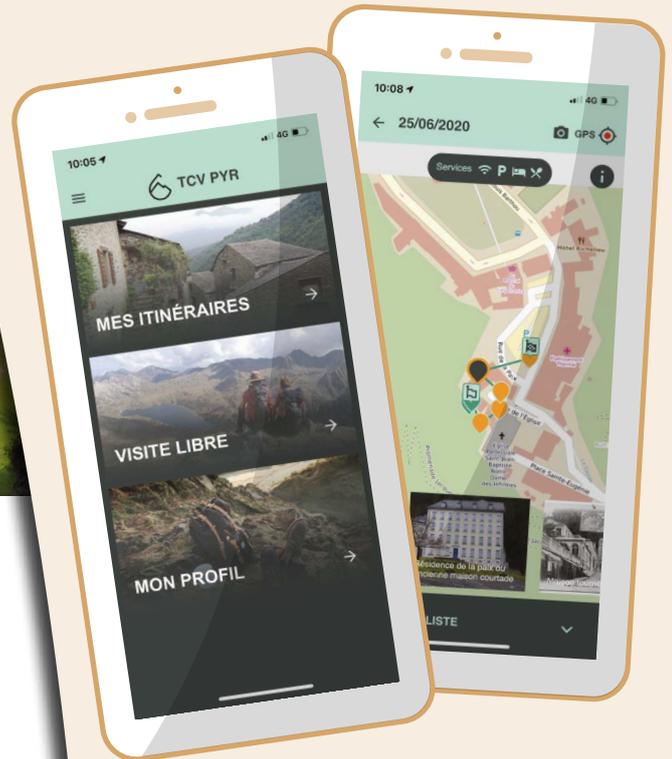
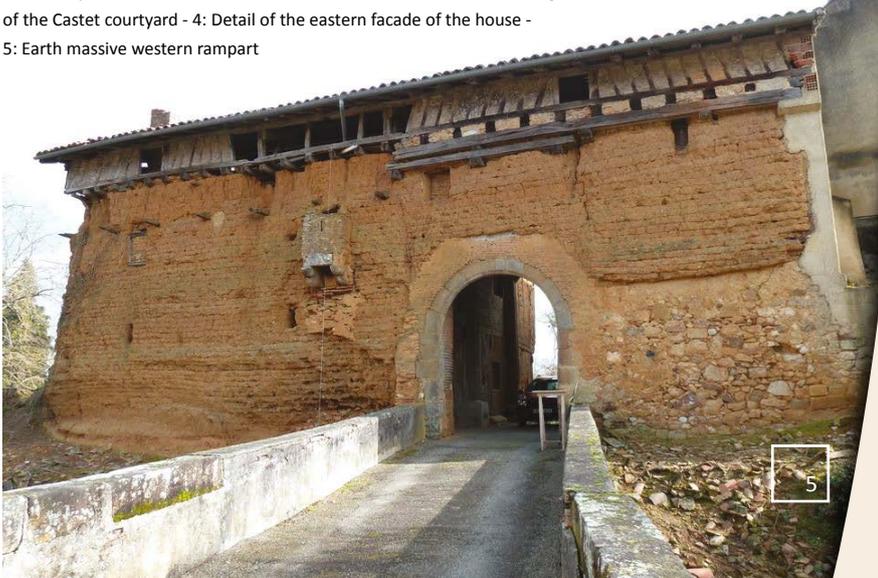
Strange sarcophagi

Two digs have already taken place. They explored the moat around the motte as well as two silos located under the half-timbered house. The latter was also modelled in 3D to perform a study of the construction. Research is now focusing on the graveyard and the church where some very interesting discoveries are expected. Use of a heat camera has already revealed some openings – the likes of which have never been seen before – under the present-day layers of mortar. In addition, the oldest sections of the masonry could possibly be related to the monolithic sarcophagi exhumed during previous campaigns in the 19th century. Incidentally, these sandstone sarcophagi, generally attributed to the early Middle Ages, raise many questions. A more in-depth study should enable to date them more precisely.

The ramparts and the Castet restored

The collective research project also fits into a valorisation programme backed by the local authorities and the association Les amis du Castet. The rampart, heavily eroded beneath the latrine, has been reworked. In-depth analyses of the original earth will soon be run to understand the exact process that was used at the time. The results will help in the upcoming restoration of the Castet. Alain Champagne is overseeing the process and is very enthusiastic at the idea of saving one of the best-preserved raw-earth constructions in France: *“The house, which is still in its original condition, may have a lot more surprises in store for us.”* Sainte-Christie-d’Armagnac doubtless has many more stories to tell.

1: Bird’s-eye view of the Castet and the church - 2: Main facade of the seigneurial house - 3: Overview of the Castet courtyard - 4: Detail of the eastern facade of the house - 5: Earth massive western rampart

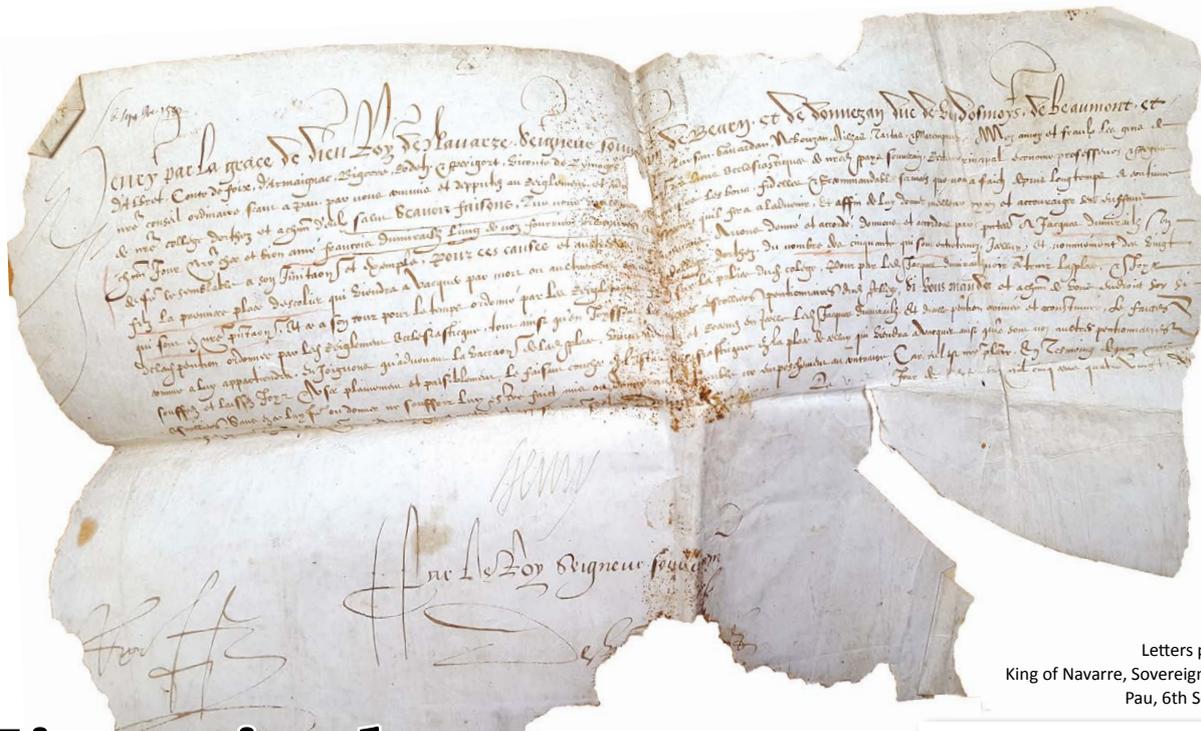


Launch of the TCV-PYR application

For three years, the TCV-Pyr programme (balneology, culture and holiday resorts in the Pyrenees) supported by the European fund FEDER listed and analysed all the heritage related to balneology and resort tourism on the northern flank of the Pyrenees. This painstaking task involved the ITEM (Identities, territories, expression, mobility) laboratory in cooperation with the LIUPPA (IT laboratory of the UPPA). Under the leadership of Philippe Roose, a team of eight researchers from the LIUPPA concentrated on developing a mobile application to highlight the points of interest or remarkable sites identified during the project. Launched last summer, the mobile application TCVPYR is freely available – for free! – on the Android and iPhone/iOS platforms. Don’t miss out!

> Look for “TCVPYR” in Google Play Store.

For iOS, scan the QR-code. When it is installed, go to “Settings” / “General” / “Device management” and approve the MAZEDIA certificate.



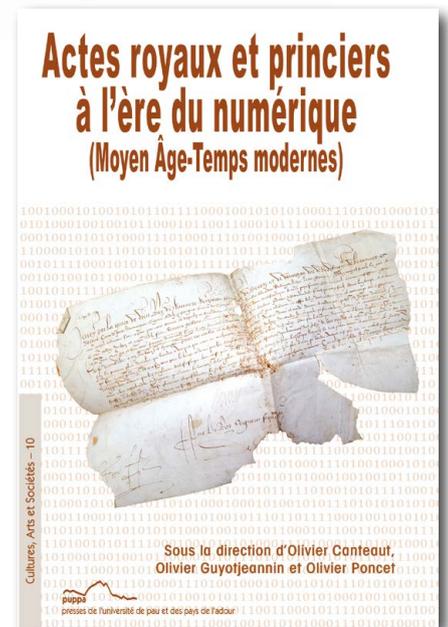
Letters patent of Henri, King of Navarre, Sovereign Lord of Béarn, Pau, 6th September 1582

Historical corpora in the digital era

The validity of digital corpora of medieval and modern times has been the object of renewed interest, partly due to historians' desire to return to the roots and partly to the development of digital tools. Existing collections were used to test digital methods and techniques. And, in return, the possibilities offered by these new tools (semantic web, interoperability) make it necessary to change the way these corpora are designed. The presentation of several projects conducted at European level is an opportunity to draw up an assessment of the experience and experiments of publishing as well as to question the benefits and limitations of exploring corpora. This volume is part of the ANR's AcRoNavarre project, coordinated by the UPPA's ITEM laboratory.

> *Actes royaux et princiers à l'ère du numérique (Moyen Âge – Temps modernes).*
 (The Acts of kings and princes in the digital era (Middle Ages - Modern times).

Under the leadership of Olivier Canteaut, Olivier Guyotjeannin and Olivier Poncet.
 Edition PUPPA. 2020

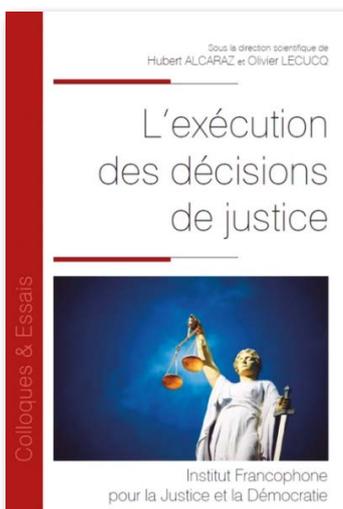


The enforcement of court decisions

This book compiles the work performed at the symposium on the enforcement of court decisions organised in Pau by the Institute for Iberian and Ibero-American studies (IEZIA/DICE) to which the UPPA professors Hubert Alcaraz and Olivier Lecucq belong. The enforcement of court decisions expresses the place held by justice in law as an institutionalised power with a specific function that helps to ensure the smooth running of the legal system, and, under the influence of modern constitutionalism, the respect of the rule of law. Based on a comparison of internal, international and European law, the book offers valuable information and considerable food for thought.

> *L'exécution des décisions de justice. (The enforcement of court decisions).*

Under the scientific supervision of Hubert Alcaraz and Olivier Lecucq.
 Éditions Institut Francophone pour la Justice et la Démocratie. November 2020.



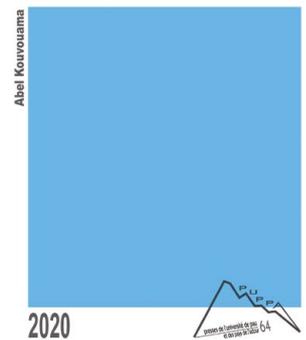
Morelly, a philosopher worth knowing

This essay is a reflection in social philosophy and political forecasting on the “Code de la nature”, a major work of Morelly, a little-known 18th century French philosopher. Morelly’s approach lies in a critical reflection regarding the best form of government and the social organisation that is the most in keeping with the “original nature” of mankind; he does this by analysing the political institutions present in modern French society, the aim being to modify the actual conduct of the rulers and the ruled. He offers philosophical and ethical answers as regards the daily constraints of modern French society when it strays from the ideal of justice, freedom and equality between men. The author of the essay, Abel Kouvouama, a philosopher and anthropologist, is a professor emeritus at the UPPA.

> *Philosophie, utopie et politique chez Morelly. (Philosophy, utopia and politics in Morelly’s work)*

Abel Kouvouama. Collection Anthroposocius. Ed. PUPPA. September 2020.

Philosophie, Utopie et Politique
chez MORELLY



2020



Robert ZIAVOULA, Patrice YENGO, Abel KOUVOUAMA

**À L'OMBRE
DE LA LIGNE DE FUITE**

UNE ALTERNATIVE DES POSSIBLES



In the shadow of the convergence line

The terms “closed”, “open”, “shadow”, “convergence line”, as categories of thought and practice, make it possible, implicitly, to analyse the concepts of border, limit, threshold, transgressivity, as well as those of identity, subjectivity, memory and trace. In all societies near and far, the notions of closed and open, shadow and convergence line, are the signs of traces left in a given space (wall, painting, street, etc.) or refracted in a zone where the light does not shine. Likewise, because the street is marked by shadows and convergence lines, it is a place of fascination, fear and temptation. Identifying street players, analysing the places where the notions of closed, open, shadow and convergence line come to life, such is the substance of the texts compiled in this collective work.

> *A l'ombre de la ligne de fuite. Une alternative des possibles.*

(In the shadow of the convergence line. An alternative to possibilities.)

Robert Ziavoula, Patrice Yengo, Abel Kouvouama, Ed. Paari. September 2020.

Séverine Le Faucheur

Ecotoxicology to rescue the environment

Séverine Le Faucheur is a bio-geochemist and ecotoxicologist working at IPREM and an associate professor at the “Water Earth Environment” laboratory of the National Canadian Institute for scientific research (INRS-ETE). Since 2019, she is also the head of the E2S UPPA partnership Chair, Ecotox, which focuses on the ecotoxicology of chemical contaminants in continental waters.

How does one become an ecotoxicologist?

I started out by studying marine chemistry at the Université de Bretagne Occidentale. The PhD I then obtained at the Swiss Federal Institute for aquatic sciences and technologies [EAWAG, which reports to the Federal Polytechnic School of Zurich] was on the subject of phytochelatins, polypeptids synthesised by algae capable of fixing metals and metalloids. I investigated metal toxicity further during my post-doctoral research at the INRS-ETE, this time focusing on the toxicity of mercury and technologically-critical new elements such as rare earth elements and precious metals. In fact, I’ve always worked at the interface between ecology and toxicology, whether in Switzerland, in Canada or in Pau.

How was the Ecotox chair born?

Ecotox is the result of discussions between E2S UPPA, the environmental chemistry and microbiology hub of the IPREM, Total’s Platform for Environmental Research in Lacq (PERL) and Rio Tinto. We wanted to pool our competencies in favour of ecotoxicology, to design new bio-indicators. Today, in Europe, water resources are essentially protected by the EU Water Framework Directive. Of course, it’s an effective regulation but it has its limitations in terms of assessing the environmental risk of chemical contaminants. We want to break down walls, by filling the existing gaps concerning mixtures of metals and organic contaminants for example. We would also like to investigate the impact of global changes causing water quality to deteriorate.

What are your research focuses?

The Chair is composed of three PhD students, one post-doc researcher, a study engineer, a dozen or so researchers from the IPREM and two industrial partners: Total and the mining group, Rio Tinto. Together, we have determined three main research focuses: the impact of mixtures of metals and contaminants on micro-algae, the use of bio-minerals – like mollusc shells – as bio-indicators of exposure to contaminants, and lastly, environmental genomics. On this last subject, we start with the detection of species’ DNA to develop indicators that will measure the impact of contaminants on micro-organism communities. To carry out this research, we are relying on the cutting-edge analytical techniques available at the IPREM as well as using the artificial rivers of the PERL where it is possible to simulate natural ecosystems in controlled conditions.

