UPVD RESEARCH

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Special Issue

Research at the University of Perpignan: understand and act for the environment

© @alexis.rosenfeld - Coral trees, innovative research to save coral reefs - CRIOBE
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Laboratories of the University of Perpignan

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Editorial

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Research at the University of Perpignan, one of the world’s oldest universities, has been intimately connected with the region, and the sites, of which it is a part, for nearly 800 years.

This close connection between place and institution has created a unique opportunity to follow the interaction and adaptation of humans within the context of their local environment for more than 540,000 years, which in turn, has enabled our researchers to propose meaningful solutions for a sustainable future within the context of global change.

Fifty years of archeological research in the prehistoric cavern of Tautavel, highlights the evolution and the links between plants, animals and humans spanning nearly 540,000 years of climate change. The Pyrenees mountains and the Mediterranean sea offer a geographic continuum to study a range of topics including the effects of altitude on human performance, the plant genome, a complete watershed and coastal erosion. Higher altitudes are ideally suited for the implementation of concentrating solar facilities such as the Odeillo furnace (the largest in the world), the Themis concentrating solar power plant, all other industrial-scale concentrating solar technologies. For 50 years, this equipment has been used to develop high temperature materials and processes adapted to extreme conditions for renewable energies and space applications. Our SCUBA diving researchers at the Cerbère-Banyuls marine reserve are developing innovative devices to restore fisheries, while on the other side of the planet, our Polynesian research station focuses on coral reef biodiversity. Our campus, situated on the border between France and Spain, creates an exceptional opportunity for research in the humanities and social sciences, where topics such as cross-country migrations, tourism and others can be explored in great detail.

All of this research uses the Pyrenees Orientales as an outdoor laboratory, where new concepts are tested and proven concepts are exported to the global research community. We collaborate with foreign research teams who conduct experiments in our laboratories, and our staff travel abroad to work in collaboration with research institutes, where long-term collaborations and exchanges are established.

Our graduate programs, which include Masters and PhD degrees, are designed and managed by our laboratories. Our graduate students are an integral part of our research teams and represent the future of these teams.

In this issue of the UPVD Research magazine, we have collected one article per laboratory to showcase the breadth of research conducted at the University of Perpignan. Beyond the specific activity of each lab, collectively, research at the University of Perpignan explores humans in their many environments, where lessons from the past are being used to make decisions in the construction of a sustainable future. We hope you will enjoy discovering our research through these highlights....
Plastic is resistant to biological and chemical degradation and plastic debris can now be found in all natural environments. Plastics are important markers that remind us that mankind has now entered into the new geological era of the Anthropocene. Analogous to sediment particles which are eroded from the soils, much of this plastic debris is washed or blown into the sea where it accumulates in surface waters or bottom sediments. Plastics have also made their way into biological food webs, where they now impact marine wildlife and biodiversity. Understanding the harmful impacts of these plastics requires precise quantification of the plastic fluxes involved and the identification of their distribution pathways in the biological, physical and chemical compartments at sea.

Over the past decades, the CEFREM research unit at the UPVD has developed an expertise in the study of particulate matter fluxes in coastal systems. Our goal is to quantify these fluxes through the land-ocean interface through a source-to-sink approach to better understand the processes which control them. Recently, researchers have focused specifically on the quantification of contaminant fluxes from river drainage basins, with macro and micro-plastic debris serving as key target compounds.

A first pioneering study on this topic was accomplished through the doctoral thesis of Mel Constant (2015-2018) who established an inventory of micro-plastic stocks and fluxes in different environmental compartments (atmosphere, rivers, beaches, coastal waters, sediments and fishes) in the coastal area of the Gulf of Lion. Micro-plastics (size < 5 mm) are less visible than macro-plastics, but they can be easily ingested by small aquatic organisms and accumulate within the food web. The study highlighted the role of rivers as main sources of plastics in the Gulf of Lion, but also revealed the importance of plastic fibers (originating from synthetic textiles and ropes) among the different forms of...
micro-plastics. For fibers, the atmospheric transport pathway might be highly significant in their land-to-sea transfer.

Another doctoral thesis at the CEFREM (Lisa Weiss, 2017-2020) aims to improve our knowledge on the plastic mass fluxes at the scale of the entire Mediterranean Sea. This study will develop a model to study the average plastic loads from rivers which are considered to be the dominant sources of plastic debris at sea. The dispersal of river-born plastics in the open sea by ocean currents will also be simulated as part of the thesis in collaboration with colleagues at the LA (Laboratoire d’Aérologie) research unit in Toulouse. Lisa’s work will benefit from her active participation in the 2019 Tara Microplastics expedition, giving her access to additional data on plastic concentrations in different Mediterranean rivers and to measurements on the sinking behaviour of riverine plastics once they have entered the sea. These parameters are relevant for the ocean circulation model which will simulate plastic dispersal at sea.

Through physical fragmentation in combination with sunlight exposure and temperature fluctuations, plastic litter or macro-plastics are the main producers of micro-plastics in natural environments. To address this issue, CEFREM has also developed local and innovative research projects on plastic litter accumulation in drainage basins, at river mouths and on the surrounding beaches. The local Têt River which enters into the Mediterranean sea after crossing the city of Perpignan is one of our favourite study sites. These projects require frequent and regular field campaigns, as well as manpower. In addition to the active participation of undergraduate and graduate students from UPVD, they aim to also involve non-academic stakeholders (associations, professionals, local resource managers, etc.) and to raise global awareness on plastic pollution through education and public outreach events. Together with the Parc naturel marin du golfe du Lion, a local environmental association of volunteers (Citeco66) and small local companies (Nostra Mar and Seaneo), researchers will combine expertise in order to suggest pragmatic, economic and local solutions to reduce the mismanaged plastic waste on land and its leakage into the sea.


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Analogous to sediment particles which are eroded from the soils, much of this plastic debris is washed or blown into the sea where it accumulates in surface waters or bottom sediments. Plastics have also made their way into biological food webs, where they now impact marine wildlife and biodiversity.
Today’s coral reefs are under siege from the impacts of global warming and climate change. Coral bleaching events, like the one that is currently underway across French Polynesia, are becoming common. During a bleaching event, the tiny algae that provide corals with food and give them their vibrant colours are expelled, and if conditions do not improve quickly, the corals will die. When this phenomenon happens at scale, the consequences can be devastating. Researchers at the Centre for Island Research and Environmental Observatory (CRIOBE USR3278 PSL Université Paris: EPHE-UPVD-CNRS) in partnership with coral reef experts from around the globe, are working to better understand how coral reefs function and to develop innovative solutions to ensure the persistence of coral reefs for today and for the future.

Dr. Laetitia Hédouin, a coral expert and researcher at the CNRS, is one of CRIOBE’s leading coral scientists. Through research, strong international collaborations, the SO CORAIL long-term monitoring service and the establishment of a community science action network, Dr. Hédouin and her team
The researchers of CRIOBE, in partnership with coral reef experts from around the globe, are working to better understand how coral reefs function and to develop innovative solutions to ensure the persistence of coral reefs for today and for the future.

natural counterparts in the wild. This is done through the selection of genetic traits that favour corals that are more adapted to stress, and through the optimisation of the protocols used to rear coral recruits and post-recruits in the nursery setting. Once the juvenile corals are large enough, they are transplanted into Moorea's lagoon. Thus far, Dr. Hédouin and her team have successfully reared early life stages of Acropora coral species that are more resistant, than those in the wild, to elevated temperatures.

Coral Refuges
In the war against climate change, scientists have hypothesized that corals found in deeper waters – waters that are often cooler and less impacted than those closer to the surface – could potentially serve as refuges. To test this hypothesis, Dr. Hédouin has partnered with Under the Pole Expeditions on a project called DEEPHOPE - where advanced diving technologies are being used to sample corals at depth (30-150 metres) to determine if mesophotic ecosystems can serve as a refuge for shallow water corals and to identify what specific mechanisms allow corals to live below the photic zone.

“In the war against climate change, scientists have hypothesized that corals found in deeper waters could potentially serve as refuges”

Engaging Local Communities
In 2017, the CRIOBE and the Pacific Coral Reef Institute (IRCP) launched ‘An Eye on Coral’ a program that engages French Polynesia's communities in the monitoring and observation of coral reefs. When local citizens spot coral bleaching, they go online and report what they have seen and where they saw it. In this way, scientists have many eyes on the reef at any given time. In response to the March 2019 alert issued by the ‘An Eye on Coral’ program, more than 30 people across French Polynesia reported bleaching. This information helped to focus monitoring efforts and has helped to geo-localise the extent of the bleaching event for further study.

Climate change is a complicated and constantly evolving process, and many of the consequences are yet to be fully understood. Research programs, like Dr. Hédouin’s, that incorporate robust science, monitoring and communities are necessary if we are to ensure that coral reefs persist through time.

Climate Resistant Corals
Dr. Hédouin led AQUACORAL, a coral restoration project that established the first pilot coral nursery project in French Polynesia. Through sexual reproduction, Dr. Hédouin and her team are producing juvenile corals in a laboratory setting that are more resistant to stress, than their

are helping to answer some of the most critical questions facing coral reefs today. Her current research is focused on two main areas: the propagation of climate resistant corals and the exploration of deep coral reefs as potential coral refuges.

Long-Term Monitoring
CRIOBE's SO CORAIL, one of France's elite INSU (National Institute of Sciences of the Universe) monitoring service stations and one of the world’s oldest coral reef monitoring programs, allows Dr. Hédouin and her team to compare observations made today at specific sites across French Polynesia, with those made over the past 30 years to define current trends and to anticipate future patterns. This invaluable monitoring service allows changes on reefs to be detected early, such that meaningful management and research actions can be taken rapidly to address these changes.
The Pacific oyster (Crassostrea gigas), endemic to Asia, was introduced to many countries throughout the world including Canada, the USA, Australia, New Zealand, Chile, Mexico, Argentina, South Africa, Namibia and in numerous European countries including France, during the 20th century. Today C. gigas is the dominant species of oyster farmed worldwide. For decades, C. gigas has suffered from mortalities but the severity of these outbreaks has dramatically increased since 2008. The outbreaks primarily affect juvenile stages, decimating up to 100% of young oysters in French farms (Figure 1). In recent years, this mortality syndrome, known as the Pacific Oyster Mortality Syndrome (POMS), has become panzootic, as it is observed in all coastal regions of France and in many countries worldwide. Today, the economic consequences are dramatic and POMS represents a great threat to the global oyster industry.

Research efforts have identified a series of factors that contribute to the disease, including infectious agents which interact with seawater temperature and oyster genetics. The dramatic increase in mortality since 2008 coincided with the recurrent detection of Ostreid herpesvirus (OsHV-1) variants in moribund oysters. This increase has naturally driven research efforts to focus on the viral aetiology of the disease. However, the involvement of other aetiological agents is suspected. In particular, strains assigned to the genus Vibrio have been shown to be associated with the disease. Recent studies have also proposed that the stability of the natural bacterial microbiota, which is abundantly present in healthy oysters, influences their resistance to stress or invasion by pathogens. Yet, investigations into the role of host genetics, pathogens, and opportunistic and commensal microbes have been limited to a restricted number of factors tested in isolation. Thus, the disease’s dynamics, relative weight
and interactions between the different parameters have yet to be established.

To address this challenge and to unravel the events that underpin the disease, the Host Pathogen Environment Interactions (IHPE) laboratory, and lead partner in the research, brought together a group of scientists with complementary skills from laboratories with outstanding experimental facilities. To retain diversity of the factors required for disease expression, the IHPE chose not to use simplified experimental pathosystems. Instead, the researchers used an experimental set-up that mimics the complexity of the pathosystem in the wild. Thanks to exceptional animal facilities and human resources, the IHPE performed experimental infections in mesocosms on a series of 15 oyster biparental families susceptible or resistant to the disease. Oysters were exposed to the disease and were regularly sampled to follow the dynamics, step by step, of the oyster holobiont (host and associated microbiota).

Reproducing the disease as it is contracted in nature was not trivial. First, oyster families were produced and maintained in biosecure conditions until experimental infections were performed to ensure that they were free of pathogens. Next, a group of oysters was exposed to the infectious environment to “contract” the disease. These “donor” oysters were transferred back to the laboratory for cohabitation experiments with “recipient” oysters that were sampled to monitor the dynamics of the disease. These complex experiments were performed in the Ifremer facilities in Argenton, after oysters were exposed to the disease in a farm located in Logonna-Daoulas (Britany, France, Figure 2).

The next challenge was to identify and to clarify the role and relative weight of the multiple disease determinants. To do this, the researchers implemented a combination of omics approaches developed by the IHPE laboratory. The molecular biology, NGS and bioinformatic resources were made available on dedicated platforms. These holistic studies were paired with histological analyses to monitor pathogen distribution and tissue damage, revealing that the OsHV-1 virus creates an immune-compromised state in oysters that leads to fatal bacteremia.

The researchers believe that this new approach, where diseases are treated as a system, provides an exceptionally well-adapted framework for studying factors governing the progression of polymicrobial infections. Such an integrative and holistic approach can now be applied to a series of multifactorial diseases that affect non-model invertebrate species like corals or pollinators.

“Research efforts have identified a series of factors that contribute to the disease, including infectious agents which interact with seawater temperature and oyster genetics”

Funding: DECIPHER project funded by the ANR (Deciphering multifactorial diseases: insight into oyster mortalities, ANR-14-CE19-0023).
The LEPSA laboratory is studying the physiological and psychological adaptations of people living in low-lying areas, in contrast with those living at moderate altitudes. Researchers are looking at the potential differences between these two populations in response to physical activity at altitude.
Mountain sports have increased in popularity in recent years and there are more and more people living at sea level or at moderate altitudes, who participate in physical activities at altitude for recreation or at a competitive level. This is certainly the case for trail running or hill-walking, which have a rapidly growing number of participants. Against this backdrop, the European Laboratory for Altitude Performance and Health (LEPSA), affiliated with the University of Perpignan, is focused on the study of physiological and psychological adaptations to medium altitude environments.

Based in the town of Font-Romeu at 1,850 m elevation, LEPSA is a natural setting for altitude research. It is not only located close to the national training centre at altitude for high-level athletes, but it is also not far from Spain, where it is close to the cross-border hospital in Cerdanya, the medical school in Girona and the hospital in Barcelona, all of which make LEPSA and its partner organisations a unique research consortium in France.

The laboratory is studying the psychological and physiological adaptations of people living in low-lying areas, in contrast with those living at moderate altitudes, such as those who have grown up in Cerdanya. The LEPSA is looking at the potential differences between these two populations in response to physical activity at altitude, with a focus on their cardiovascular and respiratory systems, as well as on their overall health. It will also assess the effects of moderate altitude on psychological issues such as people’s judgment.

The challenge for LEPSA is therefore to better understand the cardiorespiratory and psychological adaptations at moderate altitudes to enable people to perform better at altitude or to simply partake in physical activity at altitude in a way that is beneficial to their health. In order to study these factors, the laboratory performed tests at low altitude (at sea level), and at moderate altitudes, either in a simulated context or in a natural environment.

In a natural environment, physical activity and sports may generate wider benefits than undertaking the same physical activity in an indoor context. Nature-based activities, or “green activities”, expose people directly to nature, and are the primary focus of LEPSA researchers. Green activities are comprised of two types of physical activity: Green Physical Activity and Green Exercise. Green PA is defined as any bodily movement produced by skeletal muscles that results in energy expenditure from the utilisation of affordances (or opportunities for interactions) that emerge from engagement with natural environments. Green Exercise, in contrast, is defined as PA that is planned, structured, rigorous, repetitive and deliberate and aims to maintain one or more components of physical fitness, from the utilisation of affordances that emerge from interacting with natural environments.

The laboratory is working to better understand the nature of the constraints which shape the benefits of green activity on health and sport performance. Natural environments are by definition irregular and are frequently characterized by dramatic variations in altitude, terrain and surface. These variations might support the emergence of different physiological consequences (e.g., cellular, cardiorespiratory) and psychological outcomes (e.g., well-being, risk taking, judgment). Green activity results from the utilisation of affordances that emerge from interacting with natural environments.

LEPSA researchers are interested in how these interactions affect different types of individuals (sedentary, athletes, high-level athletes, carriers of chronic diseases, etc.) in order to optimize sporting performance and/or to improve health. Within this common theme, the objectives of the study are addressed at several scales ranging from the cellular approach to a more global physiological approach to cognitive and social processes.

Future research is necessary to understand how and why green physical activity might influence health and sport performance with a multidisciplinary rationale. New studies on the interactions between constraints on green physical activity effects are being considered, including levels of engagement, types of environment, level of physical activity, adventure, skill levels and groups. It is hypothesized that natural affordances may yield a variety of physical, physiological, and psychological benefits which may enhance sports performance as well as the maintenance or improvement of physical and psychological health.

“In a natural environment, physical activity and sports may generate wider benefits than undertaking the same physical in an indoor context.”
The 120 km-long Têt River flows out of the Pyrenees to the Mediterranean. By displaying a mappable sequence of five terrace units between the former frontal moraines of the high range and the offshore sedimentary depocentres, its 1400 km² watershed is well suited to quantify the spatial and temporal variability of the topographic uplift in the easternmost part of the Pyrenean range. In addition, Têt fluvial terraces host prehistoric settlements that were identified in the 1950’s (Creus, 1950, 1957) and gave rise to numerous successive collection campaigns of prehistoric pebble tools, found as discrete concentrations of artefacts called “paleolithic localities.”

A fluvial terrace is an abandoned river floodplain that is separated from the current floodplain (or a lower fluvial terrace) by a steep slope, known as the terrace scarp. Valleys often contain flights of multiple terraces that record the river response to long-term climate changes in phase with vertical uplift of the terrestrial crust. These ancient river banks ascribed to each terrace unit were also places that were highly favoured by Paleolithic human groups given the close proximity of water, the presence of cobbles, and probably animal resources.
variability over the last million years. Given that fluvial incision rate is a well constrained proxy for tectonic uplift at regional scale, HNHP calculated that the Têt terrace sequence underwent a surface uplift of roughly 240 m over the past 1 Ma in the higher part of the catchment (cf. range covered by snow on Figure 1) but only about 60 m in the Roussillon basin near Perpignan. The data also suggest an increasing uplift rate for the last hundred millennia, with 30 to 40% of this uplift occurring in the last 200 ka (Delmas et al., 2018). A resumed interest in these prehistoric settlements has also emerged. Researchers are now working to examine all collections from a diachronic perspective to highlight important technical thresholds during the Middle and Upper Pleistocene. The transition between the Ancient Paleolithic characterized by pebble lithic industries (figure 2) and a Lower Paleolithic that was slightly more technically evolved and included the concept of bifacial shaping, is one of the questions that still needs to be resolved, as is an explanation for the appearance of complex production systems at the end of the Lower Paleolithic and the beginning of the Middle Paleolithic. Additional surveys will be carried out and fine-scale GIS mapping of all the settlements will conducted. The first datings for the fluvial staircase established within this study allow, for the first time, conclusions concerning the technical and cultural evolution of the Paleolithic populations of this Mediterranean region to be drawn and compared to similar Mediterranean sequences like the Rhône alluvial deposits of the “Costières du Gard”.

Funding :
TCN dating of the alluvial profiles was funded by the Bureau des Recherches Géologiques et Minières through the RGF AMI-Pyr program. ESR dating was funded by UMR-CNRS 7194 Histoire Naturelle de l’Homme Préhistorique.

References:

Recently, the multidisciplinary HNHP team revisited studies on this geomorphological and archaeological foreground complex of the Eastern Pyrenees. Our first objective was to better define the time period for the development of the Têt fluvial staircase. The researchers used two cross-checking dating methods, namely in situ-produced Terrestrial Cosmogenic Nuclide vertical profiles and Electron Spin Resonance dosimetry of optically bleached quartz grains (Delmas et al., 2018). Results indicate that the higher fluvial terrace T5 was built 1 Ma ago, at the time of the Early to Middle Pleistocene transition, corresponding to the onset of the 100 ka climatic cycles (Head & Gibbard, 2015). The three lower levels (T1, T2 and T3) were found to be synchronous with the three last 100 ka climatic cycles.

These new datings have allowed research to evolve in several important ways. By reconstructing the longitudinal profile of the river at different times in the past, it is possible to quantify the fluvial incision rate and its spatial and temporal variability.
Research on new sensing technologies for detecting contaminants and studying their fate and potential interactions has created great expectations on major economic sectors, such as healthcare, food, and the environment. From an analytical aspect, combining advanced recognition biomolecules with the potential of optical or electrochemical systems has enabled the development of novel biosensors that provide interesting advantages such as portability and ease of use. With nearly three decades of experience, the Biosensors-Analysis-Environment (BAE) laboratory at the University of Perpignan is a leading group in biosensor research, which develops innovative systems for the detection of various target compounds including pesticides (organophosphates), toxins (mycotoxins, phycotoxins, cyanotoxins) and microorganisms. Particular attention is devoted to the selection and optimization of original
Within the context of the “One Health” approach, the BAE team also focuses on the evaluation of the persistence of pesticide residues in soils, considered as a major threat for in-soil living organisms. Several approaches based either on candidate gene analysis using molecular tools (qPCR, RT-qPCR and high throughput sequencing) or on enzymatic activity analysis using biochemical assays are currently under development in the laboratory. The ultimate goal is to use these responsive genes for the development of specific microbial markers to assess environmental exposure to specific classes of herbicides.

References
When cities don’t grow anymore: are decline and degrowth the cradle of innovation?

While metropolization and big city dynamics have drawn the attention of scientists and the public at large for decades, for many cities and towns worldwide, urban reality has a completely different image. According to recent UN statistics, the urban world is still a world of small and middle-sized cities in which many are facing economic and social difficulties. Half of the world’s urban population lives in towns with less than 200,000 inhabitants both in the global North and South. These ordinary cities have long been forgotten by public policies which use standard tools and regulations designed to promote big city economics and global competition – tools and policies which fail to meet the needs of these smaller towns. Many scholars and practitioners are now seriously contesting mainstream urban and land politics that appear to be socially and environmentally unfair leading to growing social and environmental injustice. In this context, ordinary towns such as mid-sized cities and declining towns in former industrial regions or urban peripheral areas are the
silent birthplace of social, environmental and urban planning innovations. Ordinary and sometimes declining cities such as Ferrol in Spain, Saint-Etienne and Montluçon in France, or larger cities in the US like Detroit, or Baltimore that are facing urban decline and demographic decrease show significant signs of innovations and alternatives. In many cases, slow growth or even de-growth, can foster innovation and alternatives to mainstream urban policies. It can be an opportunity for local stakeholders to join together and promote different, adaptive and innovative ways of dealing with urban planning in a depressed urban context.

Looking at urban alternatives in ordinary and declining cities and towns

Within the ART-Dev research unit at the University of Perpignan Via Domitia (UPVD), researchers are investigating processes, dynamics and realities of urban innovation in ordinary and declining cities. Two ANR programs (Déclin and Gelule) and another program financed by the Maison des Sciences Humaines Sud (MSH-SUD; program Rebond), lead by Max Rousseau (CIRAD-ART-Dev) and Aurélie Delage (UPVD-ART-Dev) are investigating the way public and private stakeholders manage de-growth and decline and how they can identify opportunities to build alternatives to mainstream urban planning. They have focused their research on urban governance, social housing, urban sprawl and urban agriculture. A PhD Candidate, Mikel Agirre Maskiarano (UPVD and University of the Basque Country), is comparing urban development strategies in two former industrial centres: Ferrol (Spain) and Montluçon and is exploring innovative modes of inclusive urban governance, alternative modes of land planning including brownfields, public spaces and urban facilities. Sophie Eftimion, PhD candidate (UPVD), is comparing urban regeneration strategies in Glasgow and Salamanca, two cities that have recently faced demographic decline, economic breakdown and urban decay. In a post-crisis environment, she is investigating the way local officials, after the collapse of mainstream urban policies (leading to the fiscal crisis after 2008), are implementing innovative urban practices such as temporary urbanism. Instead of promoting real estate developments, public officials in de-growth contexts now focus temporary urban developments according to community needs such as pop-up spaces in popular neighbourhoods. Urban slow growth programs are now implemented in the US (in Jackson, Mississippi for instance) and are also being trialed in European cities. They promote environmental regeneration, urban agriculture and temporary uses of spaces (...). Urban planning is now focused on building circular economies.

Education as an alternative lever for land and urban development?

Lastly, scientists from the ART-Dev research unit are also developing innovations and alternatives, emphasizing education as a booster for alternative urban planning. Through her thesis and subsequent publications, Stéphanie Baffico explored the green school strategy in two afro-american ghettoes in Baltimore. In a devasted urban environment, she analyzed how local activists and urban planners place schools and education at the centre of urban alternative regeneration strategies. Through her PhD, Nora Nafaa is interested in the way alternative schools and models of education are challenging (or not) traditional educational guidelines and types of governance in Philadelphia and Atlanta. In a recent paper she considers that some stakeholders use urban, social and environmental alternatives as catchwords to promote business as usual. In cooperation with colleagues from the University of Montpellier, a newly established program will be devoted to understanding alternative schools in peripheral areas in Occitanie, where researchers will try to figure out what's behind these so-called ‘alternative schools’, how they are integrated in educational and urban planning, and how they can be a lever for local development.
The Cherenkov Telescope Array

The Cherenkov Telescope Array (CTA) brings together around 1500 scientists and engineers from 32 countries with the goal of building the world's largest and most sensitive very high-energy gamma-ray observatory. CTA will be used to understand the role of high-energy particles in the most violent phenomena of the Universe and to probe the nature of dark matter. CTA will be able to detect hundreds of objects in our galaxy, the Milky Way.

These galactic sources will include the remnants of supernova explosions, the rapidly spinning ultra-dense stars known as pulsars, and stars in binary systems or in large globular clusters. Beyond the Milky Way, CTA will detect star-forming galaxies.
and galaxies with supermassive black holes at their center and, possibly, whole clusters of galaxies. The gamma rays detected with CTA may also provide a direct signature of annihilating dark matter particles, evidence for deviations from Einstein’s theory of relativity, or bring a definitive answer to the content of cosmic voids, the empty spaces that exist between galaxy filaments in the Universe.

**How does CTA work?**

When a high-energy particle enters the atmosphere, it produces a cascade of particles and electromagnetic radiation from its interaction with the atoms of the atmosphere. This phenomenon is called Extensive Air Shower (EAS). The charged accelerated particles that enter the atmosphere are called Cosmic Rays and the showers they generate are composed of particles that spread in the same direction as the cosmic ray because of its high velocity. An EAS also generates a flash of blue light because of the Cherenkov effect. The CTA telescopes will collect this blue light to produce an image of the EAS onto highly sensitive cameras. Physicists will be able to reconstruct the nature, energy and direction of the incident gamma rays from a detailed analysis of these images, and they will then be able to study the violent phenomena at the origin of the very high energy emission.

**So many computations!**

Scientists need to run large-scale simulations to rebuild the gamma-ray dynamics from telescope images. They use CORSIKA (Cosmic Ray Simulations for Kascade) a program that simulates the development of air showers in the atmosphere initiated by photons, protons, nuclei, or any other particle using Monte-Carlo methods, i.e. relying on the random sampling of distributions. Prior to deploying the CTA telescopes, exhaustive simulations need to be run. Most of these computations are run on the EGI’s (European Grid Initiative) grid resources where up to 10,000 processors are made available to the CTA consortium. As an example, the consumed computing time exceeds 10,000 years for the simulation campaign that has led to the selection of telescope sites. CORSIKA is an important piece of software at the core of these simulations: more than 90 % of CPU time is spent in it. Considering the scale of these simulations, massive gains in computing cost (execution time and energy consumption) are possible with code optimization. Such a task is thus crucial for the computing part of the Cherenkov Telescope Array project.

LUPM (UM, CNRS) and DALI-LIRMM have joined forces for this optimization issue in the context of a CNRS funded project for interdisciplinarity: “PEPS Astro-Informatique”.

**Software optimizations**

A program such as CORSIKA is written in a high-level language, the source language, easily read and understood by scientists. Another program, called a compiler, is then used to read this source code and transform it into a more low-level language: the machine language or target language. As its name indicates, the machine language can be understood and executed by the machine, i.e. by the processor.

During this transformation, the compiler has a huge number of opportunities to optimize the program and to build a target code suitable for the target machine and processor. However, due to the complex nature of large source programs such as CORSIKA, compilers often fail and are not able to fully optimize the generated executable program.

Our main line of attack is to manually transform the source code to help the compiler find the best optimization and obtain the « best performances ». Modern processor architectures have new instructions, called vector instructions, to simultaneously perform operations on multiple data. We have already transformed CORSIKA to help the compiler use these new instructions. Hence the newer version of CORSIKA is now 1.5x faster while maintaining the same computing accuracy. Our next step is to reach a 2x acceleration ratio.
Contact phenomena involving deformable bodies are abundant in industry and in everyday life. The contact of the piston with the skirt, the wheel on the road and a shoe with the ground are three examples among many others. Playing an important role in structures and in mechanical systems, contact phenomena have long been studied in the engineering literature. The mathematical literature dedicated to the study of contact phenomena is more recent. The reason for this is that, along with complex physical and surface phenomena, contact processes are modeled by strongly nonlinear problems which give rise to important mathematical difficulties.
The Mathematical Theory of Contact Mechanics (MTCM) is the part of Applied Mathematics that deals with the study of mathematical models of contact with different materials, varied geometries, and different contact conditions. Located at the crossroads of several scientific disciplines, its main characteristic is the cross-fertilization between models and applications, on the one hand, and mathematical and numerical analysis, on the other. Research in this field is motivated by significant applications in different industrial sectors (especially in the metallurgical industry and the automotive industry), civil engineering, geophysics and medicine. Within the MTCM, the study of a specific contact phenomenon involves four distinct steps: modeling, variational analysis, numerical analysis and numerical simulations. The following paragraphs provide a brief description of these steps.

**Modeling** brings together mechanical, thermodynamic and tribological hypotheses to describe the geometry of the problem, the materials involved (metals, rocks, soils, rubbers, polymers), the forces acting on the mechanical system as well as the characteristic of the contact surfaces. At the end of this step we associate each contact process with a so-called mathematical model, i.e. a system of partial differential equations with initial and boundary conditions. The **variational analysis** of the models is dedicated to results ranging from the existence and uniqueness of solutions to continuous dependence on data and parameters, among others. The **numerical analysis** of the models is focused on the study of associated discrete schemes; existence and uniqueness results of the discrete solutions are established, followed by error estimation and convergence results of the discrete solutions to the solution of the continuous problem. Finally, the **numerical simulations** (based on efficient resolution methods) allow us to check the reliability of the mathematical models used in the study of contact phenomena.

Their research on MTCM is carried out in collaboration with well-recognized researchers from Jagiellonian University in Krakow (Poland), University of Iowa City (USA), Oakland University (USA) and Guangxi University of Nationalities (China). It was supported by two international programs: the Seventh European Community Framework Program under the Marie Curie International Research Staff Exchange Scheme and the European Union’s Horizon 2020 Research and Innovation Program under the Marie Sklodowska-Curie.

The MTCM represents one of the major research topics of the **Laboratory of Mathematics and Physics** (LAMPS) of the University of Perpignan Via Domitía. The contribution of the researchers to this theory started more than twenty years ago. It concerns the modeling and analysis of frictional or frictionless contact phenomena with wear, adhesion, damage, thermal and piezoelectric effects. The researchers of the LAMPS developed a number of abstract mathematical tools in the study of these models, including various existence and uniqueness results for variational and hemivariational inequalities. Moreover, they paid particular attention to the numerical analysis of the models, for which they obtained results on error estimates, developed methods of solutions and provided representative numerical simulations. To this end, LAMPS researchers used ideas from many fields of research: partial differential equations, operator theory, calculus of variations, optimal control, mechanics of continua, functional and numerical analysis.
The steps leading to juvenile radicalization, today, question the multiple forms of intervention targeted at vulnerable families, whether they show educational difficulties or are clearly abusive (...) In order better understand the processes involved in youth radicalization, and how to prevent it, the CORHiS hypothesizes that effective interventions by child protection actors cannot treat all family contexts in the same way.
Here, the CORHIS presents the “PETRA” research project led by Manuel Boucher, Professor of Sociology at the UPVD, responsible for the “Intervention Sciences and Social Transformations” division of the CORHIS Laboratory. This research focuses on the prevention of juvenile radicalisation, as defined by sociologist Farhad Khosrokhavar\(^2\), with the aim of improving socio-educational responses within the “child protection” framework that concerns minors at risk or at risk of being so.

The steps leading to juvenile radicalisation, today, question the multiple forms of intervention targeted at vulnerable families, whether they show educational difficulties or are clearly abusive. Thus, the families’ place in policies to prevent juvenile radicalisation is of interest not only for those concerned with the interest and protection of children against ideological recruitment that could potentially lead to forms of extreme violence (against oneself and others), but also for those directly concerned with children and young offenders, and more generally, public order and peace.

In order better understand the processes involved in youth radicalisation, and how to prevent it, the researchers hypothesize that effective interventions by child protection actors cannot treat all family contexts in the same way. In terms of radicalisation, each family environment is specific: among the many factors of radicalisation, the family is an important element. Families can directly or indirectly lay the groundwork for radicalisation. From this perspective, family situations where risks of radicalisation are identified for children or adolescents should not be targeted with the same type of intervention. To prevent and to combat the process of radicalisation, actions must be carried out in a differentiated way according to the diversity of the family situations.

To confront this hypothesis with reality, three research questions were identified: the theory and the realities of the radicalisation processes from the point of view of child protection actors and families; the practices of social actors with regards to radicalisation phenomena in child protection; the practices of social actors with regards to radicalisation phenomena in the social environment of families.

In practice, the research involves qualitative and participatory survey methods: document collection and analysis; individual and group interviews; direct observations and “sociological intervention” groups. The originality of this project rests in the application of the sociological intervention methods invented by Alain Touraine\(^3\), which seeks to analyze through interview and confrontation, and to gradually lead research participants to reflect on their situation, on the meaning of their commitment and action. Within this context, PETRA is thus focused on increasing the ability of social actors to think critically and to take action on the processes involved in radicalisation.

Ultimately, PETRA’s goal is to produce new insights into the prevention of radicalisation. Further, it aims to develop operational recommendations that can inform the professional practices of socio-educational workers and public policy to prevent radicalisation.

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1. Funded by the CNAF and CIPDR, the PETRA project began in March 2017 for a period of 24 months. The research team relies mainly on a consortium of social work training institutions (STMs) and universities.
2. By “radicalization”, Farhad Khosrokhavar (Radicalisation, Paris, Maison des Sciences de l’Homme, 2014, pp. 7-11) points out that “the process by which an individual or group adopts a violent form of action, is directly linked to an extremist ideology with political, social or religious content that challenges the established political, social or cultural order.”
Within the current context of climate change, of accelerated biodiversity erosion, and pervasive talk of collapse, environmental arts and humanities have been taking issues with our modern worldview.

Since Latour’s recent rehabilitation of Margulis and Lovelock’s Gaïa theory, the environmental humanities and sciences have been debating whether and when we might have entered the Anthropocene (Crutzen), and what such a reality might entail. Prior to Latour’s call to re-establish a dialogue between the sciences and humanities, ecofeminists, ecopoets, and ecocritics have been stressing the need to reconcile arts and science and to rethink what humans have culturally constructed as our idea of “nature”. Thinkers such as Carolyn Merchant and Rachel Carson have decried “the death of nature” entailed by anthropocentric approaches to the living world. Contributions such as Carson’s Silent Spring (1962) have rung a wake-up call, forcing humans to reevaluate the ecocidal backlashes of a disenchanted ontology, where nonhuman nature is silenced, systematically reduced to inert matter, destined to be conquered, charted, and plundered in the name of human exceptionalism.

The theme of reenchantment leading much of the research carried out within the UPVD ecopoetics workshop since 2015 stems from a simple observation: when business and industry are mostly driven by calculations of immediate, economic profit, and when change is only too slow to come in the face of alarming, scientifically proven environmental destruction, what but a reenchantment of our vision of the world we depend on for survival could move us humans to value and readjust our interconnections with it? Within the current context of climate change, of accelerated biodiversity erosion, and pervasive talk of collapse (Diamond, Servigne), environmental arts and humanities have been taking issues with our modern worldview.
The immersive experiences provided by art can retrain our sensitive, affective “response-abilities”, which, in turn channel our ethical sense of “responsibility” (Haraway). Ecological data is now widespread via specialized and popular media, and yet, it has proved insufficient to bring about effective changes in human attitudes, policies, and ways of life. This paradox can be explained by psychological defense mechanisms such as “psychic numbing” (Slovic), processes of psychological dissociation, denial (e.g. climate sceptics), and “environmental generational amnesia” (Kahn Jr). This is where environmental literature—and arts in general—can make a difference. Whereas ecological textbooks and scientific publications may be experienced as overly specialized and lacking vitality, many will happily learn facts about the world via a novel or movie. Because it moves toward biocentrism, ecopoetics enriches the quality of experiences a reader is capable of; it provides extra-ordinary ways of thinking and perceiving, knowing and feeling, including animal, vegetal, mineral, and elemental ones.

Our work is situated within a larger, contemporary project of reenchantment that focuses on creative materiality and narrative agency (Barad, Bennett, Iovino, and Oppermann). It calls attention to the relational processes through which matter and meaning are entangled, constantly interwoven within fields and fluxes forming patterns that call for paradigmatic, transdisciplinary reading grids. Serres’ notion of a “natural contract” lies in his intuition that the world must be speaking a certain language that might allow us, should we be able to hear it, to articulate ourselves within it. Today’s transdisciplinary approaches to the language of nature and the nature of language tend to re-instill a sense of the marvelous in the complex “intra-actions” between all lifeforms (Barad). We are now re-learning the language of trees, animal cultures such as those of ants, birds, and cetaceans, or how matter travels across human and nonhuman boundaries. New materialism calls for new perspectives onto the world—a world perceived as “vibrant” (Bennett), as “a web teeming with meanings” (c.f. Wheeler’s work on biosemiotics), where “naturecultures” (Haraway) evolve in rhizomatic ways that determine our co-becoming with nonhuman organisms.

The UPVD ecopoetics workshop first organized an international conference in 2016, exploring the theme “Dwellings of Enchantment: Writing and Reenchanting the Earth”. As it turned out, most papers tackled human wonder at the natural world outside of cities—a rather telling symptom of the pregnancy of our dichotomous thinking, still prompting us to conceive nature as opposed to culture and cities, if not humans. With seventy percent of humans predicted to be living in cities within a couple of decades, it appeared crucial to complete the work started in 2016, by calling for a second conference dealing with urban ecopoetics, therefore addressing human and nonhuman intra-actions within urban milieus. Hence the international gathering that has taken place in Perpignan, June 11-14, under the aegis of the CRESEM, to promote transdisciplinary research on “Reenchanting Urban Wildness: To Perceive, Think and Live with Nature in Cities”: https://ecopoeticsperpignan.com/programme-reenchanter-le-sauvage-urbain-reenchanting-urban-wildness/
The capacity of energy storage technologies is directly related to the corresponding amount of implemented storage material, and as such, a huge amount of mineral materials will be required to meet the demands of the energy transition. For instance, to support the anticipated growth of solar powered technology (representing roughly 10% of the entire electricity production in the future) about twenty times the worldwide annual nitrate salt production will be required. Considering that these nitrates are also used to produce fertilizers, a major conflict of use between energy and food production will likely emerge. Critical attention is thus needed

A growing global movement concerning the impacts of global warming and the emerging scarcity of fossil fuels has mobilised the so-called ‘Energy Transition’. The success of this transition will depend on a simultaneous reduction in energy consumption (via significant changes in behaviour and through increased efficiencies), the recycling of waste heat, optimisation of energy grids and a thorough integration of renewable energies. Among the many key processes and systems implicated within the energy transition, energy storage units will play a vital and strategic role in helping to shape the future of a sustainable energy network.

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to avoid the major depletion of the still-available natural minerals on earth to achieve the desired goals. Unfortunately, what this issue highlights is that even as we transition to a system based on renewable energies, if we are not diligent, the energy transition will not be sustainable.

Facing this challenge, a decade ago, the PROMES laboratory proposed an alternative approach: It proposed the use of industrial wastes, and only wastes, to produce high temperature ceramics capable of storing thermal energy. This approach offers several advantages: (1) industrial wastes are widely available worldwide at low cost (for some waste, the owners even pay you to collect them), (2) for dangerous wastes (such as asbestos containing wastes, ACW) it allows an advantageous pay-back of the inertization cost and impacts, and (3) it avoids the depletion of natural mineral resources.

This approach was first applied to each of the major known industrial inorganic wastes (wastes without carbon matter): ACW, coal fired power plant fly ash, municipal solid waste incinerator fly or bottom ash, metallurgic slags... and for each, a specific ceramic was elaborated by melting the waste at 1,400°C followed by the crystallization of the molten product under controlled cooling. It was previously demonstrated that these ceramics could be used to store thermal energy up to 1100°C, even under extreme conditions such as very high heating or cooling rates or under corrosive environments. This elaboration route also offers the major advantage of being able to produce the ceramic in the shape of highly-efficient heat exchangers (Figure 1) instead of the usual granular media. These first generation recycled ceramics demonstrated thermal storage performances similar to those of commercial synthetic ceramics, but at a lower cost and with a better resistance to thermal cycling and thermal shocks. However, these recycled ceramics also had the same low thermal conductivity of commercial synthetic ceramics, limiting the power levels of charge or discharge. This challenge led to a new generation of recycled ceramics, also developed at the PROMES laboratory.

The second generation of recycled ceramics is based on industrial wastes containing both inorganic and organic fractions, and like the previous generation, was also developed by mixing intentionally selected inorganic and organic wastes together. This new approach led to the production of enhanced ceramics composed of a share of SiC and Mullite. The former fraction of SiC enhances the thermal conductivity of the ceramic while the Mullite fraction offers the mechanical strength. This composite ceramic (Figure 2) has all of the advantages and none of the disadvantages associated with each fraction (SiC alone is known as fragile, Mullite alone has a poor thermal conductivity). Moreover, the selection of initial wastes and the operating conditions of the elaboration route allow the amount of each fraction to be regulated.

This new approach is of particular interest with respect to the current case involving the dismantling of wind farms. At the moment, every part of a wind turbine can be recycled – except for the blades. Blades are made of glass fibers embedded in epoxy resins... a mixture of inorganic and organic matters. With the recycled ceramics technology developed by PROMES, these blades can now be recycled and used for thermal energy storage, thereby contributing to the circular economy whereby renewable energies assimilate their wastes.

The first and second generation high temperature recycled ceramics can be used for various applications such as: (1) concentrating solar power plants, (2) valorisation of industrial waste heat, and (3) affordable and efficient sub-thermal storage needed in adiabatic compressed air electricity storage processes (ACAES). The latter case also offers an opportunity to design innovative wind farms, including efficient and affordable energy storage, to manage their critical current intermittencies.

The corresponding thermal energy storage units (Figure 3) are currently designed, optimised and produced by the start-up Eco-Tech Ceram created in 2014 by young researchers who earned their PhDs at PROMES. Their technology has been awarded twice by the Worldwide Race for Innovation (CMI I and CMI II).

![Figure 1: first generation of recycled ceramics](© photo Xavier Py)

![Figure 2: SiC/Mullite second generation of recycled ceramics](© photo Xavier Py)

![Figure 3: Eco-Tech Ceram's Eco-Stock thermal energy storage unit](© photo Xavier Py - PROMES)
The Centre for Economic and Development Law is known for its work in the fields of competition and consumer law and public action and development law. However, these focal areas do not prevent the emergence of new areas of investigation and research by the CDED research teams. In recent years, the environment and climate change have fueled important initiatives that constitute milestones for more extensive research.

During the 2017-2018 academic year, the CDED, at the initiative of its new director, Professor Marcel Sousse, organised a series of conferences devoted to various legal aspects of climate change, which today plays a major role in the public debate. The first CDED conference on climate change was held in October 2017, with a focus on the Monsanto trial, and was led by Christian Huglo, an internationally recognized lawyer in the field of the environment, well known for the work he did with Corinne Lepage (lawyer and former Minister of the Environment) on the Amoco Cadiz and Erika trials. This conference was the first in a series of dynamic conferences that continued through the first half of 2018 and centred around the following themes: companies facing the environment (Prof. Jean-Marc Moulin - UPVD); the creation of an independent public authority in environmental matters (Julien Bétaille - MCF Toulouse); the implementation of group action in environmental law (Prof. Jérôme Julien - University of Toulouse); the difficulties of introducing genuine environmental responsibility (Prof. Mathilde Hautereau-Boutonnet - University of Lyon); public action in water resource management (Prof. Catherine Ribot - University of Montpellier); and a critical
approach to urban planning law with a focus on the environment (Prof. Jean-Marc Février - UPVD). Each of these conferences perfectly embodied the spirit of the UPVD and CDED, through the dissemination of knowledge and research as well as through participation in public debate on issues relevant to the city and its citizens. These conferences strengthened the CDED’s focus on sustainable development, and their quality and timeliness have led the CDED Director to publish them to increase their accessibility.

In addition, at the initiative of the laboratory, two doctoral contracts co-financed by the Occitanie Region and the UPVD were recruited to work on the legal aspects of financing the energy transition and the environmental responsibility of companies. Thanks to the financial support provided by the CDED, these two doctoral students traveled to Laval University (UL) in Quebec in Spring 2019 to participate in a panel on sustainable development organised jointly by the UL Faculty of Administration Sciences (FSA) and the UL Faculty of Law. The students presented two research papers devoted to the financing of the energy transition through crypto-actives and the ‘say on pay’ mechanism (shareholders’ vote on the remuneration of company directors) as a tool for steering companies’ environmental policy. The presentations earned first prize for best presentation from Professor Olivier Boiral, Director of the Canada Research Chair on the Internationalization of Sustainable Development and Organisational Accountability. This visit was part of a broader partnership approach aimed at creating an institutional link between the CDED and the UL on the theme of Corporate Social and Environmental Responsibility. This link enabled Professor Moulin’s laboratory to participate in a week of seminars and symposia in October 2018 on this subject and to introduce an international symposium organised by the UL Center of Study on Economic Law, headed by Professor Ivan Tchotourian, on the subject of socially responsible business in the face of the multiplication of border zones.

Green is not a passing fad for the CDED, which sees new angles to the study of the market within the field of the environment, sustainable development and climate change. The environmental responsibility of economic and public agents, the financing of the energy transition, and corporate social responsibility are also opportunities for the CDED to establish future partnerships with other UPVD research units that also work on environmental issues.
Deciphering the Mechanisms of Plant Survival and Adaptation to Environmental Changes

Global changes significantly increase environmental stressors for plant growth, development and reproduction that may potentially have an impact on all of Earth’s agro and ecosystems. Understanding the determinants of plant acclimation and adaptation now, more than ever, has implications for both basic science and key socio-economic challenges. The seven research teams at LGDP work to unravel how genomic variations and alterations in gene expression contribute to plant responses to stress. These joined efforts have provided major contributions to our understanding of the acclimation of plant model Arabidopsis thaliana and the adaption of rice plants. While this fine-grained molecular knowledge originates in our core ability to pioneer mechanistic experimental approaches, we are currently developing complementary innovative theoretical and population field studies to explore the natural diversity of the genomic and mechanistic bases of plant responses to ongoing environmental changes.

LGDP
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Genes form only a tiny part of genomes that also contain DNA sequences, called transposable elements (TEs), that are able to multiply themselves, invade genomes and become key determinants of their structure, function and evolution. We participated in several genome sequencing consortia, which allowed us to address critical questions such as estimating TEs’ turnover rate (1) and their contribution to genetic diversity within unprecedented population genomic datasets such as the 3,000 rice genomes (2). TEs are powerful evolutionary forces and we are now investigating their role in stress adaptation and biological innovations. Still, TEs are for the most part harmful, but a small RNA (siRNA)-based process that promotes the formation of heterochromatin is usually capable of silencing their transcription. Using the cutting-edge approach of UV-assisted laser cross-linking, we found that the AGO4-siRNA complexes, major actors of TE silencing, are recruited through direct interaction with DNA and not RNA (3). This unexpected result forced us to re-examine our understanding of TE epigenetic silencing and will allow for new insights into their stress-induced reactivation.

While chromatin remodelling is essential for plant survival during heat stress, the epigenetic mechanisms involved in this reorganization remain elusive. In 2016, a novel team co-supervised by two young researchers, experts in chromatin structure and organization, joined the LGDP to work on an integrated view of how epigenetics and chromatin structure and organization help plants survive stress.

In response to stress, plants typically change their pattern of gene expression to switch on protective mechanisms. These changes occur at transcriptional, post-transcriptional (on mRNA) and post-translational (on protein) levels. We found that mRNAs involved in the maintenance of basal cellular functions are rapidly targeted to a heat triggered degradation process that contributes to the downregulation of the gene expression program which governs plant growth and development (4). Not all mRNAs undergo turnover when stressed: those coding for the translation machinery must be stored and protected from decay. When stress ends, mRNAs are released and re-enter translation for the plant to shift back to growth and development (5). Similar processes are also established at the protein level. We found that the protein composition of the nucleolus varies reversibly in response to heat stress. The nucleolus could hence regulate protein function and, through storage, protect those needed to shift back to growth when stress ends (6). Finally, we identified new actors involved in plant adaptation to high temperatures, drought and phosphate deprivation. All of these factors are involved in the regulation of the oxidoreduction state of the cell that post-translationally changes protein functions (7, 8), which will expand our knowledge of the plant response to complex stresses.

New steps towards the Eco-genomic modelling and field studies of natural populations

A key emerging potential at LGDP is to integrate our advancing knowledge of the molecular mechanisms regulating genome expression into mathematical and computing models to predict the ecological and evolutionary dynamics of natural populations. We are developing complex multi-scale ‘Eco-genomic’ theories that represent virtual plant populations whose abilities to cope with new environmental challenges depend upon genes and TEs composing their genomes. These powerful explanatory tools have already provided breakthrough insights into the determinants of TE dynamics in asexual organisms and their contribution to the evolution of sex (9). Such approaches are opening new avenues to anticipate how molecular mechanisms determine the phenotypic plasticity and evolutionary potential of natural populations to face ongoing global changes.

An obvious complementary approach is to investigate the underlying molecular mechanisms at work in a plant’s natural environment. This new research approach is being explored through a collective project that aims to elucidate the mechanisms present in natural populations of Arabidopsis spread along a strong local altitudinal gradient (from sea level to 3,000 m). Such innovative studies of the genesis of natural plant diversity are crucial to better understand the evolution of relevant phenotypes and the long-term response of Mediterranean ecosystems to climate change. Implementing such an interdisciplinary approach on this key plant model is an important first step before adapting its use to other non-model plant systems, such as Euro-Mediterranean orchids.

Management Control as a Response to an Organizational Crisis

Management Control Systems (MCS) are a major theme that drive the management research community. Since the founding work of Robert N. Anthony, the definitions, scope and organizational issues of MCS (which has taken multiple names) have evolved and are numerous. The questioning of management accounting because of its “lost relevance” contributed to the development of innovative models and the uninterrupted vitality that drives research in control today.

Research academics in management sciences from the University of Perpignan who work in the Accounting & Society group of the MRM laboratory (Montpellier Research in Management) carry out research in accounting, management control and auditing. Many of their recent work focuses on management tools, particularly in terms of MCS and performance management.

An established institution draws the focus of research attention

MCS research improves our understanding of not only what management control serves, but also to whom it is useful. To provide insights into the way in which management control is executed, a recent research project analysed the emergence of management control within a singular public organization: the French cooperation and cultural network abroad, under the Ministry of Foreign Affairs.
This organization has been in existence for more than 100 years and is relatively unknown to the French public because it operates outside of France, in almost all the countries of the world where it conducts cultural cooperation projects and actions in the broad sense, including the promotion of Francophonie. However, this unique instrument of soft power, included within program 185 “Cultural Diplomacy and Influence” of the State budget within the mission “External Action of the State”, is the most prominent cultural network in the world, ahead of other networks such as the British Council, the Goethe Institute or the Confucius Institutes.

Facing the crisis...

Over the past 20 years, this organization has suffered dramatic budgetary and staff losses, leading elected officials to refer to it as a “network in crisis”. However, for France, its strategic function remains emphasized and its employees, 6,000 cultural agents, have seen their missions expand in recent years, particularly towards economic and tourism development. How has this unique but universal organization, both functional and yet at risk, adapted, renewed and redefined itself?

... by mobilizing its internal actors to build a new MCS

This research showed that the implementation of the LOLF (Constitutional by law No. 2001-692 of August 1, 2001 of the Budget Act and part of the “New Public Management” trend), within the context of limited budgets and employment restrictions, would require a new approach. In response, the French cultural network abroad called upon its forces, those serving overseas as well as those based in the central administration, to design, co-build and deploy a managerial innovation: a tailor-made MCS.

This innovative strategy transformed the idea of operationalizing cultural projects into a results-oriented process, leading to the implementation of a general “managerial” approach: the establishment of a management control to allow it to do more and better with the limited available resources. With this in mind, the essential elements of its MCS, such as management control files and budget planning, have been co-constructed with the active participation of its agents. This explains why employees without a history of management culture have been open to the use of new management tools similar to those implemented in private sector companies. In addition, this process of pooling and exchanging has made it possible to blur the divisions between the operational agents and the support functions of the organization.

Today, the “making of” a specific management control bore fruit: this organization is self-financed to nearly 70%, which secures its long-term sustainability. It now has homogenous information covering the entire network, which strengthens its organizational learning capabilities and feeds projects and annual performance reports into quantitative and qualitative data. This managerial (r)evolution of the Cultural network continues with the development of new practices, the strengthening of the use of digital technologies and a focus on good practices for the implementation of innovative projects.

References

For years, researchers at the University of Perpignan have conducted studies on the marine environment, with many of these studies focused on the environments within the Mediterranean land-sea continuum. This work investigates the natural and anthropogenic processes that control aquatic and sedimentary environments and is characterized by multidisciplinary programs (from the evolution of the coastline, to the transfer of particles from watersheds to deep canyons, to the study of fish populations). The success of this work depends on the researcher's ability to directly access the marine environment at the surface (via watercraft) or underwater (scientific diving), in order to collect the data necessary to maintain databases that are essential for cutting-edge basic research as well as for research that looks into environmental responses to societal issues (evaluation and monitoring of biological and geological resources).

Within this context, a dedicated platform known as the Marine Environment Interventions and Expertise (IEEM) emerged. The first phase in the establishment of this platform consisted of acquiring equipment followed by the construction of a building via the provision of premises by the municipality of Barcarès, allowing for the grouping and sharing of all the equipment. At the regional level, the deployment of marine instruments and vessels in the Mediterranean is becoming widespread but remains expensive and largely inaccessible. Currently, the University of Perpignan is the only institution with a fleet of small fast boats which can access shallow water areas such as lagoons along the coastal strip (6 miles of coastline - 60 m deep).

The UPVD investment in the IEEM platform's research vessels and equipment is in line with a regional context oriented towards integrated and sustainably managed coastal zones and associated water quality and sedimentary bottoms. This regional effort is a partnership...
between a variety of institutions including the Marine Reserve of Cerbère Banyuls and the Marine Park of the Gulf of Lion which spans the entire coastline of the Pyrénées-Orientales (4,000 km²). The platform is also incorporated within the different regional and national observatories (e.g. SNO-DYNALIT DYNAMIC LITTORAL and Coastline).

The IEEM technology platform is based at the University of Perpignan Via Domitia (UPVD) and is spread across two sites: the CREM antenna at the Marine Ecosystems Research Centre in Barcarès and at the University of Perpignan Via Domitia campus. The platform is split into three technical sub-platforms that are available internally to other UPVD laboratories, as well as to private companies and public institutions:

1. Fleets service (CREM - Port-Barcarès): the equipment allows access to the lagoons and to the sea at shallow depths: BWA 7.5 m semi-rigid + 150 HP Yamaha engine - Bombard semi-rigid 5 m + 50 HP Yamaha engine - 6m aluminum boat with cabin + 4T 100 HP Yamaha engine.

2. Scuba Diving Service Station (CREM - Port-Barcarès): The Diving Service is currently used for all marine research projects and for courses included within the UPVD Master 1 BEE program (‘Récollection et traitement des données en écologie’ and ‘Sciences of the Sea’. The station is also open to the university diploma (DU) program, ‘Scientific Diving in Marine Environment’.

3. Instrumentation service (Hydro/Geophysics) (UPVD - Perpignan): The study of the evolution of the coastline and the transfer of particles from watersheds to deep canyons is possible with the following instruments and equipment:
   - geophysical equipment (e.g. CMAX CM2 side scan sonar EDF (325-780 kHz), Mini Sparker SIG Pulse S1 (20-300 Joules), High precision GPS positioning (eg DGPS Ashtech Proflex 500) and an Iris Pro + mapping camera for photogrammetry of the littoral zone and river plumes
   - hydrodynamic equipment (e.g. measuring currents: ADCP RDI BB 300 kHz, ADCP RDI Sentinel 600 kHz with wave sensor, measuring variations in height of the soft substrate: NKE ALTUS 2 MHz (x3) ultrasound altimeters, and
   - sea platform POEM: a meteorological buoy located in 28m of water in front of the port of Canet at the mouth of the Tet river
   - fluvial station for continuous monitoring of liquid and solid inputs to the coastal zone.

“The success of studies on the marine environment depends on the researcher’s ability to directly access the marine environment at the surface (via watercraft) or underwater (scientific diving).”
Bio-Environnement is a technology platform dedicated to life sciences which seeks to provide high-tech support to all of the University of Perpignan’s biological laboratories, and to regional academic partners and private partners that have developed high-tech projects.

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Bio-Environnement is a technology platform dedicated to life sciences which seeks to provide high-tech support to all of the University of Perpignan Via Domitia’s (UPVD) biological laboratories (BAE, CEFREM, CRIOBE, IHPE, LGDP), and to regional academic partners. In addition, Bio-Environnement offers its services to private partners that have developed high-tech projects, who may benefit from the technology and the advanced scientific skills provided by our laboratories. The platform was created thanks to two successive CPER grants (Tecnoviv - CPER 2007-2013; Bio-Environnement – CPER 2015-
Because these technologies generate a large amount of data, a close connection with the existing bioinformatic facility is essential. This facility offers sequence analysis services thanks to a computing cluster (360 cores) implemented within the campus, allowing for a quick and comprehensive analysis of millions of sequences, simultaneously.

In 2020, a new dedicated building, located adjacent to most of the biology laboratories, will host the Bio-Environnement platform. This building will enhance the platform's accessibility for all users and adapted workspaces will improve the services provided. A confined rooftop greenhouse will also allow us to develop new services in plant cultures. The platform will offer tightly controlled conditions in three independent compartments, with the ability to create different climates (from tropical to temperate conditions), with control over experimental parameters including the regulation of temperature, light intensity, day length and relative hygrometry. This platform is ideal for projects on plant physiology and ecophysiology in the context of global climate change.

The on-going development and expansion of the Bio-Environnement platform offers technologies that are essential for today's biological research. Because these technologies are rapidly evolving, we will maintain our focus on new and emerging technologies in order to continuously adapt our services and implement novel methods when necessary. This effort will help to optimise the efficiency and the autonomy of UPVD laboratories involved in the study of living organisms and their adaptation to their environment.

2020) that supported the development of genomic, bioinformatic and cell biology facilities.

The cell biology facility includes a confocal fluorescence microscope, which allows for the precise imaging and quantification of biological events, ranging from the micrometric (subcellular compartment) to the centimetric (whole small organisms or parts of complex organisms) scales. Today, these tools are essential to decipher functional biology, by studying the distribution and the dynamics of biological molecules. A fluorescent cell sorter is also available, for cell sorting and counting.

The genomics facility of the Bio-Environment platform was completed in 2018 with the addition of NGS (Next Generation Sequencing) technology, which provides fast and flexible access to the latest nucleic acid sequencing technologies for researchers and students from within the UPVD campus as well as from outside. Over the past decade, new NGS systems have been introduced that enable DNA (DeoxyriboNucleic Acid) and RNA (Ribonucleic Acid) to be sequenced more quickly and cheaply than previous methods and with tremendously high throughput. As such, these innovations have revolutionised the study of biology across all domains, from functional biology to ecology and evolution. The Bio-Environment NGS facility is fully equipped with two sequencing machines that allow millions of sequencing reactions to be performed at the same time. This newly established facility has already provided sequencing data for a wide variety of organisms and topics such as coral reef response to global change, modification of bacterial communities in oyster diseases and molecular mechanisms involved in plant development.

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Bio2Mar, the Marine Biological and Biotechnological platform, is a multi-institutional platform (CNRS, Sorbonne University, University of Perpignan and Pierre Fabre laboratory), supported by the Occitanie Region [Grand Plateau Technique Régional (GPTR)], and is a component of the European Marine Resource Centre (EMBRC). It brings together expertise (researchers, engineers, technicians) and equipment in the field of global analysis of metabolism. The platform is involved in several European and ANR projects, and provides support to local, departmental and regional companies. Bio2Mar is a member of the Réseau Francophone de Métabolomique et Fluxomique and a partner of the national infrastructure in metabolomics & fluxomics.

Bio2Mar provides public research organisations and private companies with high-tech tools and skills to promote marine biodiversity. The platform is divided into four units:
1- Biodiversity and Molecular Biology,
2- Microbiology and Culture,
3- Biomolecules and Environmental Chemistry,
4- Secondary Metabolites, Xenobiotics & Metabolomics.

Units 1, 2 and 3 are located at the Oceanological Observatory at Banyuls/mer, and unit 4 is located at the University of Perpignan.

Bio2Mar is currently working to acquire IBISA labelling accreditation and is taking the steps necessary to earn ISO 9,001 certification.
The Secondary Metabolites, Xenobiotics & environmental Metabolomics (MSXM) unit

The detection, identification, and quantification of biologically active compounds from complex matrices are challenging and time-consuming tasks for life science researchers. Advances in this field have generally been related to advances in analytical chemistry techniques. One major recent development is the emergence of metabolomics, which can be considered as the comprehensive analysis of low molecular weight metabolites (<1500 Da) in given organisms in different physiological states.

Gas Chromatography (GC), or Ultra High Performance Liquid Chromatography (UHPLC), coupled with Mass Spectrometry (MS) are two extremely versatile analytical techniques that combine the physical separation capabilities of gas or liquid chromatography with the mass analysis capabilities of mass spectrometry. GC-MS and LC-MS are powerful techniques used for many applications because they offer high sensitivity and specificity.

Nuclear Magnetic Resonance (NMR) spectroscopy is one of the principal techniques used to obtain structural information of molecules. Detailed information on the topology, dynamics and three-dimensional structure of molecules in solution and in solid state can be obtained.

The capacity for NMR spectroscopy to be highly reproducible and quantitative, and for mass spectrometry to detect multiple compounds with high sensitivity, make them key tools in metabolomics. Metabolomics, together with other “omics” data acquisition technologies, open up new perspectives for systems biology studies and a holistic approach to understanding the fundamental rules that govern the dynamic functioning of a cell or an organism living in a changing environment.

MSXM, hosted at the CRIOBE on the University of Perpignan campus, develops and provides state-of-the-art tools and equipment (NMR, UHPLC-HRMS, GC-MS, ...) to the scientific community as well as expertise for system-level investigations of metabolism, including both metabolomics and structure elucidation of secondary metabolites, within the primary fields of application: chemical ecology, metabolomics applied to marine and aquatic environments, identification of valuable bioactive compounds in the pharmaceutical, cosmetic or agrochemical sectors, and environmental chemistry with pollutant analysis.

The joint use of LC-MS, GC-MS and NMR allows the analyses to be extended and to accelerate the identification and quantification processes.

Some examples of projects developed thanks to the MSXM unit

- Coralgene (Genomic complexity of the coral holobiont across the Pacific): ANR (2018-2020), Tara-Pacific expedition (2017-2018). This very ambitious project will reveal a massive amount of cryptic and novel biodiversity, will shed light on the complex links between genomes, transcriptomes, metabolomes, organisms, and ecosystem functions in coral reefs, and will provide a reference for the biological state of modern coral reefs for the large research community working on coral adaptation to global and regional stressors.

- All Dream (Caractérisation de composés bioactifs issus de la diversité microALgale par métaboloMique différencielle et Déréplication assistée par mise en REseAu Moléculaire): in partnership with GreenSea and Akinao (2017-2020). All Dream aims to develop an innovative tool adapted to the analysis of the chemical diversity of microalgae and the evaluation of their potential as biocontrol agents.

- Ecosystem impacts; Cyanobacteria, CO2 sequesters and producers of “keystone” molecules that structure coral reef ecosystems: Ministère de la Transition Écologique et Solidaire, FRB, Fondation Total (2017-2019). One of the three objectives of this project seeks to evaluate the impact of acidification and temperature increase on chemical mediation and thus attraction/repulsion phenomena in our model ecosystem, coral reefs.

- SensoCao: in partnership with CEMOI (2016-2019). The project should make it possible to highlight the existence of soil effects, vintages or harvests in the aroma of Ivorian cocoa and to identify its biomarkers.
The EnRMAT research platform at the University of Perpignan Via Domitia provides state-of-the-art equipment for alternative energy research. Specifically, EnRMAT provides human resources and technical solutions adapted to the characterisation of materials for energy (C2M), the tests of solar thermal and photovoltaic products and the calibration of associated measuring instruments (CESP). It offers integrated services and analyses to public laboratories and to industrial companies (large groups and start-ups) to support them in their innovation projects: development of new materials, solar equipment, development and energy processes (capture, energy conversion, performance, certification).

EnRMAT platform consists of two technical platforms: C2M and CESP.

Sub technical platform “Scanning Electron Microscopy and Microanalysis”:
This sub-platform features a Hitachi SEM-FEG S-4500 field-effect scanning electron microscope (SEM) and its associated preparation equipment for high-resolution surface imaging and physico-chemical EDS analysis of samples. This equipment is intended for research laboratories at the UPVD and for external public laboratories, as well as for private companies, and allows for the characterisation of materials including biological and geological samples.

Sub technical platform “Physico-chemical properties of surfaces and materials”:
This sub-platform has privileged access to the PCM characterisation platform which is a part of CNRS’s UPVD-based PROMES
laboratory, and is equipped with several surface imaging technologies (AFM, 3D profilometry and optical microscopy) which are capable of mapping specific surface properties (electrical, magnetic, mechanical ...), to study surface states and their morphologies. It also includes mechanical characterisation techniques (nanoindentation, tribometer and scratch test) and chemical techniques by infrared spectroscopy.

Sub technical platform “Test on solar thermal collectors”: This sub-technical platform is comprised of two specific calibration benches: one for autonomous CO2 sensors and the other for temperature probes.

Implications for EnRMAT in research projects:
The EnRMAT platform is involved in several research projects and also participates in various European and international standard and certification networks.

The technical platform CESP is included within an R&D project supported by ADEME that is working to develop standardized methods to determine the energy performance of PVT hybrid solar collectors and individual hybrid solar systems for the production of domestic hot water and space heating. PVT hybrid solar collectors combine on the same collector photovoltaic cells to produce electricity and a thermal recovery exchanger to produce heat.

The technical platform C2M collaborates with several UPVD partner laboratories, and is integrated in several national, European and international research projects (ANR, PIA, Horizon 2020), as well as in external collaborative projects (laboratories and large groups). It is recognized as an active member in several networks, notably through the CNRS Mission for Transversal and Interdisciplinary Initiatives (RéMiSol, RCCM) and regional and national groups (Club MEB, GN-MEBA ...).
The Experimental Ecology Research Station CORAIL

The Experimental Ecology Research Station (CORAIL), was established on the island of Moorea in French Polynesia in January, 2016. It is a part of the Centre de Recherches Insulaires et Observatoire de l’Environnement (CRIE) and is the newest of the 5 research stations included within France’s RéNSEE Experimental Ecology Research Station network. From mountains to corals, the mission of RéNSEE’s experimental ecology stations is to acquire general and multidisciplinary knowledge on the study of the link between the dynamics, evolution and functioning of ecosystems and biodiversity. Their objective is to propose scenarios for the conservation and management of natural resources in relation to the changing needs of human societies.

CORAIL: Environmental Context and Issues

Globally, coral reefs are home to 25% of marine fauna and flora while covering only 0.2% of marine surfaces. In addition to their biodiversity, coral reefs are an economic, social and cultural resource that provide...
CORAIL provides a number of facilities that enable in vivo and in situ experiments on corals and, more broadly, on coral reef ecosystems. These facilities make it possible to manage and control the variables related to climate change.

**CORAIL: Services**

Integrated within the CRIOBE, CORAIL has access to the CRIOBE’s facilities, such as accommodation capacity for 30 people, a SCUBA diving service, 3 vehicles, 4 boats, along with internet facilities at the reception desk and a laboratory equipped with basic equipment.

In addition to the marine station facilities, CORAIL provides:

- in vivo experiment spaces where the temperature - pH - light cycles can be monitored and programmed in a controlled aquatic environment,
- large-volume outdoor basins for larger experiments and also for monitoring temperature - pH cycles,
- a coral nursery with cutting beds which can be customized according to experiments,
- an optical laboratory,
- a service of Chemistry analysis,
- a service of Molecular Biology analysis,
- training rooms : from small to large (amphitheater).

**CORAIL: Technological Innovation**

In addition to the services currently provided by CORAIL, a new cutting edge in situ research platform is currently being designed. This platform will essentially consist of a modified barge that will be temporarily positioned on pilings, directly on the coral reef where equipment can be deployed directly for in situ experimentation. The project will be organized around 4 elements:

- a network of in situ sensors with continuous recording, relayed on the internet in real time,
- a network of in situ cameras for real-time observations on behaviors, activities, etc.,
- a coral nursery and other model organisms (clams, clown fish, etc...),
- in situ controlled environment greenhouses to integrate environmental changes directly into the environment.

Designed on the basis of offshore oil techniques, this tool is innovative because it will hover above the reef, will have an energy and operational autonomy of nearly 3 months and will accommodate 3 staff 24 hours/ 7 days a week, and 10 people per day. It can also be transported in container mode with an internal structure that allows it to be lifted like a container and loaded on a ship to operate in the atolls of Polynesia. The objective is to have a flexible system that can be adapted to all coral reef research in Polynesia.

**CORAIL: Access the Services**

To access CORAIL services, project proposals must be submitted via email to station.corail@cnrs.fr. These proposals will then be reviewed by the CORAIL steering committee who will then make their decision to accept or reject the proposal according to the following criteria: scientific interest, service requirements (equipment, laboratory and farming spaces and materials, offices, accommodation, vehicles, etc.), compatibility with ongoing projects, and the business plan.
Miro Translate is a hybrid cloud-based subtitling platform that is capable of producing captions and subtitles for video lectures. This tool is being developed by Laura Cacheiro Quintas and Samuel Calegari within an eLearning research project conducted by the MIRO.EU-PM Programme (ANR-11-IDEFI-0027), which is part of the French National Research Institute (ANR) Initiatives for Excellence in Innovative Training (IDEFI). Miro Translate is the focus of an ongoing doctoral thesis co-directed by the University of Perpignan Via Domitia in France and the University Jaume I in Spain.
In both the automatic production of captions and subtitles, the machine output is displayed on the user interface, where subtitlers have access to a set of functionalities for post-editing. To identify the necessary editing options, an analysis of a large corpus of explicit extratextual subtitling norms both from the academic and the professional industries was conducted. Sociocultural and temporal criteria were applied to select the norms comprised within the corpus since subtitling standards are culturally-dependant and reflect the expectations of the target audience. The results of this study identified four groups of functionalities related to (a) professional requirements, (b) spatial and formatting requirements, (c) time and duration requirements and (c) target text editing requirements. The picture below shows Miro Translate’s user interface.

**Background**

Several factors contributed to the development of Miro Translate. First, the growing number of students enrolled in distance learning, including those with disabilities. In this regard, most European countries have ratified the Convention on the Rights of Persons with Disabilities (2006) and have adopted domestic regulations in favour of accessibility. Second, the role of audiovisual content in higher education, in particular in eLearning contexts. Studies show how audiovisual content has a positive impact on the effectiveness, commitment and satisfaction of eLearning students (Zhang et al., 2006).

Video lectures that display captions and subtitles have become a cost-efficient option for the distribution of a common document in multiple languages. The growing demand for captions and subtitles requires specific tools adapted to the needs of eLearning distributors. Miro Translate was created in response to the challenge faced by higher education institutions of implementing specific measures to ensure equal access for all students, including those with hearing impairments.

**Miro Translate platform**

This hybrid solution allows users to create their own profile and to save different subtitling projects. Artificial Intelligence applications provided by the cloud computing platform Microsoft Azure help users to perform automatic tasks. First, to generate automatic captions, the platform uses Automatic Speech Recognition technology and speech transcription (speech-to-text) helping subtitlers to speed up the text input task. Second, to generate automatic subtitles, Miro Translate uses the Microsoft Translator API to perform Neural Machine Translation (text-to-text).

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**Conclusions**

The output options are another key feature of Miro Translate since potential users are teachers, administrative or technical staff whose needs and technical knowledge vary. Users choose from (1) webVTT or SRT files if they wish to integrate the output files within a website or a video player; (2) TXT or PDF files if they wish to use the audiovisual content as notes; (3) MKV files if they wish to watch videos offline, and (4) a public URL if they wish to publish a video via a standalone player.

The Miro Translate platform creates captions and subtitles for pedagogical videos and develops synergies between Artificial Intelligence applications and human subtitlers. This tool presents an intuitive interface designed in response to teachers needs and demands. Subtitlers have at their disposal different functionalities, error rate indicators and help messages to facilitate the editing process and to comply with international subtitling regulations, including deaf and hard-of-hearing subtitling standards. In addition, Miro Translate constitutes a pedagogical tool that helps students to improve their foreign language skills and to better understand and retain information since the message is simultaneously received through the visual and the auditory channels.
ART-Dev: Actors, resources and territories in development, UMR 5281 CNRS-UPVD-UPVM-CIRAD-UM

Geography: dynamics of urban and rural territories, sustainable development, local development in northern and southern countries.

BAE-LBBM: Biosensors, analysis, environment, team of USR 3579 CNRS-UPMC

Environments: study of the anthropogenic impacts on the water quality, biosensors and new analytic tools.

CDED: Centre for economic law and development, EA UPVD 4216

Law: study of markets, economic law, environment law.

CEFREM: Centre of education on research mediterranean environments, UMR 5110 CNRS-UPVD

Geosystems and aquatic ecosystems: functioning and evolution of the earth-sea continuum under the effect of the global changes.
CORHIS: Communication, human resources and social intervention, EA UPVM-UPVD
Sociology: communication, science of intervention and social transformation.

CRESEM: Centre for research into societies and environments in the Mediterranean and beyond, EA 7397 UPVD
History, art history, literature, sociology, comparative law: history, arts and heritages of mediterranean societies.

CRIOBE: Centre for island research and environmental observatory, USR 3278 EPHE-UPVD-CNRS
Coral reefs: study of coral reefs, analysis of the origins of biodiversity and the ways in which it is maintained, chemical ecology, the characterisation and biological activities of new metabolites. Located in Perpignan, France and in Moorea, French Polynesia.

DALI LIRMM: Digits, architectures and computer softwares, project of the UMR 5506 CNRS-UM
Computer science: numerical accuracy, high performance computing and IT security.

ENTROPIE: Tropical marine ecology of the Pacific and Indian oceans, UMR 9220 IRD-CNRS-UR

FAiD: Development aid federation, FED 4264 UPVD-IRD
Development aid: cross-functional body for development aid.

HNHP: Natural history of the prehistoric human being, UMR 7194 CNRS-MNHN-UPVD
Prehistory: naturalistic and multidisciplinary study of Prehistory rooted in a heritage approach, the keywords of which are human lineage, environments, behaviours and long term. Excavation site: Caune de l'Arago (Homme de Tautavel -560 000 years).

IHPE: Hosts, pathogens, environments, interactions UMR 5244 CNRS-UPVD-IFREMER-UM
Biology and ecology: study of various interaction biological systems involving several invertebrate species of medical, veterinary, economical or ecological interest.

IMAgES-EspaceDev: Modelling and analysis in geo-environment, team project of the UMR 228 IRD-UM-UAG
Environment: environmental questions considered on both macroscopic and microscopic scales.

LAMPS: Laboratory of mathematics and physics, EA UPVD 4217
Mathematics and physics: modelling, analysis and digital simulations with applications in mechanics, physics, chemistry and engineering sciences.

LEPSA: Performance, health and altitude European laboratory, EA UPVD 4640
Psychology and physiology: Development of research focusing on performance, moderate altitude and health. Located at 1850 m above sea level, next to the national centre of training in altitude at Font-Romeu.

LGDP: Plant genome and development laboratory, UMR 5096 CNRS-UPVD
Biology: research into the mechanisms for reprogramming plant gene expression and restructuring plant genomes in stress conditions.

MRM: Montpellier Research in Management, EA 4557 UM-UPVM-UPVD-MBS
Economy and management: research into management sciences and mangement of organisations.

PROMES: Processes, materials and solar energy, UPR 8521 CNRS - convention UPVD
Solar energy: study of solar energy, particularly concentrated solar energy and all of its applications. Located in Perpignan (France), Odeillo (solar furnace) and Targassonne (Thémis solar tower), France.