

Programme de la journée

9h-9h30 : Accueil

9h30-9h45 : Inauguration de la journée

9h45-10h45 : Communications orales – Session 1

10h45-11h : pause café

11h-12h: Communications orales – Session 2

12h-13h30 : Repas

13h30-14h : Présentation posters en amphi

14h-15h : Conférence de Lionel Scotto d'Appolonia

15h-16h : Session posters

16h : Concours photo, Remise des prix, Conclusion

Communications orales – Session 1

**Proposed phylogenetic inference and haplogroup determination in *Echinococcus multilocularis* from whole mitochondrial DNA sequencing**

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*Echinococcus multilocularis* is a flatworm of the family Taeniidae responsible for alveolar echinococcosis, a rare but severe disease mimicking a liver cancer. The disease usually occurs in the cool and high regions of the northern hemisphere, mainly in China but also in the historical European cradle including the Franche-Comté Region. The study of the genetic polymorphism of this parasite has so far been carried out on the basis of a few mitochondrial/nuclear genes or nuclear microsatellites.

We propose to establish phylogenetic inference from whole mitochondrial DNA sequencing of *E. multilocularis* samples from various endemic areas worldwide and to define haplogroups in French patients in order to make comparisons between genetic and clinical data.

The French human samples were collected by the National Reference Centre for Echinococcoses, the other samples (human, rodent, dog samples) came from collections of previously published data (Alaska, Canada, Japan, China, Spitzberg-Norway, Switzerland, Belgium, Germany, Sweden, Luxembourg). Sequencing was performed by Illumina technique. The analysis of the raw data was performed using a workflow created on the Galaxy platform.

Seventy-nine samples were sequenced; 44 haplotypes were emphasized from haplotype network analyses and three major haplogroups stand out (named Arctic, Asia-North America and Europe); three subgroups can be distinguished in France, one corresponding to the most recent cases found in the west of the country.

Genetic polymorphism analysis performed on the whole *E. multilocularis* entire mitochondrial DNA allowed to reach a better definition of the existing groups at the continental level. For French patients, three groups stand out and will permit in a second time to compare genetic and clinical data.

Keywords: *Echinococcus multilocularis*, NGS, Illumina technique, mitochondrial genome, phylogenetic inference

**Essential oils/antibiotics combination on *Pseudomonas aeruginosa* strainsisolated from the lungs of cystic fibrosis patients**

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The use of essential oils (EOs) is a common practice in patients with cystic fibrosis (CF) to treat pulmonary infections with *Pseudomonas aeruginosa*, but also to other pathogens such as *Staphylococcus aureus.* However, our team has shown that cinnamon and lemongrass EOs have an antagonistic action to that of antibiotics (Tetard *et al*., 2019; 2021). As tea tree, eucalyptus, ravintsara, clove and thyme EOs are preferentially used by CF patients, we tested the effect of these EOs on *P. aeruginosa* CF strains, alone and in co-culture with *S. aureus*.

*P. aeruginosa* strains were isolated through a longitudinal surveillance protocol of CF patients coming from the University Hospitals of Besançon and Montpellier at different stages of the disease; *S. aureus* strains were co-isolated from the same samples. Antibiograms and determination of the Minimum Inhibitory Concentrations (MICs) allowed to compare the antibiotic susceptibility of the strains with and without EO extracts. Calibrated *P. aeruginosa/S. aureus* co-cultures were exposed to EO-antibiotic combinations and monitored over time by counts of both species on selective media (*Pseudomonas* Isolation Agar and Chapman).

Our results showed that some natural compounds extracted from EOs (eugenol, terpinen-4-ol, and carvacrol) modify the resistance of *P. aeruginosa* to antibiotics (antagonism or synergy), whereas others (γ-terpinen) have no effect. In addition, in the same patient, primary colonization strains respond differently to EOs than those isolated later in the course of the disease. Finally, *S. aureus*, usually hypersusceptible to EOs, is able to maintain in mixed culture with *P. aeruginosa*, probably because of *P. aeruginosa* metabolic capacities. We are currently testing the effect of EOs directly on sputums and studying their impact on the pulmonary flora.

Keywords: *Pseudomonas aeruginosa*, essential oils, *Staphylococcus aureus*, antibiotic resistance

**Contribution of French Peatlands to the Carbon Neutrality National Goal in 2050**

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Peatlands are natural carbon sinks, as peat results from the accumulation of organic matter little or not degraded. In Europe, nonetheless, 50% of peatlands are considered in a damaged state (Tanneberger et al. 2021) and release important amounts of CO2 into the atmosphere (5-30 eqCO2.ha-1.yr-1, Bonn *et al*. 2014), contributing to global warming. Restoration of the hydrological functionality of peatlands has proved to be an efficient tool to avoid these emissions. In France, a ministerial report (Tuffnell & Bignon 2019) emphasized the need for peatlands'integration in National Low Carbon Strategy, targeting carbon neutrality by 2050. To do so, a better knowledge of French peatlands, total carbon stocks and vulnerability of these stocks is required to help decision makers and managers in prioritizing areas for restoration. Old and rough estimates show that French peatlands would represent 100,000 ha, i.e. around 0.2% of the national surface area, and the only inventory of French peatlands made in 1949 provides a first total carbon stock estimation of 101.6 MtC for peatlands inventoried at that time, with main stocks being located in lowland regions such as Normandy or Picardy. We have however no idea of the current situation of French peatlands and carbon stocks.

The aims of our project are to build a decision-making tool in collaboration with stakeholders concerned, using a bottom-up approach based on regional data aggregation (localization, thicknesses, physical-chemical parameters of peat...). The implementation of a typology based on operational indicators (water depth, typical peatland vegetation...), revealing the state of degradation of French peatlands, will tell us which sites are the most disturbed and main GHG emitters. These data will finally be crossed with prioritization criteria such as property status, land use or price of land, which dictate restoration costs thus influencing financial and administrative possibilities to implement a restoration action on a site. By highlighting the localization, distribution and status of peatlands and their carbon stocks, this project will provide a better understanding of French peatlands and propose a participative and functional decision-making tool for policy-makers and natural spaces managers.

Keywords: peatland, peat, carbon stock, GHG emissions, restoration

**Diffusion of H2 and O2 produced by self-radiolysis of tritiated water adsorbed onto zeolite 4A**

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Tritium is the most common radioactive isotope of hydrogen, having a half-life of 12.32 years. It is produced naturally in low amounts by the interaction of cosmic rays with the upper atmosphere, as well as during various processes in the nuclear industry. Tritium is a low-energy β emitter which poses low risks to human health when exposed externally. Nevertheless, its release in the environment must be controlled. The chemical properties of tritium, being similar to the more common isotopes, make it impractical to store in gaseous form. It is thus catalytically oxidized to tritiated water (HTO or T2O), in turn chemically similar to water. This tritiated water is then adsorbed onto a hydrophilic microporous molecular sieve, zeolite 4A, as an additional safety measure.

Complications arise due to the self-radiolysis of free tritiated water, which causes the release of hydrogen (H2) and oxygen (O2). Such a mixture is problematic inside of a closed vessel, and a catalyser must be added to recombine the hydrogen and oxygen into water. Radiolysis is also observed with zeolite 4A saturated in tritiated water. However, it has been found that at lower water loading ratios, the emitted H2 and O2 could be readsorbed into the zeolite. It is hypothesized that the zeolite acts as a catalyser itself, and that recombination happens in this case as well.

The diffusion of H2 and O2, as well as water and other species, is suspected of playing a role in this recombination process. *Ab initio* molecular dynamics (AIMD) simulations of the diffusion of various mixtures of these species were done. These trajectories show a threshold in the diffusivities, which is consistent with experimental data of recombination inside zeolite 4A.

Keywords: Tritium, Water radiolysis, Zeolite 4A, Density functional theory

Communications orales – Session 2

**Interactions between Norse farmers and their environment in Greenland: new insights of the Western Settlement**

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At the end of the 10th century Scandinavian took advantage of the Medieval Warming Period to settle in Greenland until the middle of the 15th. Norse famers imported with them agropastoralism in Greenland and were able to make a long-distance trade with Scandinavia, especially walrus ivory. The Eastern Settlement (60°N) was the largest settlement and probably the best studied by both archaeologists and paleoenvironmentalists. At higher latitude (64°N), the Western Settlement, in the actual Nuuk’s fjord, was smaller and abandoned 100 years before the Eastern settlement. Human activities were constrained by a harsher climate, forcing an adaptation towards hunting and fishing activities. Previous studies have not clearly evidenced human activities in this settlement, suggesting an important part of hunting in the economy. Therefore, high-resolution multi-proxy analyses of lacustrine sequences performed in Itinera and Pingu lakes, provide a first glimpse of climate change and human-environment interactions in the Kapisillit area. The Norse settlement results in subtle vegetation change between 1100-1250 cal. AD. Indeed, fire events are contemporaneous of this first *landnám* with clearing of the shrubby heath and increase in herbaceous plants. Coprophilous fungi spores do not really evidence any grazing pressure and decreasing values could be interpreted in terms of hunting wild herbivores. As soon as the middle 13th century, human impact disappears with the first cooling of the Little Ice Age. However, the definitive abandonment during the 14th, according to archaeological and historical data, remains unclear on the basis of the paleoenvironmental approach. Then, we can compare other human footprint through vegetation changes like Inuit hunters that were also present both in Greenland and Canada.

Keywords: Palynology, micro-charcoals, Greenland, Norse landnám, Western Settlement, human impact, anthropogenic indicators

**Incubation behaviour and importance of extended recesses in an Arctic shorebird: The Sanderling (*Calidris alba*).**

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Sanderlings (*Calidris alba*) undertake a spectacular long migration to reach the Arctic where they breed during the short summer. In this harsh and unpredictable environment, incubation is challenging due to high energetic demands and variable resource availability. Incubating birds hence face a time allocation compromise between two fundamental and exclusive behaviours: incubation and foraging. In-bout and off-bout periods are known to be highly variable between individuals, leading sometimes to exceptionally long recess periods. Until recently, extended incubation recesses were considered to occur infrequently and their quantification and determinants remain poorly documented. We used thermoprobes placed in the nest cups to monitor the incubation behaviour of uniparental Sanderling at Hochstetter and Karupelv, NE Greenland, during eleven breeding seasons (2011-2021). This allowed us to determine the occurrence of extended recesses, quantify the inter-individual variation in the incubation patterns, and define the causes and consequences of this variation for these income breeders (i.e., where individuals rely on available resources during breeding, with only very short-term energy reserves). Extended recesses are a feature of uniparental nests. Their probability of occurrence decreases with increasing temperatures, as well as their duration, also modulated by the body condition of the individual. Birds seem to switch from reproduction to self-maintenance under stressful conditions (environmental or intrinsic ones). They could represent a powerful mechanism allowing incubating birds to cope with energy deficit under challenging conditions, but could have both short-terms consequences (i.e., lengthening of the incubation period and increase risk of predation) and long-term consequences (growth and reproductive success).

Keywords: Arctic shorebirds, Sanderling, Incubation behaviour, Extended recesses, Parent-offspring trade-off.

**Hydrogeological modelling of the Arcier karstic hydrosystem – TRANSKARST Project**

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Karstic aquifers represent a major drinking water reserve of the Earth as 25% of world population use it. Its vulnerability, due to a complex structure, combined with the diversity of anthropogenic pressures and the issue of climate change strongly impact the water quality. So, their study is crucial to answer these societal, economic, and ecological challenges, both at large and small scales.

The TRANSKARST (TRANSdisciplinary research on KARST) research consortium, gathering scientists and water resource managers, is dedicated to the study of the Arcier karstic spring (Eastern France). An holistic approach based on multidisciplinary studies is carried out to the Arcier's catchment aiming at improving our understanding of the origin, the pathways and the impact of mineral, organic and microbiological contaminations affecting regional karstic aquifers.

The first step allows to have a comprehensive view of the geological structure and the hydrodynamical behaviour of the Arcier hydro system. Since February 2020, a rigorous field work have been done to collect numerous data: structural geology, geophysics (ERT, gravimetry and passive seismic), hydrodynamics (rainfall, water level/flow rate), physico-chemical (electrical conductivity, temperature, turbidity, major and traces ions, isotopes) data and artificial tracer tests.

Detailed studies of the geological structure and the fracturation network were compiled in a 3D numerical model (3D Visual Karsys). The first results show a new vision of the local geology: the watershed is delimited by complex fold and thrust structures, located on both sides of a tabular plateau. An intensive fracturation, linked to its tectonic story and the karstification, is observable. This first conclusions combined with hydrodynamic data, throughout a rainfall/flow rate analysis, and tracer tests, show a direct link between the geology and the karst reactivity. Then the model will be improved to simulate the comportment of water bodies and their circulations, to confirm the first conclusions.

**Ancient sedimentary DNA as indicator of past disturbances in boreal forests**

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Boreal forests occupy 30% of the global forest area and provides many ecosystem services essential to the development of societies (water resources, timber production, maintenance of the global climate balance). Their functioning, structure and dynamic are intrinsically linked to natural disturbance regimes, particularly insect outbreaks and fire. While the dynamic of fire regimes in the face of climate change are fairly well understood, insect pest outbreaks are poorly known, especially spruce budworm (*Choristoneura fumiferana*, SBW), as well as the interaction of these two disturbance regimes. This project therefore aims to answer the following question: how have the cross-dynamic of these two disturbance regimes responded to past and present climate changes? Paleoecology, through its long-term approach, allows a better understanding of these dynamics. The project will be conducted at large spatial scale in different bioclimatic domains of Quebec, selected as key ecosystems for the understanding of fire/epidemic dynamics. The objectives of our project are: (i) to develop a methodology for reconstructing TBE epidemics, over a 1500-year period thanks to qPCR quantification of sedimentary DNA, in order to obtain a complete warming - cooling - warming cycle. (ii) Investigate the interactions between these two natural disturbances, over the last 1500 years, using sedimentary DNA and macro-charcoals. (iii) To evaluate the changes in macroinvertebrates communities (diversity and assembly rules) during SBW outbreaks, and the role of these communities in regulating SBW epidemic cycles, using *Next Generation Sequencing*. This project opens the perspectives of a better understanding of the cross dynamics of epidemics/fires in the face of various past climatic changes and would thus allow a better understanding and prediction of the impacts of climate warming on the forest dynamics of Quebec.

Keywords: Disturbance ecology, Fires, Insect pest outbreaks, Paleoecology, Sedimentary DNA, Spruce budworm

Posters

**Interaction between geological and ecological factors in the determinism of epidemics along the African rift, case of Lakes Kivu and Tanganyika**

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Cholera is a highly pathogenic bacillus that has been endemically affecting African Rift populations since the 1970s. Despite significant advances on the role of volcano-tectonic activity and lakes in the dynamics of cholera epidemics, the mechanisms that allow *Vibrio cholerae* 01 to sustain itself during inter-epidemic periods and to spread along the hydrological continuum of the Great Lakes Kivu and Tanganyika remain unclear.

The objective of this study is to investigate the geological (including geomorphological, hydrogeological, and volcano-tectonic activity) and ecological causalities of the temporal dynamics and spatial distribution of cholera outbreaks along Lakes Kivu and Tanganyika.

The study will first synthesize existing data on the chemistry of the large lakes (temperature and salinity/conductivity, the two key parameters for the survival of the bacillus), the planktonic communities (phytoplankton and zooplankton, host organisms of the bacillus in its aquatic phase) and the cholera cases, on both sides of the lake.

In parallel, a physico-chemical, planktonological and cholera case monitoring is planned at the level of Bukavu. In this context, an attempt will be made to obtain cross-sectional data on the quality of the lake's surface water during an outbreak and in the lull phase.

The link between the number of cholera cases and environmental variables will then be investigated, explicitly considering the upstream-downstream continuum and the eastern and western shores of the lakes.

Keywords: cholera, health ecology, hydrogeology, volcano-tectonism, lake Kivu, lake Tanganyika

**Role of rhizospheric microorganisms from a mercury-enriched brownfield site**

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In environments polluted by anthropogenic activities, the roots represent one of the preferred entry pathways of soil pollutants into plants. The microorganisms of the rhizosphere could therefore play a major role in promoting their growth on contaminated soil. The objective of the thesis is to improve the phytoremediation potential of woody species that have grown on a brownfield site contaminated with mercury (Hg), one of the most toxic metals, by studying the rhizospheric microorganisms associated with them.

This project will characterise these communities of microorganisms by shotgun metagenomics, isolate Hg-tolerant bacteria and fungi by culture-dependent approaches and reintroduce them into the root environment in order to assess their potential to promote plant growth. The ultimate objective is to promote the production of biomass on soils that cannot be used for agriculture. The Hg transfer and accumulation pathways will be studied in the isolated candidates in order to improve knowledge of the mechanisms involved in Hg resistance. The project also aims to assess the Hg potential dispersion in the environment through the development of an innovative biomonitoring method based on the engineering of fluorescent biosensors.

Keywords: mercury soil contamination, rhizospheric microorganisms, functional characterization, metagenomic, bioremediation, environmental biomonitoring

**Adaptation of plant root exudates to a multi-contaminated soil in a context of phytoremediation**

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The impacts of anthropic activities on soil, especially contamination that are resulting, has many negative consequences on ecosystem functions. To evaluate the ecological consequences of soil degradation, it is crucial to improve our knowledges on soil biota interactions and the impacts of their relations with metal and organic contaminants. The management of contaminating wasteland with nature-based solution (NBS) to limit the environmental impact of contamination is becoming attractive. To improve the efficiency of these approaches, one of the key factors is the ability of species to adapt to the local edaphic conditions. Plants are producing a wide variety of chemicals that are released to the soil compartment to recruit beneficial microbes that are able to protect plant against stress caused by contamination. If the interactions between plants and microorganisms are described in soil with mono-contamination, few data are available in case of multi-contamination. The present study aims at identifying the variation in root exudate profiles of a plant species exposed to either trace elements (TE), or polycyclic aromatic hydrocarbons (PAH) or both. Our results highlighted significant variations in the production of some organic acids, such as isocitric acid that was released in TE-contaminated soils at higher amounts as compared with PAH-contaminated soils, control or multi-contaminated soils. Moreover, fumaric and malic acid releases decreased in comparison to control under PAH exposure. These variations are linked to the modulation of rhizospheric enzymatic activities, especially protease and phosphatase. These results demonstrate the ability of plants to modulate their root exudation profile when exposed to multiple pollutants. The final outputs of this work will highlight the mains biological processes involved in the restoration of soil quality to improve the ecological parameters of contaminated soils.

Keywords: Root exudates, multi-contamination, phytoremediation, microorganisms

**Conservation of the Eurasian lynx (Lynx lynx) in Western Europe: investigation of the population viability.**

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Changes in public opinion and legislation in favour of the conservation of the Eurasian lynx (*Lynx lynx*) made its return to Western Europe in the mid-20th century possible. Several reintroduction programs, particularly in the Swiss Jura, the Swiss Alps and the French Vosges, contributed to the growth and expansion of the Eurasian lynx, along with the restoration of suitable habitat and the increased density of ungulate prey. Nevertheless, the species still faces several threats, including a loss of genetic diversity and direct persecution due to conflicts with human activities. Other threats, such as the potential impact of chemicals, have never been investigated in these populations. The low population density, the large home range size of individuals and their elusive behaviour make estimating population size difficult. This study aims to investigate the viability of the lynx populations in France and Switzerland, thus providing knowledge in order to identify the main threats endangering these populations. Molecular analyses of non-invasively collected samples, such as faeces, were designed to assess the genetic structure and the level of genetic diversity in the lynx populations, as well as to characterise their diet. Estimating the impact of lynx predation on domestic and game species can help clarify debates regarding conflicts with the hunting and breeding communities. Finally, toxicological analyses are currently being conducted to investigate the exposure of the Swiss lynx population to different chemicals (mainly trace metals and pesticides) and thus identify a potential supplementary threat.

Keywords: faeces, DNA, genetic structure, genetic diversity, diet, human-wildlife conflicts, ecotoxicology

**Adding complexity to a model with switching behaviour and intraguild predation: from two to three-prey functional responses**

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Living species interact with each other in complex food webs, mostly via predation, a phenomenon that yielded many modelling research studies. Previous work has been done with one predator and multi-preys’ systems. Among them, one has the originality of including a multi-species functional response component of the predator so that the plasticity of the predator’s feeding behaviour in the face of several prey can be considered (see Baudrot et al., 2016, Ecology). The present talk focuses on the extension of this latter model incorporating several predators. As a study case, a concrete application focuses on a system in North America composed of coyotes and foxes as generalist opportunistic predators and two rodent species, meadow vole and deer mouse, as preys. This system is particularly relevant to study because it includes a well-known multi-predator effects that is intraguild predation (a prey and a predator share a same prey). Here, coyotes eat foxes, while both also share rodent species as preys. The proposed model is described by ordinary differential equations and multi-prey functional responses of Holling III shape. These latter formulations able to model switching behaviour of both predators, that is a change of preference for a prey with a variation of its relative density. This phenomenon, that has already been studied for one predator and two prey systems, is now extended to a more complex community, with 3-prey species and one predator eating another. New interesting patterns can be observed and described.

Keywords: Intraguild predation, multi-predator, multi-prey, switching

**Impact of magmatic activity and magma-sediment interactions on fluids circulation and chemical element transfer (sulfur, carbon and metals)**

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Magmatic activity in young sedimentary basins rich in organic matter can have an impact on the transfer of chemical elements (metals, sulfur, carbon) between major deep reservoirs and the ocean. Intense magmatic activity, such as that which allowed the formation of the North Atlantic Igneous Province in the Paleocene-Eocene, is likely responsible for a large transfer of greenhouse gases causing the global warming known as Paleocene-Eocene thermal maximum 56 Ma ago. Consequently, the understanding of magma-sediment-fluid interactions is essential to better understand the transfer processes and to quantify the fluxes of chemical elements (including carbon) during first steps in opening an ocean basin. The Guaymas Basin in the Gulf of California, which was drilled by the International Ocean Discovery Program (IODP) during Expedition 385, represents the nascent stage of an ocean characterized by sediments, primarily organic-rich biogenic siliceous, intruded by a very dense network of shallow magmatic sills. The physical and chemical changes produced by the placement of sills in OM-rich sediments include: the temperature rise of the sediments in contact with the sill leading to the cracking of the sedimentary organic matter, the formation of new mineral phases, and the initiation of hydrothermal fluid convection. In addition, the assimilation of sediments in the magma promotes the precipitation of metalliferous phases such as sulphides. The quantification of the elementary transfers associated with these processes therefore requires combining complementary approaches: an investigation of the mineralogical and chemical petrophysical properties of the rocks and sediments in the contact aureoles from natural samples taken from the Guaymas basin; and a study by numerical modelling of the thermal and physical behaviour of magma and sediments and the quantification of elementary transfers associated with sill formation.

Keywords: igneous sills, contact metamorphism, fluid-rock interaction, Guaymas Basin

**Detection of precursors to the triggering of gravitational instabilities: multi-parameter chronicles, artificial intelligence and modelling**

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Landslides are gravitational movements that occur under the combined action of predisposing factors (topography, lithology, structure of the massif, etc.), triggering factors (precipitation, earthquakes) and propagation factors. With recent climate change, mountain territories have experienced an increase in the risk associated with landslides. This has led to the implementation of monitoring systems (multi-sensor probes) and forecasting models (susceptibility map, time displacement forecast) to arrive at warning systems.

Several methods of temporal forecasting landslides exist and are already employed but are limited only to landslides considered. This limitation is due to the complexity generated by the predisposition factors (varied lithology, fracking evolution) and by their relationship with the external parameters (infiltration and circulation of rain).

The acquisition of long data chronicles on many landslides now allows the use of new forecasting models such as artificial intelligence and machine learning.

The objective of this thesis is therefore to propose a model for forecasting landslides over time with artificial intelligence based on the use of long data chronicles (displacement, rainfall, conductivity, etc.) as well as physical laws and models. The aim will be to identify the precursors to the triggering of gravity instabilities and to be able to adapt to any context of landslides.

Initially, the objective will be to create a database using and analysing raw data from long data chronicles acquired on the Séchilienne landslide. This database will aim to build a first displacements forecasting model based on machine learning using several variables (displacement-rain, displacement-rain-chemistry, displacement-chemistry, etc.).

Keywords: Landslides, temporal forecasting model, machine learning, rainfall, data chronicles, multivariate analysis