ALEYIN : an Underneath Karstic Robotic Journey

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LIRMM, HSM, IES, IMAG, MRM/LEM, REEDS, SYERA

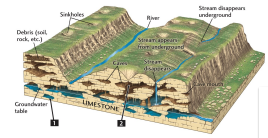
A flagship project of Labex Numev

Key words: Robotics, Water Resource Prospection, Protection, Active Management

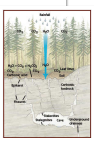
RESUME/Abstract : The Aleyin Initiative aims at conceiving, designing and engineering an intelligent and practical robotic system to explore/inspect and characterize natural hydro-system consisting of flooded karstic network and mining/hydraulic galleries, contributing to the global challenge of **prospection**, **protection**, **active management** of the **water resource** and **hydrogeological risk assessment** and **prevention**.

Karst: Definition

- A topography formed from the dissolution of soluble rocks such as limestone, dolomite, gypsum and marble



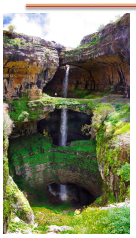
- Characterized by **underground drainage hydrosystems** with skinholes and caves.



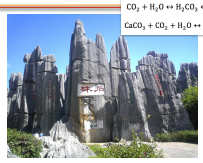
$$CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H^+ + HCO_3^-$$

$$CaCO_3 + CO_2 + H_2O \leftrightarrow Ca^{++} + 2\,HCO_3^-$$

Karst: Surface Stigmata



Balaa, Tannourine, Lebanon



Stone Forest, Shilin Yi, Yunnan, China

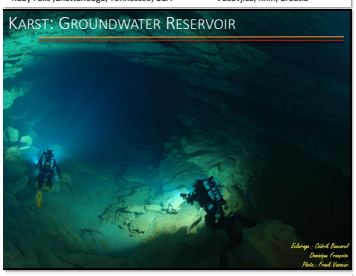
Karst: Underground Continuation

Ruby Falls ,Chattanooga, Tennessee, USA

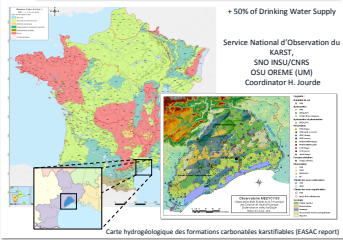
Cueva de los Cristales, Naica, Mexico

Vucovjica, Knin, Croatia

Karst: Groundwater Reservoir

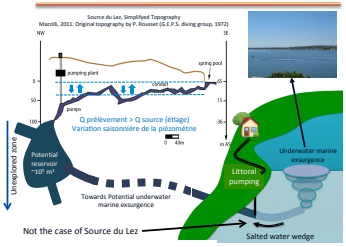


Karst: GW Management : a National Issue



Carte hydrogéologique des formations carbonatées karstifiables (EASAC report)

Sources du Lez: a Seminal Study Case



APPROVED

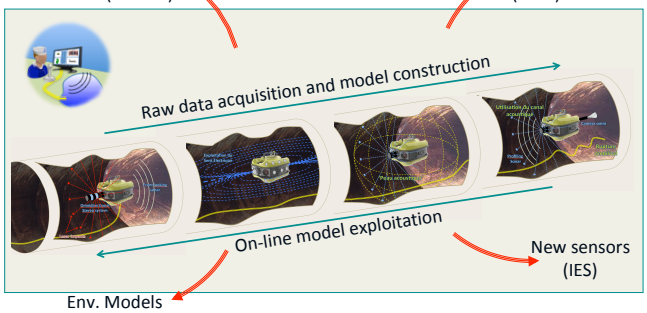
Demande d'aide Européenne
(programme operationnel FEDER-FSE Languedoc-Roussillon 2014-2020)

Annexe specifique – « Recherche & Societe(s) »

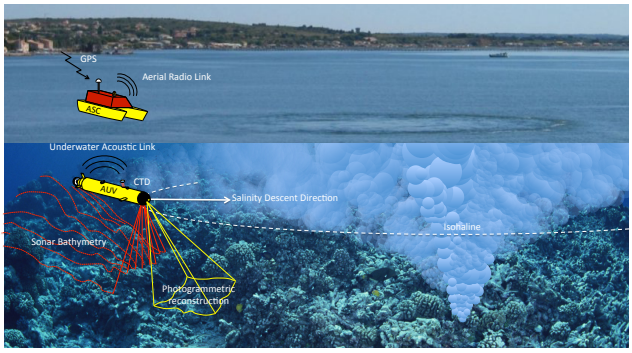
Projet LEZ 2020
2020-2023
Robotic Exploration of the « Sources du LEZ »

The Aleyin Initiative

- Subaquatic Autonomous System for Karstic Exploration



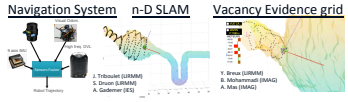
- AUV/ASC for Underwater Fresh-Water Spring Localisation and Qualification



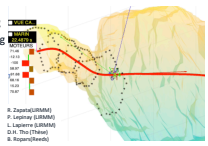
Forces at Work

- New Sensors

- GPS-Free Navigation

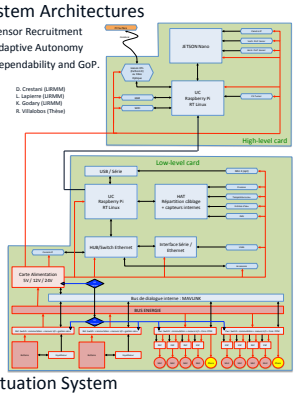


- Guidance
  - Autonomous Centring
  - Autonomous Targeting
  - Env. Models Inclusion



- Control
  - Robustness
  - Co-Control
  - Open-loop Stability

- System Architectures
  - Sensor Recruitment
  - Adaptive Autonomy
  - Dependability and GoP.



- Actuation System
  - Redundancy Management
  - Adaptive Geometry
  - Hyper-redundancy

- Robots Development

Hydrogeological Risk Assessment

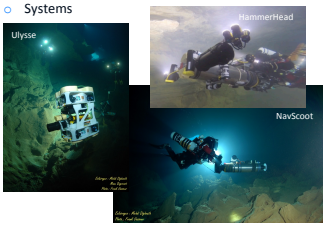
- Montpellier's Catchment Basin : a Seminal Case

- Hydrogeological Risk : Skinholes

Terrain Results

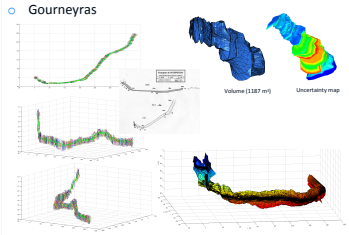
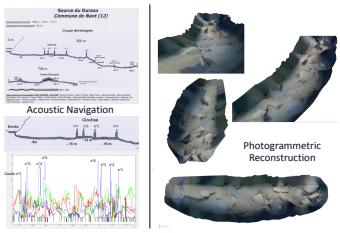
- Ulysse
  - 2x6 Thrusters
  - IMU
  - Camera
  - Acoustic camera
  - Profiling Sonar
  - DVL

- Systems



- Gourneyras, 2016, 2017, Durzon, 2018

- Gourneyras



- Durzon, Nant, 24/06/2018