

ANNUAL REPORT 2025



LIMNOLOGY CENTER

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1. Objectives

In 2025, the Limnology Center devoted 85% of its resources to operating and developing the LÉXPLORE platform, while advancing research on particulate matter settling, expanding the Lémanscope citizen-science project, and improving the LÉXPLORE data pipeline. The Center's overarching objective remains to carry out multidisciplinary research with strong socially relevance that supports the sustainable management of natural water resources.

2. Promote interdisciplinary collaborations

Networking

The Limnology Center team oversees the collection of settling material using sediment traps, which are currently deployed from LÉXPLORE for multiple projects in collaboration with various institutions:

- Eawag, Sedimentology Group: Characterize the fluxes of nutrients, organic and inorganic carbon, as well as minerals (SEDTRAP) 2019-present.
- EPFL, Center for Imaging: analyze the images of particles taken by an holographic camera (Lake Snow) 2023-present.
- EPFL-ENAC, Central Environmental Laboratory: Assess the deposition and accumulation of microplastics in lake sediments (Microsed) 2019-present.
- UNIL, Past, Present and Future of Alpine Lakes: quantify the sedimentation of fecal pellets and zooplankton (GEN-Z) 2024-2025.

In partnership with EAWAG - Remote Sensing Group, UNIL-Collaboratoire, and the Association pour la Sauvegarde du Léman, the LIMNC team leads Lémanscope, a major citizen-science initiative that strengthens the dialogue between science and society and raises awareness of Lake Geneva's ecological state (2023-present). Through the FLAKE project (2025), the LIMNC strengthened its collaboration with ENACit4research to streamline the LÉXPLORE data pipeline and enhance data quality and FAIR workflows.

In addition, the LIMNC team collaborated closely with the following partners, who have an active project (acronym in parenthesis) on LÉXPLORE.

Projects which started in 2025:

- EPFL-ENAC, SENSE: An open source, low- tech and performant CTD for lakes and oceans (MAKE-CTD).

- UNIL, Faculty of Biology and Medicine, Radiation Physics. Measuring the bioavailability of radionuclides in Lake Léman using diffusive gradients in thin films (IRACTINIDES).
- EPFL-ENAC, Laboratory of Sustainability Robotics. Multi-robot aerial system for underwater sampling (MEDUSA).
- University of Copenhagen, Department of Biology, Terrestrial Ecology Section. Volatile Organic Compound (VOC) Dynamics in Lake Geneva (VOLAKE).
- EPFL-ENAC, SENSE: Testing low tech sensors for aquatic citizen science (SailowXPLORE).

Earlier projects still running in 2025:

- EPFL-ENAC, SENSE: test and improve the SubOcean probe (SubOcean++), design and build a probe for continuous monitoring of dissolved CO₂ in seawater (SENSE-pCO₂) 2024-2025.
- UNIGE, Microbial Ecology Group: investigate dynamics of phytoplankton (ALGA) 2024-present
- UNIGE, School of pharmaceutical sciences, Department of Microbiology and Molecular Medicine: Identify antimicrobial and anti-virulence compounds from fungal microorganisms (MycoMediX) 2024-present.
- UNIL, Past, Present and Future of Alpine Lakes: quantify the Zooplankton link in lakes: Lake GENeva as a sandbox (GEN-Z) 2024-present.
- Eawag, Microbial Ecology Group: study bacterial resistance to antibiotics (ARTFUL) 2023-present.
- UNIGE, The climate and non-linearity group: determine the effects of wind on waves (Wind2Waves) 2023-present.
- UNIGE, Microbial Ecology Group: investigate biofilm on microplastics (Plastisphere) 2023-present, and parasites on diatoms (Asterionella) 2023-2025.
- EPFL-ENAC, Central Environmental Laboratory: quantify Quagga mussels within the EPFL water cooling system (QuagPlore) 2023-present.
- UMR CARRTEL: investigate CO₂ and CH₄ through different methods (CarboLéX) 2023-present.
- Eawag, Remote Sensing Group: quantify primary production (Lake3P) 2022-present.
- EPFL-SB, Laboratory of Astrophysics: use a lake telescope to detect cosmic ray particles from the Milky Way Galaxy (LACTEL) 2022-present.
- UNIL, Forensic Science: quantify the contamination of pollutants (Aqua-Gabs) 2021-present.
- UNIL, GAIA lab: characterize the precipitation in Lausanne area (RainGauge) 2021-present.
- UNIGE, The Bakker Group: measure arsenic with innovative in situ probes (SyBam) 2021-2025.
- Eawag - UNIL, Aquatic Physics Group: measure turbulence at high frequency (LéWalk) 2020-2025, and measure skin to bulk temperature (Skin2Bulk) 2020-present.

Workshop

The Limnology Center brought together 55 scientists from 8 institutions for the 5th LéXPLORE workshop on 4 September 2025, providing an excellent forum for interdisciplinary collaboration. The program included presentations on four major research projects, sixteen short pitches, and a dynamic poster session. Francesco Pomati (Eawag) delivered the keynote speech, offering inspiring insights into high-frequency plankton measurements using the aquascope dual-camera system.

3. LéXPLORE Management

Business plan

In 2025, LéXPLORE achieved several important milestones. The Canton of Vaud issued a positive decision on 20 May 2025 regarding the concession renewal, following the lifting of two oppositions, and the official amendment extending the concession to 31 December 2036 was granted on 16 October 2025.

The new tariff structure, developed with EPFL Controlling and validated within the Steering Committee, entered into force on 1 January 2025, making LéXPLORE officially eligible as an SNSF-funded platform.

Together, the Steering Committee President and the Operational Director prepared the forward-looking business plan, including long-term governance considerations and financial planning. As requested by partner institutions, they also developed minimum-operation scenarios without fundraising, including a fallback option with only three institutional partners if needed.

While the partnership with CARRTEL will not continue, EPFL, Eawag and UNIL have confirmed their commitment to supporting the platform, and UNIGE is expected to reach a final decision on its participation before the end of 2025.

Infrastructure

In 2025, the LéXPLORE platform required continuous monitoring and several targeted interventions to maintain its long-term reliability. The buoy perimeter was reinforced through the elevation of navigation lights and the replacement of the overstressed B3 buoy, with ROV inspections confirming that anchoring points and Dyneema ropes remained in good condition. A structural assessment by SAN in March confirmed the platform's overall integrity, and in April

an aluminum structure was added on the southern side to host scientific instruments and provide sheltered workspace. Later in the year, a marked decline in battery performance became a major concern, increasing reliance on the generator and prompting plans for a full battery replacement in 2026.

Improve the quality of the core dataset

The LIMNC technicians continued to prioritize data quality in 2025 through regular cleanings and calibrations. Within the FLAKE project, the core dataset benefited from a new automated instrument-control program that improved fault detection and overall reliability. The team also managed several instrumentation challenges, including calibration issues arising from the bankruptcy of Sea & Sun and the blacklisting of Idronaut. The Idronaut profiler was upgraded with a turbidity sensor and fitted with a reinforced armored cable and adapted winch drum, ensuring stable operation. The Thetis profiler remained out of the water due to an internal winch failure and is still undergoing repairs. The wave buoy was returned to the manufacturer for major upgrades. The temperature-profiling system was fully replaced by a new Soundnine inductive chain that became operational in September 2025. The team also recovered and redeployed the fallen OxyPARs mooring and maintained uninterrupted meteorological measurements. Across all systems, the FLAKE project further strengthened operations by enhancing the data pipeline and standardizing quality-control workflows.

4. Major equipment acquired

In 2025, several important instruments were acquired to support LÉXPLORE operations. The LIMNC purchased a 5-liter Niskin bottle, and acquired a titanium C-Fluor turbidity sensor, which was mounted on the Idronaut profiler. A new Soundnine inductive temperature-profiling chain was covered by the LÉXPLORE funds.

5. Human resources

Tom Battin	Director ad Interim
Natacha Pasche	Operational Director
Guillaume Cunillera	Chief Technical Officer
Jérémy Keller	Technician Specialist
Laurence Glass-Haller	Administrative assistant and project manager for Lémanscope

6. Communication and outreach

The LIMNC team organised and led 23 visits to LÉXPLORE for different groups, including 9 public visits for ~280 persons.

During the reporting period, a range of communication, outreach, and public-facing activities, primarily linked to the Lémanscope project, were carried out. The LIMNC team also supported communication efforts for the LÉXPLORE platform, for which additional materials and updates are available on its website (www.lexplore.ch).

On TV

25.11.2025 : RTS Forum - L'état de santé du lac Léman passionne les scientifiques et la population: interview de Natacha Tofield-Pasche | RTS

On Radio

15.03.2025 : RTS Forum des Idées - Lémanscope, un projet de science participative pour connaître l'état de santé du lac Léman

21.03.2025 : RTS CQFD - La journée mondiale de l'eau et ses enjeux en Suisse

In the newspapers

25.11.2025 : EPFL - Autour du projet scientifique, une vraie communauté s'est créée

25.11.2025 : myScience - Autour du projet scientifique, une vraie communauté s'est créée

The LIMNC also regularly updated the websites for LÉXPLORE for the Limnology Center.

7. Research activities within LIMNC

Lémanscope

The SNF AGORA project Lémanscope, developed with EAWAG, UNIL and the ASL, engages citizens in measuring lake colour and transparency to strengthen links between science and society. In spring 2025, three special events were organized: on 15 May at the Maison de la Rivière (Tolochenaz, VD), on 27 May at INRAE (Thonon-les-Bains), and on 12 June at the Pointe à la Bise Nature Reserve (GE), to strengthen community dynamics and foster exchanges between participants and researchers. These gatherings were designed to sustain participant engagement by offering guided visits and thematic presentations, providing updates on project progress, showcasing participants' experiences, and fostering convivial exchanges through roundtable discussions and shared meals. Bringing together between 12 and 25 participants, they addressed key topics such as biodiversity, algal blooms, and the complementarities between citizen and academic science. The events generated strong interest, encouraged rich discussions, and helped reinforce the connection between participants, scientists, and the lake.

In addition, to sustain this momentum during the colder winter months, three webinars were organized in 2025 on topics highly valued by the community. Well attended and available as replays on YouTube and the lemanscope.org website, they covered the status of Lake Geneva fish populations with Chloé Goulon (INRAE), the quagga mussel, discussed by Bastiaan Ibelings and Salomé Boudet (UNIGE), and the growing concerns over plastic pollution in Lake Geneva with Alexis Pochelon (ASL)

Citizens continued collecting data until the end of October 2025, and after cross-checking and validation, 2'408 measurements were retained for analyses and modelling, demonstrating good accuracy and confirming the reliability of the citizen-generated dataset.

FAIRifying LÉXPLORE: enhancing open research data pipelines for Advanced LaKE Science (FLAKE)

Supported by the ORD Call FLAKE (CHF 30,000, 2025, 6-month project), the project significantly improved the robustness and quality of the LÉXPLORE data pipeline and its associated quality-control processes. The data transfer system was migrated to a secure cloud-based infrastructure at Eawag, supported by a new on-site computer and a customized program that enables rapid detection of transfer issues. In parallel, a collaborative QA/QC framework was co-designed with the LÉXPLORE community and fully integrated into the

Datalakes platform, assigning dedicated data curators and advisors to each dataset and providing an interactive tool for assessing and flagging data. Through workshops and dedicated data clean-up days, the project strengthened community engagement and fostered a shared commitment to data quality within the LÉXPLORE community. In particular, a two-day data clean-up workshop was held in Thun on 11-12 September 2025, bringing together 15 participants to review, curate, and improve datasets. These efforts improved data integrity and strengthened the quality and usability of LÉXPLORE's open research data.

Temporal and spatial variations of the settling particles fluxes in Lake Geneva (SEDTRAP)

The LIMNC team investigates suspended particles in Lake Geneva, continuing to deploy four sediment traps near LÉXPLORE in collaboration with the Central Environmental Laboratory. By compiling the sediment-trap data collected between 2020 and 2024, the team prepared and submitted a manuscript to Aquatic Sciences and published the associated [dataset](#) on Zenodo. These efforts further increase the scientific output of the project and enhance the accessibility and visibility of the collected data. In parallel, Natacha Pasche also worked with the Ecotox Center on an additional manuscript intended for submission to *Aqua & Gas*, further strengthening collaborations and broadening the dissemination of the project's findings.

Dynamics of the suspended particulate matter in Lake Geneva (LakeSnow)

Within the LakeSnow project, the LIMNC team continued investigating suspended particles and the influence of the Rhône River interflow on their flocculation. In 2025, Inès Laury joined the project for a summer internship and subsequently continued as a student assistant, contributing to new ex-situ measurements as well as water sampling and filtration campaigns. Following the unsuccessful outcome of the previous funding proposal, Natacha Pasche prepared a revised submission together with Edward Andò from the EPFL Center for Imaging as co-PI. Machine-learning efforts also progressed: Antoine Tissot explored particle clustering strategies as part of his project, while collaboration with the EPFL Center for Imaging continued to improve particle identification and segmentation. In parallel, we partnered with the EPFL BioImaging Platform to store and manage all holographic images on the OMERO platform, facilitating more robust and scalable data analysis. To strengthen expertise in image-based workflows, Natacha Pasche also followed the course Image Processing for Life Science (BIO-695).

Exploring the activity and dynamics of a subaquatic pockmark

In 2025, the LIMNC technical team conducted a new exploration of the active pockmark in Lake Geneva using the ROV in July, confirming that the structure was active once again. This work follows earlier investigations carried out in 2024, which led to the publication of a note in the Swiss Bulletin for Applied Geology. Building on these results, a contract has now been established to deploy instrumented moorings within the crater to monitor its activity over the whole year. This initiative is pursued in collaboration with the Division Géologie, Sols, Déchets et Eaux Souterraines (DGE-GEOD), with the broader goal of assessing the geothermal potential of this unique underwater feature.

Conferences

- Natacha Pasche, Laurence Haller, Daniel Odermatt, Adrien Bonny, Alexis Pochelon, Suzanne Mader, Alexandre Camus: **Lémanscope: Mobilisation de la société civile pour surveiller la qualité de l'eau du Léman**. Presentation. CitSci Helvetia'25, 5-6.06.2025, UNIL, Lausanne.
- Natacha Pasche, LÉXPLORE and the Limnology Center: enabling collaborative science, Swiss Lake Day, 3.09.2025, Lausanne.
- Swiss Geoscience Meeting, 5-6.12.2025, Bern:
 - Natacha Pasche: co-chair Limnology and Oceanography session.
 - Laurence Haller, Daniel Odermatt, Adrien Bonny, Alexis Pochelon, Suzanne Mader, Alexandre Camus and Natacha Pasche: **Lémanscope: Participatory Science to Monitor Lake Geneva's Water Quality**. Presentation.

Peer-reviewed publications

The LIMNC team published the following paper in 2025:

- Giorgis D., L. Bazalgette, R. Marchant, P. Blunier, N. Pasche, G. Cunillera, J. Keller, and E. Mignot. 2025. **Note préliminaire sur des indices de résurgences profondes dans le Léman**. Bulletin for Applied Geology 30: 91.

The LIMNC submitted two additional manuscripts with an associated dataset during the year:

- Faval E., G. Cunillera, J. Keller, N. Dubois, D.J. Janssen, and N. Pasche, 2025: **Rivers beneath the surface: how riverine inputs shape sedimentation in a large peri-alpine lake**. submitted to Aquatic Sciences. <https://doi.org/10.21203/rs.3.rs-8204613/v1>

- Pasche N., G. Cunillera, and J. Keller, 2025. **Sediment traps dataset at LÉXPLORE Platform (2020-2024): Fluxes for total mass, carbon-nitrogen-phosphorus content, and metal analyses.** [10.5281/zenodo.17607859](https://doi.org/10.5281/zenodo.17607859)
- Pasche N and Wüest N, 2025. **Identifying meromictic coastal lakes influenced by marine interactions**, submitted to Inland Waters.

Overall, the LIMNC dedicated 2.8 full-time equivalent positions (85% of its personnel resources) to the management and research coordination of LÉXPLORE-related projects. In 2025, six peer-reviewed publications stemmed from research conducted on LÉXPLORE and are listed in the LÉXPLORE annual report.

Current consulting and expert activities

- Member of the Scientific Committee of the International Commission for the protection of Lake Geneva (CIPEL).
- Member of the Committee for the Swiss Society Limnology and Hydrology.
- Advisory for the Kivu working group of the African Center for Aquatic Research and Education.

Proposals

- **PI for SNSF:** Tracking and imaging suspended particles to assess carbon and nutrient sinking fluxes in lakes (TRACE). CHF 498'000, 2027-2029 (submitted & not accepted).

8. Education

Teaching activity

Limnology course, ENV-425 for 15 Master students, spring term 2025, Environmental Engineering, EPFL. 15 students were trained to take measurements on LÉXPLORE platform.

Student supervision

- Inès Laury, Characterising lake snow in Lake Geneva, summer internship 2025.
- Emma Favel, Rivers beneath the surface: how riverine inputs shape sedimentation in a large peri-alpine lake, preparing publication as student assistant.
- Antoine Tissot-Favre, Automated Identification and Characterization of Particles in Holographic Images from Lake Geneva, Semester project in collaboration with EPFL Imaging Center

- Alicia Skorik, Retrieving the Léman's phytoplankton taxa from remote sensing reflectance measurements using a spectral optimization algorithm, bachelor thesis for BIO-ENG-390.

Student visits on LÉXPLORE

The LIMNC team supported the following visits on LÉXPLORE:

- 29.04.2025: 14 master students from EPFL
- 2-3.06.2025: 11 master students from UNIL for a 24h campaign
- 10.06.2026: 20 pupils and accompanying teachers from local schools
- 13.06.2026: 24 pupils and accompanying teachers from local schools
- 17.10.2025: 50 bachelor students from UNIL
- 29.10.2025: students from UNIGE
- 05.12.2025: 50 bachelor students from UNIL
- 9.12.2025: 14 students from the Red Sea

9. Conclusions and future direction

2025 was a pivotal year for the Limnology Center, marked by the renewal of the LÉXPLORE concession until 2036, securing the long-term future of the platform and reinforcing its role as a unique infrastructure for freshwater research. The Center continued to foster interdisciplinary collaborations, supporting a diverse portfolio of projects while maintaining high-quality monitoring and operational services.

Important progress was achieved in data management through the FLAKE project, which enhanced the reliability, accessibility, and FAIRness of LÉXPLORE data. At the same time, infrastructure upgrades and continuous maintenance ensured the platform's operational stability and scientific performance. Research activities resulted in students projects, new submitted manuscripts, and open datasets.

The Center also strengthened its engagement with society through LémanScope, which demonstrated the value of citizen science for monitoring Lake Geneva and raising environmental awareness.

Looking ahead, a key priority will be the formalization of the long-term commitment of partner institutions through a new consortium agreement, providing a robust governance framework for

LéXPLORE. In parallel, LIMNC will continue to enhance data services and infrastructure, support innovative research projects, and expand scientific and societal partnerships to ensure the platform's long-term sustainability and impact.



LéXPLORE workshop, EPFL, 4th Sept 2025