Platform LéXPLORE

Annual report July 2022 to June 2023

LéXPLORE platform ©Natacha Tofield-Pasche, 14th July 2022

Summary

During the reporting period, LéXPLORE reached a total of 48 projects and was used 57% of the working days. We continued to improve the quality of the core dataset with monthly cleaning and calibrations, and could send most instruments for factory calibration. Six new peered-reviewed papers were published, and three PhD students finalized their thesis using the platform. LéXPLORE can now be visited virtually, and the public visits welcomed nearly 150 persons. Public outreach will continue with the Agora project *Lemanscope*, accepted by FNS.

1. Administration

The LéXPLORE Steering Committee (SC) held 2 meetings on the following dates: 28th November 2022 and 9th May 2023. During these meetings, the SC mainly started to discuss the strategy for the future of the platform after end 2026. A document evaluating the costs for a potential extension of 10 years was submitted to the SC in December 2022. In addition, the SC validated 7 new project applications.

The engineering company VBI and ICTP finalized their study for a more robust safety perimeter. The total costs for this new structure were estimated to 275 kCHF. Given this large expense, the SC decided to remain with the solution already implemented by the technical team.

2. Exploitation

As usual, the Limnology Center managed the day-to-day exploitation of LéXPLORE. This year, the main focus was to determine the potential costs after 2026. The renovation costs for an extension of 10 years were established with the companies that built LéXPLORE. At the same time, the call for offers to deconstruct the platform did not receive any offer. However, we still manage to receive SAGRAVE's estimation to remove all the material from the lake. In conclusion, the current and future business plan for LéXPLORE are still under preparation.

Concerning the safety perimeter, the buoy B3 broke and the Technical Pool managed to repair it rapidly on 5 and 6th October 2023. The state of two other buoys (B7 and B8) were checked using our ROV. As the buoys can be repaired internally, we are therefore confident that that this internally-implemented solution is more sustainable for the future.
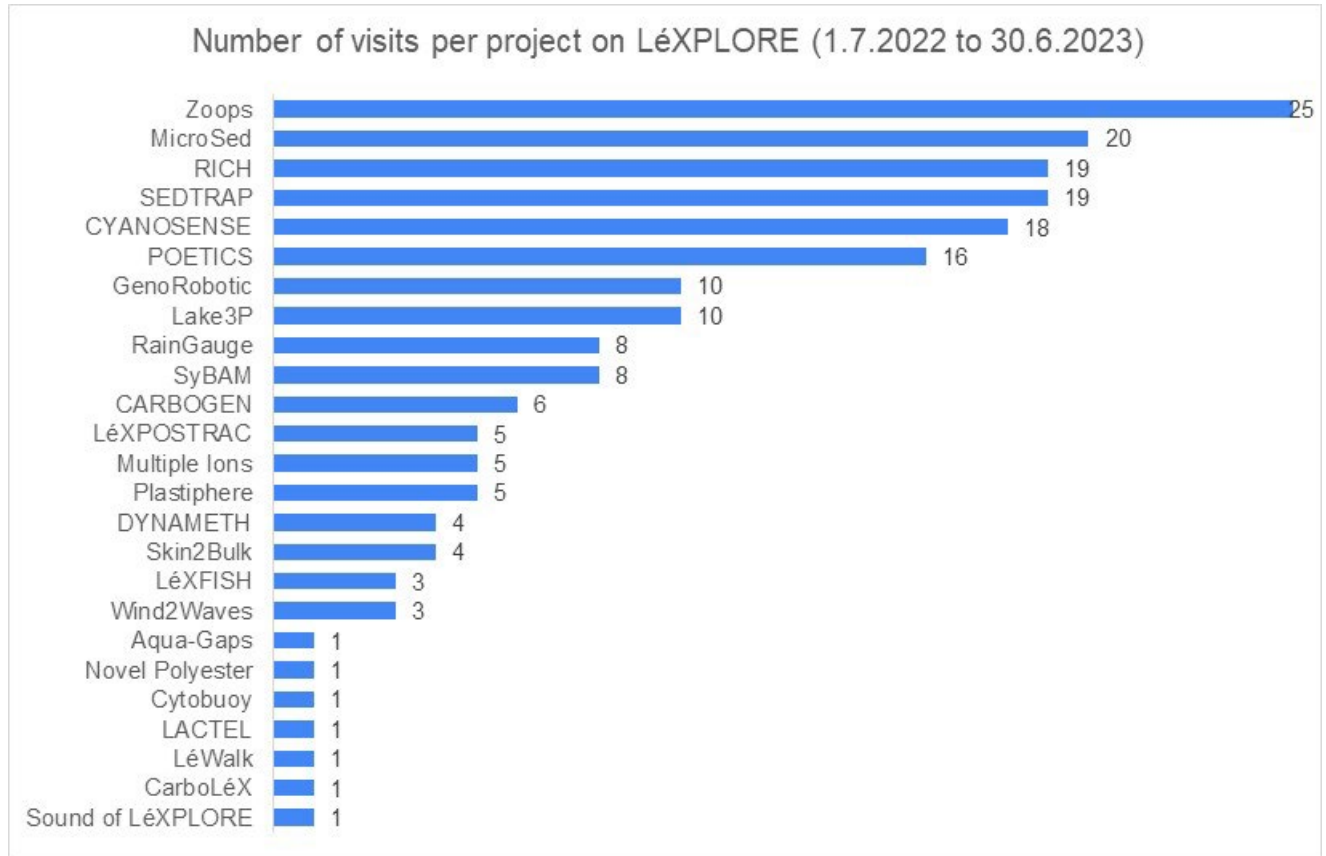
On the reported period, the Technical Pool worked mostly to improve the quality of the core dataset with more regular cleaning and calibrations. Through EPFL-ENAC calls, we purchased two additional multiparameter sondes (Sea and Sun, Idronaut). In 2023, we could therefore send the current sondes for factory calibration, without interrupting the data collection. On a monthly basis, the technical team maintained, cleaned and calibrated the multiparameter sondes. On 1st February 2023, a vertical profile was taken for cross calibration with Thetis, the two Sea and Sun sondes and the two Idronauts sondes measuring at the same time. Such cross calibrations are planned regularly during the rest of the year. In December 2022, the entire technical team worked during a full week, to consolidate the technical documentations for each instrument of the core dataset. This documentation also includes the detailed metadata that will be added on the DATALAKES website.

Concerning the other instruments, the two Acoustic Doppler Current Profilers (ADCP) and the upper temperature chain were sent to the factory for revision in January 2023. Replacement ADCPs and a temperature chain were temporary provided by Eawag. Through a successful call, Unil has ordered a new temperature chain, where each temperature sensor can be changed independently contrary from our current chains. This chain will be installed by end 2023. The sensors from the meteorological station were also replaced by new sensors, to ensure a continuous data collection during factory calibration. The automatic profiler Thetis has generated a large workload due to the maintenance, the multiple technical problems to solve, and three emergencies. But the time allocated was strongly reduced, as the Thetis maintenance are now scheduled during the dedicated monthly maintenance. The Thetis collected data continuously throughout the reported period, up to 20th June 2023 linked with a problem with the battery. In conclusion, all the instruments from the core dataset were renewed and calibrated this year, which will improve the quality of the data.

The technical team improved the LéXPLORE infrastructure and performed maintenances dedicated to the infrastructure every two months. They also installed nets against the birds, as too many of them felt at home. After repairing the winches, they moved the platform two meter south on October 2022.

To monitor the use of LéXPLORE, each team leader recorded their visits on the logbook. From 1st July 2022 to 30th June 2023, the platform was used at 351 occasions: 195 for the projects, 100 for technical operations, and 56 to fulfil special requests. The special requests comprised: 7 for the media, 19 visits,

6 teaching activities, and 24 others occasions (equipment test, punctual sampling, and a citizen project). The technical team worked for 68% on the core dataset, 25% on the infrastructure, and 7% on the safety perimeter. Similar to last year, the platform was used during 148 days in total, which represents 57% of the working days. The number of visits per project were distributed as shown in the following graph.

Number of visits per project on LéXPLORE (1.7.2022 to 30.6.2023)

Project	Visits
Zoops	25
MicroSed	20
RICH	19
SEDTRAP	19
CYANOSENSE	18
POETICS	16
GenoRobotic	10
Lake3P	10
RainGauge	8
SyBAM	8
CARBOGEN	6
LéXPOSTRAC	5
Multiple Ions	5
Plastiphere	5
DYNAMETH	4
Skin2Bulk	4
LéXFISH	3
Wind2Waves	3
Aqua-Gaps	1
Novel Polyester	1
Cytobuoy	1
LACTEL	1
LéWalk	1
CarboLéX	1
Sound of LéXPLORE	1

3. Scientific Projects

By end June 2023, we had a total of 48 projects: 19 running, 4 upcoming, 22 completed, and 3 cancelled projects. In addition, one project is in the validation phase. A separate scientific report describes the results from all the projects. The list below presents the collaborators and the project title, together with their link to the LéXPLORE website.

Current running projects:

1. Breider Florian, Hanahan Jonathan, Vernez Karine, Coudret Sylvain, Loizeau Jean-Luc: **Deposition and Accumulation of Microplastics in Lake Sediments (Microsed)**

2. Bouffard Damien, Sebastiano Piccolroaz, , Gil Coto Miguel, Lavanchy Sébastien, Cunillera Guillaume, Dinkel Christian, Fernandez Castro Bieito: **LéWalk: autonomous turbulence profiling**

3. Ibelings Bastiaan, Thomas Mridul, Fillion Roxane, Mesman Jorrit, Devanthery Matthieu, de Loes Sebastien, MUSE-Master students, Müller Beat: **POETICS - PlanktOn vErTICal Structure**

4. Bouffard Damien, Bieito Fernandez Castro, Piccolroaz Sebastiano, Michäel Plüss, Sebastien Lavanchy, Wüest Alfred: **Skin2Bulk: investigating the surface boundary layer**

5. Mridul Thomas, Pomati Francesco, Suarez Ena, Fillion Roxane, Ibelings Bastiaan: **Plankton in Lake Geneva : you can't have it both ways**

6. Maner Jenny, Drieschner Carolin, Ebi Christian, Schönenberger René, Angst Levin, Bloem Simon, Solsona Miguel, Renaud Philippe, Schirmer Kristin: **Rainbow$_{flow}$ chip$_{online}$: Fishcell biosensor for automated water quality testing**

7. Adam Nicolas, Selz Jonathan, Lecine Sofian, Hirt Timothée, Deloose Christophe, Bernier-Latmani Rizlan, Maerkl Sebastian: **GenoRobotics CoWaS - Continuous Water Sampling**

8. Estoppey Nicolas, Pfeiffer Fabienne, Glanzmann Vick, Reymond Naomi, Huismann Sofie, and Weyermann Céline: **Aqua-Gabs/MONET in Lake Leman**

9. Perga Marie-Elodie, Frech Benoit, Vittoz Jérôme, Gravey Mathieu: **the sounds of LéXPLORE**

10. Tercier-Waeber Mary-Lou, Ibelings Bastiaan, Layglon Nicolas, Gressard Tanguy: **Synergic interaction between arsenic species and microorganisms in freshwater contrasting dynamic conditions (SyBAM)**

11. Mariethoz Gregoire, Koch Erwan, Berne Alexis: **Installation of a drip-based rain gauge on LéXPLORE**

12. Dubois Nathalie, Mittelbach Benedict, Eglinton Timothy, White Margot, Rhyner Timo: **Radiocarbon Inventories of Switzerland (RICH)**

13. Natacha Tofield-Pasche, Guillaume Cunillera, Nathalie Dubois, David Janssen: **Temporal and spatial variations of the settling particles fluxes in Lake Geneva (SEDTRAP)**

14. Odermatt Daniel, Damm Alexander, Pasche Natacha, Alikas Krista, Soomets Tuuli, Spyrakos Evangelos: **Monitoring Lake Primary Production using the PACE satellite (Lake3P)**

15. Bakker Eric, Forrest Tara, Zdrachek Elena, Damala Polyxeni, Cherubini Thomas: **Submersible Probe with In-line Calibration and Symmetrical Reference Element for Long-term Continuous Measurement of Environmentally Relevant Ions (Multiple ion)**

16. Laureen Mori-Bazzano, Bastiaan Willem Ibelings: **Characterization of Biofilm formation on different types of plastic substrate**

17. Jeremy Keller, Jake Vander Zander, Marie-Elodie Perga: ZOOPS – temporal dynamics of zooplankton

18. Brunetti Maura, Babanin Alexander, Jérôme Kasparian: **Wind2Waves**

19. Beauvais Rébecca, Ferrari Benoît, Casado-Martinez Carmen, Rohrbach Emmanuelle: **LéXPOSTRAC: Tracking ecotoxicological effects of lake suspended particulate matter on the ostracod *Heterocypris incongruens***

Upcoming (or delayed) projects

20. Bellouard Yves, Rey Samuel, Ayer Baptiste, Sala Federico, Ibelings Bastiaan, Pomati Francesco: **PhytoWaveTaxa: all glass sensors for algae population monitoring**

21. Bahr Alexander, Schill Felix, Lavanchy Sébastien and Cunillera Guillaume: **SUBMULE – easy access to submerged data**

22. Neronov Andrii, Kneib Jean-Paul, Shutska Lesya, Bernard Florian, Lesrel Jean, Haefeli Guido: **LAC TELescope**

23. Didier Jézéquel, Paris Jean-Daniel, Lozano Mathis, Ruffine Livio, Fandino-Torres Olivia, Grilli Roberto, Chappellaz Jérôme, Mettra François, Perga Marie-Elodie, Berg Jasmine, Khatun Santona: **CarboLéX**

Completed projects:

24. Carratalà Anna, Ibelings Bastiaan, Odermatt Daniel, Janssen Elisabeth: **Remote sensing and risk assessment of toxic Cyanobacteria in Lake Geneva (CYANOSENSE).**

25. Larivé Odile, Wynn Htet Kyi, Li Chaojie and Tamar Kohn: **Effect of lake exposure on Enterovirus population**

26. Maxime Hedou, Jeremy Luterbacher, Lorenz Manker: **Biodegradability assessment of PBX, a sustainable bio-polyester developed at EPFL**

27. Jézéquel Didier, Moiron Marthe, Perga Marie-Elodie, Escoffier Nicolas: **DynaMeth - Dynamics and origin of methane in the water column of Lake Geneva**

28. Perga Marie-Elodie, Perolo Pascal, Lambert Thibault, Escoffier Nicolas, Chmiel Hannah, Fernandez Castro Bieito, Bouffard Damien: **CARBOGEN: carbon cycling in Lake Geneva**

29. Bouffard Damien, Perga Marie-Elodie, Runnalls James, Russo Stefania: **REPRODUCE - léxploRE PRODUct ACcESs**

30. Guillard Jean, Rautureau Clément, Tran-Khac Viet, Goulon Chloé: **LéXfish: monitoring fish presence below LéXPLORE**

31. Joost Stéphane, Carratalà Anna, Charlotte Weil, Vajana Elia, Guillaume Annie, Kohn Tamar: **Local adaptation of bacteria communities to environmental conditions (LAC)**

32. Barry Andrew, Foroughan Mehrshad, Porté-Agel Fernando: **Spatio-temporal analysis of wind field characteristics over Lake Geneva**

33. Müller Beat and Kathriner Patrick: **In-situ pursuit of whitening events applying on-site analysis and profiling**

34. Doda Tomy, Bieito Fernández Castro, Ulloa Hugo, Ramon Casanas Cintia, Damien Bouffard: **Buoyancy driven nearshore flows in lakes (HYPOTHESYS, experiments on LéXPLORE**)

35. Vennemann Torsten, and Cotte Gabriel, **Mixing of Rhône River in Lake Geneva**

36. Piccolroaz Sebastiano, Fernandez Castro Bieito, Alfred Wüest, Chmiel Hannah, Minaudo Camille, Pascal Perolo, Troy Cary: **Surface Turbulence and CO_2 Lake Exchange Experiment (CO_2LEX)**

37. Haltiner Linda, Piet Spaak, Dennis Stuart: **Life in the deep: colonisation by Dreissena along a depth gradient**

38. Lattaud Julie: **Variability in stable isotopic composition of long-chain diols as a proxy for environmental conditions in lakes**

39. Violaine Piton, Wynn Htet Kyi, Barry Andrew, Reiss Rafael: **Test measurements for Long-Range ADCP parametrization**

40. Wüest Johny, Fernandez Castro Bieito, Ulloa Hugo, Minaudo Camille, Lavanchy Sébastien, Shubham Krishna, Piccolroaz Sebastiano, Chmiel Hannah: **Primary production under oligotrophication in lakes**

41. Bouffard Damien, Fotis Georgatos, Bouillet Eric, Perez Cruz Fernando, Minaudo Camille, Lavanchy Sébastien, Sukys Jonas, Safin Artur, Tran-Khac Viet, Runnalls James: **DATALAKES - Heterogeneous data platform for operational modelling and forecasting of Swiss lakes**

42. Odermatt Daniel, Runnalls James, Abolfazl Irani Rahaghi, Remika Gupana, Anita Schlatter, Camille Minaudo: **Whitening detection and optical characterization (W-DOC)**

43. Gallorini Andrea, Arpagaus Philippe, Loizeau Jean-Luc: **MetOxiC : Methylmercury in Oxic water Column**

44. Carratalà Anna, Chmiel Hannah, Joost Stéphane, Janssen Elisabeth, Kohn Tamar: **Unravelling the diversity, functioning and toxin production of cyanobacteria populations in lake Geneva (CYANOFUN)**

45. Beauvais Rébecca, Casado-Martinez Carmen, Lüthi Christina, Ferrari Benoît: **LéXPOCHIRO: Effects of lake suspended matter quality on growth, emergence and molecular endpoints in *Chironomus riparius***

Project cancelled

46. Ibelings Bastiaan, Alegre Stelzer Julio, Mesman Jorrit, Fillion Roxane, and Suarez Ena: **Winter Blitz**

47. Schuback Nina, Oxborough Kevin, Moore Mark, Ibelings Bastiaan, Odermatt Daniel, Lavanchy Sébastien: **Single Turnover Active Fluorescence of Enclosed Samples for Aquatic Primary Productivity (STAFES-APP)**

48. Piccolroaz Sebastiano, Cunillera Guillaume, Chmiel Hannah, Perolo Pascal, Lavanchy Sébastien: **caGAStrophic: designing a low-cost, automated, floating chamber for gas flux measurements at the air-water interface of water bodies**

During this period, the SyBAM project organized two 24 h campaign were organized on 31st August – 1st September 2022 and on 2-3rd November 2022. The ZOOPs project performed a 24h campaign on 13-14th April 2023.

4. Communication and events

As an highlight, Eawag created a virtual visit of LéXPLORE, which can be explored interactively under https://www.eawag.ch/repository/lexplore/index.htm. Throughout the year, we performed six days of public visits for a total of 153 visitors. These visitors greatly appreciated to discover the platform and the different demonstrations. The proposal for Lemanscope was accepted by the SNF AGORA, and aims at understanding the variations in lake colour and transparency across the entire lake Geneva. Natacha Tofield-Pasche, Daniel Odermatt and the Association pour la Sauvegarde du Léman will start this citizen science project in October 2023.

The following communication, events and outreach activities took place during the reported period:

- 16th March 2023: The hidden secrets of climate change – Tout petit mais indispensable, le phytoplancton, 19 min

- 2nd March 2023 : the scientific workshop had to be postponed to 13th November 2023

- 8th October 2022: 20 minutes, Plateforme scientifique à Pully: Que se passe-t-il sur cette île flottante ?

- 29th September 2022: Le Journal de l'UNIGE, Visite virtuelle au milieu du Léman

- 26th September 2022: Eawag , LéXPLORE opens its virtual doors, and MyScience, LéXPLORE ouvres ces portes virtuelles

- 23rd August 2022: Géoblog, Physical and biogeochemical processes regulating the dynamics of surface CO2 in a large and deep hardwater lake

- 15th August 2022: Mise au point : Moule quagga : sus à l'envahisseur ! 12 min
- 30th May 2022: Le journal de l'UNIGE, Campus n°52
- 30th May 2022: UNIGE, Campus Junior n°35 été 2023, page 24
- 27th April 2022: Le journal de l'UNIGE, «Léxplore» sonde le Léman

In addition, the following educational activities took place:

- 7th December 2022: Visits of 15 students from UNIGE
- 26th April 2023: Visits of master students from UNIGE
- 4th May 2023: Visits of bachelor students from UNIL
- 9th May 2023: Visits of 7 master students from EPFL
- 11th May 2023: Visits of bachelor students from UNIL
- 26th June 2023: Summer school from CARRTEL

5. Scientific Publications

Escoffier N, Perolo P, Many G, Tofield Pasche N, Perga M-E, 2023. **Fine-scale dynamics of calcite precipitation in a large hardwater lake**. Science of The Total Environment 864:160699. doi.org/10.1016/j.scitotenv.2022.160699

Perolo P, Escoffier N, Chmiel HE, Many G, Bouffard D, Perga M-E, 2023. **Alkalinity contributes at least a third of annual gross primary production in a deep stratified hardwater lake.** Limnology and Oceanography Letters 8:359-367. doi.org/10.1002/lol2.10311

Escoffier N, Perolo P, Lambert T, Rüegg J, Odermatt D, Adatte T, Vennemann T, Perga M-E, 2022. **Whiting Events in a Large Peri-Alpine Lake: Evidence of a Catchment-Scale Process.** Journal of Geophysical Research: Biogeosciences 127:e2022JG006823. doi.org/10.1029/2022JG006823

Gallorini A, Loizeau J-L, 2022. **Lake snow as a mercury methylation micro-environment in the oxic water column of a deep peri-alpine lake.** Chemosphere 299:134306. doi.org/10.1016/j.chemosphere.2022.134306

Gupana RS, Damm A, Rahaghi AI, Minaudo C, Odermatt D, 2022. **Non-photochemical quenching estimates from in situ spectroradiometer measurements: implications on remote sensing of sun-induced chlorophyll fluorescence in lakes**. Opt. Express, OE 30:46762–46781. doi.org/10.1364/OE.469402

Safin A, Bouffard D, Ozdemir F, Ramón CL, Runnalls J, Georgatos F, Minaudo C, Šukys J, 2022. **A Bayesian data assimilation framework for lake 3D hydrodynamic models with a physics-preserving particle filtering method using SPUX-MITgcm v1.** Geoscientific Model Development 15:7715–7730. doi.org/10.5194/gmd-15-7715-2022

Fernández Castro B, Bouffard D, Troy C, Ulloa HN, Piccolroaz S, Sepúlveda Steiner O, Chmiel HE, Serra Moncadas L, Lavanchy S, Wüest A, 2021. **Seasonality modulates wind-driven mixing pathways in a large lake.** Commun Earth Environ 2:215. doi.org/10.1038/s43247-021-00288-3

Fernández Castro B, Chmiel HE, Minaudo C, Krishna S, Perolo P, Rasconi S, Wüest A, 2021. **Primary and Net Ecosystem Production in a Large Lake Diagnosed From High-Resolution Oxygen Measurements.** Water Res 57:e2020WR029283. doi/10.1029/2020WR029283

Rahaghi AI, Minaudo C, Damm A, Odermatt D, 2021. **Optical Closure of Remote Sensing Reflectance Using Automated Hyperspectral Profiler Data**. In: 2021 IEEE International Geoscience and

Remote Sensing Symposium IGARSS, Brussels, Belgium, 2021, pp. 6832-6835, doi.org/10.1109/IGARSS47720.2021.9554464

Minaudo C, Odermatt D, Bouffard D, Rahaghi AI, Lavanchy S, Wüest A, 2021. **The Imprint of Primary Production on High-Frequency Profiles of Lake Optical Properties**. Environ. Sci. Technol. 55:14234–14244. doi.org/10.1021/acs.est.1c02585

Perolo P, Fernández Castro B, Escoffier N, Lambert T, Bouffard D, Perga M-E, 2021**. Accounting for surface waves improves gas flux estimation at high wind speed in a large lake.** Earth System Dynamics 12:1169–1189. doi.org/10.5194/esd-12-1169-2021

Steinsberger T, Wüest A, Müller B, 2021. **Net Ecosystem Production of Lakes Estimated From Hypolimnetic Organic Carbon Sinks.** Water Res 57:1–16. doi.org/10.1029/2020WR029473

El Serafy GYH, Schaeffer BA, Neely M-B, Spinosa A, Odermatt D, Weathers KC, Baracchini T, Bouffard D, Carvalho L, Conmy RN, Keukelaere LD, Hunter PD, et al., 2021. **Integrating Inland and Coastal Water Quality Data for Actionable Knowledge**. Remote Sensing 13:2899. doi.org/10.3390/rs13152899

Wüest A, Bouffard D, Guillard J, Ibelings BW, Lavanchy S, Perga M-E, Pasche N, 2021. **LéXPLORE: A floating laboratory on Lake Geneva offering unique lake research opportunities**. WIREs Water 8:e1544. doi.org/10.1002/wat2.1544

PhD Theses

Perolo P, 2022. **Physical and biogeochemical processes regulating the dynamics of surface CO2 in a large and deep hardwater lake**. PhD Thesis: Uni. Lausanne. serval:BIB_9DE85404D454

Gallorini A, 2022. **Hypoxic and anoxic micro-environments in the water column of a peri-alpine lake: the potential role of lake snow in Hg methylation.** In Role of Lake Snow in the Methylmercury cycle of a Deep Lake. PhD Thesis (Chap 3): Uni. Geneva, no. Sc. 5658. doi: 10.13097/archive-ouverte/unige:162094

Haltiner A, 2022. **Veliger density and environmental conditions control quagga mussel colonization rates in two perialpine lakes.** In Ecological and evolutionary aspects of invasive quagga mussels in deep perialpine lakes. PhD Thesis (Chap 2). ETHZ no 28906. doi.org/10.3929/ethz-b-000599405

Cotte G, 2021. **Processes driving nutrient dispersion in Lake Geneva during the stratification period (study using the LéXPLORE platform).** In Mixing of Rhône River water in Lake Geneva (Léman): Implications on the biogeochemistry of the lake. PhD Thesis (Chap 3). Uni. Lausanne. serval:BIB_A16B0E629D4F
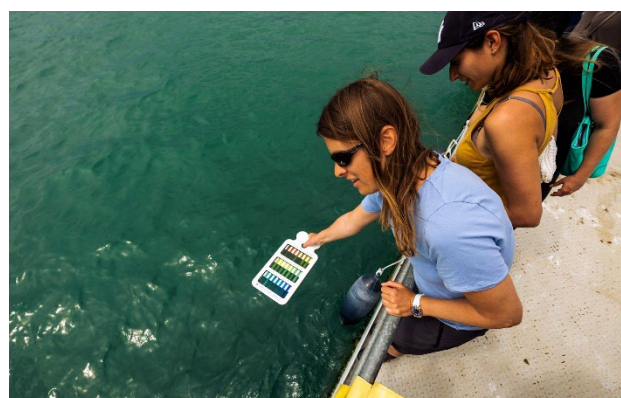
6. Way Forward

The next steps for LéXPLORE are the following:

- Optimize the exploitation of LéXPLORE and its infrastructure.

- Improve the data quality of the core dataset within the DATALAKES Platform

- Present the results on LéXPLORE in national and international conferences.

- Encourage interdisciplinary exchanges during the LéXPLORE workshop in November 2023.

- Promote international scientific collaborations and collaborative projects around LéXPLORE.

- Encourage the use of LéXPLORE for summer schools

- Launch the citizen-science project Lemanscope including the public visits on LéXPLORE
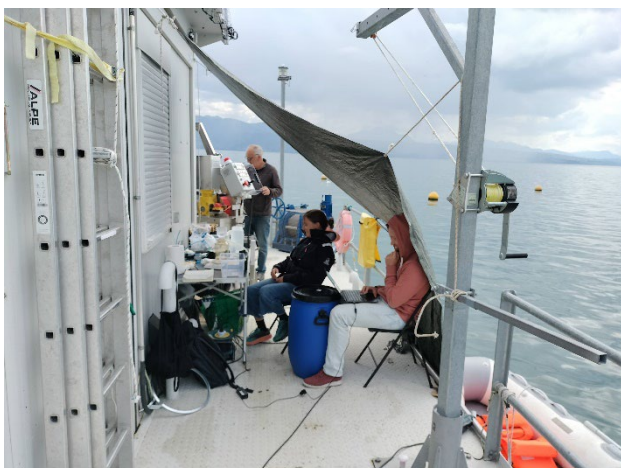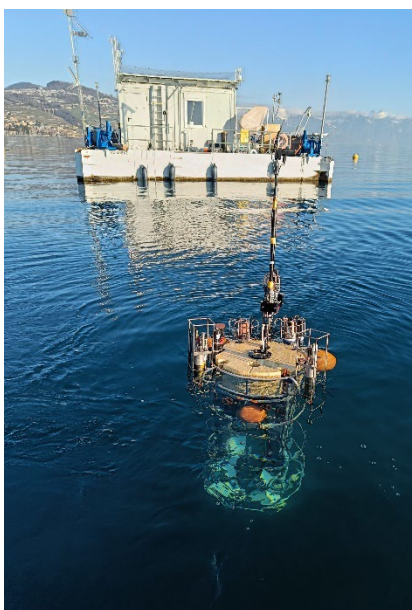
Images of scientists at work on LéXPLORE

Visits on LéXPLORE