



The mission of the LIMNOLOGY Center is to provide socially-relevant and multi-disciplinary research to ensure the sustainable use and conservation of natural water resources, both on national and international levels.

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## LIMNOLOGY Center

Ecole Polytechnique Fédérale de Lausanne

### EDITORIAL

The year 2015 was characterized by an enormous productivity:

In March the first expedition to Lake Onego brought eight research groups from EPFL, UniGe, Eawag, INRA-Thonon and the Observatoire Midi-Pyrenees onto the ice in Petrozavodsk. This unusual workplace was a great new experience, which was enriched by the high-caliber inauguration in presence of Dr. Paulsen, both EPFL and NWPI directorates, the former Federal Minister Couchepin and the project personnel. The first data revealed already many surprising observations and some of the groups returned to Lake Onego again in October.

Right after, the last set of ULM flights on Lake Geneva completed this part of the project, before the EPFL team took off for the next expedition on Lake Baikal. From 9 July to 13 August scientist from Moscow and Irkutsk State Universities and from EPFL investigated coastal regions over the entire lake using ULM, drones and lake *in-situ* instrumentation. This Léman-Baikal project was concluded in Lausanne on 30 November by a ceremony with the sponsor and the EPFL directorate with invited stakeholders from Switzerland and Russia.

The collaboration with Russia continued from 21-31 August, when the Swiss-Russian International Summer School: *"Lake ecosystems under pressure"* took place at the Baikal Biological Station in Bolshie Koty. And last but not least – from 5 to 9 July we invited Russian colleagues to SEFS / Geneva, where we organized a special session on Lake Baikal.

We warmly thank the researchers, the support personnel and the sponsors for this encouraging constructive Russian-Swiss collaboration.

Alfred Wüest, Director LIMNOLOGY Center



View on Lavaux vineyards and Swiss plateau from ULM

## RESEARCH PROJECT

### Leman-Baikal Project:

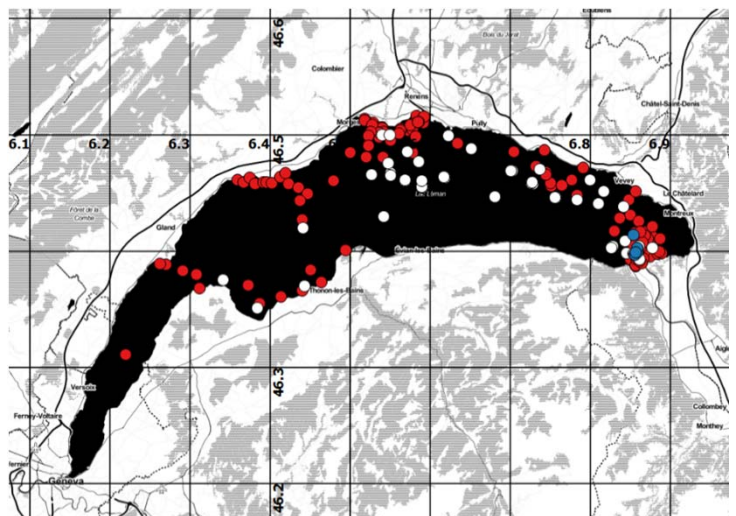
The Leman-Baikal project is an international Swiss-Russian collaboration. This project aims at comparing the water quality in Lake Lemman in Switzerland and Lake Baikal in Russia, using a newly developed remote sensing platform mounted on ultralight aircrafts. The collected hyperspectral images will be used to map the spatial heterogeneity of water properties at a higher spatial and temporal resolution than ever achieved.

In 2015, the last flights on Lake Lemman took place from April to June 2015. The flights focussed near the mouths of the Rhône River, near Cully and Morges. The same site was flown over three times a day at three different altitudes. This strategy will allow to detect processes at short-time scales, and also to better interpret the atmospheric correction.



View on Lake Lemman and Lausanne during data acquisition on ULM

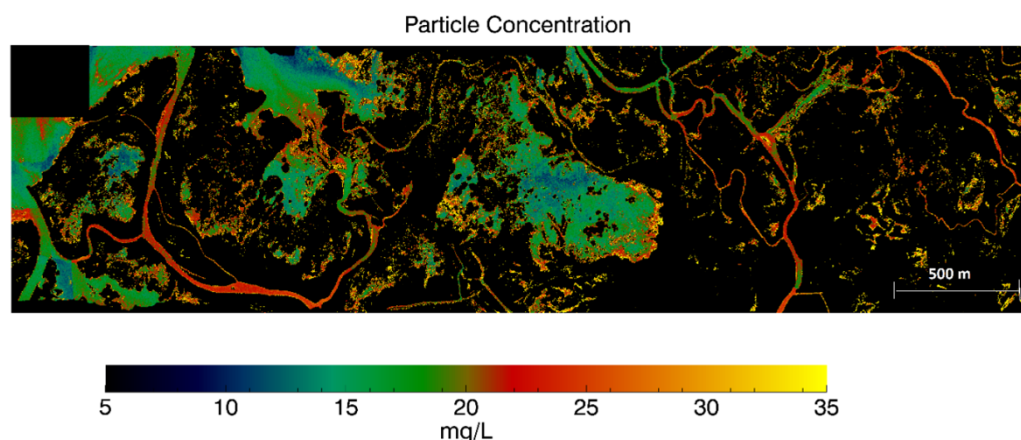
A new software HypOS was developed to visualize and correct the hyperspectral images. We therefore expect that data interpretation will soon assess the heterogeneity of water quality on both lakes. On 30<sup>th</sup> November 2015, a closing ceremony for the project gathered and thanked all stakeholders.



Ground control locations sampled in 2015 (white), 2014 (red) and 2013 (blue)

## RESEARCH PROJECT

### Leman-Baikal Project



Particle map of the north-eastern part of the Selenga Delta on 17<sup>th</sup> August 2014, courtesy from Vincent Nouchi

From 9<sup>th</sup> July to 13<sup>th</sup> August 2015, Swiss and Russian scientists carried out an extended field campaign over the entire Lake Baikal, where five sites were investigated in more details. On the first three sites, the remote sensing platform was mounted on a ULM, while the last two sites were investigated using a smaller camera mounted on a drone. To calibrate the collected images, a large effort of ground-truthing was accomplished. The different types of phytoplankton were also analysed in the surface water, to assess their potential distinctions by remote sensing. The success of this last campaign was ensured by the collaboration with Russian scientists from the Geography Faculty of Moscow State University (MSU) and the Baikal Institute of Nature Management (BINM) in Ulan Ude.

Four Russian students, Mikhail Tarasov, Galina Shinkareva, Tatiana Zengina and Tamir Boldanov, worked on the data collected on the Selenga Delta during four-month internship. They managed to create a map with the main vegetation types in the Selenga Delta.

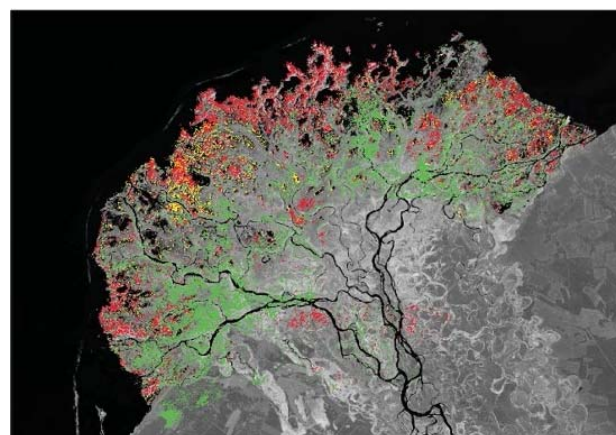
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Map of the main aquatic vegetation the Selenga Delta in 2014



## RESEARCH PROJECT

### Lake Ladoga: life under the ice.

Interplay of under-ice processes by global warming, 2014-2017



The ice camp on Lake Onego with the scientific team and the sponsors

As Lake Ladoga did not freeze in 2015, the first campaign was relocated to Lake Onego. From 13<sup>th</sup> to 28<sup>th</sup> March, scientists from 7 subprojects successfully collected multidisciplinary data on the physics of convection cells, phytoplankton, zooplankton, microbiology, greenhouse gases, and sediment. As new technologies, an automated underwater vehicle with multi-parameter sensors was successfully deployed under the ice, and hyperspectral images of the ice cover were collected with a drone.

The second campaign from 25<sup>th</sup> May to 7<sup>th</sup> June assessed the spring conditions of Lake Onego. The shallow near-shore areas were warmer than the deeper parts and showed a gradient in phytoplankton concentrations. The third campaign investigated Lakes Onego and Ladoga from 12<sup>th</sup> to 26<sup>th</sup> October, when both lakes were already mixed.

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ECOLOG research vessel in May 2015

# HUMAN RESOURCES

**Director:** Prof. Alfred Wüest, and **Deputy Director:** Dr. Natacha Tofield-Pasche

**Secretary (10%):** Tania Gonin, and **Technician (20%):** Sébastien Lavanchy

## Teams involved within Lemna-Baikal Project

**TOPO/LASIG:** Dr. Yosef Akhtman, Dragos Constantin, Prof. Bertrand Merminod, Prof. François Golay, Kevin Barbieux

**ECOL:** Prof. David Andrew Barry, Abofazl Irani Rahaghi

**APHYS-Margaretha Kamprad Chair:** Dr. Damien Bouffard, Vincent Maurice Nouchi, and Prof. Alfred Wüest

**WIRE:** Dr. Valerio Iungo Giacomo and Prof. Fernando Porté-Agel

**EFLUM/CRYOS/Princeton:** Prof. Mark Hultmark, Dr. Hendrik Huwald, Gilad Arwatz and Prof. Marc Parlange

**Gamaya:** Sergei Smirnov, Dr. Manuel Cubero-Castan

In Russia:

**Moscow State University:** Mikhail Tarasov, Galina Shinkareva, Prof. Tatiana Zengina, Tamir Boldanov, Lisa Shestova, Andrey Piotrovskiy, Dr. Olga Tutubalina, Prof. Sergey Chalov, Prof. Mikhail Slipenchuk

**Biological Institute in Irkutsk State University:** Prof. Maxim Timofeyev, Dr. Daria Bedulina, Dr. Olga Rusanovskaya

**Geoscan:** Alekanders Trufanovs

**Baikal Institute for Nature Management (SB RAS):** Alexander Ayurzhanayev, Zhargalma Alymbaeva, Margarita Zharnikova, Elena Brianskaya, Mikhail Ovdin, Natalia Luzhkova



Scientific team in Istomino research station near Selenga Delta in 2014

# HUMAN RESOURCES

## Teams involved within Lake Ladoga Project

In Russia:

**Northern Water Problems Institute, KRC RAS, Petrozavodsk:**

Physic group: Dr. Arkady Terzhevnik, Dr. Roman Zdorovenov, Dr. Galina Zdorovenova

Biological group: Dr. Natalja Kalinkina, Chekryzheva Tatjana, Tekanova Elena, Syarki Maria, Georgiev Andrei

Chemical group: Dr. Petr Lozovic, Rodkina I.S., Efremova T.A., Ptitca A.I., Stepanova I.A., Zobkova M.V., Basova S.V., Efremenko N.A., Dmitrieva Yu.F., Zobkov M.B., Galakhina N.E., Kalmykov M.V., Ikko O.I.

Hydrological-climatic group: Prof. Nikolay Filatov, Larisa Nazarova, Nikolai Palshin, Tatjana Efremova, Andrey Balagansky, Vasili Kovalenko

Sediment group: Dr. Dmitry Subetto, Dr. Natalia Belkina, Makarova Elena, Liudmila S. Syrykh

**Limnological Institute St-Petersburg:** Anna V. Ludikova

**Arctic and Antarctic Research Institute:** Dr. Boris Ivanov

**Nansen International Environments and Remote Sensing Center:** Dr. Anton Korosov and Vladimir Volkov.

In France:

**UMR CARTEL, INRA-Thonon-les-Bains:** Dr. Emilie Lyautey, Dr. Marie-Elodie Perga, Dr. Victor Frossard, and Dr. Thomas Camille

**OMP-LEGOS:** Dr. Alexei V. Kouraev.

In Switzerland:

**University of Geneva:** Prof. Daniel Ariztegui, Prof. Bastiaan W. Ibelings, Prof. Christel Hassler, Marie-Caroline Tiffay and Evanthia Mantzouki

**Eawag:** Dr. Nathalie Dubois, Alois Zwysig, Dr. Beat Müller and Carsten Schubert

Within EPFL:

**APHYS-Margaretha Kamprad Chair:** Dr. Damien Bouffard, and Prof. Alfred Wüest

**DISAL:** Dr. Felix Schill, Dr. Alexander Bahr, and Prof. Alcherio Martinoli

**TOPO:** Dr. Yosef Akhtman, Kevin Barbieux and Prof. Bertrand Merminod



## SCIENTIFIC PUBLICATIONS

Arwatz G, Fan Y, Bahri C and Hultmark M. (2015): **Development and characterization of a nano-scale temperature probe (T-NSTAP) for turbulent temperature measurement**, Measurement Science and Technology (26): 035103. doi:10.1088/0957-0233/26/3/035103

S. Chalov, J. Thorslund, N. Kasimov, J. Nittrouer, Y. Akhtman, E. Garmaev et al., **The Selenga River delta – geochemical barrier protecting Lake Baikal's waters**. Submitted to the Journal of Regional Environmental Change.

Bouffard D., R.E. Zdrovennov, G.E. Zdrovennova, N. Pasche, A. Wüest and A.Y. Terzhevik (2016). **Ice covered lakes – Effects of solar radiation on convective plumes and internal waves**. Submitted to Journal of Hydrobiologia.

Publications in Russian:

B. Ivanov. **Lake Ladoga: life under ice. Interplay of under-ice processes by global change. A Russian-Swiss multi-disciplinary project**. In Russian Polar Investigations. № 2 (20), 2015. P.40-42 (in Russian).

Filatov N. and Terzhevik A. **Joint Russian-Swiss project investigations of winter regime of Lakes Ladoga and Onego**. Proceedings of Karelian Research Center RAS, Series of Limnology. № 5, 2015, pp. 86-89 (in Russian with English Summary).

## NEWSPAPER ARTICLES

TASS Russian News Agency, on 27.03.2015. Interview of Nikolai Filatov by reporter Igor Lukjanov.

News ENAC on 23.04.15. Life under the ice on Lake Onego. <http://actu.epfl.ch/news/life-under-the-ice-on-lake-onego/>

## TELEVISION

30 min documentary on **“Leman-Baikal. Trans-Eurasian flight”** by Atlas Media Movie Studio, Lake Baikal Protection Fund and UNDP. Available on <https://www.youtube.com/watch?v=1ET8FU4SzUo>

Russian TV, Ch 1: 16.03.2014. and Karelian TV. Interview of Mr. Frederic Paulsen.

Russian TV, Ch 1: 24.03.2015. Interview of Nikolai Filatov <http://www.youtube.com/watch?v=2VOuVbAXnMM>



## CONFERENCES AND WORKSHOPS

Leman-Baikal Project:

M. S. P. Cubero-Castan, D. Constantin, K. S. Barbieux, V. M. Nouchi and Y. Akhtman et al. **A new smoothness based strategy for semi-supervised atmospheric correction: application to the Léman-Baïkal campaign.** 7th Workshop on Hyperspectral Image and Signal Processing: Evolution in Remote Sensing, Tokyo, Japan, 2015.

M. Tarasov, G. Shinkareva, O. Tutubalina, D. Constantin, Y. Akhtman et al. **Investigation of heavy metals distribution in suspended matter and macrophytes of the Selenga river delta using airborne hyperspectral remote sensing.** 9th EARSeL SIG Imaging Spectroscopy workshop, LIST, Luxembourg, 2015.

V. Nouchi, D. Odermatt, D. Bouffard, N. Pasche, A. Wüest. **Water quality retrieval using hyperspectral observations by ultralight aircrafts over the Selenga Delta in Lake Baikal.** Talk, SEFS 9, Geneva, July 2015.

A. Irani Rahaghi, U. Lemmin, M. Riffler, S. Wunderle, D.A. Barry. **A Multiscale Surface Water Temperature Data Acquisition Platform: Tests on Lake Geneva, Switzerland.** Poster, AGU Fall Meeting, San Fransisco, December 2015.

A. Irani Rahaghi, U. Lemmin, D. Bouffard, M. Riffler, S. Wunderle, D.A. Barry. **Seasonal Spatial Patterns of Surface Water Temperature, Surface Heat Fluxes and Meteorological Forcing Over Lake Geneva.** Poster, AGU Fall Meeting, San Fransisco, December 2015.

Project Ladoga:

A. Terzhevik, R. Zdorovenov, D. Bouffard and G. Zdorovenova. **Russian-Swiss cooperative study of under-ice convection in Lake Onego: Preliminary results.** 4<sup>th</sup> European Large Lakes Symposium: Ecosystem Services and Management in a Changing World. Talk, Joensuu, Finland, August 2015.

Limnology Center:

N. Pasche and A. Wüest. **Limnology Center: multidisciplinary research and new technologies to study lakes.** Talk, SEFS9, Geneva, July 2015.

## TEACHING

N. Pasche and A. Wüest. **Lake Physics: complementary aspects of mid-sized lakes (Switzerland) and Lake Kivu (Eastern Africa).** Swiss-Russian International Summer School: Lake ecosystems under pressure: processes and impacts. Baikal Biological Station of Irkutsk State University (Bolshie Koty), 21-31 August 2015





## 9<sup>th</sup> Symposium for European Freshwater Sciences

Geneva, Switzerland | July 5-10, 2015

# NETWORKING

The special session SS11: Lake Baikal – an interdisciplinary laboratory of freshwater sciences was organized with the following presentations:

M. Schmid, C. Tsimriti, N. Budnev, M. Schurter, M. Sturm, A. Wüest. **What can we learn from 13 years of temperature observations in the South Basin of Lake Baikal?**

C. Tsimriti, A. Wüest, M. Schmid. **Internal waves in Lake Baikal's South Basin**

N. Budnev. **Baikal Neutrino Observatory as a deep-water laboratory for interdisciplinary researches**

N. Granin, V. Kozlov, E. Tsvetova, R. Gnatovsky, K. Kucher, E. Troitskaya. **Ring structures on the ice of Lake Baikal**

M. Sturm, E. Vologina, N. Budnev, M. Schurter. **Results of 20 years of sediment trap monitoring. Particle dynamics in ocean-like Lake Baikal**

E. Litchman, M. Brady, D. O'Donnell, K. Shchapov, E. Silow, E. Theriot, P. Wilburn. **Physical, chemical and biological drivers of phyto- and bacterioplankton diversity in Lake Baikal: some results from the Dimensions of Biodiversity project**

H. Bürgmann, N. Torres, B. Müller. **Anaerobic methane and ammonium oxidation occurs in stacked redox zones linked to iron- and manganese oxide layers in Lake Baikal sediment**

G. Swann, V. Panizzo, S. Roberts, L. Vologina, M. Horstwood, A. Mackay. **Can silicon isotopes be used to assess anthropogenic impacts and nutrient utilisation in Lake Baikal, Siberia?**

D. Karthe, K. Westphal. **Water quality challenges along Lake Baikal's main artery: A meta study integrating recent research findings from the Selenga River Basin**

V. Nouchi, D. Odermatt, D. Bouffard, A. Wüest. **Water quality retrieval using hyperspectral observations by ultralight aircrafts over the Selenga delta in Lake Baikal**

G. Shinkareva, M. Lychagin. **Distribution of dissolved and suspended heavy metals in the Selenga River delta.**

E. Silow, S. Shimaraeva, L. Krashchuk, K. Onuchin, H. Pislegina, O. Rusanovskaya, K. Shchapov, D. Bedulina. **Recent trends in planktonic community of Lake Baikal and their possible reasons.**

## OUTLOOK

In 2016, the Limnology Center would like to promote the following projects:

### Research Platform LÉXPLORE on Lake Lemman

The goal of the research platform on Lake Lemman is to acquire continuous records of physical and biogeochemical processes, as well as phytoplankton and zooplankton. This platform will also promote international and regional collaboration with other research groups.

Most of the scientific equipment for the platform was purchased in 2015, thanks to the R'Equip funding "Léman exploration (LÉXPLORE)". On 9<sup>th</sup> November 2015, the Canton of Vaud gave the authorizations to construct this platform near Pully. However, this decision might still be contested in the Cantonal Court.

In May 2015 with UNIGE, a 6 m-long sediment core was retrieved at the platform future location, to assess the sediment density for the mooring. Using this core, a master student from UNIGE will also evaluate the temporal evolution of the trace-metals contamination in Lake Geneva.

### Underwater Automatic Vehicles to investigate ecological niches

This interdisciplinary project is a collaboration between Prof. Bastiaan Ibelings from UniGE, Prof. Alcherio Martinoli from DISAL and Prof. Alfred Wüest from APHYS. The aim is to develop underwater automatic vehicles to investigate the spatial heterogeneity of physico-biological processes in lakes. The proposal SINERGIA was accepted in July 2015, and the first tests took place on Lago Cadagno in September 2015.

### Lakes on the Canadian West Coasts

The goal of this project is to investigate very old water masses from the last ice-age, that are trapped in former fjords. These masses experience double diffusion and contain high concentrations of gases and old organic matter. The idea was discussed with potential interested parties (EPFL, ETHZ, Eawag, University of British Columbia, Institute of Ocean Sciences). A first GIS survey to identify potential lakes is planned in 2016.

### Lakes in Antarctica

This project aims at studying double diffusion in ice-covered lakes in Antarctica. Potential interested parties are EPFL, ETHZ, WSL and Eawag.