

# Annual Report 2017

January 2017 to December 2017

## Margaretha Kamprad Chair of Environmental Science and Limnology

### Physics of Aquatic Systems Laboratory APHYS at EPFL



## 1. OBJECTIVES

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The aims of the *Physics of Aquatic Systems Laboratory* (APHYS) are to understand the physical processes in natural waters and the responses of aquatic systems to external forcing. The main focus is on anthropogenic influences, such as nutrient inputs, hydropower production, heat use from surface waters, climate change and human activities in the catchments. We study the effects on surface waters and their sensitivity to those drivers and outline consequences for water resources management. Besides *in-situ* measurements we apply hydrodynamic modelling and use remote sensing information.

## 2. RESEARCH ACTIVITIES

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### 2.1. Oxygen depletion in Lake Geneva (SNF funded)

Lake Geneva, once the classic example of an oligotrophic alpine lake, is still recovering from excessive phosphate loading during the last 60 years. The main goal of this project is to quantify and parameterize the rate of oxygen depletion in the hypolimnion of Lake Geneva. Using a MP8 lander, oxygen microprofiles are measured at high-resolution (sub-mm scale) through the sediment-water interface to determine the flux of oxygen from the lake-water into the sediment. To determine the relative importance of different pathways of organic matter mineralization, sediment cores were taken to quantify the flux of reduced substances. The oxygen depletion in the hypolimnion is estimated based on the measured data and a simple conceptual model of oxygen depletion. The results compare well with the CIPEL long-term measurements since the 1950s.

ADCPs for small-scale measurements are deployed in close proximity in order to quantify the variations of sediment oxygen uptake as a function of bottom boundary layer currents. Using ADCP current meter records, two numerical models are calibrated to determine the currents in the bottom boundary layers of Lake Geneva and allow determining the variability of sediment oxygen uptake with bottom boundary layer dynamics for the whole lake.

A one-dimensional hydrodynamic model was used to simulate the long-term changes in deep-water mixing, which is most crucial for the supply of oxygen into the deep-waters during winter. An oxygen model including gas exchange with the atmosphere, oxygen production and oxygen depletion based on the measured currents was coupled to the hydrodynamic model.

### 2.2. Particles distribution in Lake Biel (ESB funded)

The City of Biel uses lake-water as part of the drinking water supply. In December 2009 extremely high particle concentrations forced a temporary shut-down of the Ipsach/Bienne drinking water treatment plant for the first time since more than ~40 years of operation. The objective of this project is to investigate the causes behind such events and to determine the potential of reoccurrence of such phenomena. The processes governing the lateral distribution of particles within the lake and how the particles are affected by anthropogenic influences was investigated using numerical modelling in one and three dimensions. The project results are intended to provide guidance for the planned major renovation of the water treatment plant and intake system used by the City of Biel.

Although the project was finished in November 2016 and the results have been presented in Biel to the relevant stakeholders, the PhD study by Love Råman Vinnå ended in August 2017.

### 2.3. Use of heat from lakes (expert service and Peak course; FOEN funded)

The political goal of reducing fossil fuel consumption will increase the use of lake water for heating and cooling of riparian infrastructures. The aim of this activity is to estimate the potentials for various lakes in Switzerland. After we have already performed various expert services for practically all larger lakes in Switzerland, we conclude these activities soon by a review of the ecological and technical

implications and requirements. The project will be concluded early 2018 which includes a Peak held in early November 2017 at Eawag in Kastanienbaum.

In a related follow-up project, the expected heating of the rivers and lakes in Switzerland will be estimated and systematically evaluated. For lakes this will include, as an example, the wintertime deep convective mixing. The project runs under the leadership of Hendrik Huwald in collaboration with Martin Schmid and Damien Bouffard (both at Eawag) and it is funded by FOEN from 2017 to 2020.

#### **2.4. Autonomous underwater robots of physical-ecological investigations of aquatic systems**

This Sinergia project “*A Flexible Underwater Distributed Robotic System for High-Resolution Sensing of Aquatic Ecosystems*“, under the leadership of Prof Alcherio Martinoli (EPFL) in collaboration with Prof Alcherio is an interdisciplinary project combining AUV robot technology and performing applied research. In a first step we focus on the explanation for the astonishing observation of a completely mixed layer in Lago Cadagno (Ticino, Switzerland) in a depth of ~12 m within the 20 m deep lake. Excessive high concentration of sulphur bacteria (*Chromatium okenii*) lead to homogenising a layer of ~1 m thickness within the strong stratification at the oxic-anoxic interface in ~12 m depth. The mechanical energetics of the mixing – most probably caused by the swimming bacteria – is subject of the research which comprises field observations (profiling of biogeochemical concentrations and temperature microstructure / turbulence) and direct numerical simulations. In summer 2017, we try again to map the two-dimensional structure of the bacterial layer by using AUV robots.

#### **2.5. Lake Ladoga (Limnology Center funded)**

The main goal of this sub-project is to study the development of under-ice convection in Lake Ladoga and its implications for algae growth under ice. The Lake Ladoga project is managed by the Limnology Center and includes eight different teams from several countries (see list below). In March 2015, the first fieldwork was performed on Lake Onega, as the ice-cover on Lake Ladoga was too weak. Also in 2016 the ice was again not strong enough for Lake Ladoga and the work focussed on Onega. The study is part of an interdisciplinary research project with the aim to better characterize:

- (i) the radiative transfer responsible for the onset of under-ice convection,
- (ii) the vertical velocities induced by the convective cells and,
- (iii) the development of phytoplankton under ice.

Our research approach consists in collecting and analysing field data in parallel to compare observations with large eddy simulations. For 2018 joint publications in a special issue is planned.

#### **2.6. Hydrodynamic modelling including data assimilation (CORESIM, ESA funded)**

This research project is tight to Damien Bouffard, who is building up an Aquatic Physics group at Eawag. However, the PhD student of the project remained at APHYS to complete his PhD at EPFL.

The aim of this project is to understand spatial variability of bio-geophysical processes in lakes. New information provided by remote sensing data coupled to three-dimensional models allows to investigate such variability. The approach is to couple all information sources of lake research (remote sensing data, field observations and numerical models) through adapted data assimilation algorithms. The coupling of those three data sources aims at providing a new, reliable, flexible, and global modelling framework for inland waters monitoring across Switzerland, Europe and possibly expanding to other lakes of the world.

In terms of system operations, the framework will be operated in real-time for several Swiss lakes, with short-term forecasting of hydrodynamic and water quality properties, available online, and open to the public. The impacts of such systems are expected at public, governmental and scientific levels. For the latter, this project aims at contributing to advances in aquatic research by (i) identifying and studying mesoscale processes such as up- downwellings, horizontal distribution of ecological

properties, and (ii) assessing the variability of lake responses to climate change, in terms of warming and ice cover.

The online platform can be viewed on [www.meteolakes.ch](http://www.meteolakes.ch).

### 3. MAJOR ACQUIRED EQUIPMENT

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We had the opportunity to complete our field instrumentation with the grants from the Kamprad Chair as well as a SNF Re-equipment grant. The acquisitions in 2017 comprise:

#### 3.1. Campbell scientific data loggers with RF communication

Campbell scientific dataloggers are reliable and versatile data acquisition system with programming capabilities. A CR6 is installed in an underwater enclosure to control different instrument (ADCP, turbidity, oxygen, chlorophyll, PAR, and temperature sensors, etc.) in real time. A CR6RF allow wireless communication (radio frequency) in area without GPRS signal like at Lake Cadagno (TI).

#### 3.2. Two RBR real time Dissolved Oxygen loggers

The RBRvirtuoso ODO is a real time logger with an optical dissolved oxygen and a temperature sensor. The low power consumption and the addition of a zebratech hydrowiper make it ideal for a long-term deployment. The loggers have been deployed at Lake Cadagno to monitor the layer of the photoautotrophic sulphur bacteria.

#### 3.3. Campbell scientific real time turbidity sensors

The OBS-3+ is a real time rugged and submersible turbidity probe that has sideways-facing optics with an accuracy of  $\pm 0.5$  NTU, and equipped with a zebratech hydrowiper. The sensor delivers an analog signal which can be read and recorded with a standard datalogger.



### 3.4. Campbell scientific weather station

GRWS100 is a low-power, portable weather station with a tiltable mast. The parameter measured are wind speed, wind direction, air temperature, relative humidity, barometric pressure, precipitation and solar radiation. The station is controlled by CR1000 logger fully programmable for an integration on the LÉXPLORE platform.

### 3.5. Thetis Profiler

The submersible, buoyant-ballasted and self-operating Thetis platform is anchored to the sediment. Vertical profiling is managed by a GSM communication and a battery-powered winch integrated at the base of the instrument. Data is transmitted via GSM communication system at the end of up-casts, when the surfaced antenna reaches air. The ~5 min surfacing time allows the Thetis to receive messages previously sent from any remote computer to modify measurement parameters setting, profiling schedule and instrument control. The batteries allow three months of profiling for a standard setup including eight 50 m long profiles per day. The deep parking of the instrument minimizes bio-fouling of optical sensors which will be regularly serviced (1 to 3 months).

The self-contained Thetis profiler carries a modular sensors set: Sea-Bird 49 FastCAT CTD (conductivity, temperature and depth), Sea-Bird 63 oxygen optode, pH, two ECO BBFL2w Triplet-w fluorometers for CHL-a and CDOM fluorescence (EX/EM 470/695 nm and 370/460nm, respectively) and four backscattering wavelength (440, 532, 630 and 700 nm), Sea-Bird ECO PAR (400 to 700 nm), AC-S spectrophotometer (80 wavelengths from 400 to 730 nm) for absorption and attenuation, two Satlantic HOCR hyperspectral radiometers for upwelling radiance and downwelling irradiance. All optical sensors are equipped with wipers. Other sensors with internal recording and batteries can be mounted on the Thetis.

### 3.6. Workstation computer

A new computer for the modelling studies has been acquired. It has been specifically chosen for the parallel computations required by the data assimilation and the faster online computations visible on [meteolakes.ch](http://meteolakes.ch).

## 4. HUMAN RESOURCES

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<b>Theo Baracchini</b>	PhD student since March 2015
<b>Nicolas Bochaton</b>	EPFL Master student, winter 2016 to summer 2017 at University of Quebec
<b>Angelo Carlino</b>	Intern at APHYS, July 5th until September 3rd 2017. Environmental and Land Planning Engineering student at Politecnico di Milano. Exchange student Fall 2016 – Spring 2016, SIE Master program, EPFL.
<b>Christel Chappuis</b>	EPFL Master student, autumn 2016 to spring 2017
<b>Hannah Chmiel</b>	Post-doc, since October 2016
<b>Tomy Doda</b>	EPFL Master student, winter 2016 to summer 2017 at UBC Vancouver
<b>Sonia Joëlle Dupuis</b>	EPFL Master student, spring to summer 2017
<b>Oriane Etter</b>	EPFL Master student, autumn 2016 to spring 2017
<b>Tania Gonin</b>	Secretary of APHYS and LIMNC, since November 2013
<b>Emilie Haizmann</b>	Intern at APHYS, July 11th to August 18th 2017. Bachelor student of Physics, EPFL.
<b>Tiit Kutser</b>	Visiting professor, April - September 2017



<b>Sébastien Lavanchy</b>	Technician at APHYS (EPFL), since May 2015
<b>Vincent Nouchi</b>	PhD student, since January 2014
<b>Yves Prairie</b>	Visiting professor, January - June 2017, with SBER
<b>Love Råman Vinnå</b>	PhD student, since July 2013
<b>Robert Schwefel</b>	Post-doc, since February 2017 (before PhD student since January 2013)
<b>Amélie Séchaud</b>	EPFL Master student, fall 2017 to spring 2018, at l'Université du Québec à Montréal.
<b>Oscar Sepúlveda Steiner</b>	PhD student, since April 2016
<b>Hugo N. Ulloa</b>	Postdoc, since February 2017 (former U de Chile)
<b>Guillaume Ulrich</b>	Civil servant at APHYS EPFL; 22 May to 30 June 2017
<b>Martin Zoller</b>	Civil servant at APHYS EPFL; 3 October 2016 to 12 February 2017.

## Visitors in 2017

- **Peter Holtermann**, Institut für Ostseeforschung, Warnemünde, Germany
- **Marco Toffolon**, University of Trento
- **Damien Bouffard**, Eawag
- **Tiit Kutser**, Department of Remote Sensing and Marine Optics, University of Tartu, Tallinn
- **Yves Prairie**, l'Université du Québec à Montréal.

## 5. NETWORKING

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### 5.1. Oxygen depletion in Lake Geneva

- Lee Bryant, University of Bath, UK
- Miki Hondzo, University of Minnesota, USA
- Beat Müller, Damien Bouffard, Thomas Steinsberger, Eawag
- Elena Sanchez, Universidad de Granada, Spain
- Lars Umlauf and Peter Holtermann, Institut für Ostseeforschung, Warnemünde, Germany
- Martin Wessels, Institut für Seenforschung, Langenargen, Germany

### 5.2. Particles distribution in Lake Biel

- Roland Kaeser, Energy Service Biel (ESB), Waterworks City of Biel
- Natalie Dubois, Damien Bouffard, Eawag
- Flavio Anselmetti and Michael Hilbe, University of Bern
- Stephanie Girardclos, University of Geneva.

### 5.3. Lake Onega Project Limnology Centre, EPFL

- Natacha Tofield-Pasche, Limnology Centre, EPFL
- Arkady Terzevik, Nikolay Filatov, Roman Zdorovenov, Nataliia Kalinkina, Natalia Belkina, Dimitry Subetto from Northern Water Problems Institute
- Kevin Barbieux, Bertrand Merminod, TOPO, EPFL
- Felix Schill, Martinoli Alcherio, Bahr Alexander, DISAL, EPFL
- Bas Ibelings, Marie-Caroline Tiffay, and Daniel Ariztegui, University of Geneva:
- Marie Perga, INRA Thonon-les-Bains
- Victor Frossard, Camille Thomas, Emilie Lyautey from University of Savoie
- Nathalie Dubois, Mischa Haas, Damien Bouffard, Eawag
- Alexei Kouraev, LEGOS
- Hilmar Hofmann, University of Konstanz.

#### **5.4. Autonomous AUV (Cadagno) Project**

- Mauro Tonolla, Andreas Bruder, Francesco Danza, Samuel Lüdin and Nicola Storelli, University of Applied Sciences and Arts of Southern Switzerland (SUPSI)
- Tobias Sommer, Hochschule Luzern – Technik & Architektur (former Post-Doc at Eawag)
- Anwar Quraishi, Alexander Bahr and Alcherio Martinoli, DISAL, EPFL
- Felix Schill, HYDROMEA SA
- Anupam Sengupta, Stocker's Microfluids Laboratory ETHZ
- George Constantinescu, University of Iowa, USA
- Talia Tokyay, Middle East Technical University, Ankara, Turkey
- Caroline Buckner, Jasmine Berg, MPI Bremen, Germany
- Helmut Bürgmann, Carsten Schubert, Damien Bouffard, Eawag.

#### **5.5. Autonomous AUV (Zurichsee / Greifensee) project**

- Bas Ibelings, Marie-Caroline Tiffay, Ena Suarez Bolanos, University of Geneva.
- Anwar Quraishi, Alexander Bahr and Alcherio Martinoli, DISAL, EPFL
- Felix Schill, HYDROMEA SA
- Jakob Pernthaler, University of Zurich
- Damien Bouffard, Eawag.

#### **5.6. Remote sensing**

- Damien Bouffard, Eawag
- Daniel Odermatt, Odermatt & Brockmann GmbH, Zürich
- SEON: Alexander Damm and Andreas Hueni; Geography Institute, University of Zürich
- Stefan Wunderle, University of Bern
- Peter Hunter, Stirling University, UK
- Tiit Kutser, Estonia.

#### **5.7. Heat use and climate warming of natural waters**

- Officers from Cantons of ZH, LU, TG, SG, NW, BE as well as various engineering companies such as AquaPlus Zug.
- Hendrik Huwald, Damien Bouffard, Martin Schmid, Adrien Gaudard, Adrien Michel.

## **6. CONCLUSION AND FUTURE DIRECTIONS**

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Within the next four years, we envisage to pursue the following new projects:

### **6.1. Sinergia project on underwater robots for high-resolution spatial mapping**

This interdisciplinary project - a collaboration with Prof Bas Ibelings from UNIGE and Prof Alcherio Martinoli from the DISAL Laboratory at EPFL aims at using underwater automatic vehicles to investigate the spatial heterogeneity of physico-biological processes in lakes. The proposal was submitted by 15 January 2015 to FNS and was approved. The project started in August 2015.

### **6.2. LÉXPLORE research platform on Lake Geneva**

The aim of this research platform is to acquire continuous records of physical and biogeochemical properties, as well as phytoplankton and zooplankton. This platform should also promote international collaboration with other research groups interested in this facility. The equipment is part of a R'Equip proposal submitted in May 2014 to FNS, which subsequently approved the request. Since 2017, we

have four partners, UniGE, UniL and Eawag besides EPFL committed to finance and operate the platform. Further core partners are welcome. The LÉXPLORE platform will be open to any scientists.

### 6.3. Primary productivity in large lakes (LIMNC-based, not yet funded)

This research project is in 2017 in the build-up phase. The goals are to explain the dependency of primary production on different levels of phosphorus forcing. Beside the reconstruction of primary production over the past decades, this project includes various goals related to new observations technology and new method of PP estimates also over very short time intervals (few days). We plan to cooperate with the partners at Lake Geneva, Lake Lugano-NB, Lake Lugano-SB, Lake Constance among others.

## 7. CONFERENCES IN 2017

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- Ulloa, H. N., K. A. Davis, G. Pawlak and S. G. Monismith, August 29 - September 1, 2016. High variability in cross-shore thermally driven exchange. **VIIIth International Symposium on Stratified Flows**, San Diego, USA.
- Wüest, A., 29 December 2016, Oxygen depletion in lakes. Talk. **Alva Moobdri and Energy and Wetland Research Group, Indian Institute of Science, Bengaluru, India.**
- Wüest, A., 4 January 2017, Cooperation over shared waters – examples from Switzerland and neighbours. Talk. **The National Institute of Engineering, Visvesvaraya Technological University, Mysore, India, International Workshop on Transboundary Water Sharing - Issues and Concerns. India**
- Wüest, A., 6 January 2017, Cooperation over shared waters – Joint water pollution control by Switzerland and neighbours. Talk. **Institution of Engineers, IEI-KSC Bengaluru, India, One Day Workshop on Trans-Boundary Watersheds / Water Transfers and IWRM. India**
- Wüest, A., 7 January 2017, History of water pollution control in Switzerland. Talk. **Department of Environmental Science, Bangalore University, and World Organisation of Students and Youths, Students for Development, at Bangalore University, Bangalore One Day International Conference on Science and Technology for Management of Emerging Environmental Issues. India.**
- Wüest, A., 6 February 2017, LÉXPLORE - a platform for high-resolution interdisciplinary observations on Léman. Talk. **GEOPOLIS Day, University Lausanne.**
- Wüest, A., 9 February 2017, Vierwaldstättersee - ein reichhaltiges Ökosystem. Talk. **Küssnacht, SZ, Ruderclub Rigi Küssnacht.**
- Wüest, A., 21 März 2017, Projekt Bielersee - Evaluation und Optimierung der Seewasserfassung Ipsach. Talk. **Studen, BE, Generalversammlung Wasserverbund Seeland AG.**
- Råman Vinnå L, A. Wüest, and D. Bouffard, 25 April 2017, Variability in response of lakes to climate change explained by surrounding watersheds. Talk. **EGU2017-15224 General Assembly, Session HS4.6/CL3.02 From sub-seasonal forecasting to climate projections: predicting hydrologic extremes and servicing water managers.**
- Schwefel, Robert; Steinsberger, Thomas; Bouffard, Damien; Bryant, Lee; Müller, Beat; Wüest, Alfred April 23-28, 2017: Oxygen depletion in a large perialpine lake. **Poster EGU General Assembly 2017, Vienna.**
- Wüest, A., 27 April 2017, Sauerstoffbedarf in Schweizer Seen: Tiefe und flache Seen reagieren verschieden auf Rückgang der Produktion. Talk. **Solothurn, Jahresversammlung, Verband Schweizer Abwasser Fachleute (VSA).**
- Wüest, A., 23 May 2017, Oxygen depletion in stratified lakes - Why shallow and deep lakes react differently? Talk. **Shanghai, 4<sup>th</sup> IWA Symposium of Lake and Reservoir Management 2017.**



- Baracchini T., Wüest A., Odermatt D., Verlaan M., Wunderle S., Lieberherr G., Bouffard D., 18 May 2017. Coupling In-situ and Remote Sensing Data with Three Dimensional Hydrodynamic Models. Talk. **IAGLR 2017, Detroit (MI)**.
- Sepúlveda Steiner, O., 13 July 2017. Bioconvection in Lake Cadagno, **Cours d'Hydrogéologie Microbille**, held by Prof. Mauro Tonolla (Uni-Geneva and SUPSI, TI) at CBA-Cadagno
- Wüest, A. and T. Sommer, 22 August 2017, Bacteria-induced mixing in natural waters. **PPNW Finland**, 21-25 August 2017.
- Bouffard, D. H.N. Ulloa, R. Zdrovennov, G. Zdrovennova, S. Volkov, S. Bogdanov, A. Terzhevik and A. Wüest, 22 August 2017, Effects of solar radiation on convective plumes and internal waves in ice covered lake. **PPNW Finland**, 21-25 August 2017.
- Wüest, A., 4 September 2017, Neue Erkenntnisse über Seeströmungsuntersuchungen im Bielersee. Talk. **Rotary Club, Lyss Aarberg. Restaurant Bären, Lyss**.
- Wüest, A., 13 September 2017. Fernerkundung: Anwendungen für Hydrologie und Limnologie – Synthese. Talk. SCNAT-SGHL. **Vereinsaal Kongresshaus, Biel**.
- Wüest, A., 20 Oktober 2017, Heizen und Kühlen mit Wasser aus Seen. Talk. **Politisches Forum, Mondsee Oestreich**.
- Wüest, A., 20 November 2017, Heizen und Kühlen mit Wasser aus Seen - *Potential, Projekte und ökologische Verträglichkeit*. Talk. **Biel, Ringvorlesung Wasser, Volkshochschule Region Biel-Lyss**.

## 8. PUBLICATIONS IN 2017

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### 8.1. Published peer-reviewed papers in 2017

- Baracchini, T., A.A. King, M.J. Bouma, X.Rodó, E. Bertuzzo, M. Pascual (2017). Seasonality in cholera dynamics: A rainfall-driven model explains the wide range of patterns in endemic areas. *Advances in Water Resources*, doi: 10.1016/j.advwatres.2016.11.012.
- Bierlein, K.A., M. Rezvani, S.A. Socolofsky, L.D. Bryant, A. Wüest, and J.C. Little (2017). Increased sediment oxygen flux in lakes and reservoirs: The impact of hypolimnetic oxygenation, *Water Resources Research* **53**(6): 4876–4890, doi:10.1002/2016WR019850.
- Gaudard, A., R. Schwefel, L. Råman Vinnå, M. Schmid, A. Wüest, and D. Bouffard (2017). Optimizing the parameterization of deep mixing and internal seiches in one-dimensional hydrodynamic models: a case study with with SIMSTRAT v1.3. *Geoscientific Model Development* **10**, 3411–3423, doi:10.5194/gmd-10-3411-2017.
- Mashayek, A., H. Salehipour, D. Bouffard, C. P. Caulfield, R. Ferrari, M. Nikurashin, W. R. Peltier, and W. D. Smyth (2017). Efficiency of turbulent mixing in the abyssal ocean circulation, *Geophysical Research Letters* **44**(12), 6296–6306, doi:10.1002/2016GL072452.
- Råman Vinnå, L., A. Wüest and D. Bouffard (2017). Physical effects of thermal pollution in lakes. *Water Resources Research* **53**(5): 3968–3987doi: 10.1002/2016WR019686.
- Razmi, A.M., U. Lemmin, D. Bouffard, A. Wüest, R.E. Uittenbogaard and D.A. Barry (2017). Gyre formation in open and deep lacustrine embayments: the example of Lake Geneva, Switzerland. *Environmental Fluid Mechanics* **17**(2): 415–428, doi: 10.1007/s10652-016-9494-8.
- Schwefel, R., M. Hondzo, A. Wüest, and D. Bouffard (2017). Scaling oxygen microprofiles at the sediment interface of deep stratified waters. *Geophysical Research Letters* **44**(3), 1340–1349, doi:10.1002/2016GL072079.
- Schwefel, R., T. Steinsberger, D. Bouffard, L. Bryant, B. Müller, and A. Wüest (2017). Using small-scale measurements to estimate hypolimnetic oxygen depletion in a deep lake. *Limnology and Oceanography* **62**, doi: 10.1002/lno.10723.
- Sommer, T., F. Danza, J. Berg, A. Sengupta, G. Constantinescu, T. Tokyay, H. Bürgmann, Y. Dressler, O. Sepúlveda Steiner, C.J Schubert, M. Tonolla and A. Wüest (2017). Bacteria-induced mixing in natural waters. *Geophysical Research Letters* **44**, 10.1002/2017GL074868.
- Steinsberger, T., M. Schmid, A. Wüest, R. Schwefel, B. Wehrli and B. Müller (2017). Organic carbon mass accumulation rate regulates the flux of reduced substances from the sediments of deep lakes. *Biogeosciences*, **14**(13): 3275–3285. doi:10.5194/bg-14-3275-2017

Valipour, R., L. Boegman, D. Bouffard, Y.R. Rao (2017). Sediment resuspension mechanisms and their contributions to high-turbidity events in a large lake. *Limnology and Oceanography* **62**: 1045–1065, doi: 10.1002/lno.10485.

## 8.2. Published non-peer-reviewed papers in 2017

Raman Vinnå L., D. Bouffard, N. Dubois, M. Hilbe, R. Käser und A. Wüest (2017). Seewasserentnahme im Bielersee – Gibt es eine ideale Position? *Aqua & Gas - Fachzeitschrift für Gas, Wasser und Abwasser* **97**(9): 14 - 20.

Gaudard A., M. Schmid und A. Wüest (2017). Thermische Nutzung von Oberflächengewässern – mögliche physikalische und ökologische Auswirkungen der Wärme- und Kältenutzung. *Aqua & Gas - Fachzeitschrift für Gas, Wasser und Abwasser* **97**(5): 40 - 45.

Gaudard A., M. Schmid et A. Wüest (2017). Utilisation thermique des eaux superficielles. *Aqua & Gas - Fachzeitschrift für Gas, Wasser und Abwasser* **97**(3): 44 - 49.

## 8.3. Submitted manuscripts to peer-reviewed Journals in 2017

Bouffard, D., I. Kiefer, A. Wüest, D. Odermatt, S. Wunderle (*submitted*). Are surface temperature and chlorophyll in a large deep lake related? An analysis using satellite imagery. *Remote Sensing of the Environment*.

Cimatoribus, A.A., U. Lemmin, D. Bouffard, and D.A. Barry (*submitted*). Nonlinear dynamics of the near-shore boundary layer of a large lake (Lake Geneva). *Journal of Geophysical Research - Ocean*.

Nouchi, V., D. Odermatt, A. Wüest, and D. Bouffard (*submitted*). Effects of non-uniform vertical constituent profiles on remote-sensing reflectance of oligo- to mesotrophic lakes. *European Journal of Remote Sensing*.

Rahaghi A.I., Lemmin U., Bouffard D., Riffler M., Wunderle S., and D.A. Barry (*submitted*). Spatiotemporal distribution and variability of surface heat flux over a large European lake using satellite, meteorological patterns and in situ measurements. *Journal Great Lakes Research*.

Råman Vinnå, L., A. Wüest, M. Zappa, G. Fink and D. Bouffard (*submitted*). Tributaries affect the thermal response of lakes to climate change. *Hydrol. Earth Syst. Sci. Discuss*, <https://doi.org/10.5194/hess-2017-337>.

Ulloa, H.N., G. Constantinescu, K. Chang, D. Horna-Munoz, O. Sepúlveda-Steiner, D Bouffard, and A. Wüest (*submitted*). Macroscopic hydrodynamics of a wind-forced stratified basin: an LES experiment. *Journal of Geophysical Research - Ocean*.

## 8.4. Reports and expert services in 2017

Schmid, M., C. Gerber, F. Bärenbold, and A. Wüest (2017). Assessment of the effects of different scenarios for methane extraction from Lake Kivu based on numerical modelling. Report commissioned by the Energy Development Corporation Ltd. (EDCL) of the Rwanda Energy Group (REG), Eawag, Kastanienbaum, Switzerland.

# 9. TEACHING

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## 9.1. Courses

- **Limnology**, Master course, spring term 2017, ENV-425, Env. Engineering, EPFL.
- **ETH-EPFL Summer School 2017** – “Catchment Transport Processes”, Einsiedeln, Switzerland 2–7 July 2017
- **Eawag Peak-Vertiefungskurs**, “Heizen und Kühlen mit Seen und Flüssen”, Kastanienbaum, Eawag, 8. November 2017, Kastanienbaum.

## 9.2. PhD Student supervised 2017

- Vincent Nouchi. Remote sensing of optical water properties; ongoing
- Robert V. Schwefel. Oxygen depletion in Lake Geneva; completed January 2017
- Love Råman Vinnå. Global and local anthropogenic effects on hydrodynamics of lakes – Applications to Lake Biel drinking water management; completed August 2017
- Theo Baracchini. Hydrodynamic modelling and assimilation of remote sensing data; ongoing
- Ulrike Kobler. Effects of pump storage operation on lakes; ongoing
- Oscar Sepúlveda Steiner. Resolving horizontal structures in lakes; ongoing
- Severin Stähly. Hydropower impact - linking biological and hydromorphological characteristics
- Sara Venuleo. Sediment-induced density flows; ongoing.

## 9.3. PhD Student exams in 2017

- Schwefel R.V. (2017). Global and local anthropogenic effects on hydrodynamics of lakes – Applications to Lake Biel drinking water management Oxygen depletion in Lake Geneva. *PhD thesis EPFL nr 7'569*. (Examiners: D. Bouffard, T Battin, D.F. McGinnis, L. Umlauf).
- Chamoun S. (2017). Influence of outlet discharge on the efficiency of turbidity current venting. *PhD thesis EPFL nr 7'736*. (Examiners: A. Schleiss, G DeCesere, H Knoblauch, M Jordeau).
- Råman Vinnå L (2017). *PhD thesis EPFL nr 7'976*. (Examiner: D. Bouffard, A. Schleiss, N Dubois, M Toffolon).

## 9.4. Master students in 2017

- Chappuis Christel (February 2017). 3D water quality modelling of an eutrophic lake. Master thesis École Polytechnique Fédérale de Lausanne, EPFL (*Supervisors: Theo Baracchini and Dr Damien Bouffard*).
- Etter Oriane R. (March 2017). Integrated modelling approach of urban wet weather discharges into lakes. Master thesis École Polytechnique Fédérale de Lausanne, EPFL (*Supervisors: Dr Damien Bouffard and Dr Luca Rossi*).
- Dupuis Sonia J. (July 2017). Validation of Landsat-8 and Sentinel-2 algorithms for atmospheric correction on Lake Geneva. Master thesis École Polytechnique Fédérale de Lausanne, EPFL (*Supervisors: Dr Daniel Odermatt and Vincent Nouchi*).
- Bochaton Nicolas (August 2017). Simulated heat storage in Canada's most northern lake: Towards a 3 dimensional model. Master thesis École Polytechnique Fédérale de Lausanne, EPFL (*Supervisor: Prof Warwick Vincent, Université Laval in Québec*).
- Doda Tomy (September 2017). Characterization of the bottom turbid layer in a pit lake and its response to convective cooling. Master thesis École Polytechnique Fédérale de Lausanne, EPFL (*Supervisor: Prof Gregory Lawrence, University of British Columbia*).

## 10. CURRENT EXPERT AND CONSULTING ACTIVITIES

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- Member of the Eawag Directorate
- Member of Advisory Board to the Swiss Competence Centre for Energy Research
- Member of Advisory Board to Forschungsstelle Nachhaltige Energie- und Wasserversorgung, University of Basel
- ContourGlobal, methan extraction in Lake Kivu, external advisor
- Co-editor of Aquatic Sciences
- Member of the Scientific/Technical Board for Lake Restoration on the Swiss Plateau, ASSAN
- Member of Group of Expert for IGKB (Lake Constance International Commission (Sachverständiger).

## 11. PROPOSALS

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### New, pending

- Heterogeneous data platform for operational modeling and forecasting of Swiss lakes (DATA LAKES), Sykus and Bouffard (Eawag), Wüest (EPFL) and Siddhartha Mishra, ETH Zurich. Swiss Data Science Center.

### Recent on-going funding

- NCCS Hydro-CH2018 – Research Project: **Evolution of stream and lake water temperatures under climate change**. Hendrik Huwald and Alfred Wüest (EPFL) and Damien Bouffard and Martin Schmid (Eawag), FOEN, Swiss Federal Office for Environment.
- **A Flexible Underwater Distributed Robotic System for High-Resolution Sensing of Aquatic Ecosystems**, Alcherio Martinoli (responsible), Alfred Wüest, Bastiaan Ibelings (Uni Geneva), CRSII2\_160726, *SINERGIA*, SNF, 386'304 kF (Total amount = 1,675 kF).
- **CORESIM, CO**upling **RE**remote **S**ensing, In situ and **MO**delling data for inland waters, Bouffard D. (EPFL), Odermatt D (Odermatt and Brockmann GmbH), Anneville O (UMR CARRTEL) and A. Wüest (EPFL), ESA, 2016 - 2018.
- **Oxygen depletion in a deep perialpine lake**, SNF Grant 200020\_165517; period = 1.7.2016 to 31.12.2017, 146 kF.
- **Léman exploration LÉXPLORE**, Research Equipment / SNF - R'Equip 2014, Alfred Wüest, Natacha Tofield-Pasche, Bastiaan Ibelings (Uni Geneva), Swiss National Science Foundation, 680 kF (split with Uni Geneva). Grant 206021\_157779, period = 01.05. 2015 to 30.04.2017 (2x12 months)
- **Life under the ice in Lake Ladoga**; 109 kF; contribution from the Limnology Center (external sponsoring via FEEL Foundation); total 1300 kF; dossier number: 9660 Internal project : 531254 (01.12.2014 au 30.11.2017)
- **SOLVE project Satellite Observation of Lakes and Vegetation Environments**; Ivanov (EPFL), Bouffard (EPFL), Clenet (EPFL), Akthman (Gamaya, CH), funded by SSO (CH).
- **Model**, Modélisation couplée hydro-biologique du Léman; DAMBRINE E, O. ANNEVILLE (UMR CARRTEL) and D Bouffard (APHYS, EPFL), ongoing.
- **Kivu Monitoring project**, Hydrodynamic modelling of Lake Kivu (EDMC/LKMP, Rwanda); PI: Deltares, NL, Damien Bouffard (EPFL), started in 2016.

### Recently finished

- **Particle distribution and fluxes in Lake Biel (assessing drinking water intake)**. Grant from *ESB Biel* (276 kFr). Ended November 2016.
- **Léman exploration LÉXPLORE**, Research Equipment / SNF - R'Equip 2014, Alfred Wüest, Natacha Tofield-Pasche, Bastiaan Ibelings (Uni Geneva), Swiss National Science Foundation, 680 kF (split with Uni Geneva). Grant 206021\_157779, period = 01.05. 2015 to 30.04.2017 (2x12 months). Ended April 2017.
- **Life under the ice in Lake Ladoga**; 109 kF; contribution from the Limnology Center (external sponsoring by FEEL Foundation); total 1,300 kF; dossier number: 9660, Internal project : 531,254 (01.12.2014 au 30.11.2017). Ended November 2017.
- **Swiss Earth Observation Network (SEON)**; Schaepman et al., January 2013 to December 2016. Ended December 2016.