

Annual Report 2014

September 2013 to August 2014

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Chair of Environmental Science and Limnology

Physics of Aquatic Systems Laboratory

APHYS at EPFL

& Eawag

1. OBJECTIVES

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 input, hydropower production, use of heat from natural waters, and climate change. We study the effects on natural waters and their sensitivity to those drivers and outline consequences for water resources management.

2. RESEARCH ACTIVITIES

2.1. Oxygen depletion in Lake Geneva (SNF funded)

Lake Geneva, once the classical example for an oligotrophic mountain lake, is still recovering from excessive phosphate loading over the last 60 years. The main goal of this project is to quantify and parameterize the rate of oxygen depletion in 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. A small-scale ADCP is deployed in close proximity to the MP8 lander to quantify the variation of sediment oxygen uptake with bottom boundary layer velocity. In addition, sediment cores were taken to determine the contribution of the up-ward directed flux of reduced substances to the oxygen depletion. Using ADCP current meter records, two numerical models will be calibrated to determine the flow in the bottom boundary layer of the lake. Combining these results with the *in-situ* measurement data, the oxygen depletion of deep waters will be estimated and compared to the CIPEL long-term oxygen profiles since the 1950s. In addition, a one-dimensional model is used to simulate the long term changes in deep-water mixing, which is crucial to supply a sufficient amount of oxygen into the lake during winter.

2.2. Particles distribution in Lake Biel (ESB funded)

The City of Biel uses Lake Biel as part of the drinking water resource. In winter 2009/2010 extremely high particles concentration forced the temporary shut-down of the Ipsach/Bienne drinking water treatment plant for the first time since ~30 years of operation. The objective of this project is to investigate the causes behind such events and to determine the potential of returning of such phenomena. The processes governing the lateral distribution of particles within the lake and how they are affected by anthropogenic influences will be investigated using numerical modelling in one and three dimensions. The origin of the particles (such as Aare at Hagneck and Suze at Biel) and the lateral distribution patterns will be determined and correlated to the model results using state of the art techniques and equipment (ADCP, Aquadop – high resolution current meters; LISST – multi-parameter system for *in-situ* observations of particle size distribution and volume concentration; high resolution temperature logger). The project results are intended to provide guidance for the planned major refurbishing of the water treatment plant and intake system used by the City of Biel.

2.3. Lemman-Baikal Project (Limnology Centre funded)

This project aims at developing new remote sensing techniques using hyperspectral camera on ULM and other low-flying platforms to characterise the water quality of both Lakes Geneva and Baikal. Our group specifically focuses on linking the optical properties collected from hyper spectral camera to the biological, physical and geological attributes. This project will provide (i) optimized water quality algorithms for remote sensing in lakes, (ii) ultra-high spectral and spatial resolution mapping of photoactive substances and (iii) better understanding of the horizontal patterns of biophysical parameter. This sub-project is part of an interdisciplinary project coordinated by the Limnology Centre.

2.4. High resolution freshwater monitoring (Freshmon, EU funded)

During overflights of satellites such as MODIS Aqua/Terra, MERIS, Rapideye, SPOT and ASTER, ground truthing information (such as the concentrations of particles, chlorophyll-a and coloured dissolved organic matter) was collected to validate remote sensing products provided by the project partners. On the research side, we focused on linking vertical profiles of water constituents to the remote sensing reflectance. The long-term goal is to connect satellite images (such as from the upcoming Sentinel-3 mission) continuously by applying hydrodynamic modelling between the scenes. More information on: <http://www.freshmon.eu/>.

2.5. Climate change and head use in Lake Constance (KlimBo; InterregIV funded)

Mild winters, hot summers, extreme heavy rain events, and strong variations of the water level affect all in some ways the hydrodynamic conditions of Lake Constance. The InterregIV project KlimBo (Klimawandel Bodensee) – coordinated by the Institute for Lake Research, Germany – aims to quantify climate-induced changes of those processes. We focus on two subprojects: (i) evaluation of the heat balance of Lake Constance and how it is affected by climate change and heat pollution. The objective is to explore the capabilities and the limits of heat use. (ii) Quantification of climatic and hydrologic developments in the catchment area of Lake Constance in order to calculate the effects on deep water renewal and particle transport into the lake.

2.6. Use of heat from Lake Geneva and in Lake Lucerne (expert service)

For nearly 30 years, EPFL has been using water from Lake Geneva to provide yearlong heating and cooling for the EPFL/UniL campus buildings and infrastructure. The system is recently reaching its capacity and encountering related problems. The objective of this project is to provide recommendations for the renovation of the installation. A careful analysis of the relevant physical mechanisms occurring in Lake Geneva, using long-term monitoring and short-term modelling, allows us to understand and predict the thermal behaviour of the stratified lake waters. Different alternatives are proposed to permit such sustainable energy policy to be prolonged over the next four decades. A similar approach was conducted in Lake Lucerne where the town of Horw investors plan to use thermal energy to heat a future neighbourhood over the winter. Historical temperature profiles and high-resolution measurements performed in winter 2013/2014 are used to establish the feasibility of such system and to compare the potential benefits with the associated risks.

2.7. Double diffusion in Lake Kivu (SNF funded)

This project focuses on the observational characterization of interfaces and mixed layers at small-scale resolution of mm to cm of the double diffusive layering in the water column of Lake Kivu. The goal is to estimate the vertical fluxes of heat, salt and dissolved gases. Therefore it was first necessary to determine the sensor responses by using a new in-situ approach that is based on variable profiling speeds. The observations lead to a correction of a commonly used flux parameterisation and this correction was confirmed in *Direct Numerical Simulations*, which correctly reproduced the interface thicknesses observed in Lake Kivu. Future research will focus on the lateral structure of double-diffusive staircases.

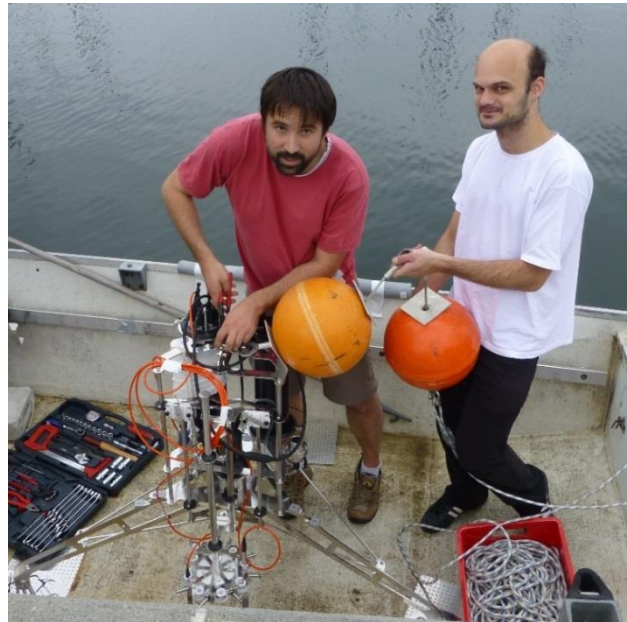
2.8. Satellite-based monitoring of chlorophyll and temperature of Lake Geneva

Since 1957, the water quality of Lake Geneva has been monitored at different locations. For several years, two locations are still measured bimonthly by the *Commission Internationale pour la Protection des Eaux du Léman* (CIPEL). However, phytoplankton growth changes daily and more suitable methods to monitor chlorophyll concentrations should be developed for the future. Satellite images from the MERIS sensor on the ENVISAT mission have been used to analyse the chlorophyll variability in space and time from 2002 to 2012. In a second step, images from the AVHRR sensor on the NOAA and MetOp missions were considered. These images showing the surface water temperature were treated by the Oeschger Centre for Climate Change Research at the University of Berne and could be directly used in this study.

During the summer months, when the stratification reaches its maximum, the nutrient concentrations in the surface layers sink to the minimum. When comparing lake surface temperature and chlorophyll concentration patterns, some episodes were found where algal growth can be related to a previous upwelling event, bringing colder and nutrient-rich water to the surface. Such relations will be analysed in the next months with the goal of understanding some of the interdependencies between physical and biological processes in Lake Geneva.

3. MAJOR ACQUIRED EQUIPMENT

We had the opportunity to further complete our field instrumentation with the grants from the Kamprad Chair as well as the fund from the EPFL start-up fund. The two pictures below show two key elements acquired in 2013, the flexible alu research boat (left) and the oxygen microprofiler (right).



3.1. RBRconcerto T.D.DOoptode

This optical sensor allows to measure dissolved oxygen and temperature over long periods of time.

3.2. RBR concerto T.D.FI.Tu (Turner)

This multi-parameter probe contains the following sensors: thermistor, pressure (depth), fluorescence, and turbidity. It is equipped with a Zebratech Hydrowiper to continuously clean the Turner sensors.

3.3. Workhorse ADCP Sentinel WHS600 / 1

This acoustic Doppler current profiler works at 600 kHz and is rated for 500m depth for *in-situ* measurements in natural waters.

3.4. Acoustic Transponding Release Model 866-A

Two additional releasers allow to anchor moorings without surface buoys.

3.5. PME 5000 SCAMP

This self-contained autonomous microstructure profiler is designed for uprising measurements to depth of 100 m. The profiler set-up is modular and can carry microsensors of temperature, salinity, fluorescence, etc.

4. HUMAN RESOURCES

Damien Bouffard:	Scientist and supervisors of PhD students at EPFL, since November 2012.
Robert Schwefel:	PhD student since January 2013, project "Oxygen depletion in Lake Geneva".
Love Råman Vinnå:	PhD student since July 2013, project "Particles in Lake Biel".
Vincent Nouchi:	PhD student since January 2014, project "ULM on Lemman-Baikal".
Tania Gonin:	Secretary of APHYS and LIMNC since November 2013.
Gabriel Fink:	Postdoc at Eawag, project "Lake Constance climate change (Klimbo)", until May 2014.
Jaime Pitarch:	Postdoc at Eawag, project "Freshmon" until November 2013.
Tobias Sommer:	PhD student until October 2013 at Eawag, project "Double diffusion in Lake Kivu"; off from November 2013 to April 2014; back in the project since May 2014.
Michael Schurter:	Technician at Eawag.
Eliane Scharmin:	Secretary of APHYS group at Eawag.
Isabel Kiefer:	Master student spring semester 2014, since August 2014 scientific assistant.
Adrien Gaudard:	Master student spring semester 2014.
Marco Toffolon:	Visiting Professor, University of Trento (Italy), Department of Civil, Environmental and Mechanical Engineering, from 1st March to 30th April 2014.
Katrina Schuler:	Visiting Master student McGill Montreal, from May to August 2014.
Oscar Steiner:	Visiting Master student, from 15 th March to 15 th June 2014.

5. NETWORKING

5.1. Oxygen depletion in Lake Geneva

- Lars Umlauf, Institut für Ostseeforschung, Warnemünde, Germany,
- Dr. Lee Bryant, University of Bath, UK,
- Beat Müller, Eawag,
- George Constantinescu, University of Iowa, USA.

5.2. Particles distribution in Lake Biel

- Roland Kaeser, Energy Service Biel (ESB), Water works City of Biel,
- Natalie Dubois, Eawag.

5.3. Lemna-Baikal Project

- Limnology Centre, EPFL,
- Russian partners from Moscow State University, Metropol, Ulan Ude University,
- EPFL partners: TOPO, LASIG, WIRE, EFLUM, ECOL laboratories.

5.4. Freshmon

- Marnix Laanen, Water Insight, Wageningen, Netherlands,
- Thomas Heege, Eomap, Seefeld Germany,
- Daniel Odermatt and Carsten Brockmann, Brockmann-Consult, Geesthacht, Germany,
- Sampsa Koponen, Syke, Finish Institute of Environment, Helsinki Finland.

5.5. Klimbo

- Thomas Wolf and Bernd Wahl, Institute for Lake Research - State Institute for Environment, Measurements, Nature Conservation, Baden-Württemberg LUBW, Langenargen, Germany,
- Ulrich Lang, Kobus and Partner, Stuttgart, Germany.

5.6. Heat use expert service

- Officers from Cantons of ZH, LZ, TG, SG, GL and AquaPlus Zug.

6. CONCLUSION AND FUTURE DIRECTIONS

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

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

This interdisciplinary project is a collaboration with Prof. Bas Ibelings from UNIGE and Prof. Alcherio Martinoli from DISAL laboratory at EPFL. The goal is to use underwater automatic vehicles to investigate the spatial heterogeneity of physico-biological processes in lakes. The proposal will be submitted by 15 January 2014.

6.2. Research platform on Lake Geneva

The aim of this research platform is to acquire continuous records of physical properties, biogeochemical processes, as well as phytoplankton and zooplankton. This platform should also promote international collaboration with other research groups interested in this facility. The equipment will be part of a Requête proposal to FNS in May 2014. First contacts with Canton Vaud and Geneva look promising concerning the required permission for anchorage.

6.3. Sentinel-3 validation team

The satellite Sentinel 3 will be launched in 2014 with high-resolution hyperspectral sensors. The APHYS team will take part as a validation team that will provide ground truthing for the validation of the satellite information. The platform (see above) will be equipped with special sensors for this purpose.

6.4. Lake Ladoga

The main goal of this research is to study the development of under-ice convection in Lake Ladoga and its implications for algae development under ice. First contacts were taken with the Petrozavodsk University to start the project after a meeting in Switzerland early 2014.

7. CONFERENCES

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- Wüest A., Workshop, Tage der Technik (Akademie Empa), Presentation: Sind die neuen Stromquellen umweltverträglich integrierbar? EMPA, Dübendorf, Switzerland, 03.10.2013.
- Wüest A. et al., Swiss Geoscience Meeting, Presentation: Using lakes as sources and sinks of heat – a new challenge in natural waters management, UNIL, Lausanne, Switzerland, 16.11.2013.
- Wüest A., ENAC Inauguration talk, Presentation: Life in waters for life – relating science to management and conservation, EPFL, Lausanne, Switzerland, 25.11.2013.
- Odermatt D. and A. Wüest. WHISPERS special session EPFL / Lausanne, Spectroradiometric applications for optically complex waters using current and future imaging spectrometers, July 2014. Session organizers.
- Akhtman Y., D. Constantin, M. Rehak, V. Nouchi, G. Shinkareva, D. Bouffard, N. Tofield-Pasche, S. Chalov, B. Merminod. LEMAN-BAIKAL: REMOTE SENSING OF LAKES USING AN ULTRALIGHT PLANE, WHISPERS special session EPFL / Lausanne, July 2014.
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- Wulf H., Damm A., Segl K., Weyermann J., Morsdorf F., Wüest A., Naegeli K., Huss M., Joerg P., Schaepman M., Simulated Sentinel-2 Products: Quantification and Validation of derived Essential Climate Variables. Sentinel-2 for Science Workshop. Oral presentation Contribution ID: 146.
- Wüest A., T. Sommer, J.R. Carpenter, M. Schmid, B. Scheifele⁵, R. Pawlowicz Double-diffusive convection in lakes – Nyos, Kivu and Powell Lake compared 17th Workshop on Physical Processes in Natural Waters, Trento, Italy, 1-4 July 2014.
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- Sommer T., J.R. Carpenter, A. Wüest. Double Diffusion in Lake Kivu and Direct Numerical Simulations.
- Fink G., and Wüest, A. (2014). A storage-extended rating curve for sediment flux estimation. *Geophysical Research Abstracts*, 16, 14519. Poster in Session HS9.4/GM7.10. EGU2014-14519 EGU General Assembly April 2014.
- Bouffard D., A. Wüest, R. Schwefel, P. Holterman and L. Umlauf. Process-based modelling of Lake Geneva, ASLO meeting, Honolulu Hawaii. February 2014.
- Berg P., Koopsmans, D., Huettel, M., Li, H., Mori, K., Wüest, A A NEW ROBUST OXYGEN SENSOR FOR EDDY CORRELATION MEASUREMENTS ASLO meeting, Honolulu Hawaii. February 2014, Session: 103 - Biogeochemistry of permeable environments.
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- Schwefel R. V., D. Bouffard, L. Bryant and A. Wüest. *Sediment oxygen uptake in Lake Geneva*. 46th International Liege colloquium, Low oxygen environments in marine, estuarine and fresh waters, Liège, Belgique, 2014.
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- Wüest A., Seminar Ufz, Magdeburg, 18 November 2013.
- Wüest A., Seminar. Using lakes as sources and sinks of heat – a new challenge in natural waters management. Swiss Geoscience Meeting, 16 November 2013 Lausanne.
- Wüest A., Sind die neuen Stromquellen umweltverträglich integrierbar. Tage der Technik 2013 (Empa, Swiss Engineering, SATW). Strom – jetzt wird's spannend, 3 Oktober. 2013.
- Wüest A, Bedeutung der Kleinwasserkraft. PEAK-Kurs Möglichkeiten und Grenzen von Kleinwasserkraftwerken, Eawag 26./ 27.Sept.
- Rahaghi A. R., Lemmin U., Bouffard D., Riffler M., Wunderle S., and D.A. Barry. 2014. Surface heat flux variability of a large lake: Lake Geneva, Switzerland. AGU Fall Meeting. San Francisco, USA.

- Sepulveda O., De La Fuente A., Bouffard D., and C. Meruane. 2014. Implementation of a 1D k-e model for studying the vertical mixing in Comau fjord, Chile. AGU Fall Meeting. San Francisco, USA.
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- Schwalb A. N., Bouffard, D., Boegman L., Leon L., Winter J.G., Molot L. and R.E.H Smith^O *. 2014. Hydrodynamic Controls on Dreissenid mussel energetics and Impacts: Insights from 3D modelling in Lake Simcoe. Conference IAGLR Hamilton, ON, Canada.
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- Bouffard D., Boegman. L., and J.D: Ackerman J.D., 2013. Physical Processes and hypoxia in Central Lake Erie. Conference ASLO, New Orleans, USA.
- Bouffard D., 2013. Physical Processes and hypoxia in Central Lake Erie. 2013. Turbulence day, Warnemunde, Germany.
- Ackerman J.D., Bouffard D., Boegman. L., and Y.R. Rao. 2013. Impact of Physical Processes on the Oxygen Depletion in Central Lake Erie. 11th Swiss Geoscience meeting, Lausanne, Switzerland.

8. PUBLICATIONS FROM SEPT 2013 TO AUGUST 2014

8.1. Published peer-reviewed papers in 2013

- Bouffard D., J.D. Ackerman, and L. Boegman (2013). Factors affecting the evolution and dynamics of hypoxia in a large stratified lake: hourly to seasonal patterns. *Water Resour. Res.*, **49**:1-15.
- Bouffard D., and L. Boegman (2013). A diapycnal diffusivity model for stratified environmental flows. *Dyn. Atm. Ocean.*, **61-62**: 14-34.
- Bouffard D., and U. Lemmin (2013). Kelvin waves in Lake Geneva. *Journal of Great Lakes Research*, **39**: 637–645, doi.org/10.1016/j.jglr.2013.09.005.
- Bouffard D., and U. Lemmin (2013). A newly developed moored sensor platform for turbulence measurements in stratified lakes. *J. Atm. Oceanic Tech*, **30**(8):1789-1802, doi: 10.1175/JTECH-D-12-00159.1.
- Finger D., A. Wüest, and P. Bossard (2013). Effects of oligotrophication on primary production in peri-alpine lakes. *Water Resources Research*, **49**(8): 4700–4710, doi:10.1002/wrcr.20355.
- Kunz M.J., D.B. Senn, B. Wehrli, E. M. Mwelwa, and A. Wüest (2013). Optimizing turbine withdrawal from a tropical reservoir for improved water quality in downstream wetlands, *Water Resources Research* **49**: 5570–5584, doi:10.1002/wrcr.20358.
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- Sommer T., J.R. Carpenter, M. Schmid, R. G. Lueck, M. Schurter, and A. Wüest (2013). Interface structure and flux laws in a natural double-diffusive layering. *J. Geophys. Res. Oceans*, **118**(11): 6092-6106, doi:10.1002/2013JC009166.

8.2. Published peer-reviewed papers in 2014

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- Fink G., M. Schmid, B. Wahl, T. Wolf and A. Wüest (2014). Heat flux modifications related to climate-induced warming of large European lakes. *Water Resources Research*. **50**, 2072 – 2085, doi: 10.1002/2013WR014448.
- Schwalb A.N., Bouffard D., Boegman L., Leon L., Winter J.G., Molot L., R.H.E. Smith (2014). 3D modelling of dreissenid mussel impacts on phytoplankton in a large lake supports the nearshore shunt hypothesis and the importance of wind-driven hydrodynamics. *Aquat. Sci. in press*.
- Akhtman Y., Constantin D., Rehak M., Nouchi V.M., Shinkareva G., Bouffard D., Pasche N., Chalov S., Lemmin U., and B. Merminod. Télédétection multi-échelle des lacs depuis un aéronef ultra léger motorisé. *Géomatique Suisse*. vol. 9, 2014.

- Müller B., R. Gächter, and A. Wüest (2014). Accelerated water quality improvement during oligotrophication in peri-alpine lakes. *Environ. Sci. Technol.* **48** (12): 6671–6677, doi: 10.1021/es4040304.
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8.3. Submitted manuscripts to peer-reviewed Journals in 2013

- Pitarch J., D. Odermatt, M. Kawka, and A. Wüest (2015). Retrieval of particle scattering coefficients and concentrations by genetic algorithms in stratified lake water. *Remote Sens.* Submitted.
- Bruder A., D. Tonolla, S. Schweizer, S. Vollenweider; A. Wüest, (2015), Mitigating the effects of hydropeaking on river ecosystems – a conceptual framework, guidelines and recommendations. *Science of the Total Environment*, submitted.
- Fink G., M. Wessels and A. Wüest (2015). The influence of changing flood regimes on river underflow events in lakes. *Journal of Hydrology*, submitted.
- Fink G., M. Schmid and A. Wüest (2014). Large lakes as sources and sinks of anthropogenic heat – capacities and limits. *Water Resources Research*. 2014WR015509R. in press.
- Scheifele B., R. Pawlowicz, T. Sommer, and A. Wüest (2015). Double diffusion in saline Powell Lake, British Columbia. *Journal of Physical Oceanography*, in press.
- Toffolon M., S. Piccolroaz, B. Majone, A-M. Soja, F. Peeters, M. Schmid and A. Wüest. Prediction of surface temperature in lakes with different morphology using air temperature. *Limnology and Oceanography*, in press.

8.4. Reports and experts services

Gaudard A., D. Bouffard and A. Wüest (2014). Alternatives for the development of the EPFL water intake in Lake Geneva. Report APHYS-14-1 pour EPFL.

Fink G., M. Wessels und A. Wüest (2014). Einfluss auf den Bodensee durch klimatische und hydrologische Entwicklungen im Einzugsgebiet. Partikeltransport in den Bodensee. KlimBo Teilprojekt 1a, 1b und 1d. Landesanstalt für Umwelt, Messungen und Naturschutz (LUBW). 18 August 2014.

Bouffard D. et A. Wüest (2013). Analyse des fluctuations de température dans la station de pompage de l'EPFL. Report APHYS-13-1 pour EPFL.

Müller B. und A. Wüest (2013). Entwicklung der Sauerstoffzehrung im Hallwilersee. Gutachten zu Händen des Kt. Aargau, BVU, Abteilung für Umwelt. Bericht Eawag, Kastanienbaum, 33 S.

9. TEACHING

9.1. Courses

- **Limnology**, Master course, spring term 2014, ENV-425, SIE, Env. Engineering, EPFL.
- The Abdus Salam International Centre for Theoretical Physics, Trieste, Italy, ICTP-University of Trieste Winter short course, **Modelling Mixing and Transport in Lakes, Harbors and Estuaries**, 10-12 of February 2014.
- **Environmental Fluid Mechanics – Lakes and Reservoirs**. University Joseph Fourier, LEGI, Grenoble, France, December 2013 (lecturer).
- PEAK-Basiskurs B20/13, Möglichkeiten und Grenzen von Kleinwasserkraftwerken, Eawag 26-27 Sept. 2013, www.eawag.ch/lehre/peak/kurse/peak_b20_13.pdf.

9.2. Ph.D. Student supervised 2013

- Sommer T. (2013). Double diffusion in Lake Kivu. *PhD thesis ETH nr 21'463*.
- Ross K.A. (2013). The effect of subaquatic volcanism on the structure of Lake Kivu in the Albertine Rift; East Africa. *PhD thesis ETH nr 21'547*.
- Schwefel R. (ongoing). Oxygen depletion in Lake Geneva.
- Raman L. (ongoing). Optimizing water intakes in Lake Biel.
- Nouchi V. (ongoing). Remote sensing on Lakes Geneva and Baikal.

9.3. Ph.D. Student exams

- Hilbe M. (2013). Subaqueous morphology and natural hazards in perialpine Lake Lucerne (Central Switzerland). *PhD thesis ETH nr 21'459*. Co-examiner.
- Cohen Liechti T. (2013). Influence of dam operation on water resources management under different scenarios in the Zambezi River Basin considering environmental objectives and hydropower. *PhD thesis EPFL nr 6012*. Examiner president (*Examiners*: A. Schleiss and J-L. Boillat).

- Cortes Cortes A. (2014) Splitting gravity currents in stratified systems. *PhD thesis Universidad de Granada*. Examiner president (*Supervisor*: F.J. Rueda Valdivia, *Experts*: E. Sanchez; R. Marcé, G. Vidal).
- Hoyer A. B. (2014) The physical control of contaminant distribution in aquatic ecosystems. *PhD thesis Universidad de Granada*. Examiner president (*Supervisor*: F.J. Rueda Valdivia, *Experts*: E. Sanchez; R. Marcé, G. Vidal).
- Thiébaud R. (2014). Résistance au déversement des poutres métalliques de ponts. Examiner president (*Supervisor*: J.P Lebet; *Experts*: M. Knobloch, D. Laurence and R. Antonio).

9.4. Master students

- Gaudard A. (June 2014). Towards a better, sustainable use of the energy of our lakes. Master thesis EPFL Lausanne. June 2014 (*Supervisor*: Damien Bouffard).
- Kiefer I. (June 2014). Analysis of chlorophyll variability in Lake Geneva using remote sensing techniques. Master thesis EPFL Lausanne. June 2014 (*Supervisor*: Damien Bouffard).
- Schenk J. (June 2014). Validating a three dimensional model for Lake Biel, term paper 2014 (*Supervisor*: Love Raman, Damien Bouffard).

10. CURRENT EXPERT AND CONSULTING ACTIVITIES

- 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.
- 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).
- Ercoftac, special interest group SIG5 in *Environmental Fluid Mechanics*.

11. PROPOSALS

New, pending

- Alfred Wüest, Natacha Tofield-Pasche, FNS - Swiss National Science Foundation, Research Equipment / SNSF - R'Equip 2014, Léman exploration (LÉXPLORE), 357.45 KCHF.
- DAMBRINE E, O. ANNEVILLE (UMR CARTELE) and D Bouffard (APHYS, EPFL): Modélisation couplée hydro-biologique du Léman, Model, accepted.

Recent on-going funding

- Lake Kivu - turbulence and double diffusion in permanent stratification, 01.05.2014 to 30.04.2016, Swiss National Science Foundation 200020_140538.
- KLIMBO - Wärmenutzung im Bodensee. Grant from INTERREG, end December 2014.
- Swiss Earth Observation Network (SEON), M Schaepman et al. December 2016.