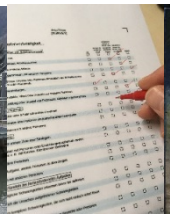
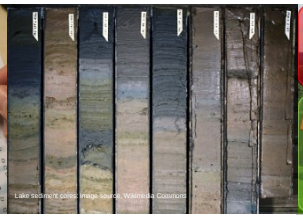
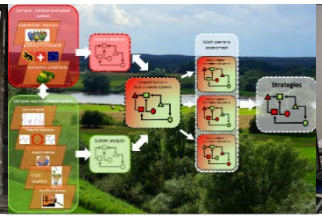
Bachelor- und Masterarbeitsthemen des Clusters Environmental Pollution

— Detaillierte Projektbeschreibungen —

1. Mercury in Visp-Raron

Background: The historical use of mercury (Hg) by an industrial plant in the town of Visp, Switzerland has resulted in Hg contamination in soils and sediments in this region. From 1930 to 1976, Hg was utilized as a catalyst for acetaldehyde production, and the Hg-containing wastewater was discharged into an open-channel canal which flows along an agricultural floodplain and then converges with the Rhone River. Current estimates indicate that approximately 50 to 60 tons of Hg were released into the canal. Following this, canal sediments were dredged and re-distributed as fertilizer for agricultural fields and private gardens, resulting in widespread Hg contamination in soils and canal sediments within the affected floodplain.

Project: The student will participate in an ongoing effort to characterize and understand Hg pollution in the area of Visp-Raron by analyzing soils and plants (crops) using analytical methods developed in our laboratory. Especially of importance is the transformation of Hg to the more mobile and more toxic methylmercury (MeHg) in soils.

Outcome: The student will learn how to realize and organize a sampling campaign or an incubation experiment. He/she will be taught how to use analytical instruments as well as how to treat the data and interpret it. He/she will be able to understand how environmental data is generated and thus how to interpret such data and such reports in his/her future career.

Prerequisite: The candidate should have attended the Bachelor course “Introduction to Physical Geography Labwork”. The following courses are also recommended: “Advanced Methods in Physical Geography Labwork I and II”, block course “Soil Biogeochemistry”.

Supervision: Prof. Adrien Mestrot

Contact: Prof. Adrien Mestrot (adrien.mestrot@giub.unibe.ch)

2. Antimony in shooting ranges

Background: Antimony (Sb) is ubiquitous in the environment and its concentrations can be elevated due to anthropogenic actitivies such as shooting activities, since it is represent 1 to 5% of bullet's content. In Switzerland alone, 10 to 25 tons of antimony enter the soil due to shooting activities and the stock of antimony in soils was estimated at 2600 tons in 2013. Interestingly, antimony can be transformed in the environment to volatile antimony compounds. These represents an understudied portion of the biogeochemical cycle of antimony and it is up to know unknown how these volatile compounds form in nature.
Project: The student will contribute to existing projects on antimony and will help to develop trapping techniques to quantify and identify volatile antimony in the environment. This project will involve both laboratory work as well as field work.
Outcome: The student will learn how to realize and organize a sampling campaign. He/she will be taught how to use analytical instruments as well as how to treat the data and interpret it. He/she will be able to understand how environmental data is generated and thus how to interpret such data and such reports in his/her future career.
Prerequisite: The candidate should have attended the Bachelor course "Introduction to Physical Geography Labwork". The following courses are also recommended: "Advanced Methods in Physical Geography Labwork I and II", block course "Soil Biogeochemistry".
Supervision: Prof. Adrien Mestrot
Contact: Prof. Adrien Mestrot (adrien.mestrot@giub.unibe.ch)

3. Assessment of heavy metal pollution, sources and transformations in the Wohlensee

Background: The Lake Wohlen is a constructed reservoir which is located on the Aare River downstream of the city of Berne in Switzerland. The reservoir was built for hydroelectrical purposes in 1920 and has a surface area of 2.7 km^2. It was recently shown that the sediment of this lake contain different heavy metals. Among them are mercury (Hg), cadmium (Cd), lead (Pb), chromium (Cr), copper (Cu) and zinc (Zn). However, it is still unclear what the pollutions sources are. They could be the sewage treatment plants, the shooting ranges, one of several waste dumps situated in the area such as Teuftal or Illiswil or the highways since their runoff waters are also going to the lake. Furthermore, Lake Wohlen was shown to be the one that emits the world's highest amounts of methane in a mid-latitude region. Methane is formed by microorganisms that also promote the methylation of heavy metals. For example, mercury could be transformed to the more mobile and more toxic methylmercury in the lake. Therefore, understanding the transformation of heavy metals in the lake sediments will help assess the environmental risk.
Project: The student will contribute to an existing project on Lake Wohlen and will help to identify the sources of heavy metals to the lake by sampling lake sediments and surrounding soils and waters. Furthermore, more advanced analytical methods will be used to assess heavy metals transformation (such as methylation). This project will involve both laboratory work as well as field work.
Outcome: The student will learn how to realize and organize a sampling campaign. He/she will be taught how to use analytical instruments as well as how to treat the data and interpret it. He/she

will be able to understand how environmental data is generated and thus how to interpret such data and such reports in his/her future career.
Prerequisite: The candidate should have attended the Bachelor course “Introduction to Physical Geography Labwork”. The following courses are also recommended: “Advanced Methods in Physical Geography Labwork I and II”, block course “Soil Biogeochemistry”
Supervision: Prof. Adrien Mestrot, Prof. Martin Grosjean, Dr. Klaus Jarosch
Contact: Prof. Adrien Mestrot (adrien.mestrot@giub.unibe.ch)

4. Eutrophication and pollution history of small lakes in the Swiss Plateau, in Poland, Ecuador or Lake Victoria (Tanzania) since ca 1850 (1 – 4 individual projects)

Background: Lake sediments contain detailed records of a wide range of pollutants (nutrients such as P and N, metals and organic compounds such as pesticides). Within the cluster ‘Environmental Pollution’ we are interested in the historical evolution of eutrophication, inorganic and organic pollutants, and their deposition in and impacts on the environment since ca. 1850. Guiding questions are (among others): what were the pre-20th century conditions? When did specific substances appear in the (aquatic) environment? When and at which levels did depositions/contaminations peak? And did legislative measures (remediation) lead to an improvement? Our field sites are located in the Swiss Plateau (Wohlensee, Moossee and Burgäschisee, others upon interest), in Poland, Ecuador and Lake Victoria.
Projects: Short sediment cores will be taken from the lakes (projects with fieldwork) and analyzed with standard sedimentological and geochemical methods (radiometric dating ^{210}Pb, ^{137}Cs, varve counting, texture and granulometry, mineralogical and chemical characterization using a triple quadrupole mass analyzer). According to the personal interest of the candidate(s), advanced techniques can be applied (e.g. hyperspectral imaging, Fe- and P-speciation, trace metal analysis such as Hg with ICP or sedimentary pigment analysis with HPLC). Feasible is the analysis of one core per MSc Thesis. Starting dates: flexible.
Learning goals: The candidates get introduced into standard laboratory techniques in Physical Geography and/or environmental chemistry. In addition (and according to the candidate’s experience), applications of advanced techniques is possible. Interest in statistics (exploratory data analysis) is an advantage. The candidates will learn how to manage their Thesis project (concept and design, organization of the lab work, data analysis and interpretation, writing and presenting).
Prerequisite: The candidates have attended the Bachelor course “Introduction to Physical Geography Labwork”. Highly recommended is “Advanced Methods in Physical Geography Labwork I and II”. ‘Soils and sediments as environmental archives’ (MSc Geography) is recommended; so is the block course “Soil Biogeochemistry”.
Supervision: Prof. Martin Grosjean and Dr. Aurea.C. Chiaia-Hernández
Contact: Prof. Martin Grosjean (grosjean@giub.unibe.ch)

5. Characterizing the Anthropocene with High-Resolution Sediment Analysis (1-2 Projects)

Background: The overwhelming increase in human interference with the environment has left traces unique to mankind. Anthropogenic signatures observed worldwide have been mainly driven by accelerated technological development, rapid growth of human populations, and increased consumption of resources. In recent decades, the demand for synthetic chemicals has reached approximately 300 million tons per year because of their use in domestic, agricultural, and industrial sectors around the globe. Chemicals released into the environment directly or indirectly can reach different environmental compartments and ultimately be incorporated into natural archives. Within the cluster 'Environmental Pollution' we are interested to identify anthropogenic organic chemicals in lake sediments from high alpine lakes and pristine places from Switzerland and abroad (e.g. Poland, Southern Ecuador, possibly South and North Greenland, sub-Antarctic islands). The goal of the project is to identify pollutants that have persisted and can be used to reconstruct and reveal environmental changes over time. The co-occurrence of thousands of different anthropogenic markers will support our understanding of the rates of human activities, their impacts on the Earth system and how environmental regulations and pollution reduction initiatives are trying to reverse these changes.

Projects: Short sediment cores will be taken from the lake(s) and analyzed with standard sedimentological and geochemical methods, and chemical characterization with high resolution mass spectrometry (HR-MS). Furthermore, intelligent data mining and statistical tools like unsupervised multivariate techniques to cluster and visualize samples according to intrinsic similarities will be used due to the large amount of data obtained from HRMS measurements. Feasible is the analysis of one core per MSc Thesis. Starting dates: flexible.

Learning goals: The candidates get introduced into standard laboratory techniques in Physical Geography and analytical chemistry. In addition (and according to the candidate's experience), applications of advanced techniques is possible. Interest in statistics (exploratory data analysis) is a must. The candidates will learn how to manage their Thesis project (concept and design, organization of the lab work, data analysis and interpretation, writing and presenting) as well as working in a very interdisciplinary research field.

Prerequisite: A strong knowledge in statistics and programming or willing to learn them. Moreover, the candidates have attended the Bachelor course "Introduction to Physical Geography Labwork". Highly recommended is "Advanced Methods in Physical Geography Labwork I and II". 'Soils and sediments as environmental archives' (MSc Geography) is recommended; so is the block course "Soil Biogeochemistry".

Supervision: Dr. A.C. Chiaia-Hernández, Prof. Martin Grosjean

Contact: Aurea C. Hernández (aurea.hernandez@giub.unibe.ch)

6. Evaluating Organic Contaminant Fluxes in Swiss Lakes

Background: Over the last decades, the use of synthetic chemicals has increased intensively in households, agriculture and industry. In order to assess an environmental risk, it is important to understand the fate, occurrence and effects of organic contaminants in the environment. Organic contaminants that are released via waste water treatment plants (WWTPs) effluents or with runoff from agricultural land after application can enter natural waters and sorb to sediments. The number and distribution of these contaminants in natural systems can vary due to different natural transport processes and reactions mechanism according to their physicochemical properties and chemical partition to water, air, soil and sediment. Therefore, if a compound persists over time, it can potentially be transported on suspended solids to locations far away from the source and/or bioaccumulate. Within the cluster 'Environmental Pollution' we are interested to increase the knowledge of the linkages between suspended solids and the fate of many organic contaminants (e.g. pesticides) in lakes. The results will provide insight into the spatial, vertical and temporal distribution (e.g. annual cycle) and mass fluxes of detected organic contaminants.

Projects: Different surface sediments will be taken and sediment traps and passive samplers will be installed in lake(s) and analyzed with standard sedimentological, geochemical and analytical chemistry methods (e.g. grain-size distribution, bulk geochemical composition, mineralogical and chemical characterization using a triple quadrupole mass analyzer). According to the personal interest of the candidate(s), advanced techniques can be applied (e.g. trace metal analysis such as Hg with ICP or the use of high resolution mass spectrometry).

This project can be combined with a process study. Passive samplers for pesticides and sequential sediment traps (at different depths of the lake) are deployed to provide pesticide data over an annual cycle (monthly resolution) from the inflow(s) and outflow, the epilimnion and hypolimnion, and the export to the sediments (sediment traps).

Feasible is the analysis of one core per MSc Thesis; field sites include Wohlensee, Moossee, Burgäschisee or a lake of interest. Starting dates: flexible.

Learning goals: The candidates get introduced into standard laboratory techniques in Physical Geography and analytical chemistry. In addition (and according to the candidate's experience), applications of advanced techniques is possible. Interest in statistics (exploratory data analysis) is an advantage. The candidates will learn how to manage their Thesis project (concept and design, organization of the lab work, data analysis and interpretation, writing and presenting). In addition the candidates will learn different field monitoring techniques.

Prerequisite: The candidates have attended the Bachelor course "Introduction to Physical Geography Labwork". Highly recommended is "Advanced Methods in Physical Geography Labwork I and II". 'Soils and sediments as environmental archives' (MSc Geography) is recommended; so is the block course "Soil Biogeochemistry".

Supervision: Prof. Martin Grosjean and Dr. A.C. Chiaia-Hernández, others of the Cluster

Contact: Prof. Martin Grosjean (grosjean@giub.unibe.ch)

7. Mercury pollution in Visp-Raron – an unsettled environmental conflict

Background: The historical use of mercury (Hg) by an industrial plant in the town of Visp, Switzerland has resulted in Hg contamination in soils and sediments in this region. From 1930 to 1976, Hg was utilized as a catalyst for acetaldehyde production, and the Hg-containing wastewater was discharged into an open-channel canal, which flows along an agricultural floodplain and then converges with the Rhone. Current estimates indicate that approximately 50 to 60 tons of Hg were released into the canal. Following this, canal sediments were dredged and re-distributed as fertilizer for agricultural fields and private gardens, resulting in widespread Hg contamination in soils and canal sediments within the affected floodplain.
The Hg contamination in soils and canal sediments became public only recently after it had been detected in the context of road construction works in the area. Concerns over health and property prices arose as well as questions of (financial) responsibility and remediation. Ever since, a variety of actors has been fighting an ongoing conflict between the polluting company Lonza, political bodies and representatives as well as NGOs and residents affected by the contamination. So far, no solution has been found.
Project: The student will develop a qualitative research project that focuses on the reconstruction and evaluation of the political conflict that has emerged in the Visp are due to the Hg contamination. The research will include interviews with the various actors involved in the conflict.
Outcome: The student will learn how to develop and conduct a qualitative research project with interviews and how to analyze discourses and political conflicts in the context of environmental pollution. He/she will be able to conduct research in a complex political setting and understand what mechanisms influence the outcome of environmental conflicts.
Prerequisite: The candidate should have attended the Bachelor course “Qualitative Methoden I”. The following course is also recommended: Lecture “Political Geography”.
Supervision: Dr. Béla Filep and Prof. Dr. Adrien Mestrot
Contact: Dr. Béla Filep (bfilep@giub.unibe.ch)

8. History, perception and governance of environmental pollution in the Wohlensee

Background: The Lake Wohlen is a constructed reservoir, which is located on the Aare River downstream of the city of Berne in Switzerland. The reservoir was built for hydroelectrical purposes in 1920 and has a surface area of 2.7 km^2. Over the course of the years, the lake has faced a multitude of environmental challenges. One more recent example is the pollution caused by the waste dump in Illiswil and the debate over its remediation. What they have in common is that they affect a variety of stakeholders to whom the Wohlensee is a resource for different purposes: agriculture, hydropower, recreation etc. Interestingly enough, the perception of the environmental challenges and the ideas for ways to govern and solve them have varied and changed over time.
Project: The student will develop and conduct a qualitative research project that focuses on the reconstruction of the history, (changing) perception and governance of environmental pollution in the Wohlensee area. This project will include media and document analysis and possibly interviews.

Outcome: The student will learn how to develop and conduct a qualitative research project and how to analyze discourses and governance processes in the context of environmental pollution.
Prerequisite: The candidate should have attended the Bachelor course “Qualitative Methoden I”. The following course is also recommended: Lecture “Political Geography”.
Supervision: Dr. Béla Filep and Prof. Dr. Martin Grosjean
Contact: Dr. Béla Filep (bfilep@giub.unibe.ch)

9. Microplastic in Soils

Background: They are small but their implications are immense. Microplastics (MIP) in the environment. These artificial particles (<5mm) pose a threat to the aquatic environment and have reached worldwide distribution in aquatic systems. Although the sources of microplastic are terrestrial, the knowledge about the occurrence and fate of microplastics in terrestrial environment is scant. Since the production of plastics continues to increase globally, so does the extent and significance of their impact. Within the Cluster Environmental Pollution we are interested in investigating the MIP concentrations in soils of different land use, the depth transport and decomposition of MIP in soils, the fate of MIP as a carrier for a number of pollutants as well as the transfer of MIP from soil into the human food chain.
Project: There can be different Master theses about the above distribution, sources, transport, decomposition of and pollutant transport with microplastics. The theses include field work as well as laboratory analyses of the samples. The generated data will be analyzed and interpreted. The generated knowledge will gain new knowledge of one of the major issues of environmental concern (according the UNEP 2016).
Outcome: The student will learn how to develop and conduct an environmental related research project. He/She will learn how to design an experiment, sample soils and investigate them with advanced analytical methods in the laboratory. The data will be analyzed with statistical methods and interpreted based on the current state of knowledge. Beside the expert knowledge about soil science and environmental pollution research, the student will develop overall competences on management and organize of a project and the presentation of scientific results.
Prerequisite: The candidate should have attended the Bachelor course “Introduction to Physical Geography Labwork”. The following courses are also recommended: “Advanced Lab Methods in Physical Geography Labwork I and II” as well as the lecture and the block course “Soil Biogeochemistry”
Supervision: Dr. Moritz Bigalke
Contact: Dr. Moritz Bigalke (moritz.bigalke@giub.unibe.ch)

10. The fate of uranium in waters and peat soils in the Bernese Seeland

Background: Because of the local geological situation, uranium concentrations in drinking and surface waters of some parts of the Seeland are elevated. Locally the elevated U concentrations caused an accumulation of uranium in peatlands. Many of the former peat areas are drained nowadays, which cause an oxidation of the uranium and a release into the next river.
Project: The student will analyze natural geological uranium deposits, the release into the surface waters and the coupling (accumulation and release) to local peat soils to understand the whole

system causing elevated uranium concentrations in local soils and waters. The focus will be on the release mechanisms and the speciation of the uranium in the different compartments.
Outcome: The student will learn how to develop and conduct an environmental related research project. He/She will learn how to design an experiment, sample rocks, waters and soils and investigate them with advanced analytical methods in the laboratory. The data will be analyzed with statistical methods and interpreted based on the current state of knowledge. Beside the expert knowledge about soil science and environmental pollution research, the student will develop overall competences on management and organize of a project and the presentation of scientific results.
Prerequisite: The candidate should have attended the Bachelor course “Introduction to Physical Geography Labwork”. The following courses are also recommended: “Advanced Lab Methods in Physical Geography Labwork I and II” as well as the lecture and the block course “Soil Biogeochemistry”.
Supervision: Dr. Moritz Bigalke
Contact: Dr. Moritz Bigalke (moritz.bigalke@giub.unibe.ch)

11. The political ecology of compost: the challenging management of a new resource

Background: Compost is a newly discovered resource. Natural resources are never given, but appear in connection with a specific socio-economic production system. The goal of the master thesis is to describe the new production system, that compost fits in as a new resource. The uses and users of the resource will be analyzed, as well as the actors who produce it, market it and regulate it. The regulation of the resource will be a special focus of the thesis. Indeed, compost can only enter the value chain if minimal quality standards are respected, in particular concerning its concentration in heavy metals, organic pollutants and waste material like plastics. Analyzing this new resource from an actor perspective, the master thesis will examine compost as an object of political games around its regulation, uses and appropriation. It will ask: How was the compost resource being discovered? Who is benefiting from the resource? How is it regulated? The difficulties linked with the reuse of organic material in order to convert it into a tradable product will be highlighted.
Learning goals: The candidate will deepen his/her knowledge in the field of political ecology. One or several case studies will be carried out. Competences will be acquired in document analysis, interviews with key actors of the field, case study analysis and scientific writing.
Prerequisite: The candidates should have a clear interest in interdisciplinary work. They should have attended the Master Course “Raumplanung II: Beiträge der Political Ecology” and “Challenges in Geography II”. The thesis can be written in German or English language.
Supervision: Prof. Jean-David Gerber, Dr. Moritz Bigalke
Contact: Prof. Jean-David Gerber (jean-david.gerber@giub.unibe.ch)

12. Release of arsenic from cultivated soils by organic phosphorus amendment

Background: Arsenic (As) is a toxic metalloid found in all environmental compartments (air, water, biota, soil). Soils with naturally high As concentrations can pose a risk for human health, for example by entering the food chain e.g. via plant uptake. Therefore, understanding the factors governing the bioavailability of As of in soil in highly important. Among these factors, the competition of As for binding sites on the soil solid phase with other ions is one of the most important. In particular, the interaction between inorganic phosphorus (P) and As was intensively studied. However, up to now no study looked at the effect of different organic P compounds affecting As bioavailability in soil. This is of interest, because organic P enters soil on a regular base by fertilization or plant residue application. The aim of this thesis is to analyze the effect of different organic P amendments on the availability of As in soil. The outcome of this thesis will help to identify the factors influencing the bioavailability of As and to reduce health hazards for animals and humans.

Project: The analyzed soils used in this thesis originate from different locations in Switzerland with naturally high As concentrations. The student will conduct a soil incubation study analyzing the effect of different organic P amendments on soil As availability. A sequential extraction is foreseen to estimate the binding strength of As on soil.

Outcome: The student will learn how to plan, realize and organize a sampling campaign and an incubation experiment. He/she will be taught how to use analytical instruments as well as how to treat the data using statistical tools. He/she will be able to understand how environmental data are generated, how to interpret them and how to report them in a scientific way.

Prerequisite: The candidate should have attended the Bachelor course “Introduction to Physical Geography Labwork”. The following courses are also recommended: “Advanced Methods in Physical Geography Labwork I and II”, block course “Soil Biogeochemistry”.

Supervision: Prof. Adrien Mestrot, Dr. Klaus Jarosch

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