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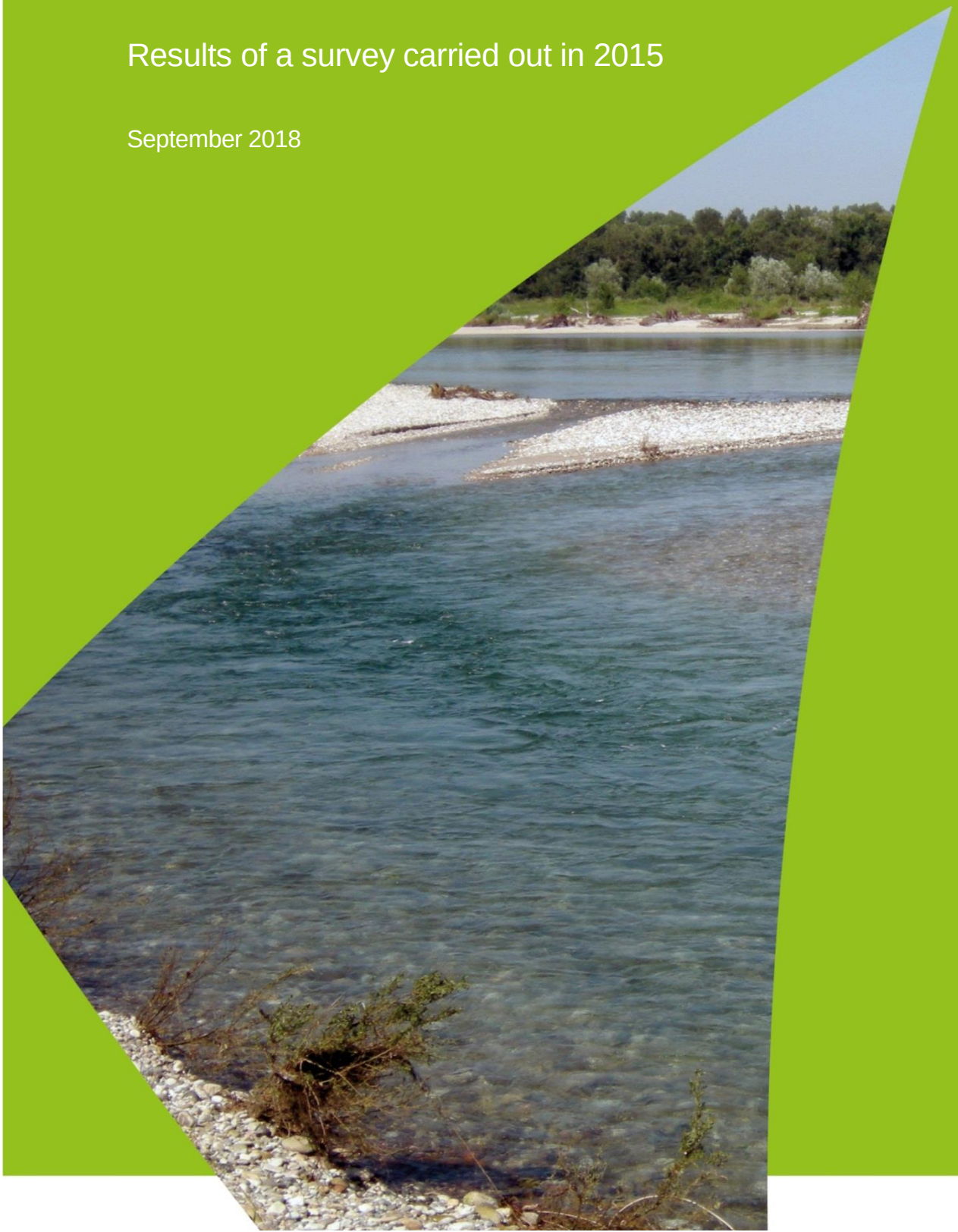
Schweizerisches Zentrum für angewandte Ökotoxikologie
Centre Suisse d'écotoxicologie appliquée
Eawag-EPFL

Current methodologies used by cantonal agencies for sampling and analysis of sediments in Switzerland

Results of a survey carried out in 2015

September 2018



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Summary

In the framework of the harmonization of sediment sampling and pretreatment in Switzerland, surveys and qualitative interviews have been conducted with all the relevant Cantonal agencies. The results of this investigation show that 14 of the 26 cantons perform sampling on sediment of which 5 have established a monitoring network. Sediments are monitored in both rivers and lakes. For the great majority of cantons, trace metals, PCBs and PAHs are still the main groups of substances analyzed in sediment. The main objectives pursued by Cantonal agencies in sediment sampling are 1) the assessment of accidental pollution 2) the monitoring of known contamination by point sources and 3) the acquisition of complementary data for water quality assessment. Currently, methodologies differ between cantons regarding the type of sediment sample collected, the type of sieving performed, the grain size analyzed and the extraction performed prior to trace metal analysis. Nevertheless, at this time, most of the cantons collect a composite sample, perform a wet sieving of the sediment at 63 μm, and for trace metal analysis, extract the material with *aqua regia*.

Content

Definitions and abbreviations

Aqua regia: acid mixture of two parts weight nitric acid and three parts weight hydrochloric acid. It is generally used in a molar ratio 1:3 for soil and sediment trace metal extraction (Baudimont, 1844; GBL, 2011).

Cantons:

AG: Aargau	GR: Grisons	SZ: Schwyz
AI: Appenzell Innerrhoden	JU: Jura	TG: Thurgau
AR: Appenzell Ausserrhoden	LU: Luzern	TI: Ticino
BE: Bern	NE: Neuchâtel	UR: Uri
BL: Basel-Landschaft	NW: Nidwalden	VD: Vaud
BS: Basel-Stadt	OW: Obwalden	VS: Valais
FR: Fribourg	SG: St. Gallen	ZG: Zug
GE: Geneva	SH: Schaffhausen	ZH: Zürich
GL: Glarus	SO: Solothurn	

Composite sample: it consists of two or more single samples or subsamples not different in nature that are combined and homogenized in order to obtain an average picture of the sampling location (ISO, 2017).

Dry sieving: sediment that has been dried in an oven (40-105°C) or freeze-dried, is sieved through a sieve with defined mesh size (here either 2 mm or 63 µm).

EC: European Commission.

HCl: hydrochloric acid.

HF: hydrofluoric acid.

HNO_3: nitric acid.

H_2O_2: hydrogen peroxide.

Investigative monitoring: monitoring to “ascertain the causes of a water body or water bodies failing to achieve the environmental objectives; or to ascertain the magnitude and impacts of accidental pollution” (EC, 2003).

Operational monitoring: monitoring to “establish the status of those bodies identified as being at risk of failing to meet their environmental objectives; and assess any changes in the status of such bodies resulting from the programmes of measures” (EC, 2003).

PAHs: polycyclic aromatic hydrocarbons.

PCBs: polychlorinated biphenyls.

Single sample: single discrete sample collected to obtain when appropriate a representative sample of the site.

Surveillance monitoring: monitoring to “assess the long term changes in natural conditions and long term changes resulting from widespread anthropogenic activity” (EC, 2003).

Wet sieving: Sediment is sieved at either 2 mm or 63 µm with the help of site water (H_20_{site}) or demineralized water (H_20_{dd}). Sieving can be performed directly on site (*in situ*) or later in the laboratory (*ex situ*).

WPO: Water Protection Ordinance of 28 October 1998 (Status as of 1 January 2018) of the Swiss Federal Council.

1. Introduction

The scope of Work Package 1 of the project “Development of a Module Sediment within the framework of the Modular Stepwise Procedure” is to provide a harmonized methodology for sediment sampling and analysis for operational staff. The harmonization should ideally be based on current methodology in Switzerland and what constitutes “best practice”.

An overview of current methodology in Switzerland was completed in 2010 through a first survey that was sent to the 26 cantonal agencies (Flück and Campiche, 2011). A second survey was prepared in 2015, covering aspects on sampling and analysis methods for sediments that were not previously addressed (e.g. collection method, transport, storage). The survey focused on the evaluation of *in situ* sediments and did not address the methodology used for the characterization of dredged materials.

The objectives of this survey were:

- To verify that the information collected in the 2010 survey is still relevant in 2015.
- To collect all relevant information in order to have a complete picture of current methodology in sampling and analysis of sediments in Switzerland.
- To identify operational staff willing to participate in a subsequent field trial.

2. Methodology

The survey (Appendix 1) was prepared and sent to all cantonal environmental agencies in Switzerland in charge of implementing the federal Water Protection Ordinance (WPO, 1998). If required, an interview was arranged by telephone and/or meetings were conducted.

3. Results and Discussion

All 26 cantons that were contacted completed and submitted the survey. In addition, seven telephone interviews were conducted to gather complementary information. As some cantonal agencies externalize their sampling and analyses, one private laboratory that is active in this domain in Switzerland also participated in the survey.

3.1 Current implementation of sediment monitoring in Switzerland

According to this new survey, 14 out of the 26 cantons had performed more or less on a regular basis sediment sampling for chemical quality assessment. Among these, seven cantons had performed sediment sampling in flowing waters (rivers/streams) while the other seven had assessed both flowing waters and lakes (Fig. 1).

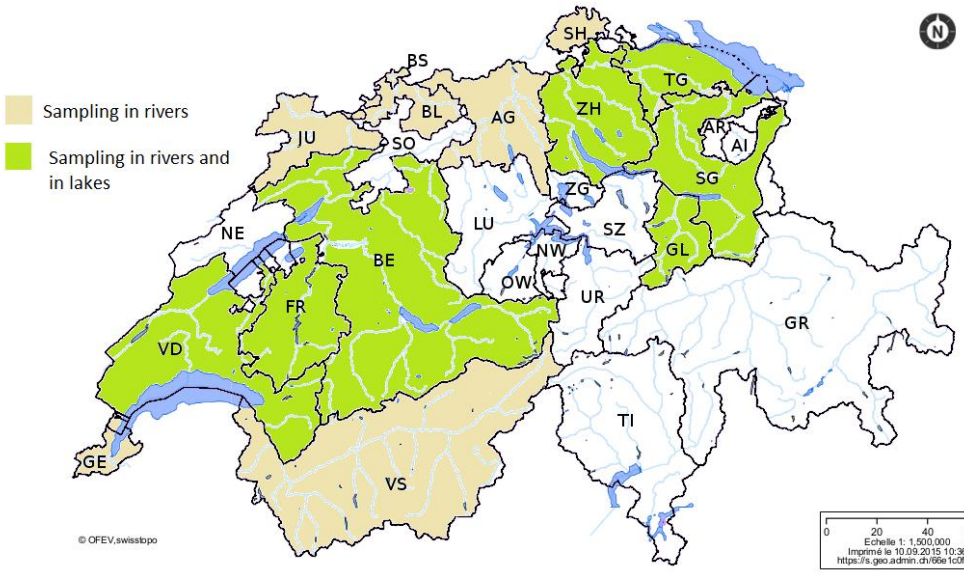

Fig. 1 Map of cantons that perform more or less regularly measurements on in situ sediment in Switzerland for rivers and lakes.

Of the 14 cantons that perform sediment quality analyses on a regular basis, six perform the sampling and analysis all by themselves while the rest externalize the work partially or completely, depending on the type of compounds that are targeted in the study.

Twelve cantons do not perform any measurement campaigns in the sediment compartment. The reasons provided by the cantons to explain this fact include the lack of financial resources and trained operational staff, the lack of evidence of sediment contamination, or the use of alternative approaches to achieve similar monitoring objectives such as passive sampling for temporal trend monitoring. Because no mandate is formulated at the federal level, the monitoring of sediment depends on the choice of cantonal agencies.

3.2 Objectives for sediment monitoring and sampling strategy

Three types of monitoring programs in rivers and lakes are in place in Switzerland for the sediment compartment:

- Investigative: to ascertain the causes, sources, magnitude and impacts of accidental pollution.

- Surveillance: to assess temporal trends in sediment quality.
- Operational: problem oriented monitoring, assessment of programs of measures.

The most common type is investigative monitoring, followed by surveillance monitoring and operational monitoring (Fig. 2). Overall, operational monitoring is less implemented than investigative and surveillance monitoring in lakes than in rivers and streams.

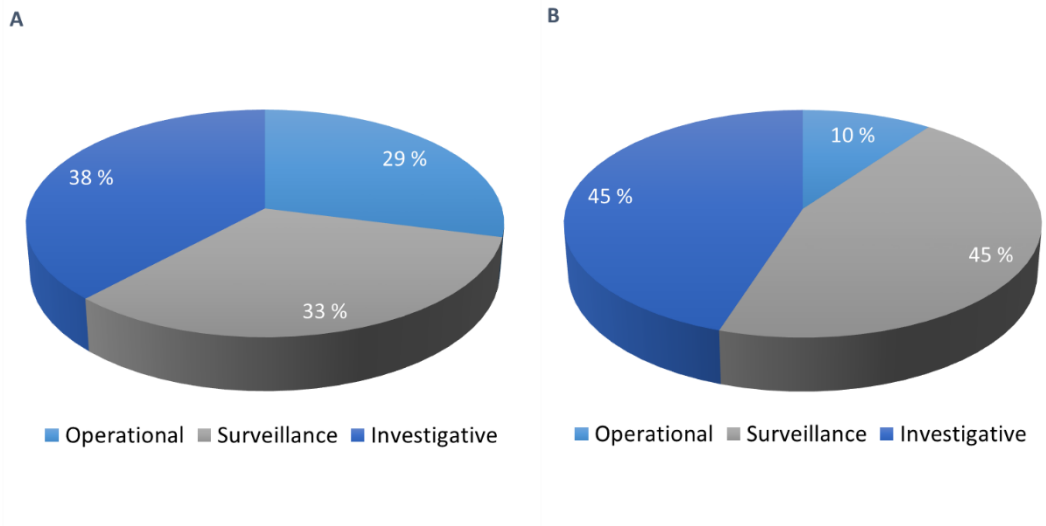

Fig. 2 Type of monitoring programs implemented by cantonal agencies for A) rivers and B) lakes.

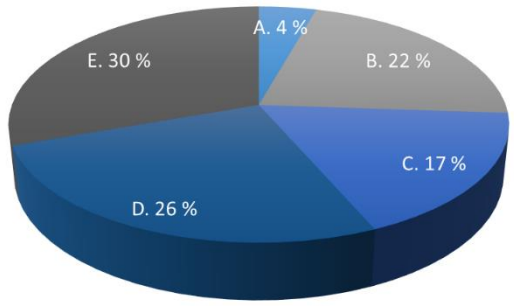

Fig. 3 Objectives pursued by cantonal agencies: A) global sediment quality assessment; B) complementary data for water quality; C) spatio-temporal evaluation of contamination; D) point source contamination E) accidental pollution.

The objectives pursued by cantonal agencies for sediment sampling are summarized in Fig. 3. Overall, sediment assessment is mainly carried out by cantonal agencies to monitor accidental pollution (30 %) or point sources of contamination (26 %), and to complement the assessment of water quality (22 %). Per types of monitoring campaigns, the two main objectives in surveillance monitoring programs are 1) to get complementary data for surface water quality assessment and 2) to have a global overview of sediment quality. Investigative monitoring is mainly carried out with the objective of evaluating the amplitude and the incidence of an accidental contamination, while operational monitoring programs are in place for following point sources of contamination such as industrial areas or waste water treatment plants.

Eight cantons (AG/BE/BS/FR/GL/JU/VD/ZH) have established surveillance monitoring programs, with sampling frequencies for sites with known contamination sources. The sampling frequency vary between one to every 10 years, with generally a higher sampling frequency for sites with high contamination problems. The remaining cantons implement sediment monitoring campaigns occasionally and do this primarily for investigative monitoring (see Table 1 Appendix 2).

Considering the coverage of the sampling campaigns, most cantons include between one to 10 sites per campaign and only three cantons implement sampling campaigns that include more than 10 sites (to a maximum of 30 sites) per campaign (see Table 1 Appendix 2).

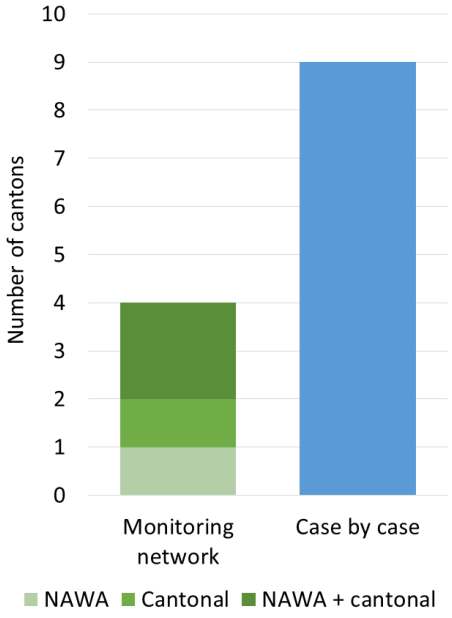

Fig. 4 Choice of the sampling site. Of 13 cantons that monitor sediment, four used a predetermined sampling network (national or cantonal). The seven others take a case by case approach.

Concerning the choice of the monitoring sites (Fig. 4), most cantons choose their sampling sites on a case by case basis according to a known environmental issue. In addition, four cantons have their own cantonal monitoring networks (AG/BE/VD/ZH) while only three cantons (BE/JU/ZH) use sites of the existing National Surface Water Quality Monitoring Network (NAWA).

The sampling period is generally selected according to the hydrological regime often together with the period when water samples are collected, or according to anthropogenic pressures such as agricultural practices or periods of industrial and urban discharges. These three factors together with logistical constraints lead to different sampling periods among cantons: four cantons sample sediments in autumn, three in winter, three in spring, and one in summer.

3.3 Sampling methodology and fieldwork

It is common practice among cantons to use field data sheets for documentation. Data collected include general information such as the date, the name of the watercourse, the coordinates of the sampling site, and most often a diagram. Some cantons also document several physico-chemical parameters in surface waters such as temperature, pH, and conductivity and dissolved oxygen.

The most common sampling tools are core and grab samplers in lakes, and scoops and hand dredges in rivers. The sampling depth ranges between 50 to 100 cm in lakes and 2 to 10 cm in rivers.

In general, three and sometimes five sampling points per site are sampled and then mixed to form a composite sample. Only two cantons keep the site replicates separate. Whereas all cantons take the necessary measures to avoid sample contamination by using the appropriate containers and samplers, less attention is paid to avoiding contamination during sieving and grinding.

3.4 Transport and storage

Five cantons keep the sample in between 2-8°C during transport to the receiving laboratory and the other cantons transport the samples directly to the laboratory at ambient temperature. The reason for not using cooling devices is principally of logistical nature because they transport approx. 10-15 l of site water with sieved fine sediment per sample. Nevertheless, the vast majority of the cantons store the samples in a cold room (generally 4°C) upon arrival to the facilities, and only a few store the samples at room temperature. Most commonly, samples are dried and grinded within 48 hours of sampling, although storage in some cases may last up to 7 days before sample treatment. After pre-treatment, some cantons store the sample up to 6 months before analysis.

3.5 Pre-treatment and chemical analyses

Concerning the type of compounds analyzed (Fig. 5), all cantons that perform sediment monitoring target trace metals in their analyses, 10 cantons target polycyclic aromatic hydrocarbons (PAHs) and nine polychlorinated biphenyls (PCBs). Only four cantons have ever monitored pesticides in sediments whereas two have considered additional compounds such as phthalates, brominate diphenyl ethers (PBDEs), hydrocarbons, organochlorines or organotin compounds. In general, the types of substances monitored in sediments by cantonal agencies are the same as reported in the 2010 survey (Flück and Campiche, 2011).

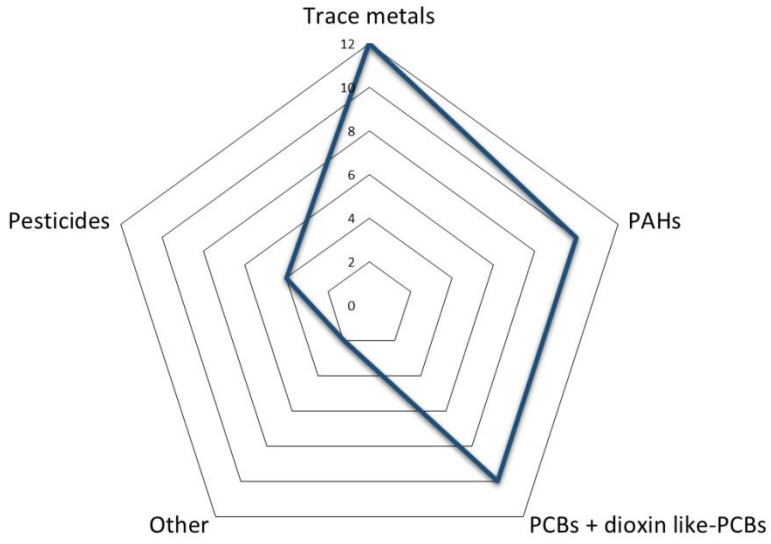

Fig. 5 Number of cantons that target each type of substances in their sediment monitoring according to the 2015 survey.

Of fourteen cantons which sample sediment, six perform chemical analyses in their own analytical laboratories, and six cantons use external private or public laboratories. The remaining three cantons perform part of the analyses themselves and use an external laboratory for the analysis of

certain substances. The analyses are commissioned to other cantonal laboratories (Geneva for trace metals, Valais for PAHs, Zurich for trace metals and organic substances), a Federal Institute (EAWAG, EMPA, EPFL) or private laboratories (Aquaplus, ProNat, Bachema, among others). The cantons generally use the competence network Lab'Eaux to find a cantonal laboratory which can perform analyses that they cannot do themselves.

The sampling process involve four steps that can be performed differently. These steps include the type of sample collected, the type of sieving used, the particle size analyzed and the extraction method for metals analysis. The options chosen by the cantons for each step expressed in percentage are summarized in the Fig. 6.

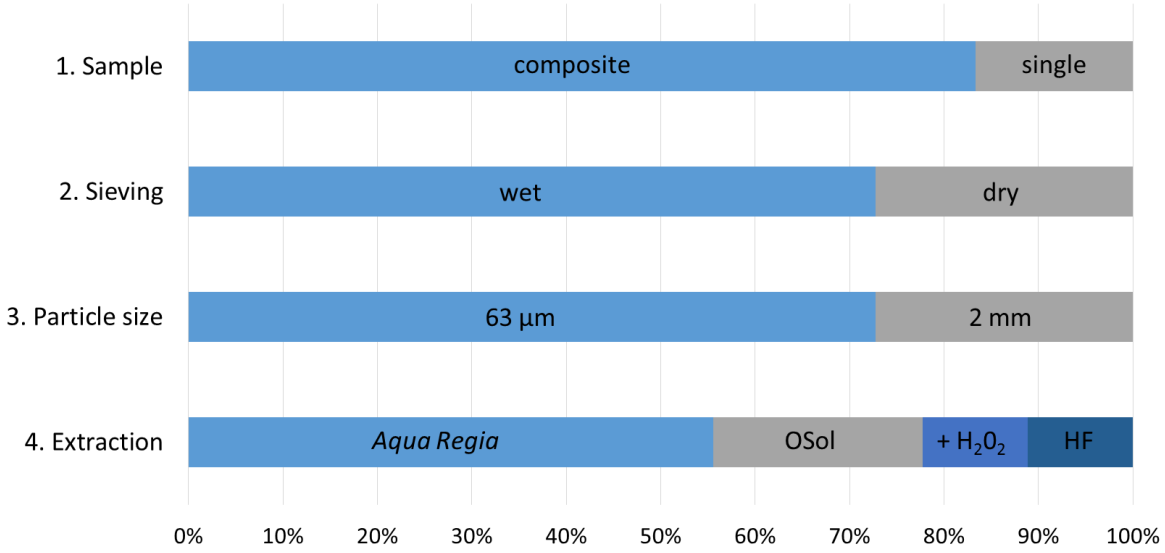

Fig. 6 Percentage of cantons performing the key steps in sediment sampling and pre-treatment, including the type of acid extraction for the determination of trace metal content.

Eight cantons analyze the fine fraction of sediments and sieve the samples at 63 µm, but using three different methodologies. Six cantons (AG, GL, ZH, JU, BE, BL) use almost the same methodology, which is sieving at 63 µm with site water (wet sieving) *in situ* or *ex situ*. The sample is then dried in the oven at 40°C and ground either manually using a mortar or with a centrifugal ball mill (Standard Operating Procedure LI009, 5 min. in a Retsch S100 by 350 rpm). Finally, the sample is extracted with a HCl/HNO_3 mixture (*aqua regia*) with either a digestion block or a microwave (SOP M301b). One canton (SG) performs dry sieving after drying the fine sediment at 40°C or freeze-drying, then extracting it in the microwave with concentrated HNO_3. Canton SH also analyses the fine fraction but did not provide further details on treatment and extraction.

Three cantons analyze the fraction of sediment after sieving at 2 mm (VS, GE, BS). Generally, the canton of Valais performs a wet sieving with site water for trace metals analysis but that can change when an external laboratory is mandated. For example, in the case of Hg, the work is externalized and the private laboratory performs dry sieving as is done in the canton of Geneva.

VS and GE differ on the extraction of sediments for trace metal analysis, one using HF and the other using HNO_3. BS performs wet sieving with demineralized water, freeze-drying and then extraction with a mixture of H_2O_2/HNO_3 in a microwave.

Of the six cantons that answered the question regarding the pre-treatment of sediments for organic substances analyses, five use the fine fraction (< 63 µm) and one the < 2 mm fraction. Of the cantons who use the fine fraction, two perform an *ex situ* dry sieving, one performs an *ex situ* wet sieving with site water and two perform an *in situ* wet sieving with site water. The canton that uses the < 2 mm fraction performs a wet sieving with demineralized water. The extraction procedure for organic substances has not been covered in this investigation.

Of seven cantons which answered the questions referring to the physico-chemical characterization of sediments, six perform loss on ignition analysis for the estimation of organic matter content in sediments, five determine water content, three measure total organic carbon and two total phosphor concentration.

4. Conclusions

The Swiss Water Protection Ordinance states that “sediments should contain no persistent synthetic substances” , “....other potential water pollutants should not accumulate in sediments” and “...[these] do not have any harmful effects on the communities of plants, animals and microorganisms.” (OFEV, 2016). Currently, only 14 of 26 cantons monitor sediments for chemical pollution to some extent and, as concluded in the 2010 survey, there is no or little harmonization between cantonal methodologies. Only the cantons of Bern, Basel-Land and Jura have already harmonized their sediment monitoring methods due to the fact that they have a common river flowing through their territory.

The most common methodology used for trace metal sediment monitoring is to form a composite field sample, wet sieve at 63 µm with site water, and extraction with *aqua regia*. The extraction methods in use for the analysis of organic substances (PAHs and PCBs) were not covered in this work. Ancillary measurements required for data interpretation such as organic matter content and grain size distribution are not often measured, which might pose problems for normalization of chemical concentrations and risk assessment.

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6. Indices

6.1 List of Figures

6.2 List of Tables

Appendix 1. Survey (DE/FR)

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Centre Suisse d'écotoxicologie appliquée
Eawag-EPFL

Strategien zur Bewertung der Sedimentqualität – In den Kantonen angewendete Techniken zur Probenahme und Probenvorbehandlung

Fragebogen

1. Allgemeine Fragen

a. Kanton

Ihre Adresse

b. Analysieren Sie *in situ* Sedimente ?

☐ Ja, die Analysen machen wir selbst.

☐ Ja, wir beauftragen ein externes Labor. Welches ?

☐ Nein, wir analysieren keine *in situ* Sedimente.

c. Von wo stammten diese Sedimente ?

☐ Fliessgewässer ☐ Seen ☐ Andere Quellen, nämlich:

Wenn Sie aus **Fliessgewässer und Seen** Proben nehmen, bitten wir Sie, dies für die nächsten Antworten zu präzisieren, ☐F (Fliessgewässer) und/oder ☐S (See) anzukreuzen.

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2. Strategien und Planung der Probenahmekampagnen

a. Was sind die Hauptziele Ihrer Sediment-Probenahmekampagnen ?

☐Überblicksweise Überwachung ☐F / ☐S „surveillance monitoring“	☐Gesamtbewertung der Sedimentqualität ☐ Überwachung von empfindlichen/geschützten Feuchtgebieten ☐Erhalten von zusätzlichen Daten zur Bewertung der Gewässerqualität ☐ Andere
☐Operative Überwachung ☐F / ☐S	☐Räumlich-zeitliche Monitoring einer bekannten Verunreinigung ☐Monitoring einer bekannten Punktuelle (ARA, Kernkraftwerk, ...) ☐Andere
☐Überwachung zu Ermittlungszwecken ☐F / ☐S	☐ Beurteilung des Ausmasses und der Auswirkungen einer unfallbedingten Verschmutzung ☐ Andere

b. Wie häufig nehmen Sie im Durchschnitt Proben, um ihre Ziele zu erreichen ?

☐Einmal pro Jahr	☐F / ☐S
☐Alle 3 Jahre	☐F / ☐S
☐Alle fünf Jahre	☐F / ☐S
☐Wir nehmen nur punktuelle Proben	☐F / ☐S
☐Anderes	

c. Wie viele Probenorte enthält ihre Probenahmekampagne im Durchschnitt ?

d. Über welchen Zeitraum ist Ihr Probennahmeprogramm geplant ?

☐ Bis zur Gewässererholung nach einer Beeinträchtigung	☐F / ☐S
☐ Einjährige Untersuchung	☐F / ☐S
☐ Mehrjährige Untersuchung	☐F / ☐S
☐ Anderer	☐F / ☐S

e. Wie wählen Sie Ihre Probenorte aus?

☐ Sie benutzen existierende Messnetze, nämlich :
- ☐NADUF (Nationale Daueruntersuchung der Fliessgewässer)
- ☐Hydrodaten vom BAFU
- ☐NAWA (Nationale Beobachtung Oberflächengewässerqualität)
- ☐SwissPRTR (Register über die Freisetzung von Schadstoffen)

2

☐ Andere, bitte präzisieren Sie :
☐ Sie benutzen die Orte der Probenahmekampagnen vergangener Jahre
☐ Sie wählen je nach Fall aus

Bemerkungen :

f. In welcher Jahreszeit nehmen Sie Proben ?

☐ Ende Sommer (August -Sept.) ☐F / ☐S
☐ Ende Winter (Feb.-März) ☐F / ☐S
☐ Andere

g. Welche Faktoren beeinflussen diese Wahl ?

☐ Das Abflussregimen ☐F / ☐S
☐ Menschliche Aktivitäten (Landnutzung, Vorkommen von Industrieabwässern, kommunale Abwässer) ☐F / ☐S
☐ Messkampagnen zur Erfassung der Gewässerqualität ☐F / ☐S
☐ Logistische Anforderungen ☐F / ☐S
☐ Andere

h. Welche Schadstoffe messen Sie gewöhnlich ?

☐ Metalle ☐F / ☐S
☐ PAKs ☐F / ☐S
☐ PCBs ☐F / ☐S
☐ Pestizide ☐F / ☐S
☐ Radioisotope ☐F / ☐S
☐ Dioxine ☐F / ☐S

☐ Andere, bitte legen Sie die Stoffliste dieser Umfrage im Anhang bei

i. Gibt es Schadstoffe, die Sie erst seit kurzem messen (weniger als 5 Jahre) ? Welche ?

j. Welche anderen Schadstoffe wären Ihrer Meinung nach besonders interessant zu messen ?

k. Nimmt Ihr Kanton an einem Projekt zur Bewertung von neuen/prioritären Schadstoffen in Gewässern teil ?

3. Probenahmemethoden

a. Welche Informationen und Parameter nehmen Sie während der Probenahme auf ?

☐ Allgemeine Informationen (z. B. Koordinaten, Gewässername, Datum, etc.)
☐ Plan des Standorts
☐ Art der Probenahme (vom Ufer, von einer Brücke, von einem Wasserfahrzeug)
☐ Geomorphologie (z. B. konkaver Bereich , Anwesenheit einer Schwelle, Vegetation, etc.)
☐ Wetter (Niederschlagsmenge, küzliches Hochwasser, etc.)
☐ Allgemeine Eigenschaften des Gewässerkörpers (Färbung, Geruch, Schlamm , Klarheit, etc.)
☐ Physikalisch-chemische Parameter , wie :

☐ Fliessgeschwindigkeit	☐ Wasserführung	☐ Temperatur	☐ pH
☐ Sauerstoffsättigung /-gehalt	☐ Leitfähigkeit	☐ Nitratgehalt	☐ Nitritgehalt
☐ Phosphatgehalt	☐ Kat- und Anionen	☐ Durchsichtigkeit	☐ Chlorophyll a
☐ Trübung	☐ Redoxpotential	☐ Wassertiefe	☐

b. Welche Gerät benutzen Sie zur Probennahme ?

☐ Handgeführte Schleppschaufel	☐ F / ☐ S
☐ Kernbohrgerät	☐ F / ☐ S
☐ Bodengreifer	☐ F / ☐ S
☐ Schöpfeimer	☐ F / ☐ S
☐ Sedimentfalle	☐ F / ☐ S
☐ Andere	

c. In welche Tief beproben Sie die Sedimenten ?

☐ Die ersten 2 bis 5 cm	☐ F / ☐ S
☐ Die ersten 10 cm	☐ F / ☐ S
☐ Bis 50-100 cm	☐ F / ☐ S
☐ Andere	

d. Wie viele Proben entnehmen Sie normalerweise pro Standort ?

☐ Drei	☐ F / ☐ S
☐ Fünf	☐ F / ☐ S
☐ Abhängig von der Standardabweichung der "Vorprobe"	☐ F / ☐ S
☐ Andere	

e. Bilden Sie aus diesen Proben eine Mischprobe ?

☐ Nein, ich behalte getrennte Proben/Replikate	☐ F / ☐ S
☐ Ja	☐ F / ☐ S

f. Sieben Sie die Sedimente vor Ort für die Metallanalyse ? ☐ Ja ☐ Nein

Wenn Ja, mit welcher Methode ?

☐ Nasssieben unter Zusatz einer Wasserprobe des Standorts	über ein ☐ 63 µm oder ☐ 2 mm Sieb
☐ Nasssieben unter Zusatz von entmineralisiertem Wasser	über ein ☐ 63 µm oder ☐ 2 mm Sieb
☐ Nasssieben ohne Wasserzusatz	über ein ☐ 63 µm oder ☐ 2 mm Sieb

g. Sieben Sie die Sedimente vor Ort für die Analyse organischer Substanzen ? ☐Ja ☐Nein
Wenn Ja, mit welcher Methode ?

☐Nasssieben unter Zusatz einer Wasserprobe des Standorts	über ein ☐ 63 µm oder ☐ 2 mm Sieb
☐Nasssieben unter Zusatz von entmineralisiertem Wasser	über ein ☐ 63 µm oder ☐ 2 mm Sieb
☐Nasssieben ohne Wasserzusatz	über ein ☐ 63 µm oder ☐ 2 mm Sieb

h. Welche speziellen Massnahmen ergreifen Sie, um das Risiko einer Kontamination der Proben zu minimieren ?
☐Material des Probenbehälters abhängig von der Art des zu messenden Stoffes (PE, PP, PS, Glas)
☐ Selektion von Typ und Material der Probenahmegeräte
☐ Selektion der Geräte zum Sieben
☐Selektion der Geräte zum Homogenisieren (Behälter, Spachtel)
☐Selektion der Geräte zum Zerkleinern
☐Persönliche Ausrüstung
☐Verhalten (Rauch, Motor, etc.)
☐ Andere ☐

4. Transport und Lagerung der Proben

☐Zwischen 2 und 8 °C
☐Sie sind gefroren (-20°C+/- 2°C)
☐Geschützt vor Licht
☐Geschützt vor Vibrationen
☐Geschützt vor Oxidation
☐ Andere ☐

b. Unter welchen Bedingungen werden die Proben im Labor vor der Vorbehandeln gelagert ?

☐Die gleiche Bedingungen wie für den Transport
☐Im Kühlraum oder Kühlschrank
☐Andere ☐

c. Nach welcher Lagerzeit Zeit werden die Proben im Labor analysiert ?

Zeit	Stoffe/Parameter	Erfolgt Vorbehandlung
☐24 Stunden	☐	☐
☐48 Stunden	☐	☐
☐7 Tage	☐	☐
☐1 Monate	☐	☐
☐6 Monate	☐	☐
☐	☐	☐

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5. Laboranalysen

☐ *Ex situ* Sieben
- ☐ Trockensiebung — über ein ☐ 63 µm oder ☐ 2 mm Sieb
- ☐ Nasssieben unter Zusatz einer Wasserprobe — über ein ☐ 63 µm oder ☐ 2 mm Sieb
- ☐ Nasssieben unter Zusatz von entmineralisiertem Wasser — über ein ☐ 63 µm oder ☐ 2 mm Sieb

☐ Trocknen durch: ☐ Backofen bei ____ °C ☐ Gefriertrocknen Andere ____
☐ Zerkleinern
☐ Extraktion mit ☐ HCl/HNO_3 ☐ HF ☐ $HF/HClO_4/HNO_3$ ☐ H_2O_2 ☐ sequentielle Extraktion
Andere ____

b. Welche Probenvorbehandlung wird für die Analyse von organischen Substanzen im Labor durchgeführt ?

☐ *Ex situ* Sieben
- ☐ Trockensieben — über ein ☐ 63 µm oder ☐ 2 mm Sieb
- ☐ Nasssieben unter Zusatz einer Wasserprobe — über ein ☐ 63 µm oder ☐ 2 mm Sieb
- ☐ Nasssieben unter Zusatz von entmineralisiertem Wasser — über ein ☐ 63 µm oder ☐ 2 mm Sieb

☐ Trocknen durch: ☐ Backofen bei ____ °C ☐ Gefriertrocknen Andere ____
☐ Zerkleinern

c. Welche physikalisch-chemischen Analysen der Proben werden im Labor durchgeführt ?

Analyse	Mit standardisiertem (s) (ISO, Osol, etc.) oder internem (i) Protokoll ?
☐ Dichte	☐s ☐i
☐ Wassergehalt	☐s ☐i
☐ Partikelgrösse	☐s ☐i
☐ Magnetische Suszeptibilität	☐s ☐i
☐ Glühverlust	☐s ☐i
☐ Gesamter organischer Kohlenstoff	☐s ☐i
☐ Gesamter Phosphor	☐s ☐i
☐ Organischer Stickstoff	☐s ☐i
☐ Acid Volatile Sulphide	☐s ☐i
☐	☐s ☐i

d. Analysieren Sie das Porenwasser des Sediments ? Falls ja, auf welchen Substanzen ? ☐ Ja ☐ Nein

☐ Orthophosphate	☐ Gesamtphosphor	☐ Ammonium	☐ Andere

e. **Wären Sie interessiert, im Jahr 2016 an einer Interkalibrationsübung (Ringtest) teilzunehmen ?**

Mit herzlichem Dank !

6

oekotoxzentrum
centre ecotox
Schweizerisches Zentrum für angewandte Ökotoxikologie
Centre Suisse d'écotoxicologie appliquée
Eawag-EPFL

Stratégies d'évaluation de la qualité du sédiment
Techniques d'échantillonnage et de prétraitements effectuées dans les cantons suisses

Questionnaire

1. Questions générales

a. Canton

Vos coordonnées

b. Analysez-vous les sédiments en place ?

☐ oui, nous effectuons les analyses nous-mêmes.

☐ oui, mais nous mandatons un autre laboratoire :

☐ non, nous n'analysons pas les sédiments en place.

c. D'où proviennent ces sédiments ?

☐ Rivière ☐ Lac ☐ Autres, précisez :

Si vous effectuez des échantillonnages fluviaux et lacustres, merci de le préciser lors des prochaines réponses en cochant ☐R (rivière) et/ou ☐L (lac)

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2. Stratégies et planification des campagnes d'échantillonnage

a. Quels sont les objectifs principaux de vos campagnes d'échantillonnage du sédiment ?

☐ contrôle de surveillance	☐ R / ☐ L	☐ évaluation globale de la qualité du sédiment ☐ contrôle au niveau de zones humides sensibles et/ou protégées ☐ obtention de données complémentaires pour l'évaluation de la qualité des eaux ☐ autres
☐ contrôle opérationnel	☐ R / ☐ L	☐ suivi spatio-temporel d'une contamination ☐ suivi d'une source ponctuelle de contaminants (STEP, centrale nucléaire, etc.) ☐ autres
☐ contrôle d'enquête	☐ R / ☐ L	☐ évaluation de l'ampleur et de l'incidence d'une pollution accidentelle ☐ autres

b. A quelle fréquence échantillonnez-vous pour remplir vos objectifs ?

☐ annuelle	☐ R / ☐ L
☐ triennale	☐ R / ☐ L
☐ quinquennale	☐ R / ☐ L
☐ nous effectuons uniquement des échantillonnages ponctuels	☐ R / ☐ L
☐ autres	

c. Combien de sites d'échantillonnage en moyenne sont compris dans vos campagnes d'échantillonnage ?

d. Sur quelle durée ce programme d'échantillonnage est-il planifié ?

☐ jusqu'à atteindre le rétablissement des atteintes portées à un milieu	☐ R / ☐ L
☐ investigation annuelle	☐ R / ☐ L
☐ investigation sur plusieurs années	☐ R / ☐ L
☐ autres	☐ R / ☐ L

e. Comment choisissez-vous vos sites d'échantillonnage ?

☐ Vous utilisez un/des réseau(x) de mesure existant(s), lesquels :
- ☐ NADUF (Surveillance nationale continue des cours d'eau suisses)
- ☐ Données hydrologiques fournies par l'OFEV
- ☐ NAWA (observation nationale de la qualité des eaux de surface)
- ☐ SwissPRTR (Registre des polluants provenant des entreprises)
- ☐ autre, précisez :

☐ Vous utilisez des données de campagne d'échantillonnage des années précédentes
☐ Vous choisissez au cas par cas

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Remarques :

f. A quelle période de l'année échantillonnez-vous ?

☐ fin de l'été (août -sept.)	☐R / ☐L
☐ fin de l'hiver (fév.-mars)	☐R / ☐L
☐autres	

g. Quels facteurs guident ce choix ?

☐le régime hydrologique	☐R / ☐L
☐les activités humaines (épandage, rejets industriels, rejets urbains)	☐R / ☐L
☐les campagnes de mesure de la qualité des eaux de surface	☐R / ☐L
☐selon des contraintes d'ordre logistique	☐R / ☐L

☐autres

h. Quelles sont les substances recherchées habituellement ?

☐métaux traces		☐R / ☐L
☐HAPs		☐R / ☐L
☐PCBs		☐R / ☐L
☐pesticides		☐R / ☐L
☐radioisotopes		☐R / ☐L
☐dioxines		☐R / ☐L

☐autres, pouvez-vous nous fournir la liste en annexe à ce questionnaire ?

i. Existe-t-il des substances qui sont mesurées seulement depuis récemment (moins de 5 ans) ?

j. Quelles autres substances représenteraient un intérêt particulier à mesurer selon votre avis ?

k. Votre canton participe-t-il à un projet d'évaluation de nouvelles substances prioritaires et/ou émergentes dans les milieux aquatiques ?

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3. Méthodes de prélèvement sur le terrain

a. Pendant l'échantillonnage, quelles informations et quels paramètres relevez-vous sur le site ?

☐ informations générales (p. ex. coordonnées du site, nom du cours d'eau, date, prestataire, etc.)
☐ schéma du site
☐ type de prélèvement (depuis une rive, un pont, une embarcation)
☐ géomorphologie (p. ex. zone concave, présence d'un seuil, végétation, etc.)
☐ météo (précipitations, crue récente, etc.)
☐ caractéristiques générales de la masse d'eau (teinte, odeur, boue flottante, limpidité, etc.)
☐ paramètres physico-chimiques, dont :

☐ vitesse du courant	☐ débit	☐ température	☐ pH
☐ saturation O_2	☐ conductivité	☐ nitrates	☐ nitrites
☐ phosphates	☐ cat/anions majeurs	☐ transparence	☐ chlorophylle a
☐ turbidité	☐ potentiel redox	☐ profondeur de l'eau	☐

b. Quels outils d'échantillonnage utilisez-vous ?

☐ drague manuelle — ☐ R / ☐ L
☐ carottier — ☐ R / ☐ L
☐ benne de prélèvement — ☐ R / ☐ L
☐ écope — ☐ R / ☐ L
☐ piège à sédiment — ☐ R / ☐ L
☐ autres

c. Quelle profondeur de sédiment échantillonnez-vous ?

☐ les premiers 2 à 5 cm — ☐ R / ☐ L
☐ les premiers 10 cm — ☐ R / ☐ L
☐ jusqu'à 50-100 cm — ☐ R / ☐ L
☐ autres

d. En règle générale, combien d'échantillons prélevez-vous par site ?

☐ 3 par sites — ☐ R / ☐ L
☐ 5 par sites — ☐ R / ☐ L
☐ en fonction de la déviation standard selon pré-échantillonnage — ☐ R / ☐ L
☐ autres

e. Formez-vous un échantillon composite avec ces prélèvements ?

☐ Non, je garde les réplicats séparés — ☐ R / ☐ L
☐ Oui — ☐ R / ☐ L

f. Effectuez-vous un tamisage sur place pour l'analyse des métaux ? ☐ Oui / ☐ Non
Si oui, selon quelle méthode ?

☐ tamisage humide avec ajout d'eau du site — **à** ☐ 63 µm ou ☐ 2 mm
☐ tamisage humide avec ajout d'eau déminéralisée — **à** ☐ 63 µm ou ☐ 2 mm
☐ tamisage humide sans ajout d'eau — **à** ☐ 63 µm ou ☐ 2 mm

g. Effectuez-vous un tamisage sur place pour l'analyse des polluants organiques ? ☐Oui / ☐Non
Si oui, selon quelle méthode ?

☐ tamisage humide avec ajout d'eau du site **à** ☐ 63 µm ou ☐ 2 mm
☐ tamisage humide avec ajout d'eau déminéralisée **à** ☐ 63 µm ou ☐ 2 mm
☐ tamisage humide sans ajout d'eau **à** ☐ 63 µm ou ☐ 2 mm

h. Quelles mesures particulières prenez-vous pour faire face au risque de contamination des échantillons ?
☐type de récipient (PE, PP, PS, verre) d'échantillonnage dépendant du type de substances mesurées
☐type et matière des échantillonneurs
☐outils pour le tamisage
☐outils pour l'homogénéisation (contenant mélangeur, spatule)
☐outils pour le broyage
☐équipement personnel
☐comportement (fumée, moteur, etc.)
☐ autres

4. Transport et stockage

a) Dans quelles conditions les échantillons sont-ils transportés jusqu'au laboratoire ?
☐entre 2-8 °C
☐ils sont congelés (-20°C+/- 2°C)
☐à l'abri de la lumière
☐à l'abri des vibrations
☐à l'abri de l'oxydation
☐autres :

b) Dans quelles conditions les échantillons sont-ils stockés avant prétraitement au laboratoire ?

☐les mêmes que pour le transport
☐dans une chambre froide/ réfrigérateur
☐autres

c) Après combien de temps les échantillons sont-ils analysés au laboratoire ?

Temps	Substances/paramètres	Prétraitements effectués
☐24 h	☐	☐
☐48 h	☐	☐
☐7 jours	☐	☐
☐1 mois	☐	☐
☐6 mois	☐	☐
☐	☐	☐

5. Analyses en laboratoire

a. Quels prétraitements subissent les échantillons pour l'analyse des métaux en laboratoire ?

☐tamisage ex situ

5

☐ sec à ☐ 63 µm ou ☐ 2 mm
☐ humide avec eau du milieu à ☐ 63 µm ou ☐ 2 mm
☐ humide avec eau déminéralisée à ☐ 63 µm ou ☐ 2 mm

☐ séchage par ☐ étuve à ☐ °C ☐ lyophilisation autre ☐
☐ broyage
☐ extraction par ☐ HCl/HNO_3 ☐ HF ☐ $HF/HClO_4/HNO_3$ ☐ H_2O_2 ☐ extraction séquentielle
autre ☐

b. Quels prétraitements subissent les échantillons pour l'analyse des polluants organiques ?
☐ tamisage ex situ
☐ sec à ☐ 63 µm ou ☐ 2 mm
☐ humide avec eau du milieu à ☐ 63 µm ou ☐ 2 mm
☐ humide avec eau déminéralisée à ☐ 63 µm ou ☐ 2 mm

☐ séchage par ☐ étuve à ☐ °C ☐ lyophilisation autre ☐
☐ broyage

c. Quelles analyses physico-chimiques des échantillons effectuez-vous ?

Analyses	Selon un protocole standardisé (s) (ISO, Osol, etc.) ou interne au canton (i) ?
☐ densité	☐s ☐i ☐
☐ teneur en eau	☐s ☐i ☐
☐ granulométrie	☐s ☐i ☐
☐ susceptibilité magnétique	☐s ☐i ☐
☐ perte au feu	☐s ☐i ☐
☐ carbone organique total	☐s ☐i ☐
☐ phosphore total	☐s ☐i ☐
☐ azote organique	☐s ☐i ☐
☐ sulfures volatiles - AVS	☐s ☐i ☐
☐ ☐	☐s ☐i ☐

d. Analysez-vous les eaux interstitielles du sédiment, si oui, pour quels composés ?

☐ orthophosphates
☐ phosphore total
☐ ammonium
☐ autres ☐

e. Souhaiteriez-vous participer à un exercice d'inter-calibration en 2016 sur l'échantillonnage ?
☐

Avec nos remerciements les plus sincères !

Appendix 2. Type of sampling design and sampling strategies

Tab. 1 Overview of the sampling strategies in Switzerland. This table contains the sampling strategies for the 14 cantons which perform in situ sediment assessment. Information for the canton of Schaffhausen (SH) comes from the survey 2010 (Flück and Campiche 2011).

Cantons	AG	BE	BL	BS	FR	GE	GL	JU	SG	SH	SZ	TG	VD	VS	ZH
Lake-Type of monitoring[a]	-	SUR	-	-	SUR/OPA/ INQ	-	SUR/INQ	-	INQ	-	SUR	INQ	SUR	-	INQ
River-Type of monitoring[a]	SUR/INQ	SUR/OPA	OPA/INQ	SUR/OPA	OPA/INQ	INQ	SUR/INQ	SUR/OPA/ INQ	INQ	-	-	INQ	SUR	SUR/OPA	SUR/OPA/ INQ
Aims[b]	POLL	GA/CON	CON/SP/ POLL	-	CMP/CON/ SP/POLL	POLL	CMP	GA/CMP/ CON/SP/ POLL	POLL/SP	-	Other	POLL	CMP	GLB/SP	GLB/CMP/ SP
Frequency same site	10 years	10 years	grab sample CBC	5 years CBC	1 years PONCT	PONCT	5 years	6 months grab sample	grab sample	-	CBC	grab sample	2-4 years	grab sample	6 years
Nr. sites per campaign	10	20-30	10	5	5	-	-	5-9	4	-	1-5	5-10	≥10	15-20	25-30
Monitoring network[c]	cantonal	NAWA cantonal	CBC	CBC	CBC	CBC	CBC	NAWA	CBC	-	CBC	CBC	CBC	CBC	NAWA cantonal
Sampling period	Nov	Jun	not fixed	Feb-Mar	Aug-Sept	-	not fixed	May-Jun/ Sept-Oct	not fixed	-	not fixed	not fixed	Mar-Jun/Sep-Dec	Nov/ Feb	Feb-Mar
Factors	CWAT	HYDR/ LOGI	HYDR/ HUM/CWAT	HYDR	HYDR/HUM/ CWAT/LOGI	Accidental pollution	LOGI	HUM/CWAT	HUM	-	other	HUM/OTH	other	HYDR/ CWAT	LOGI
Type of substances[d]	TM	TM/PAHs	TM/PAHs/ PCBs/PEST	TM/PAH	TM/PAHs/ PCBs/RAD	PEST	TM/PAHs	TM/PAHs /PCBs/PEST	TM/ PAHs/ PCBs	TM	TM/ PAHs/ PCBs	TM/PCBs/ PAHs	None normally	TM/ PAHs/ PCBs	TM/ PAHs/ PCBs

[a]SUR: surveillance monitoring, OPA: operational monitoring, INQ: investigative monitoring. [b]GA: global assessment of sediment quality, CMP: complementary data for water quality assessment, CON: spatio-temporal evaluation of contamination, SP: punctual contamination source monitoring, POLL: accidental pollution assessment. NAWA: national network on surface water quality, [c]CBC: case by case approach. CWAT: water sampling campaign, HYDR: hydrological regime, LOGI: logistic constrains, HUM: human activities in the watershed. [d]TM: trace metals, PAHs: polycyclic aromatic hydrocarbons, PCBs: polychlorinated biphenyls, PEST: pesticides, RAD: Radionuclides.

Appendix 3. Collecting method in the field and pre-treatment

Tab. 2 Overview of sampling and pre-treatment methodology applied by cantonal agencies.

Cantons[a]	AG	BE		BL	BS	GE	JU	SG		SH	SZ	TG		VD	VS	ZH	GL
Water body[b]	R	L	R	R	R	R	R	L	R	R	SP	L	R	R	R	R/L	R/L
Depth[c] (cm)	-	50-100	10	10	2-10	2-5	2-5	50-100	10		2-5	50-100	10	2-5	10	2-5	
Sampling device	Beaker	Corer	Hand dredge	Bailer	Grab sampler	Hand dredge	Bailer	Corer/ Grab sampler	Bailer		Hand dredge	Corer	Corer/ Hand dredge	Corer/ Grab	Bailer	Bailer	
Composite sample	Yes		Yes	Yes	Yes	No	Yes		Yes		Yes		Yes	No	Yes	Yes	
Pre-treatment for trace metal analysis																	
Fraction for analysis	63 µm	63 µm	63 µm	63 µm	2 mm	2 mm	63 µm	63 µm	63 µm	63 µm	2 mm				2 mm	63 µm	63 µm
Type sieving[d]	*ex situ* wet H_20_{site}		*in situ* wet H_20_{site}	*in situ* wet H_20_{site}	*ex situ* wet H_20_{dd}	*ex situ* dry	*in situ* wet H_20_{site}	*ex situ* dry			*ex situ* dry				*in situ* wet H_20_{site}	*ex situ* wet H_20_{site}	*ex situ* wet H_20_{site}
Drying	40°C	40°C	40°C	40°C	Freeze-drying	40°C	40°C	40°C	40°C		105°C	40°C	40°C		40°C	40°C	
Extraction	*aqua regia*	*aqua regia*	*aqua regia*	*aqua regia*		HF	*aqua regia*	HNO_3 conc.			HNO_3 conc				HNO_3 (Hg)	*aqua regia*	*aqua regia*
Pre-treatment for organics analysis																	
Fraction considered			63 µm	63 µm	2 mm		63 µm	63 µm			2 mm				63 µm		
Type sieving[d]			*in situ* wet H_20_{site}	*in situ* wet H_20_{site}	*ex situ* wet H_20_{dd}		*ex situ* wet H_20_{site}	*ex situ* dry			*ex situ* dry				*ex situ* dry		
Drying			40°C	40°C	Freeze-drying		40°C	40°C			40°C				35°C		
Ancillary measurements[f]			DW, TOC	DW, TOC	DW, TOC		DW, TOC				DW, TOC			TOC, P_{tot}	DW	TOC, P_{tot}	

[a]Canton FR and GL externalize sediment analyses. The applied methodology at FR and TG depends on which laboratory is mandated. GL mandates AWEL (Amt für Abfall, Wasser, Energie und Luft) thus the methodology of ZH applies. SH did not provide additional information. [b]Type of water bodies studied. R: rivers, L: lakes, SP: sedimentation pond. [c]Depth of sediment collected (in cm). [d]H_20_{dd}: sieving with demineralized water; H_20_{site}: sieving with the help of site water. [e]For the analysis of Hg, sediments is sieved *ex situ* after drying. [f]Complementary measurements. DW: dry weight; TOC: total organic carbon, P_{tot}: total phosphor.