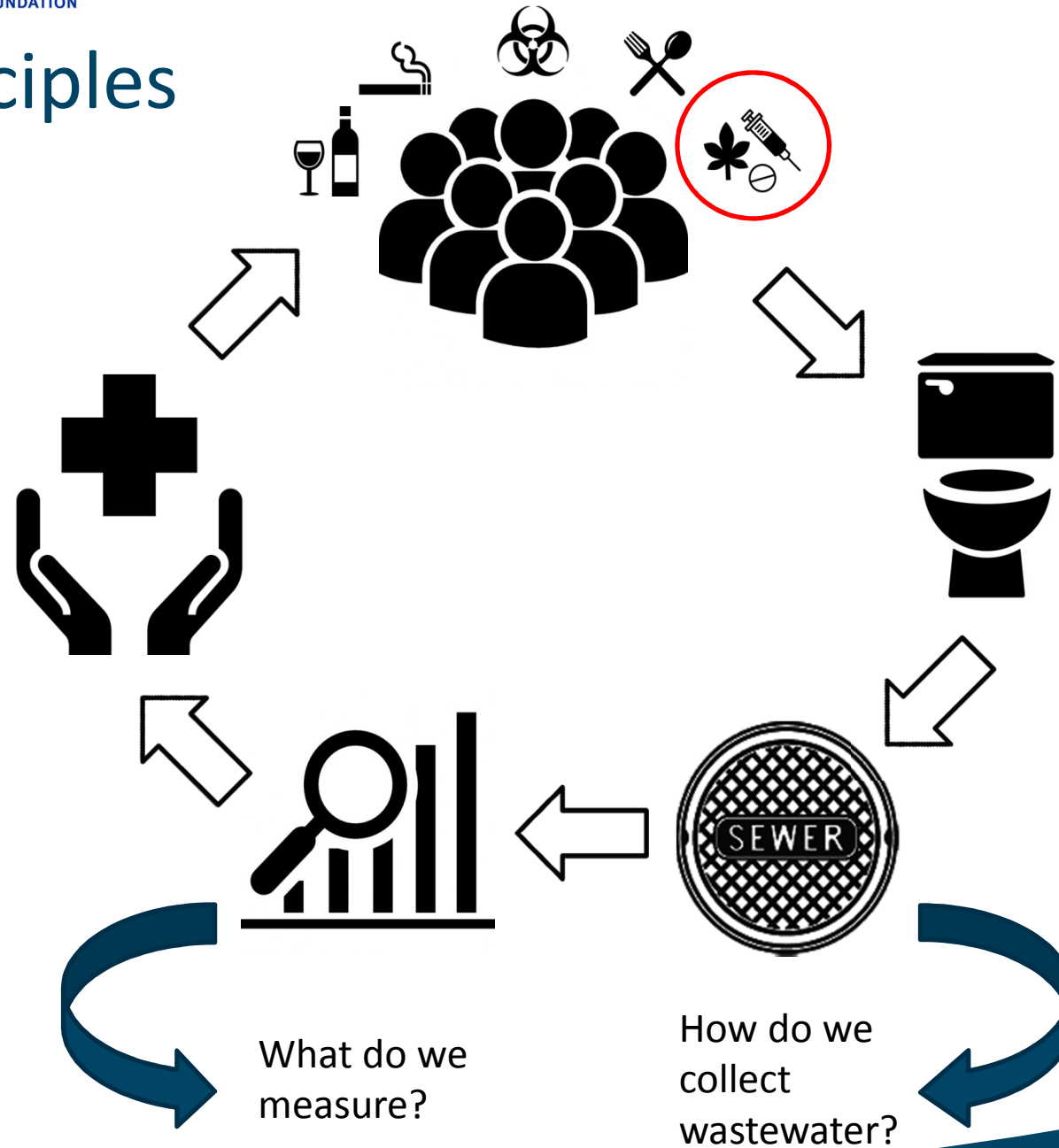


Assessing geographical differences in illicit drug use - A comparison of results from epidemiological and wastewater data

Frederic Been
Toxicological Centre
University of Antwerp

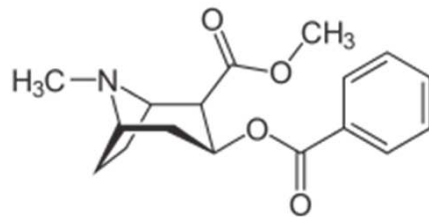
Annual Expert Meeting GPS
EMCDDA, Lisbon, 19-20 Sept. 2016

I. Principles



I. Principles

Parent compound

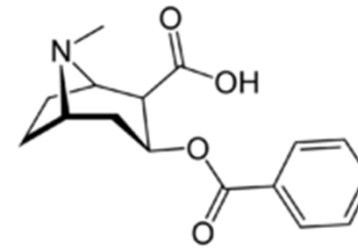


Cocaine

! Can occur in wastewater for other reasons than consumption!



Metabolite



Benzoylecgonine

Are (generally) produced by the human body after intake

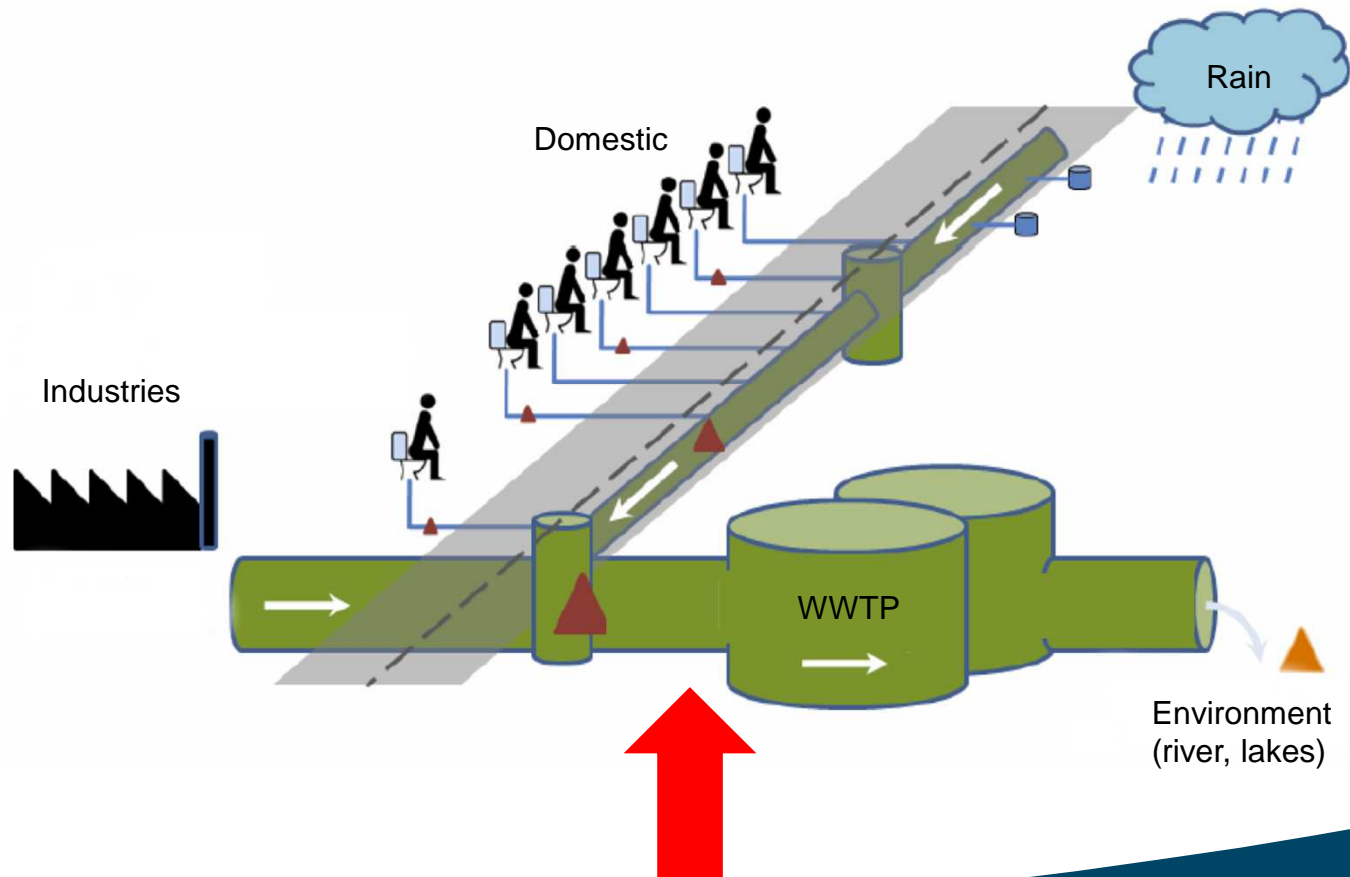


Specific markers of consumption

I. Principles

Wastewater sampling

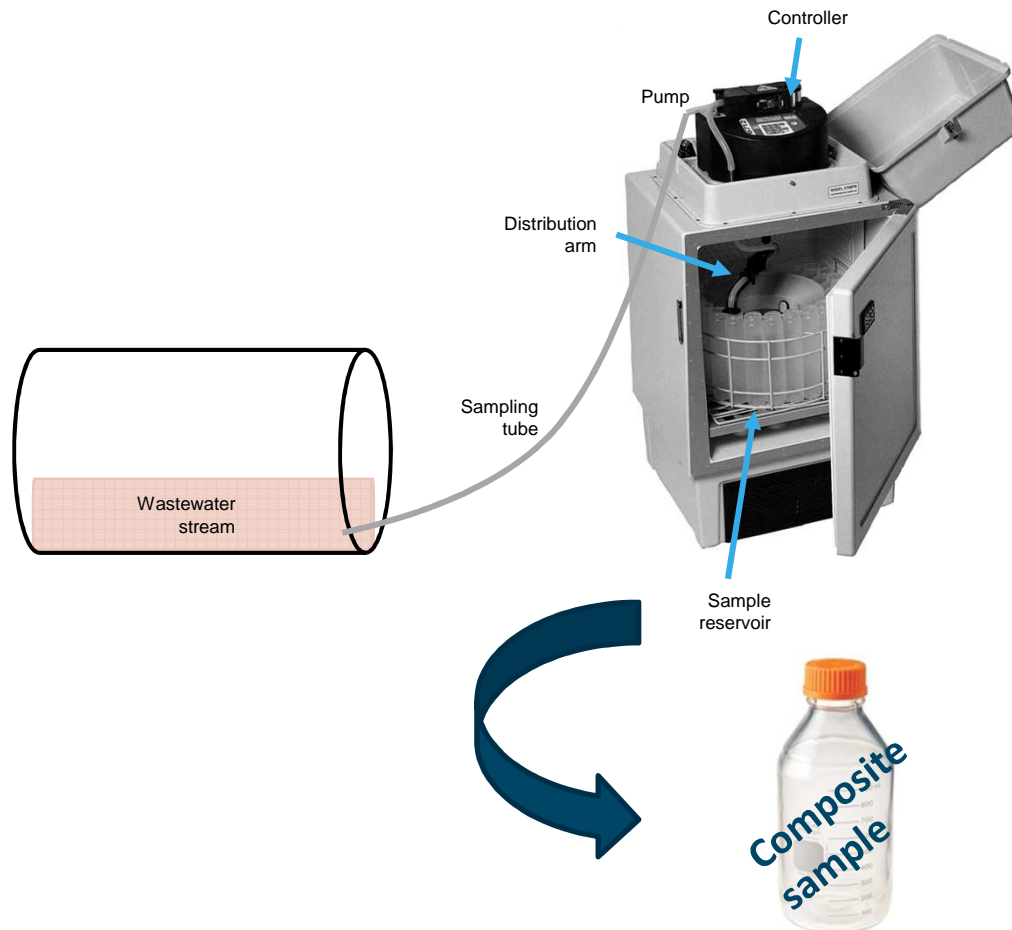
Where?



I. Principles

Wastewater sampling

How?



Collects a certain volume (fixed or variable) of wastewater every n minutes during 24h

Sample representative of the whole day

I. Principles

1. Concentrations

Amount of metabolite and/or parent compound in the collected wastewater sample



→ Nanograms per litre
part per billion of a gram

I. Principles

2. Population normalised loads

- Absolute loads divided by the size of the population served by the WWTP

$$Pop. Loads \left[\frac{mg}{day \cdot 1000 inhab} \right] = \frac{Concentration \left[\frac{ng}{L} \right] * Flow \left[\frac{L}{day} \right]}{10^{-6} * Population}$$

↖ WWTP personnel
↖ Census, registered inhabitants

Used to compare results from different sampling locations

The screenshot shows the website of the European Monitoring Centre for Drugs and Drug Addiction. The main heading is "Wastewater analysis and drugs – a European multi-city study". Below the heading, there are navigation tabs: "intro", "1. Analysis", "2. Interactive", "3. Terms and definitions", and "4. Methods and ethics". The "intro" tab is selected. The content includes an "Introduction" section with the text: "The findings of the largest European project to date in the emerging science of wastewater analysis are taken up in this 'Perspective on drugs'. The project in question analysed wastewater in over 60 European cities and towns (hereinafter referred to as 'cities') to explore the drug-taking habits of those who live in them. The results provide a valuable snapshot of the drug flow through the cities involved, revealing marked geographical variations*." Below the text are four images: 1. Analysis: results from a European multi-city study (showing a pipe), 2. Interactive: explore the data from the study (showing a map), 3. Terms and definitions (showing a document), and 4. Understanding the wastewater method, and addressing ethical issues (showing a person holding a document).

I. Principles

3. Back-calculation

- Amounts of (pure) substance initially consumed

$$\text{Consumption} \left[\frac{g}{\text{day}} \right] = \text{Loads} \left[\frac{g}{\text{day}} \right] * \frac{1}{\text{Excretion}[\%]} * \frac{M_{wc}}{M_{wm}}$$

Proportion of the initial dose that will be excreted as parent compound and/or metabolite(s).

Example of cocaine (urine):

- Metabolised to **benzoylecgonine 32.5%**

Ratio between the (molecular) mass of the parent compound (cocaine) and the metabolite (benzoylecgonine)

I. Principles

What we measure (generally)

Parent	Metabolite
Cocaine	Benzoyllecgonine
Amphetamine	-
Methamphetamine	-
MDMA	(HMMA)
Heroin	Morphine, 6-MAM, Codeine
Cannabis	THC-COOH, (THC-OH)
Ketamine	
Methadone	EDDP
Cathinone	-
Mephedrone	-
NPS (Cannabinoids, cathinones,...)	
Alcohol	Ethyl sulfate
Tobacco	Nicotine, cotinine,...
Benzodiazepines	
and other pharmaceuticals	

II. Advantages

- No human-related biases
- Quantitative
- Costs
 - Few samples (14-28 per WWTP) for an annual estimate (uncertainty $\leq 20\%$)
 - 100-150€/sample (~ 3-4 substances)
- Geographical dimension
 - Atlas of drug use
 - Data granularity
- Temporal dimension
 - Routine sampling allows follow-up
- Retrospective

II. Limitations

- Uncertainties
 - Pharmacokinetics (back-calculation)
 - Degradation (in-sewer transformation) and adsorption (suspended solids)
- Population estimates (commuters, holidays)
- Patterns of drug use
 - Quantity
 - Frequency
 - Risk behaviours
 - Poly drug use
- Screening
 - NPS

III. Geographical differences

Objectives

- Investigate **geographical features** with regard to different indicators
 - Wastewater analysis
 - GPS
 - Crime statistics
- **How well do they overlap?**
- **Specific regional features?**

Been F., Bijlsma L., Benaglia L., Berset J-D., Botero-Coy A. M., Castiglioni S., Kraus L., Zobel L., Schaub M., Bücheli A., Hernández F., Delémont O., Esseiva P., Ort C., *Assessing geographical differences in illicit drug consumption – A comparison of results from epidemiological and wastewater data in Germany and Switzerland*, Drug and Alcohol Dependence, 2016, 161, 189-199.

III. Geographical differences

Wastewater

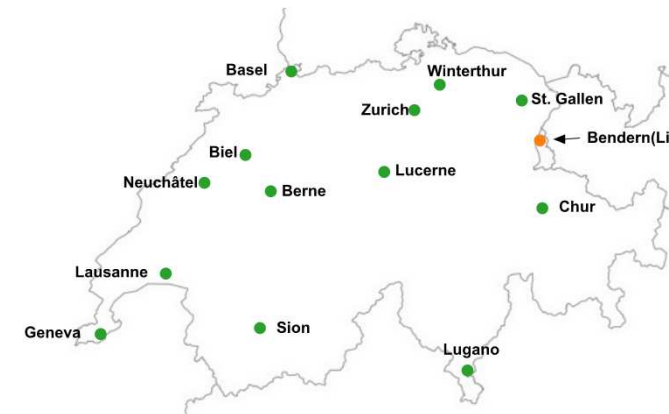
- Germany
 - 5 cities (8 WWTP)
 - 5.8 mio inhabitants
- Switzerland & Liechtenstein
 - 14 cities (14 WWTP)
 - 2.3 mio inhabitants

Sampling

- 1 week, 18-24 March 2014

Measurement

- Population normalised loads
 - Cocaine, amphetamine, methamphetamine and MDMA (THC-COOH and 6-MAM)



III. Geographical differences

Prevalence data

- Results from General Population Surveys
 - Switzerland: specific for investigated areas (CoRoIAR)
 - Germany: Federal States (Bundesländer) only, except Berlin

Crime statistics

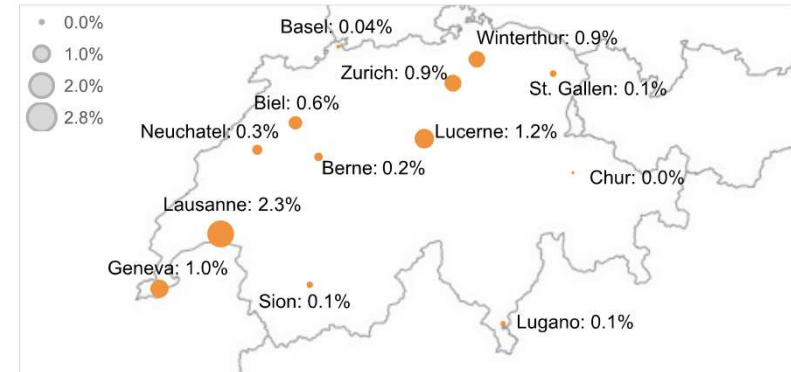
- Number of reported offences for consumption
 - Specific for investigated areas

III. Cocaine – CH & FL

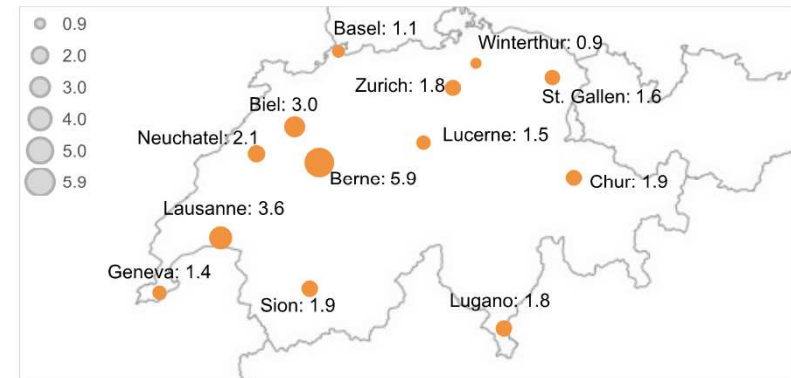
Cocaine – CH & FL

- Prevalence and offences: heterogeneous
 - Reporting bias?
 - Concealment?
 - Availability?
 - Law enforcement strategies?
- WW suggest homogeneous consumption within cities of similar size

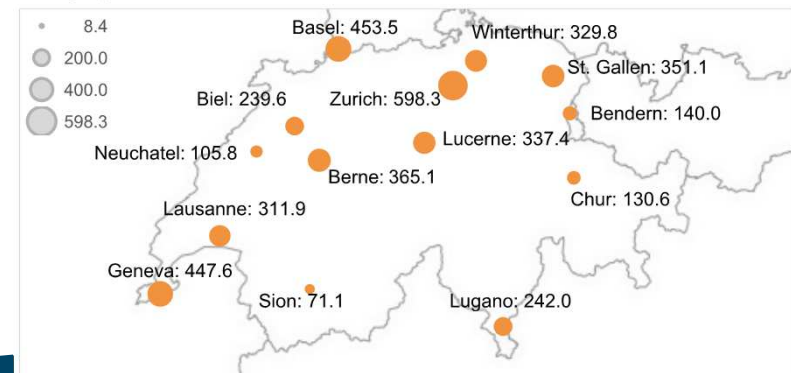
Cocaine Prevalence



Cocaine Consumption Offences

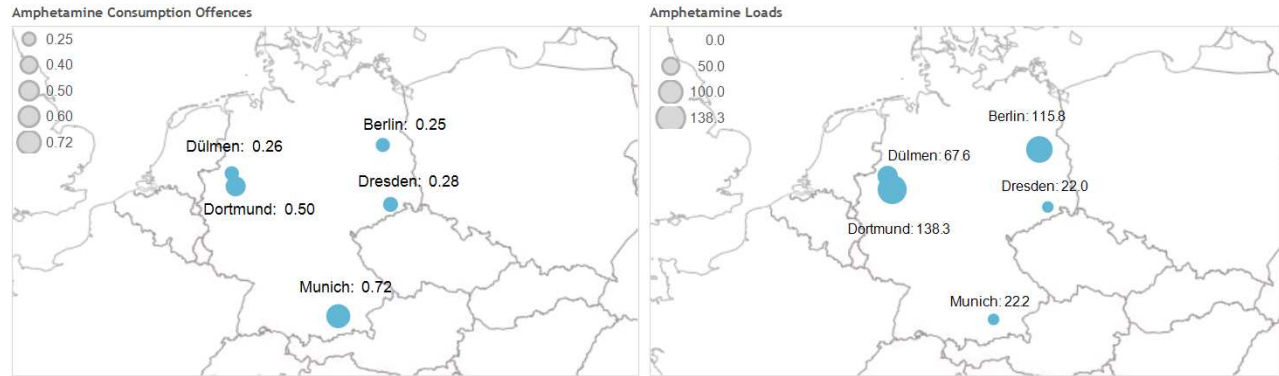


Benzoylcegonine Loads



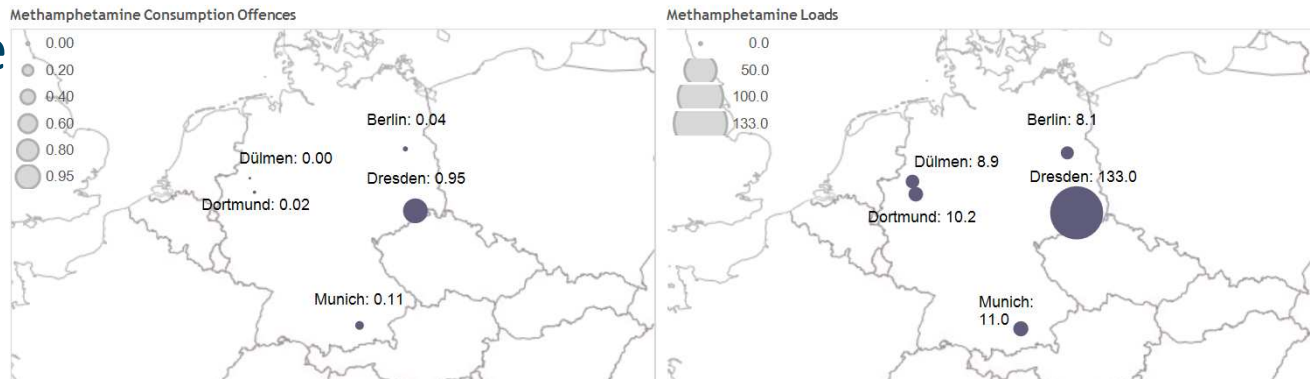
III. Amphetamine & Meth - Germany

Amphetamine



- Offences vs Wastewater → Opposing picture

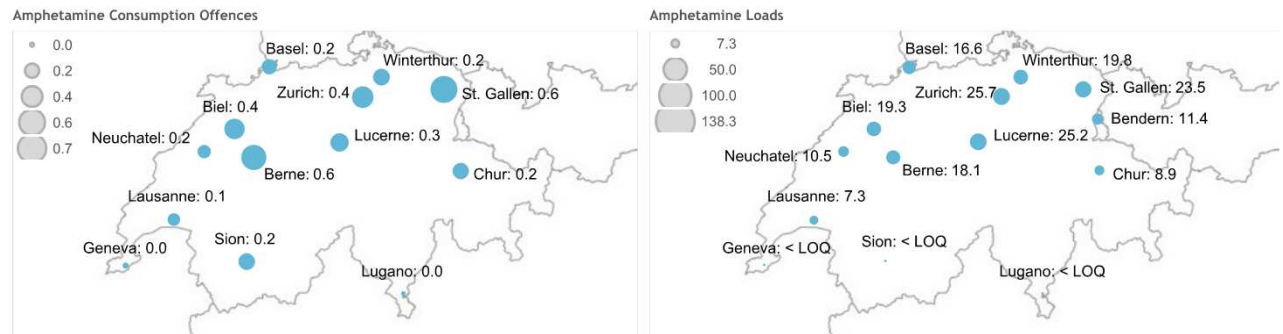
Methamphetamine



- Consistent results, consumption limited to Dresden ✓
 - Major stimulant

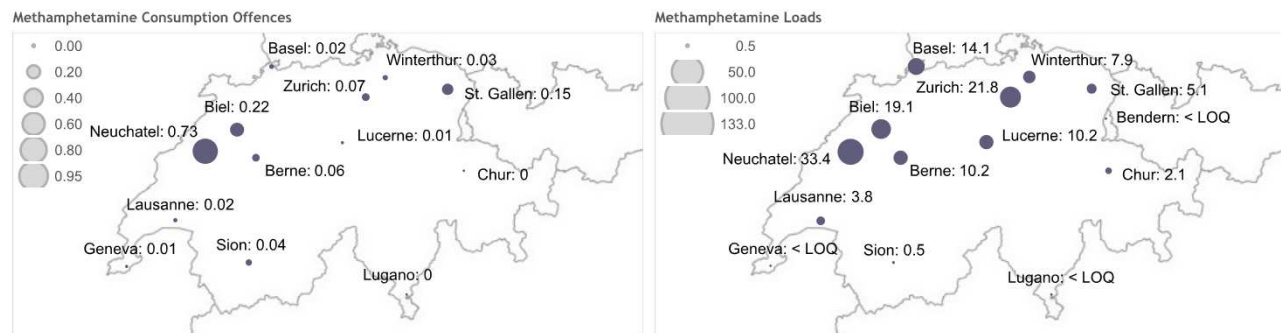
III. Amphetamine & Meth – CH & FL

Amphetamine



- Increased consumption in north-eastern part (german speaking?) ✓

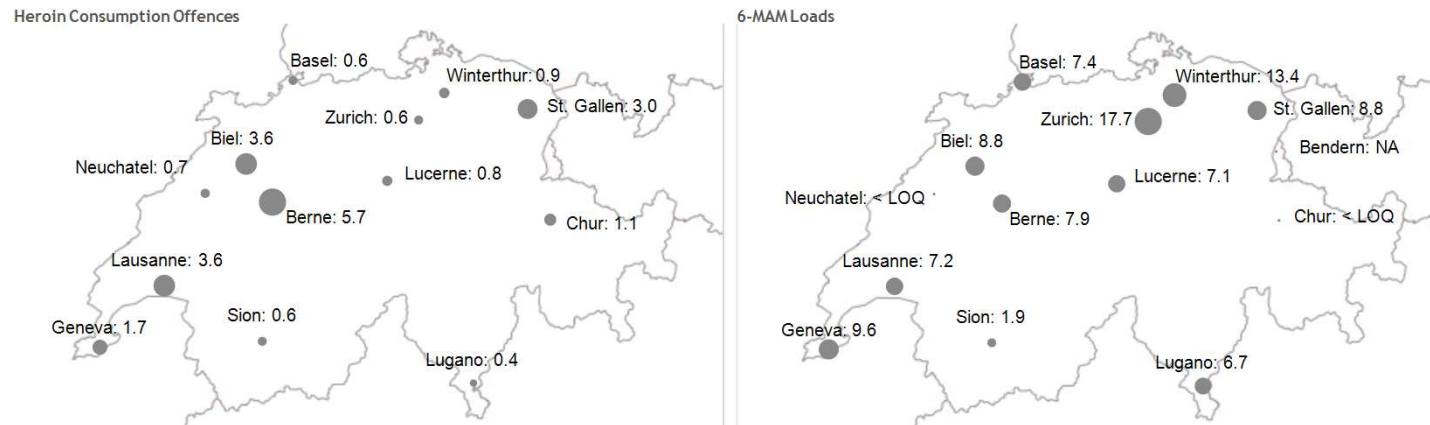
Methamphetamine



- Significant consumption in “golden triangle” ✓
- Yet, wastewater suggests that consumption touches also other areas

III. Heroin – CH & FL

- Offences vs Wastewater



- Strong dissimilarities
 - Visibility?
 - Strategies?
- Wastewater suggest “homogeneous” use
 - Except smallest catchments

IV. Conclusions

Geographical features – Indicators overlap?

✗ Cocaine & Heroin

- Stigmatised?
- Visibility & repression?

✓ Amphetamine, methamphetamine (MDMA and cannabis)

- Overall good overlap
- Less stigmatised/repressed?

IV. Conclusions

Wastewater

- Geographical data
 - Limited only by the size of the catchment/WWTP
- Trend analysis
 - Sufficiently long time series

Surveys/Indicators

- Crucial information about users background
 - Habits
 - Frequency
- Guide the selection of what to look for in WW
 - NPS?

IV. Conclusions



Refine current estimates

- Prevalence
- Number of users per category
- Quantities



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Integrating environmental and self-report data to refine cannabis prevalence estimates in a major urban area of Switzerland

Frederic Beer, Christian Schneider, Frank Zobel, Olivier Delémont, Pierre Esseiva



Acknowledgments

Lubertus Bijlsma, Christoph Ort, Lisa Benaglia, Pierre Esseiva, Olivier Delémont, Frank Zobel, Ludwig Kraus, Alexander Bücheli, Michael Schaub, Felix Hernandez, Sara Castiglioni, Jean-Daniel Berset, Ana M. Botero-Coy, Alexander van Nuijs, Adrian Covaci, Foon Y. Lai, Juliet Kinyua

Swiss Federal Statistical Office
Institut für Therapieforschung (IFT), München
German and Swiss Police

Wastewater treatment plant personnel

Swiss National Science Foundation (SNF)



Thank you!

