How measurements of illegal drugs, alcohol and nicotine in wastewater can improve and supplement substance use epidemiology

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Traditional sources and measurements

- **Individual measurements**
  - Population surveys
  - Surveys in user groups (persons in treatment, in relief measures, among users)
  - Biologic materials: Measurements in hair/ saliva/ blood/ urine
  - Register data

- **Aggregated measurements**
  - Customs and police seizures
  - Sales figures for alcohol and tobacco
  - Surveys or registered information reported by personnel in the municipalities

- **Statistical techniques**
  - Assemble/combine several data sources
  - Statistical modelling
Measurements in wastewater

- What is consumed is excreted – some of it in the toilet
- Substances that can be measured:
  - Cocaine
  - Amphetamine
  - Methamphetamine
  - Cannabis
  - Ecstasy
  - Opioids: Heroin/6MAM, Morphine, Codeine, Methadone/EDDP
  - Synthetic cannabinoids (In progress)
  - Alcohol
  - Nicotine
  - Other pharmaceutical drugs that are misused
Daily measurements of methamphetamine and cocaine in Oslo from 4-30. September 2009. Milligram per hour

Source: Figure 2 in Malcolm Reid et al.: Quantitative assessment of time dependent drug-use trends by the analysis of drugs and related metabolites in raw sewage. Drug and Alcohol Dependence 119 (2011)
Daglige trender: Alkoholførsøk i Oslo

Percentage of total weekly alcohol consumption (%)

- Sun
- Mon
- Tues
- Wed
- Thu
- Fri
- Sat

Reid et al. 2011. Alcohol Clin Experiment Res. 34, 941.
Amphetamine consumption in 19 cities in Europe.
2011

Consumption loads of cocaine, heroin, cannabis (THC) and methamphetamine in Milan 2005-2009

Oslo Narkotikaforbruk - 2010
Normalisert etter folketall (per 1000 innbyggere)

- Cocaine
- Ecstasy (MDMA)
- Methamphetamine
- Amphetamine

Source: NIVA
Narkotikaforbruk
Normalisert etter folketall (per 1000 innbyggere)

- Cocaine
- MDMA
- Methamphetamine
- Amphetamine

Source: NIVA
Figure 1  Pathway of elicit drugs in sewer network systems

From application by NIVA to NRC
Source. Malcolm Read, NIVA
Sources of bias and uncertainty

- What proportion of consumption is excreted from the body to the toilet?
- Any leaks in the sewer pipes? Overflow during heavy rain?
- Any influential chemical processes in the sewer?
- Proper wastewater plant description?
- Proper measurement place?
- Proper sampling plan?
- Proper measurement instrument and analysis?
- Proper back calculation estimation procedure?
Requirements for quality measurements

- (Get access to wastewater plant)
- Establish knowledge about wastewater plants
- Standardize procedures for sampling wastewater
- Standardize procedures for chemical analyses
- Measure water flow in wastewater plants
- Estimate population associated with wastewater plants
Strengths and weaknesses

**Strengths**

1. Measure consumption in cities with low costs
2. Realistic estimates of uncertainty (with good sampling and back-calculation procedures)
3. Results on a daily/weekly/monthly/yearly basis
4. Effective to find presence of new drugs (with known ‘chemistry’)

**Weaknesses**

1. Difficult and costly to measure in areas with many small wastewater plants and thus for a whole country
2. Aggregated measure, no personal information
3. Variation in measurements vs. variation in consumption to be explored further
4. No good way of measuring heroin so far
5. Identify the population associated with the plant. Commuters?
Possible estimates derived from back-calculated wastewater measurements

1. Grams of pure substance consumed per day (or other period)
2. With knowledge of purity: market size in grams
3. With knowledge of the number of persons associated with the wastewater plant: grams per 1000 persons per day
4. With knowledge of the average dose consumed of the substance: the number of doses consumed per day (per 1000 associated person)
5. With knowledge of average consumption per person per day (24 hour): the number of persons consuming per day (per 1000 associated person)

Methodology: Can use surveys to calculate quantity/frequency measures of consumption and compare with wastewater results

Nordic monitoring activity

- **Norway**: Norwegian Institute for Water Research: Kevin Thomas and Malcolm Reid/ SIRUS Ellen J. Amundsen / SERAF (Sewprof) Jørgen Bramness

- **Finland**: Åbo Academic University: Axel Meierjohann/ National Institute for Health and Welfare (THL): Aino Kankaanpää, Kari Ariniemi, Kimmi Kuoppasalmi and Teemu Gunnar / Helsinki Regions Environmental Services HSY: Mari Heinonen

- **Sweden**: Umeå University: Marcus Østman

- **Denmark**: Technical University of Denmark: Benedek Plosz

- **Iceland**: University of Iceland: Kristin Olafsdottir, Arndis Löve
Activities, networks, research


- SEWPROF: SEWPROF aims to develop inter-disciplinary and cross-sectorial research capability for the next generation of scientists working in the newly-emerging field of sewage epidemiology. [http://sewprof-itn.eu/](http://sewprof-itn.eu/)
References


