Complementing Traditional Demand-based Approaches: Wastewater-based Epidemiology for Illicit Drug Market Size Estimation

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BACKGROUND AND AIMS

- "The **drug market size** refers to the **estimated value and quantity** of specific illicit drugs that are available to, or consumed by, a **given population during a specified period**"[1]

- Useful indicator when combined with other metrics[1-3]
  - Relative "**importance**" of different drugs
  - Prioritise interventions, **aid policy decisions**
    - > and later **evaluate impact** of interventions/new policies
  - Provides **comparative measure** to law enforcement activities
    - > seizure of product (e.g., is 1 kg cocaine significant?)
    - > dismantling of drug network
  - Provides revenue estimation of **organised crime networks**

- Aim: assess the use of **wastewater-based epidemiology (WBE)** as a **complementary approach** to traditional techniques of estimating the illicit drug market size

(TRADITIONAL) ESTIMATION TECHNIQUES

top-down, supply side[2]

Consumed = (Drug Produced – Seized – Loss) * Purity

Market Value = Consumed * Price

- Starts from quantity of **drug produced** (e.g., geoimaging)
  - > little evidence-based
  - > many uncertainties (e.g., yield, fertiliser used)

bottom-up, demand side[2]

Consumed = Number of Users * Frequency of Use * Average Used Each Time

Market Value = Consumed * Price

- Starts from **drug consumers** (e.g., surveys)
  - > uncertainties: misreporting, non-response, hidden population, …

WBE[3]

More similar to **demand-based** approach
  ≈ **consumption**; at least fraction that ends up in the sewer

  > **high spatial resolution** compared to other techniques
  > other data sources are needed for **purity** and **price**
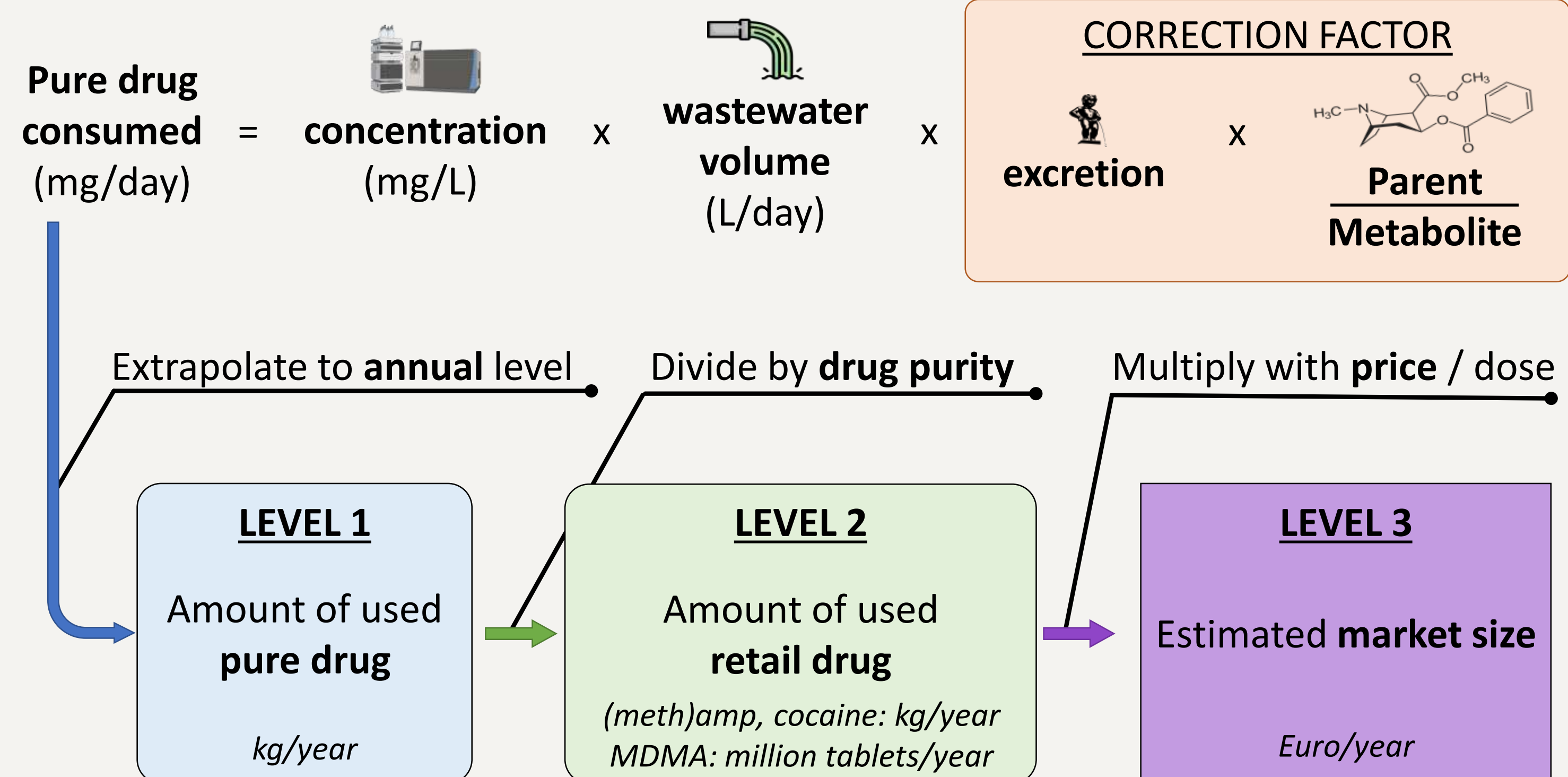 > measuring **retail** market size of **cities** (no extrapolation to country level)

WASTEWATER-BASED EPIDEMIOLOGY

- **Influent wastewater** contains a wealth of information about the population connected to a wastewater treatment plant (WWTP)
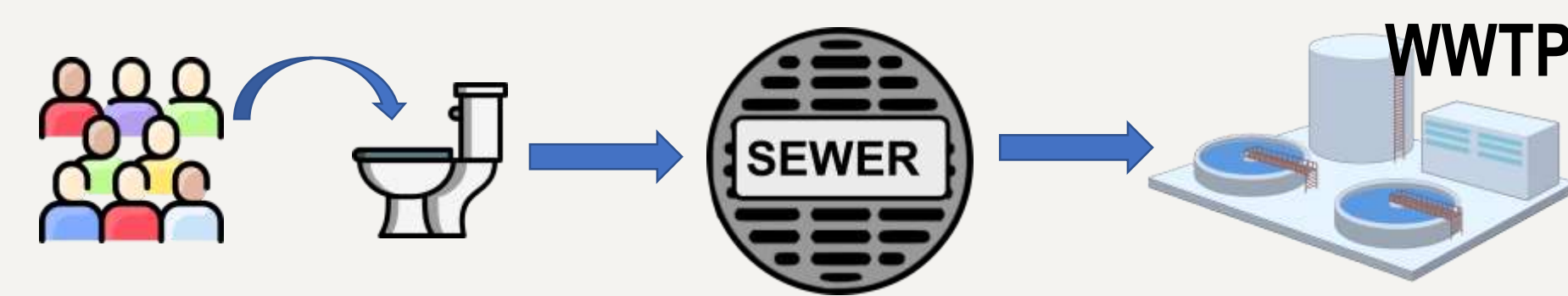
- After humans have been exposed to xenobiotics, **metabolic excretion products** (biomarkers) are released, transported, and pooled in the **sewer system**
- Daily, 24-h composite, influent wastewater samples are analysed for these biomarkers, and measured concentrations are back-calculated to **mass loads**

BACK-CALCULATION

Pure drug consumed (mg/day) = concentration (mg/L) x wastewater volume (L/day) x **CORRECTION FACTOR** [excretion x Parent/Metabolite]

Extrapolate to **annual** level → Divide by **drug purity** → Multiply with **price** / dose

LEVEL 1 — Amount of used **pure drug** — kg/year

LEVEL 2 — Amount of used **retail drug** — (meth)amp, cocaine: kg/year; MDMA: million tablets/year

LEVEL 3 — Estimated **market size** — Euro/year

MATERIALS AND METHODS

- **Yearly annual baseline estimates** from influent **wastewater** obtained through **score** network (score-network.eu)
- **137** cities in Europe analysed
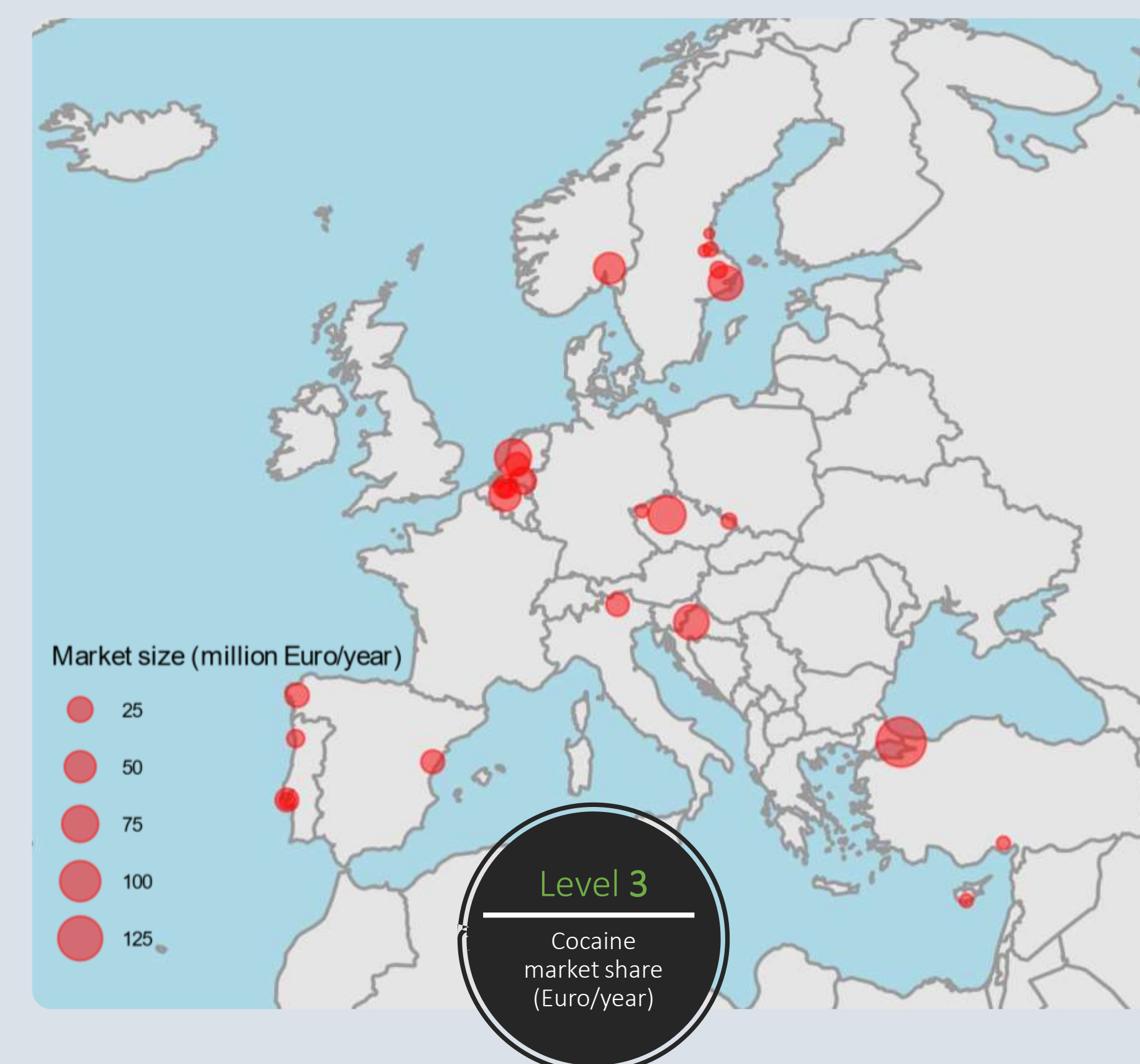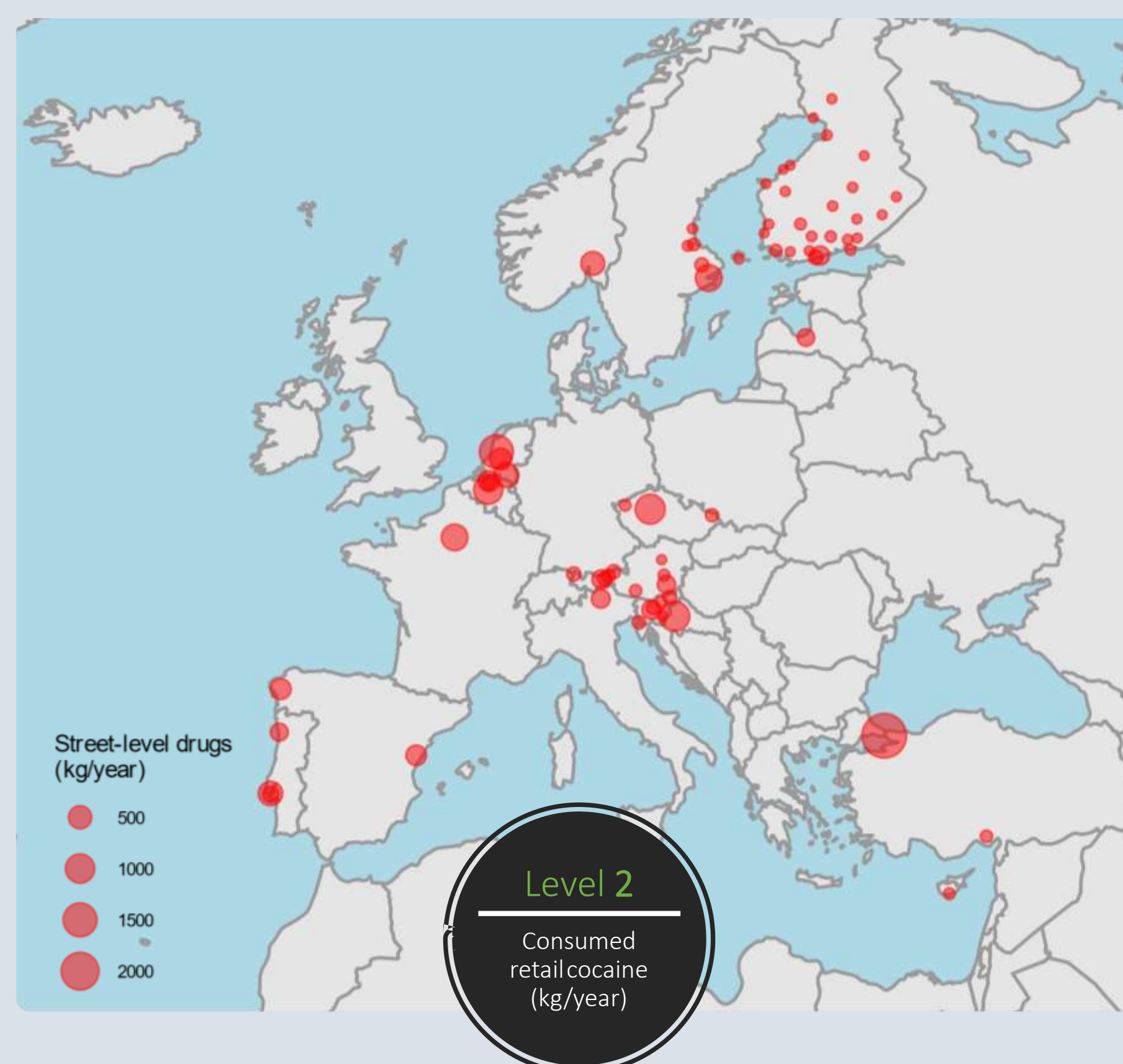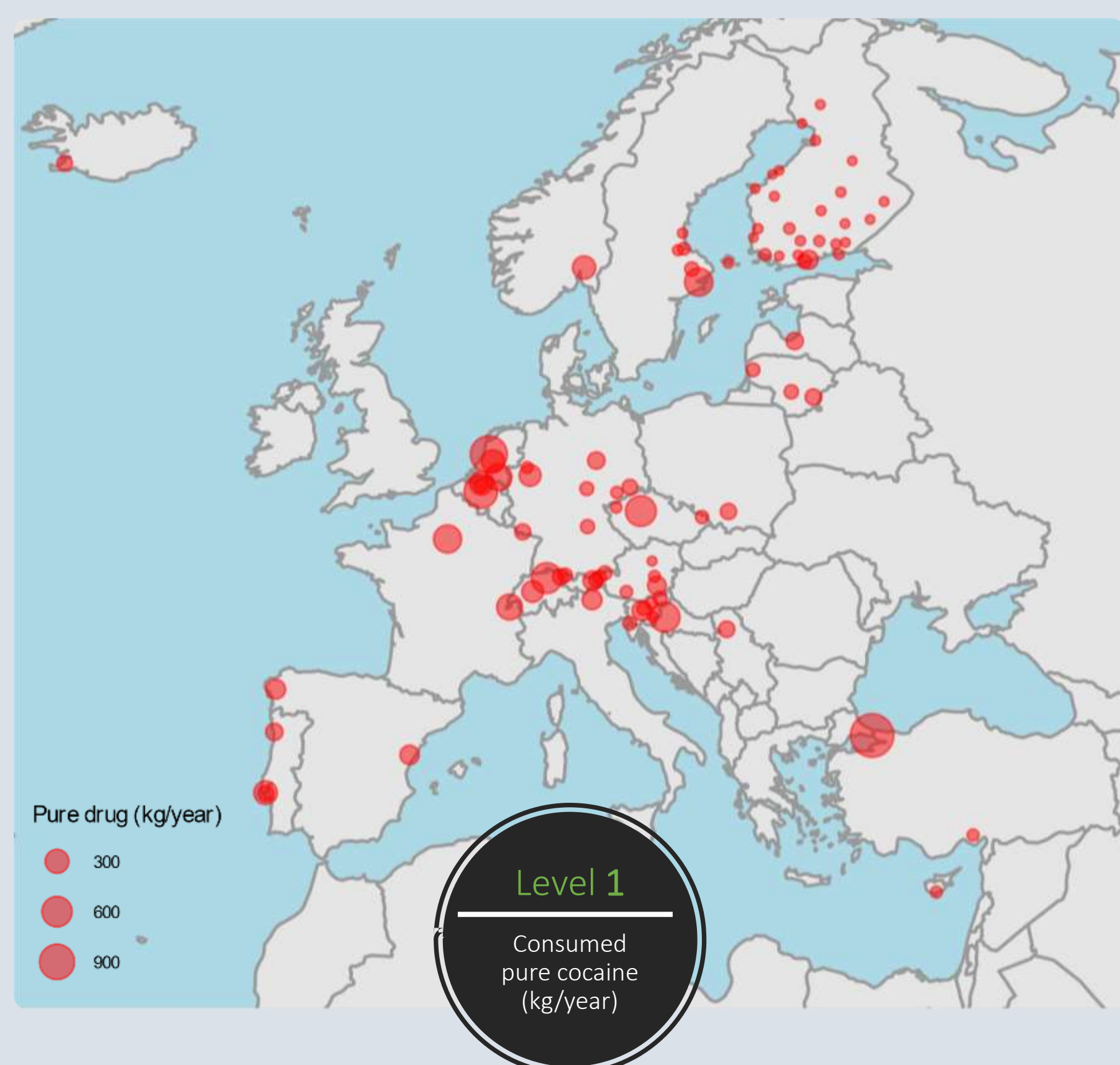
Analysed period: 2015-2021

Drugs analysed	Correction Factor	Reference
Amphetamine	2.77	(Gracia-Lor et al., 2016)
Cocaine (via benzoylecgonine)	3.59	(Castiglioni et al., 2013)
MDMA	4.40	(Gracia-Lor et al., 2016)
Methamphetamine	2.44	(Gracia-Lor et al., 2016)

Drug pricing and purity data
- Statistical bulletin 2022 published by EMCDDA[4], data until 2020

RESULTS: COCAINE IN 2020

Level 1 — Consumed pure cocaine (kg/year) — Pure drug (kg/year): 300, 600, 900

Level 2 — Consumed retail cocaine (kg/year) — Street-level drugs (kg/year): 500, 1000, 1500, 2000

Level 3 — Cocaine market share (Euro/year) — Market size (million Euro/year): 25, 50, 75, 100, 125

DISCUSSION AND CONCLUSIONS

L1: calculation pure drug
⚠ "Normal" week to assess baseline consumption ⇒ likely underestimation
  - E.g., drug tourism, seasonal drug consumption, COVID-19
- Overlapping metabolization pathways (methamphetamine ⇒ amphetamine)
- Influence of licit drug use (e.g., amphetamine for ADHD)

L2: calculation retail drug
- Drug purity ~ based on limited number of seizures

L3: calculation market share
- Drug price ~ based on limited number of studies, or simply not available

Challenges to improving spatio-temporal comparison
- Drug purity and pricing at **country level**
- Different **priorities**: e.g., law enforcement focussed on different tasks
  legislations: e.g., tolerated drug use vs "crackdown"
  recording of data: e.g., only if exceeded certain amount seized

Conclusion
- Need for more, and more representative, **price and purity** data
- WBE has potential as **complementary approach** to traditional, demand-based

References
1 ECMDDA, 2019 - Estimating the size of the main illicit retail drug markets in Europe: an update.
2 Udrisard et al, 2022- Improving the estimation of the size of the European drug market
3 Been et al, 2016 - Analysis of illicit drugs in wastewater – Is there an added value for law enforcement?
4 EMCDDA, Statistical Bulletin 2022 — price, purity and potency