The copper metabolism of cities: Insights into Vienna and Taipei

Ulrich KRAL
Chih-Yi LIN
Hwong-wen MA
Paul H. BRUNNER

25th June 2013, University of Ulsan, Ulsan, Korea
7th International Conference of the International Society for Industrial Ecology
Cities are hotspots of material turnover, THUS we need more attention on:

a) substance flows and stocks on urban scale
b) city comparisons of flows and stocks
Joint research

Vienna University of Technology
Institute for Water Quality, Resources and Waste Management (Austria)

National Taiwan University
Graduate Institute of Environmental Engineering (Taiwan)
Goal

Comparing the anthropogenic copper metabolism of Vienna and Taipei
Opening the black box

16 processes
41 flows, 6 stocks
105 input parameters
Opening the black box…

…to show the Cu turnover

Vienna

City of Vienna, 2008

12,300
Imports

8,200
Exports

180,000
+3,433

660
landfilled material

7
emissions

Landfill
+660

Environment
+7

Taipei

City of Taipei, 2009

11,100
Imports

3,900
Exports

30,000
+7,139

60
landfilled material

1
emissions

Landfill
+60

Environment
+1

Flows: g Cu/cap.yr
Stocks: g Cu/cap

…and much more.
Import into the city

**Vienna**

- **12 kg Cu per cap.yr**

**Use phase**

- Vehicles: 26%
- Electrical & electronic appliances: 22%
- Cu containing goods. E.g. (Sheet metal, Wires, Cables, Pipes, etc.): 52%

**Taipei**

- **11 kg Cu per cap.yr**

**Use phase**

- Household commodities & cars: 39%
- Industrial Equipment: 16%
- Electricity grid: 14%
- Construction material for buildings: 31%
Stocks and changes in stocks

Vienna
- Begin of 2008: 180 kg Cu/cap.yr
- End of 2008: 180 kg Cu/cap.yr (+2% p.a.)

Taipei
- Begin of 2008: 30 kg Cu/cap.yr
- End of 2008: 90 kg Cu/cap.yr (+26% p.a.)
Non-point versus point emissions

Non-point sources

Point sources

Surface runoff makes the difference.

Surface runoff

Vienna
~14 g Cu/cap.yr
53%

Taipei
~5 g Cu/cap.yr
12%
Flows into environmental sinks

- **g Cu/cap.yr**

Legal standards are **NOT** in force.

- **Urban soil**
  - **0.80** Compost
  - **1.60** Deposition

Legal standards are **in force**.

- **Overflow from WWTS**
  - **2.30**

- **Effluents**
  - **1.10**

- **Surface runoff**
  - **1.00**

- **Receiving water**
  - **4.40** downstream flow
Removal efficiency…

…of waste water system.

Vienna

100% Input to waste water system (13 g Cu/cap.yr)

Landfill

Overflow 18%

Effluents 8%

Surface runoff 9%

Taipei

Landfill

Overflow 0%

Effluents 22%

Surface runoff 4%

100% Input to waste water system (5 g Cu/cap.yr)

Sewage sludge 65%

Sewage sludge 74%

100% Output of waste water system
Flows into anthropogenic sinks

kg Cu/cap.yr

Exported waste incl. recyclables

6.70

External antroposphere

+8.20

Exported products

1.50

Factor 12

Recovering potential

0.66

bottom-ash and APC residues

Landfill

+0.67

Filter cake

0.01
Cu content in bottom ash

MSWI

Vienna

660 g Cu per cap.yr

Landfill

Taipei

60 g Cu per cap.yr

Construction sector
4 key messages

- Distinct urban profiles are found in the dynamics of Cu stocks.
- Non-point Cu sources require more attention by urban governance.
- To avoid environmental overloads, end-of-pipe technologies are prerequisite to remove Cu from waste streams and store it in sanitary landfills.
- Much Cu is recycled, but there are still recovery potentials available.
Worldwide city benchmarking requires global methodology and local knowledge.