



Federal Agency  
for the Safety  
of the Food Chain

# Estimation of the dietary exposure to Cadmium

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# Agenda

- Introduction
- Objectives
- Databases
- Results
- Conclusions & perspectives



# Sources of cadmium (Cd)

- Occurs naturally in rocks and soils
- By-product from the production of non-ferrous metals zinc, lead, copper

$$\frac{\text{Anthropogenic emissions}}{\text{Natural emissions}} = 10 \text{ (WHO 1992)}$$

- Zinc and copper melters in the northern part of Belgium (Campine region)

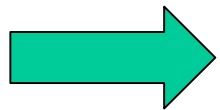


Area contaminated with cadmium



# Exposure through the environment

- Sources of Cd exposure:
  - Ambient air
  - Smoking
  - Dust ingestion
  - Drinking water
  - Diet



**Diet 99% of Cd exposure for non smokers**

(Monography.2004 Risk Assessment Cadmium)

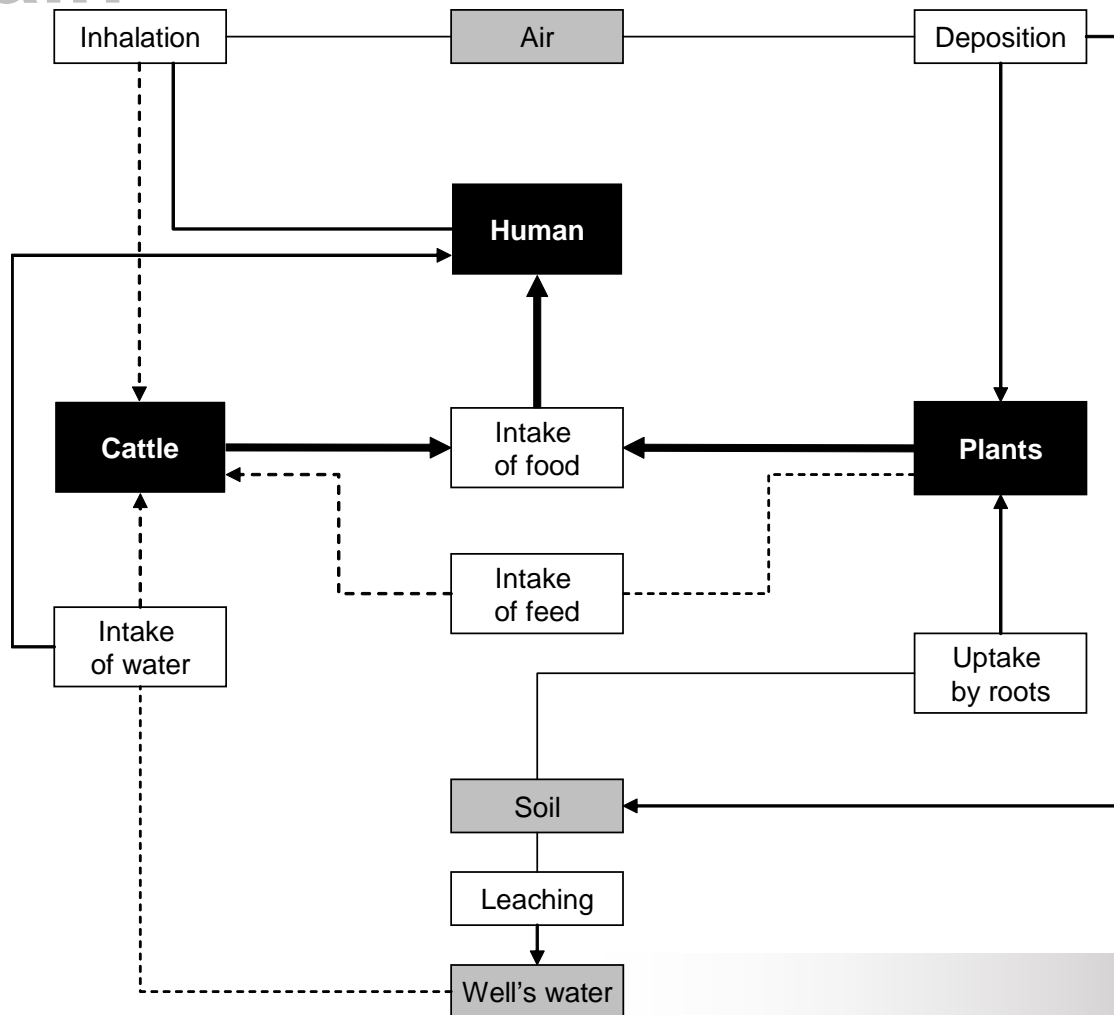


# Health effects

- kidney is the main target organ for chronic Cd toxicity
  - environmental exposure to cadmium is associated with renal tubular dysfunction  
(Koçak et al. 2006. Pathophysiol. Haemost. thromb.35(6):411-6)
- Increased risk of bone fractures  
(Staessen et al. 1999. Lancet 353 (9159):1140-4)
- Increased risk of Cancer (lung cancer)  
(Nawrot T. et al. 2006. Lancet 7: 119-126)



# Main routes for entry in the food chain



# Objectives

- Estimate the Cd dietary intake in area of northern Belgium close to non-ferrous metal plants with consumption of local food
- Compare to Cd dietary intake of the general adult population in Belgium



# Sampling

- Sampling campaign 2004-2005 by the FASFC in Campine and in the rest of Belgium
- Vegetable food products (n= 132; carrots, cabbages, potatoes, berries, ...) and animal food product (n= 53; kidney, liver, meat) sampled
- Samples in contaminated area taken at a distance of 4 to 10 km of the emission sources





# Consumption data

- Belgian food consumption survey (IPH, 2006)
  - Average and 97,5 percentile consumption data
  - For adults between the ages of 19 and 59 years
- Other models:
  - UK chronic intake calculation model (NEDI : National Estimate of Dietary Intake)
  - WHO: GEMS/food consumption data



# Food product

## 13 major foods groups:Vegetables

Commodity	Consumption (kg/day)		Data source
	Average	P97.5	
<b>Fruit (all)</b>	0.111	0.288	IPH 2006
berries	0.006	0.015	NEDI 2006
other fruit	0.106	0.273	IPH 2006 and NEDI 2006
<b>Vegetables (all)</b>	0.141	0.257	IPH 2006
Leafy vegetables	0.016	0.030	IPH 2006 and NEDI 2006
Stem and root vegetables	0.023	0.042	IPH 2006 and NEDI 2006
Other vegetables	0.102	0.186	IPH 2006 and NEDI 2006
<b>Potatoes</b>	0.281	0.466	IPH 2006

Subdivision according to EU maximum level legislation

# Food product

## 13 major foods groups: Meat

Commodity	Consumption (kg/day)		Data source
	Average	P97.5	
<b>Meat (all)</b>	0.143	0.285	IPH 2006
poultry meat	0.019	0.053	IPH 2006
cattle meat	0.068	0.128	WHO 2006 and IPH 2006
pig meat	0.056	0.104	WHO 2006 and IPH 2006
<b>Offal (all)</b>	$3.0 \cdot 10^{-4}$	0.003	IPH 2006 and NEDI 2006
cattle offal	$1.2 \cdot 10^{-4}$	0.001	WHO 2006 and NEDI 2006
kidney	$2.0 \cdot 10^{-5}$	$1.7 \cdot 10^{-4}$	NEDI 2006
liver	$9.7 \cdot 10^{-5}$	$8.4 \cdot 10^{-4}$	NEDI 2006
other offal	$1.8 \cdot 10^{-4}$	0.002	WHO 2006 and NEDI 2006



# Food product

## 13 major foods groups: Others

Commodity	Consumption (kg/day)		Data source
	Average	P97.5	
<b>Cereals</b>	0.194	0.402	IPH 2006
<b>Eggs</b>	0.010	0.028	IPH 2006
<b>Milk &amp; milk products</b>	0.164	0.483	IPH 2006
<b>Cheese</b>	0.032	0.075	IPH 2006
<b>Fish</b>	0.017	0.050	IPH 2006
<b>Seafood</b>	0.006	0.025	IPH 2006
<b>Oils and fats</b>	0.021	0.073	IPH 2006
<b>Other (sweets, sugar, ...)</b>	0.295	0.987	IPH 2006



# Contamination data: Vegetables

Commodity	Data source	Regions at ambient Cd levels
Fruit		
Berries	Sampling campaign FASFC	Sampling campaign FASFC
Other fruit		Beernaert 1990
Vegetables		
Leafy vegetables	Haskoning 2004	Sampling campaign FASFC
Stem and root vegetables	Sampling campaign FASFC	Sampling campaign FASFC
Other vegetables	Sampling campaign FASFC	Sampling campaign FASFC
Potatoes	Sampling campaign FASFC	Sampling campaign FASFC




# Contamination data: Meat and other foods

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Commodity	Data source	
	Contaminated area	Regions at ambient Cd levels
<b>Meat</b>		
Poultry meat	Monitoring FASFC	
Cattle meat	Sampling campaign FASFC	Sampling campaign FASFC
Pig meat	Monitoring FASFC	
<b>Offal</b>		
kidney and Liver of cattle	Sampling campaign FASFC	Sampling campaign FASFC
Other offal	Beernaert 1990	
Other foods	Scoop 2004	



# Cd in food

Commodity	Mean (mg/kg) Contaminated area		Mean (mg/kg) Regions at ambient Cd levels	Maximum limit (mg/kg)
Berries	0.012	>	0.0061	0.05
Leafy vegetables	0.277	>>>	0.0304	0.2
Stem and root vegetables	0.085	>>	0.0207	0.1
Other vegetables	0.008	~=	0.0072	0.05
Potatoes	0.051	>	0.0209	0.1
Meat	0.004	>	0.002	0.05
Liver	0.446	>	0.203	0.5
 Kidney	2.862	>	1.250	1



# Estimation of the dietary intake

*Exposure = consumption x residue level*

Dietary intake of cadmium ( $\mu\text{g}/\text{day}$ ) =

$\sum (\text{consumption}_i \text{ (average or P97.5)} \times \text{average concentration Cd}_i)$

Where  $i$  = food group or food subgroup

Compare to provisional tolerable weekly intake  
(PTWI) =  $7 \mu\text{g}/\text{kg bw}/\text{week}$  (WHO 2001)





# Dietary Cd Intake

- Adult population in contaminated area

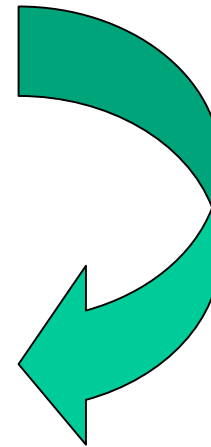
- Average Cd daily intake:

- 31  $\mu\text{g}/\text{day}$  or 52% PTWI

- General adult population

- Average Cd daily intake:

- 17  $\mu\text{g}/\text{day}$  or 28% PTWI



=2X



# Contributing food to the exposure

- Potatoes
  - 46% daily intake in contaminated area (or 24% PTWI)
  - 35% daily intake at ambient environmental Cd levels (or 10% PTWI)
- Vegetables
  - 23% daily intake in contaminated area (or 12% PTWI)
  - 10% daily intake at ambient environmental Cd levels (or 3% PTWI)
- Cattle offal
  - 0.3% daily intake in contaminated area (or 0.2% PTWI)
  - 0.3% daily intake at ambient environmental Cd levels (or 0.07% PTWI)



# Contributing food to the exposure

- Cattle offal low contribution despite large concentration BUT...
- ...if 143 g meat replaced by liver or kidney eating 1 portion of liver/month
  - ➔ increase intake = 3,5% of the PTWI
- ...if 143 g meat replaced by kidney eating 1 portion of kidney/month
  - ➔ increase intake = 23% of the PTWI



# Conclusions & perspectives

- Deterministic approach reveals that:
  - Possible intake in contaminated area > intake of general adult population in Belgium
  - Potatoes, vegetables highest contributors
- A probabilistic approach recommended to improve Cd intake estimation



# Thank you for your attention

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*Cadmium in the food chain near non-ferrous metal production sites*

*Food Additives and Contaminants, 2007 1-9*

