Source-related measurement of ambient air quality using plants as bioindicators

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Soil monitoring in Czech Republic
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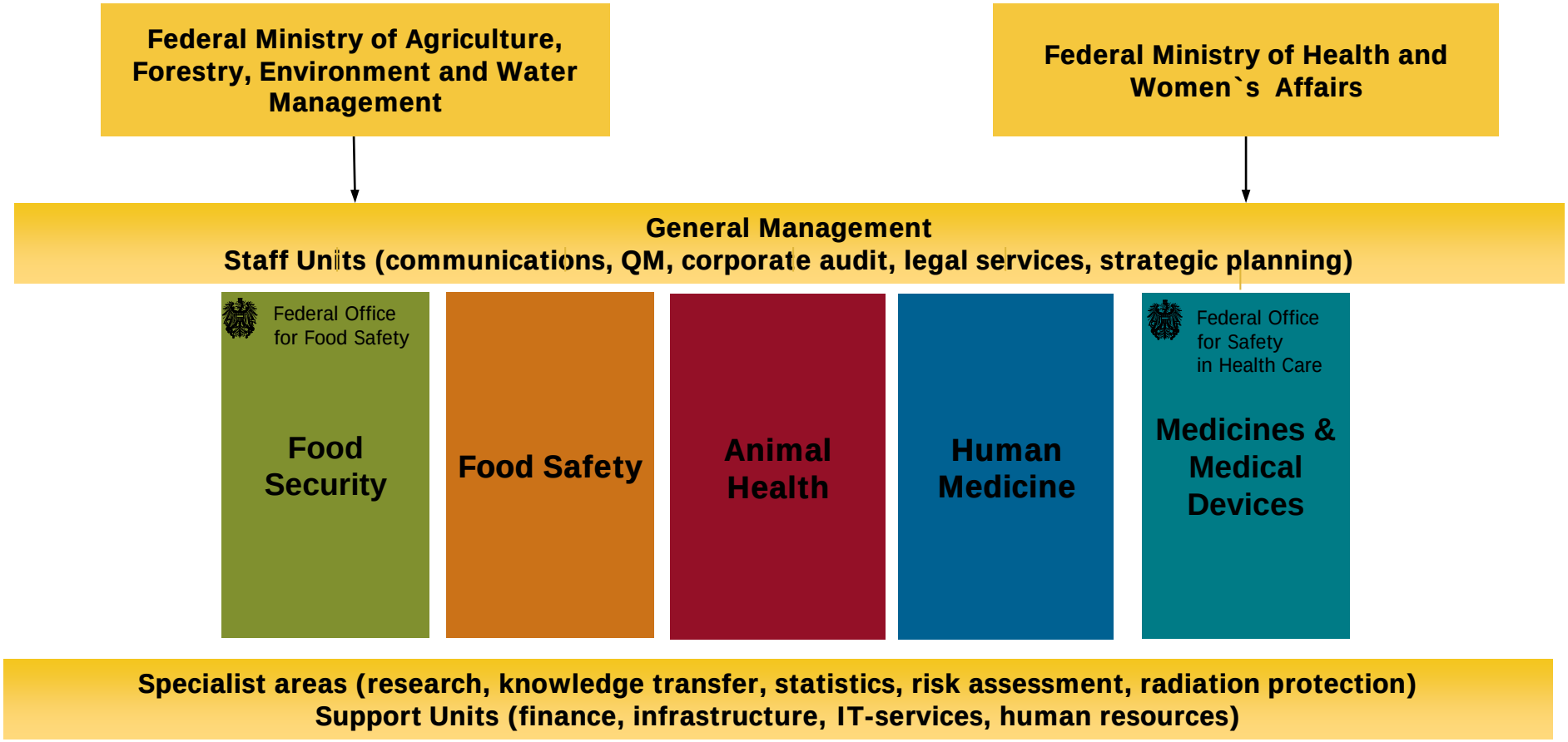
Company Structure



tasks

- **Mycotoxins** (KONA is nominated as National Reference Laboratory (NRL))
- **Vitamins**
- **Polycyclic Aromatic Hydrocarbons** (PAH) (KONA is nominated as NRL)
- **Opium alkaloids**
- **sweeteners**
- Organisation and implementation of **air pollutant measurements with plants** (biomonitoring) according EN ISO/IEC 17020 (body performing inspection)

contents

- Rating health risks from food
- FAQs in the area of air pollutants and their effects
- Terms and definitions
- Methods (standardised grass exposure, meadow grass,...)
- Biomonitoring with plants – examples, assessment

Rating health risks from food (Kuiper-Goodman, 1998 und 2004)

AKUTE	CHRONIC
HIGH RISK	
Microbiological	**Mykotoxins**
Phycotoxins	**Anthropogenic contaminants**
Some phytotoxins	Some phytotoxins
Mykotoxins	Unbalanced diet
Anthropogenic contaminants	Phycotoxins
Pesticide residues	Food additives
Food additives	Pesticide residues
	Microbiological
LOW RISK	

FAQs in the field of air quality control
(a selection)

- Which pollutants are emitted?
- Are plants plants injured or endangered through emitted air pollutants?
- Can I eat my vegetables?
- Is it possible to use meadow grass as feeding stuff?
- Is soil endangered?
- Which region is affected with air pollutants?
- Can we expect an environmental pollution from the near industry?
- Is it possible to control emissions with plants?
- Are there relations between chemical-physical air measurements and biological measuring techniques (e.g. plants)?

Emission – Immission (VDI 3957 Bl.1)

Emission *(„what `s coming out“):*
Numerous sources (traffic, industry, power plants, waste incinerators, agriculture, domestic furnaces,..) release undesired substances as emissions into the ambient air.

Transport:
In the air, these substances can be transported long distances while being subject to transformation processes.

Immission *(„what is arriving“):*
Being gases or particles of different sizes, they can enter organisms, water bodies and soil with rain or dust. Air pollutants can attach to plant surfaces or can be adsorbed.

Biological measurement techniques – terms, methods
VDI Standard 3957 Part 1

Response indikator(RI): Organism which can indicate environmental conditions and their modification by either showing specific symtoms (molecular, biochemical, cellular, physiological, anatomical or morphological) or by ist presence/absence in the ecosystem (effect indicator)

Bioaccumulator (BA): Organism which can indicate environmental conditions and their modification by accumulating substances present in the environment (air, water or soil) at the surface and/or internally.

Passive biomonitoring: With this method the air pollutants accumulated in grassland vegetaion, leaves , needles and sprouts of trees growing in the monitoring measurement area are analysed. Examples: *meadow grass* (BA), *leaves* (BA, RI), *needles* (BA, RI), *lichen survey* (RI), *moss survey* (RI), *food and feed plants* (BA, RI)

Aktive biomonitoring: A standardised organism is brought to the monitoring measurement area to be exposed for a fixed period of time. Examples: *Standardised grass exposure* (BA), *standardised exposure of curly kale* (BA), *standardised exposure of tobacco* (RI), *standardised exposure of gladioli* (RI), *spruce exposure* (BA)

Standardised grass exposure - an aktive biomonitoring with an accumulating indicator

VDI Standard 3957, Part 2 (2016)

Standardised cultivation of Italian ryegrass in a greenhouse

Cultures are exposed for 26-30 per period in the study area (4-5 periods/a)

Analyses of the grass samples

Standardised grass exposure - Standards

In following VDI Standards this method is mentioned:

VDI 3957, Part 1: Fundamentals and aims of biomonitoring

VDI 3957, P. 2: Method of the standardised grass exposure

VDI 3957, P. 10: Source-related measurements using bioindicators

VDI 3857, P. 2: Orientation values for maximum background levels of selected inorganic air pollutants

Standardised grass exposure - experiences and advantages

- Optimum and recommended completion of physico-chemical measurements
- Reliable and robust standardised bioaccumulator
- Examples of application: traffic, brick factory, Al-plant, glas industry, steel production, incinerators, ...
- Parameter experiences available: As, Ba, Be, Bi, Cd, Cl, Co, Cr, Cu, F, Hg, Li, Mo, Ni, Pb, S, Sb, Se, Sr, Tl, V, Zn; PAHs, (OCPs), PCBs, (HCB), (HCH), PCDD/F,..
- Effect-relationship: relation to the protected resource vegetation (plants), feed materials and complete feed of vegetable origin (forage) and to „similar“ food of vegetable origin.

Scope for bioindicators (examples)

(OmB = Orientation values for maximum background levels)

	Control of an emission source	**Investigations following hazardous incidents**
Issue/question	Do effects of air pollutants on vegetation occur in the vicinity of an emission source?	Are there risks with respect to human health after eating food plants or of feed uptake by domestic animals?
Which pollutants?	Heavy metals, organ. pollutants,..	Heavy metals, organ. pollutants,..
Which bioindicator (method)?	Aktive biomonitoring (e.g. standardised grass exposure)	Passive biomonitoring (e.g. meadow grass, salad, leaves)
Area of immissions, Fixation of the exposure sites	Dispersion calculation, inspection of the region, area of influence	inspection of the region, area of influence, selection of samples
implementation	Perennial exposures (associated controls)	Mostly onetime and prompt samplings
assessments	Proof of immissions using OmB, Several regulations (e.g feed)	Several regulations (feed, food)
Follow up	Possible controls of local-produced feed and food; restrictions for the polluter?	Associated controls;

Basic assessment criterias for biological measuring techniques

3 categories:

- **Orientation values for maxiumum background levels** (OmB) see VDI Standard 3857, Part 2: OmB = 75%Pzt + 1,5 . IQR

- **Influence of immission** (value > OmH)

- **Guidance values of toxicological concern**: use specific regulations (e.g. feed: Directive 2002/32/EG, VDI Standard 2310, Reg. 1881/2006)

In the case of an influence of immission clarification can be necessary through analyses of local-produced feed and food.

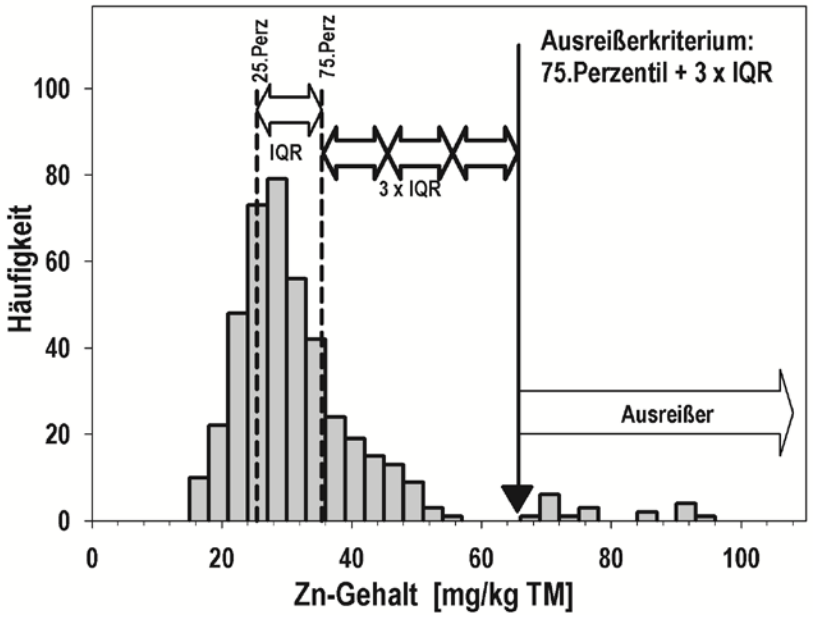
Orientation value for maxiumum background levels (OmB)
VDI Standard 3857, Part 2

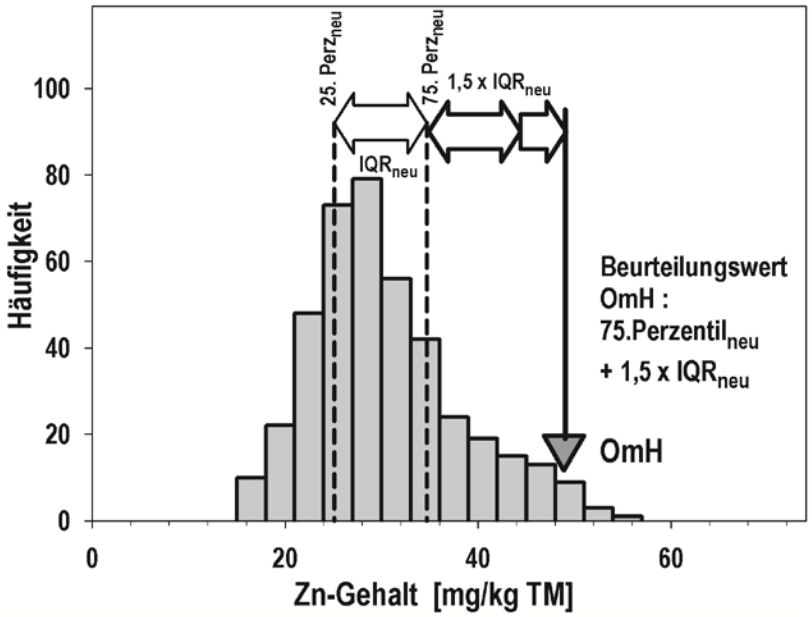
- OmBs refer to standardised grass cultures that had been exposed for several exposure periods per year at background sites (without direct influence of local emissions).

- The data for deriving the assessment value OmB shall originate from background sites spanning at least three years. They should encompass all exposure periods within a year, usually at least four exposure periods of 28 days.

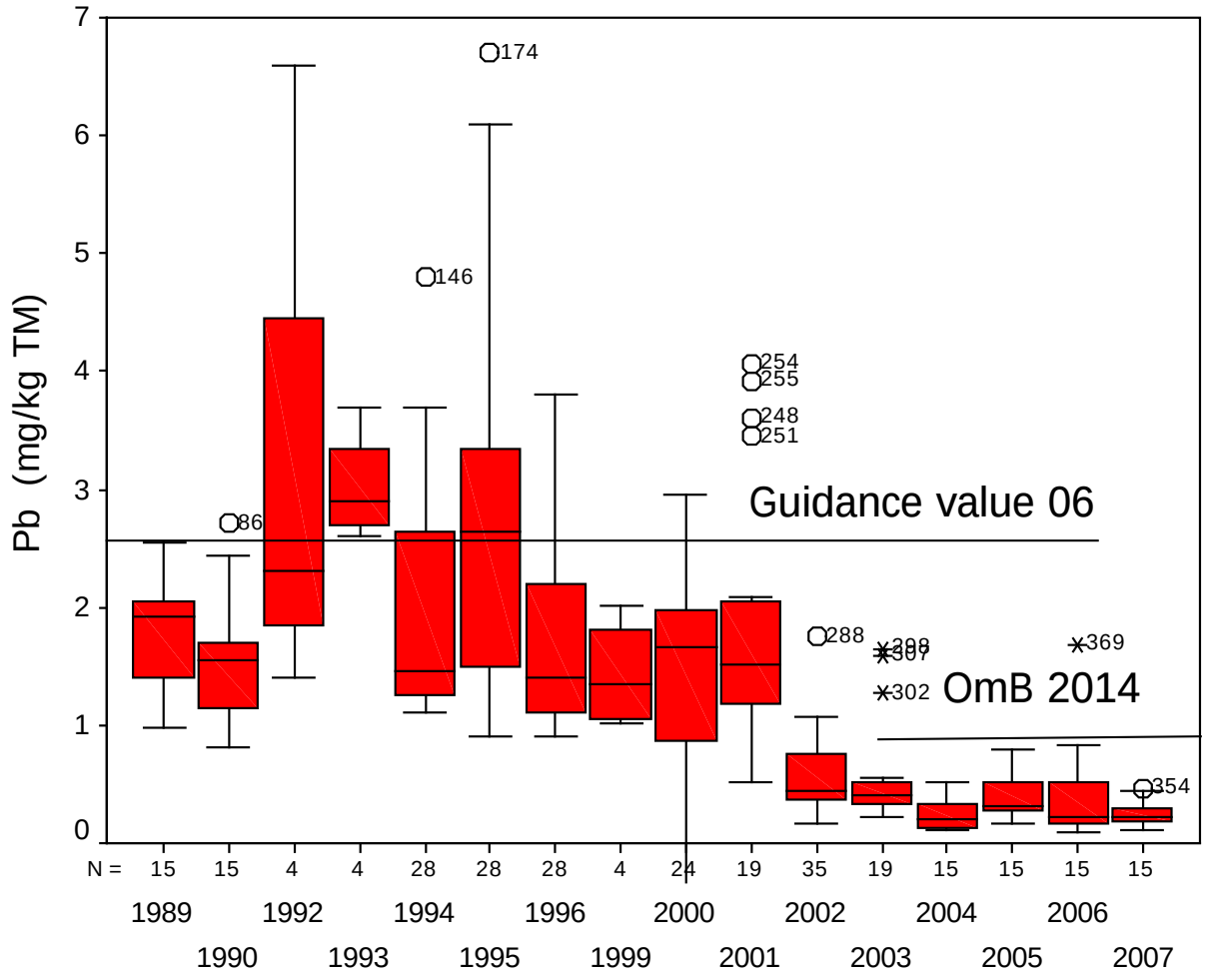
- Calculation of the OmB:
  - Recognising and eliminating outliners. The outliner criterion is defined as:
    75% Pzt. + 3 x IQR (IQR= 75%Pzt – 25%Pzt)
  - Calculation of the OmB: OmB = 75% Pzt. + 1,5 x IQR

outliners, OmB (figure from Kostka-Rick)





Standardised grass exposure
Example: OmBs for Pb



Biomonitoring – Guidance values (OmBs, GV) / EU maximum levels/ VDI-Maximum immission dose (MID) (selection; in mg/kg d.m. resp. d.w.); status 1/2017)

	OmB standard. grass culture	OmB meadow grass	GV (95%Pzt) Tree leaves	EU – max. level (feed)	MID (VDI 2310)
Al	87				500
As	0,2	0,1		2	2
Sb	0,04	0,1	(0,4)		
Cd	0,14	0,4	0,21	1	>0,4
F	5	5	5	30	>30
Hg	0,025	0,02	0,06	0,1	>0,05
Ni	3,0	3,5	9		50
Pb	0,75	0,8	0,9	30 (forage)/5	>1

Biomonitoring – Guidance values (OmBs, GV) / EU maximum levels/ VDI-Maximum immission dose (MID) (selection; in mg/kg d.m. resp. d.w.); status 1/2017)

	OmB standard. grass culture	OmB meadow grass	GV (95%Pzt) Tree leaves	EU – max. level (feed)	MID (VDI 2310)
Cr	0,7	0,7	0,8		50
Mo	4,2	4,1	0,64		>3
Tl	0,12	0,08	0,09		>0,5
V	0,14	0,25	0,27		10 (Sheep)
Zn	75	62	45		>300
PCDD/F	LB: (0,5) ng I-TEQ/kg UB: (0,6) ng I-TEQ/kg	LB: (0,15) ng I-TEQ/kg UB: (0,24) ng I-TEQ/kg		0,75 ng WHO-TEQ/kg (UB)	0,1 ng WHO-TEQ/kg für dairy cows

Biomonitoring – Guidance values (OmBs, GV) / EU maximum levels/ VDI-Maximum immission dose (MID) (selection; in mg/kg d.m. resp. d.w.); status 1/2017)

	OmB standard. grass culture	OmB meadow grass	GV (95%Pzt) Tree leaves	EU – max. level (feed)	MID (VDI 2310)
PCB (6)	(<0,005)	(<0,005)	(<0,005)	0,01	>0,09, >0,16
Benzo(a) pyrene	0,4	0,4	0,9		
EU-PAH (4)	1,8	(4,5)			
EPA-PAH (6)	4,1	6	20		
EPA-PAH (12)	9,4	20	40		

„car traffic - biomonitoring“: summary

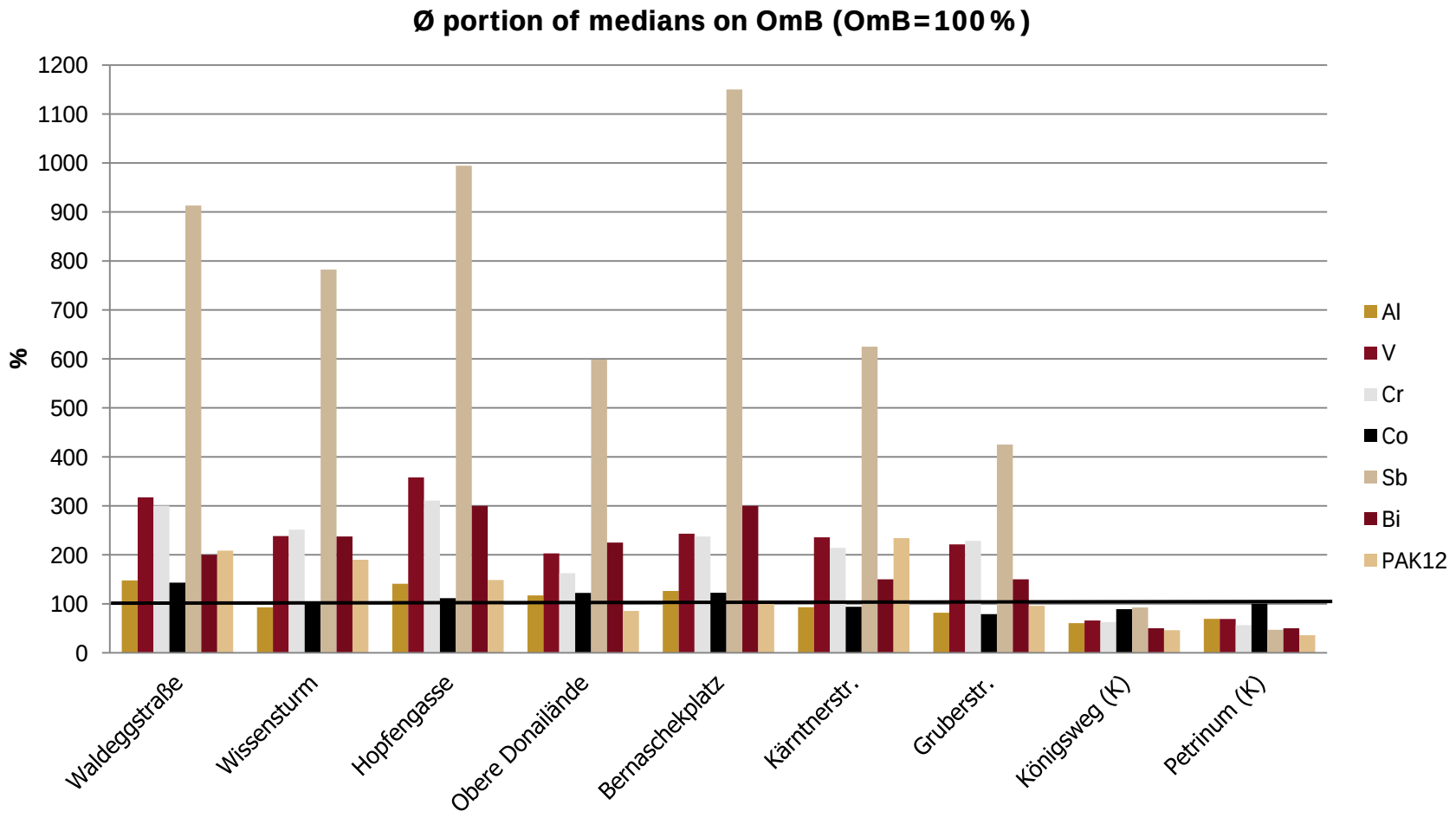
- Influence of topography on effects of immissions
- frequent influences of immissionse due to traffic:

  Al, V, Cr, Co, Sb, Bi, PAH
- Ranking of the frequent immissions:

  Sb >> V > Cr, Bi > PAH > Al, Co
- Possible short and small immissions:

  Ba, As, Cd, Pb, Ni, Cu

„car traffic - biomonitoring“: summary of results

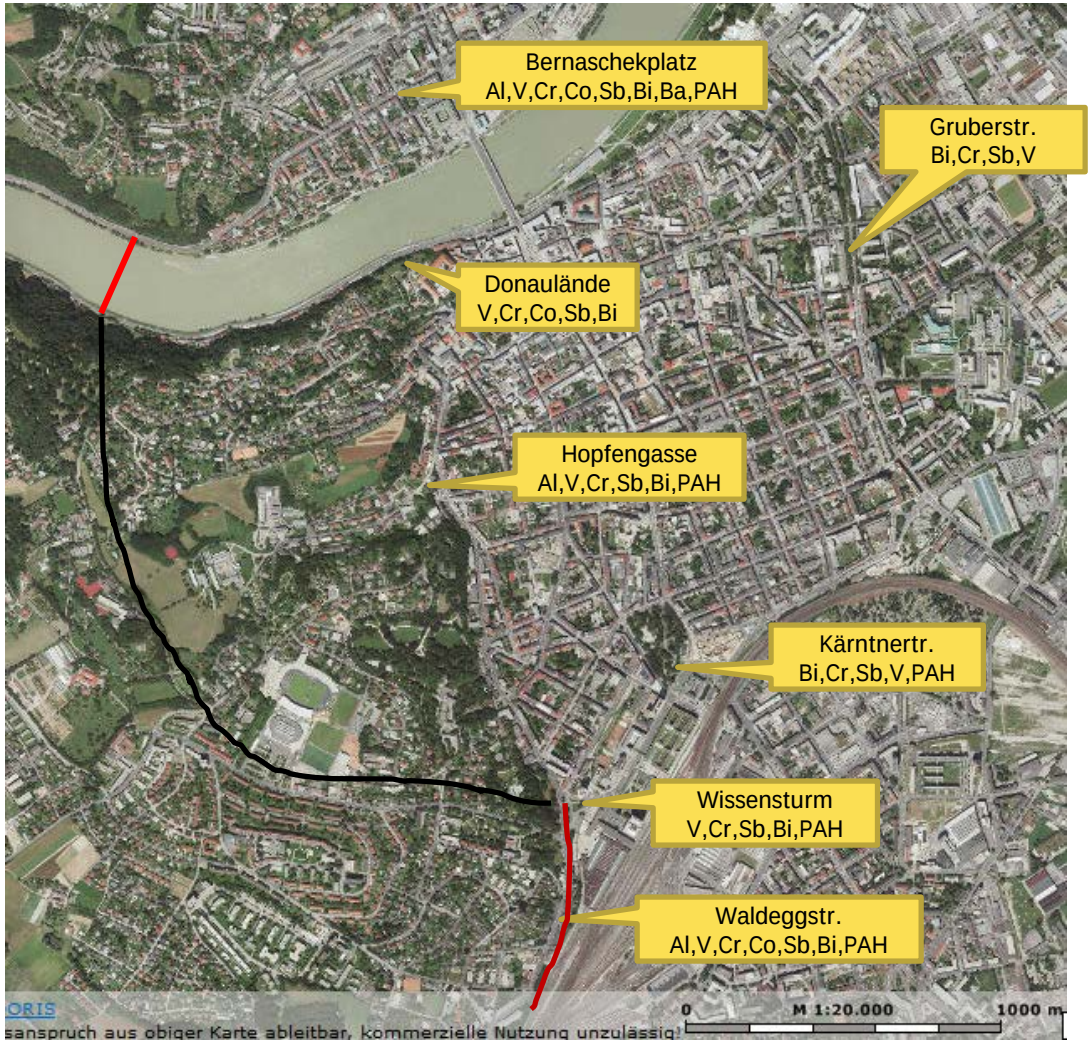


Biomonitoring: „traffic – measuring points“ Median>OmB (Immissions)

bridge planed

Tunnel planed

Biomonitoring Measuring points



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Thank you for your attention

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