

Assessment of Human Exposure from PCDD/F Contaminated Sites Compared to Background Exposure

Annika Åberg, Karin Wiberg, Mats Tysklind, Environmental
Chemistry, Umeå University, Sweden

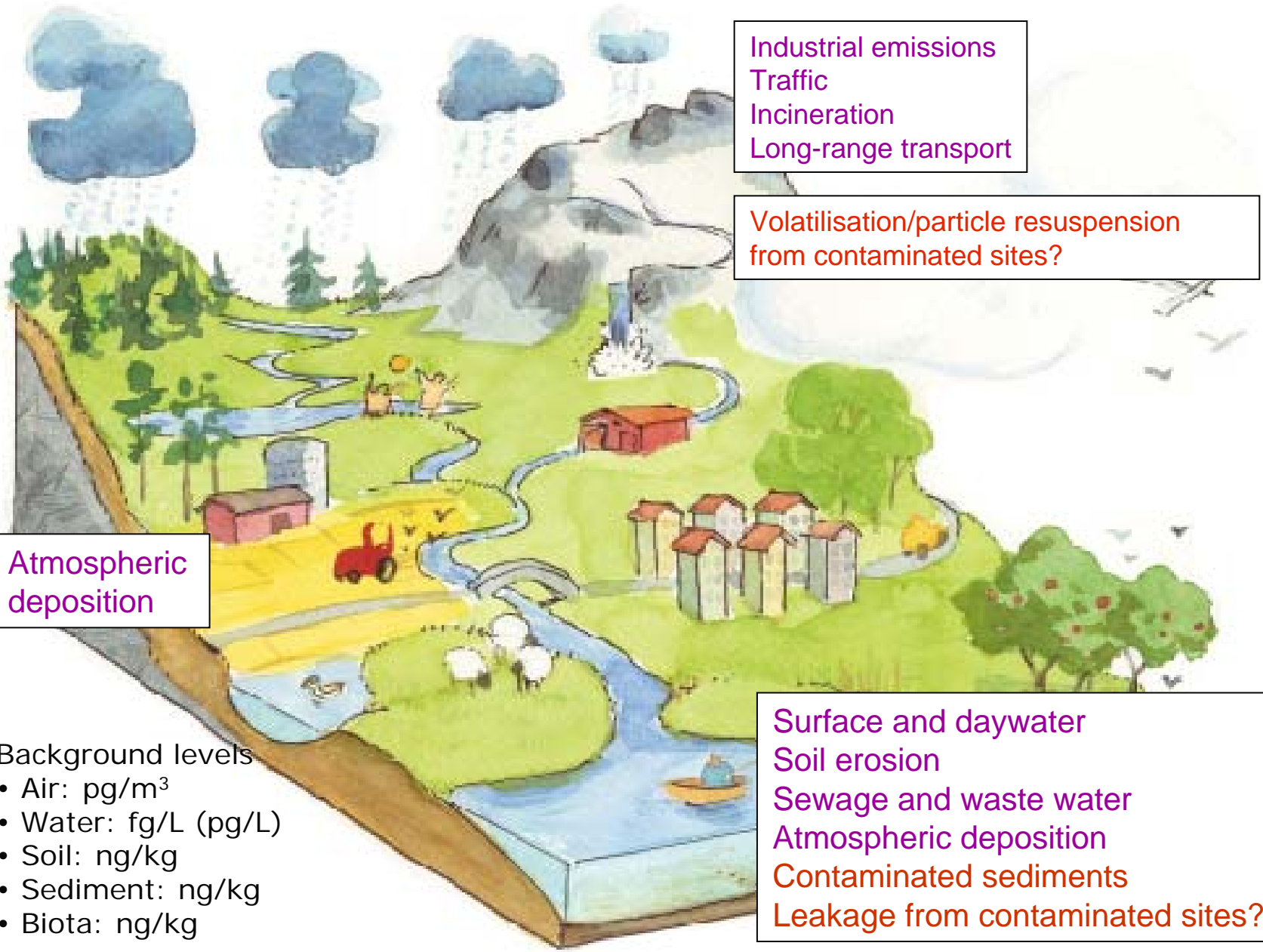
Annika Hanberg, Karolinska Institutet, Sweden

Ingegerd Ask, SWECO VIAK, Sweden

Matt MacLeod, ETH, Switzerland

Question of concern:

May a contaminated site lead to elevated exposure to humans compared to the overall background exposure?



Industrial emissions
Traffic
Incineration
Long-range transport

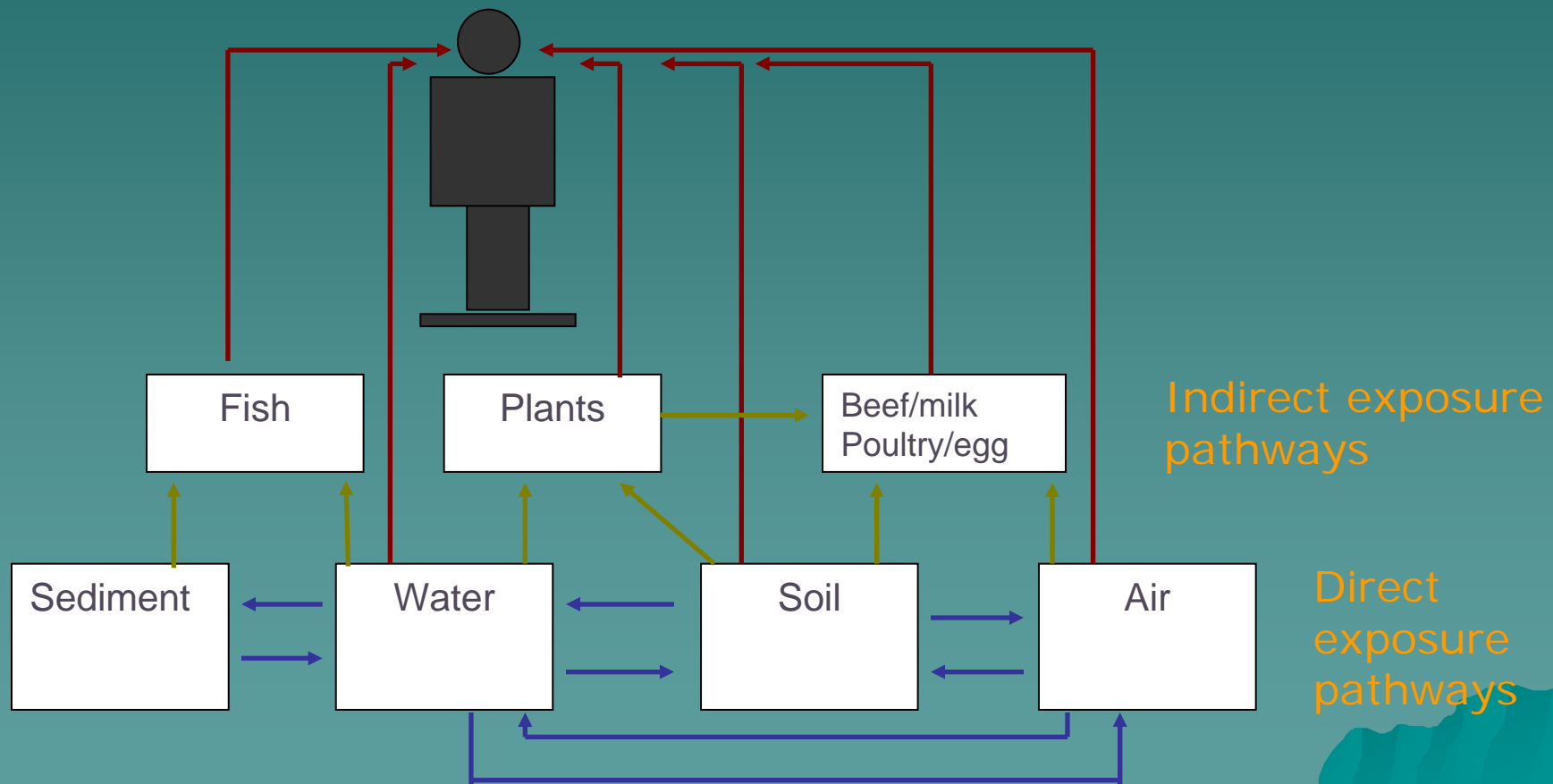
Volatilisation/particle resuspension
from contaminated sites?

Atmospheric
deposition

- Background levels
- Air: pg/m^3
 - Water: fg/L (pg/L)
 - Soil: ng/kg
 - Sediment: ng/kg
 - Biota: ng/kg

Surface and daywater
Soil erosion
Sewage and waste water
Atmospheric deposition
Contaminated sediments
Leakage from contaminated sites?

Conceptual Model of Transport & Human Exposure to Dioxins



Combined Fate & Exposure Models

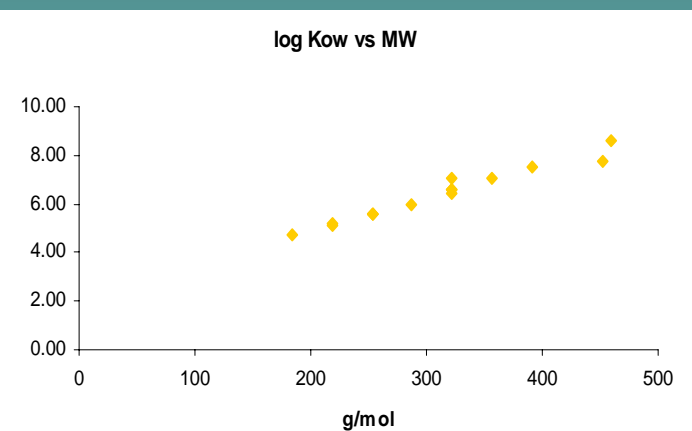
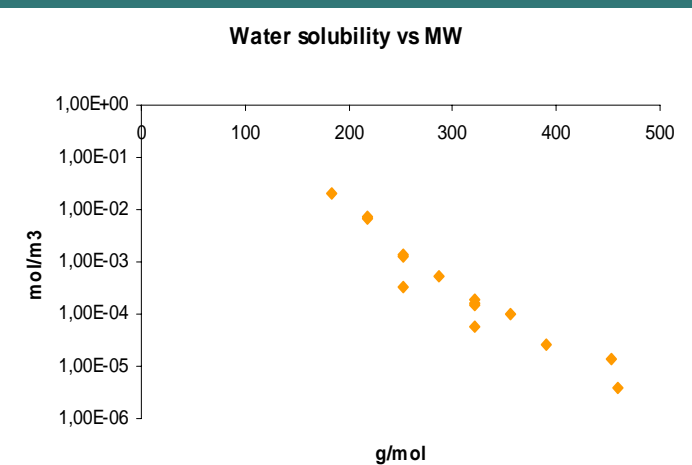
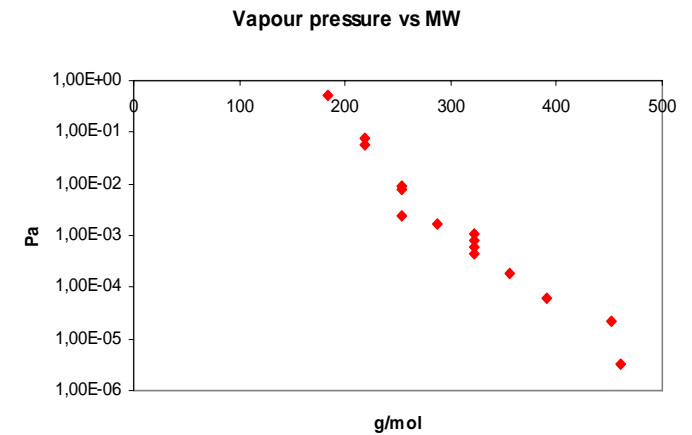
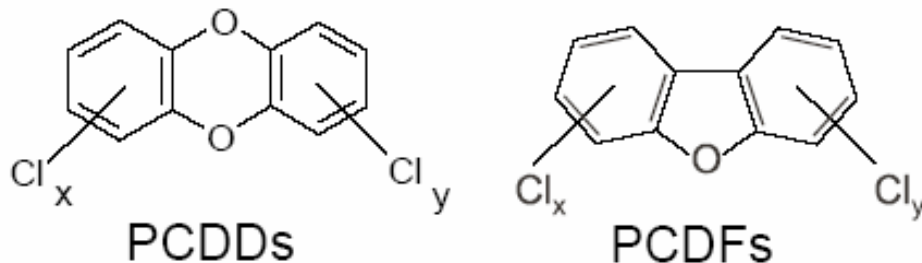
– tools to evaluate the impact of different contamination sources on

- ◆ the environment
- ◆ the human exposure

Dioxins?

Polychlorinated
dibenzo-*p*-dioxins
(PCDDs)

Polychlorinated
dibenzofurans
(PCDFs)

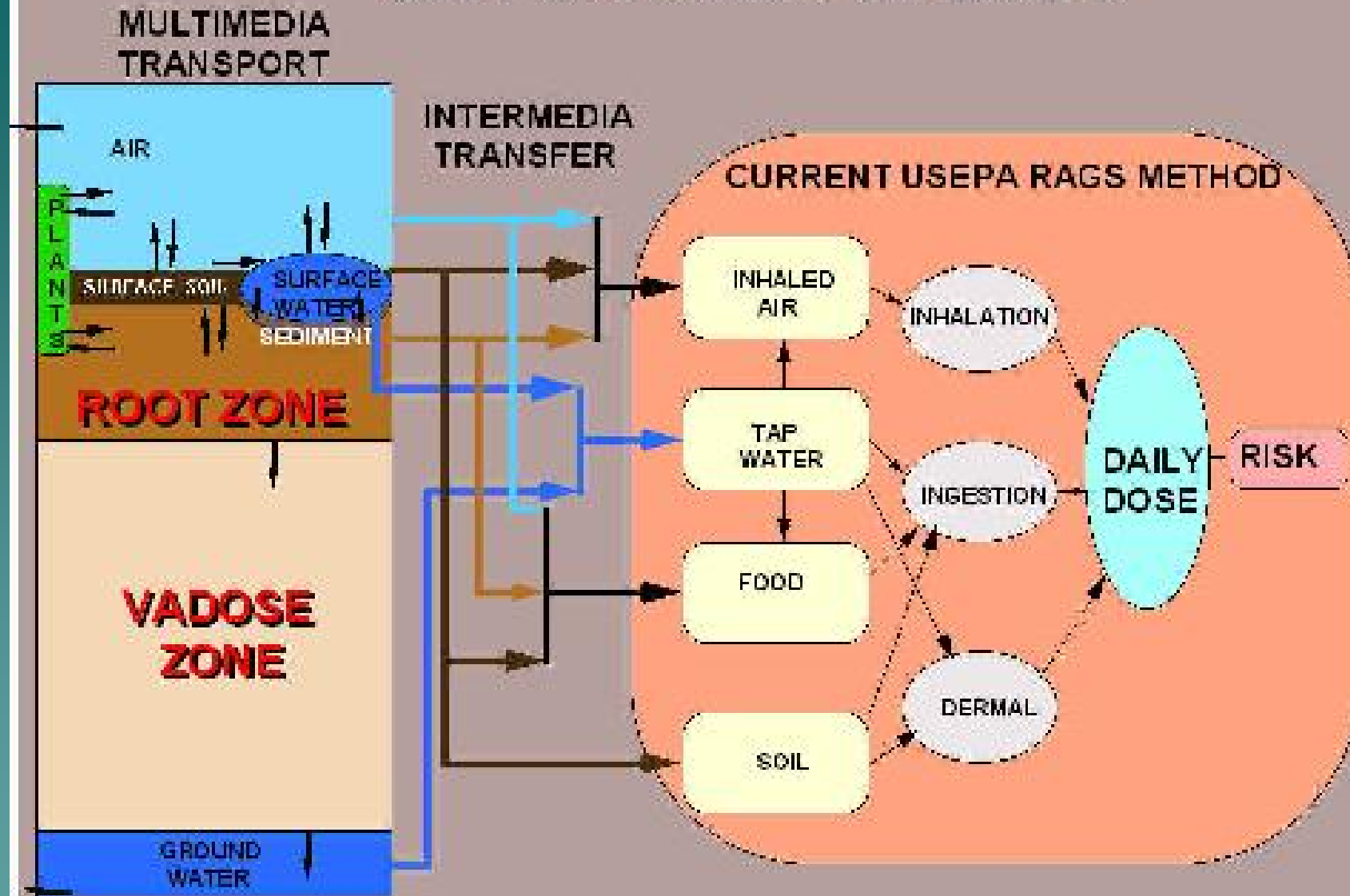


	Exposure pathway	EUSES	NV	CSOIL	CLEA	CaITOX
	Ingestion of soil outdoors		X	X	X	x
	Ingestion of soil /dust indoors			X	X	
	Dermal contact outdoors		X	X	X	x
	Dermal contact indoors			X	X	
	Inhalation of particles outdoors		X	X	X	x
	Inhalation of particles indoors		X	X	X	x
	Inhalation of vapours outdoors	x	x	X	X	x
	Inhalation of vapours indoors			X	x	x

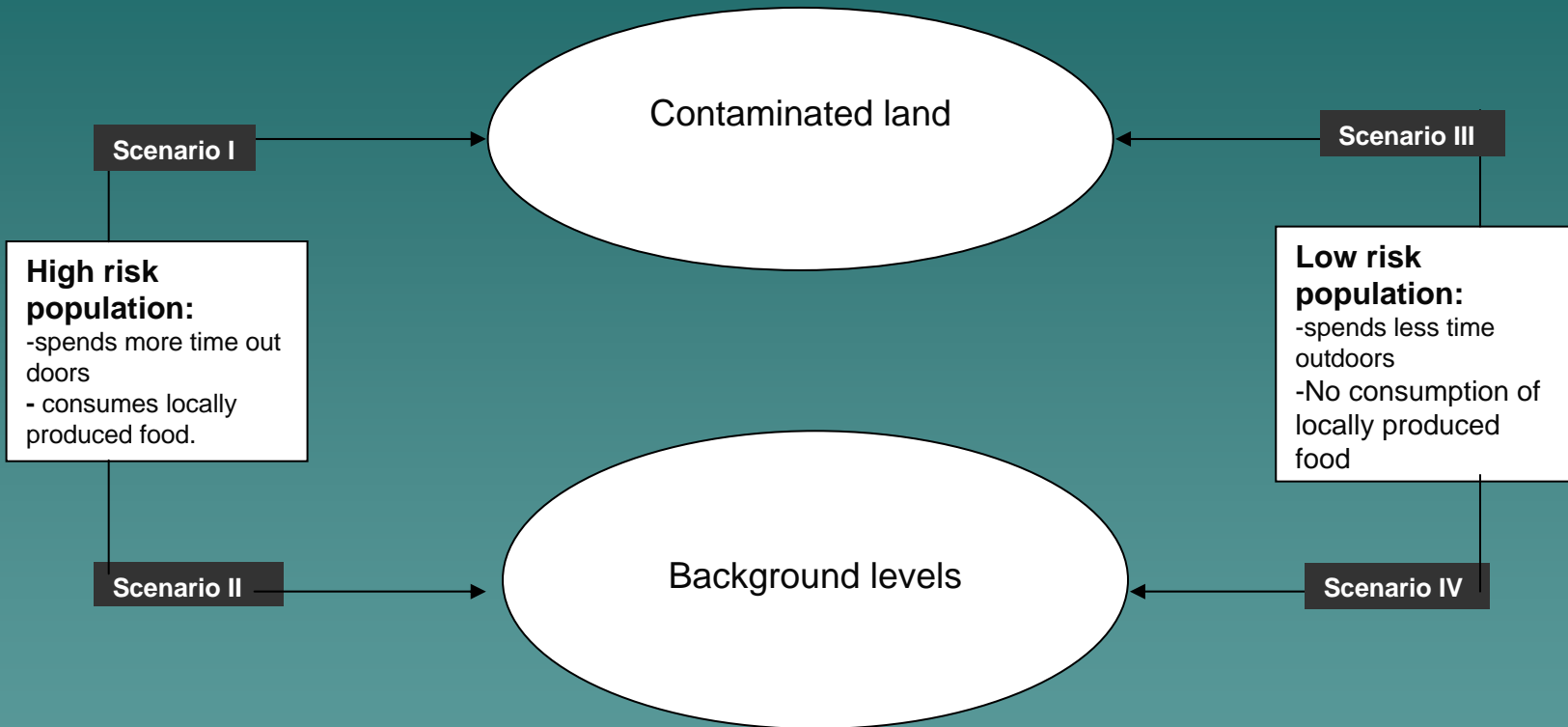
Modified from Rikken & Lijzen, 2004)

Exposure pathway	EUSES	NV	CSOIL	CLEA	CaITOX
Ingestion of plants	x	x	X	x	X
Ingestion of soil on plants				x	X
Ingestion of fish	X	x			X
Ingestion of meat	x				X
Ingestion of milk	X				X
Ingestion of egg					X
Ingestion of breast milk					X
Ingestion of drinking water	x	x	X		X
Ingestion of bathing water					X
Dermal contact during bathing					X
Dermal contact during showering			x		X
Inhalation of vapours during bath/shower			x		X

CalTOX Model Structure



Modelling Scenarios ...



Direct exposure pathways to humans

Inhalation
Ingestion
of soil



Ingestion of
drinking water

Dermal
contact

Indirect exposure pathways

Ingestion of:

Fish

Meat

Milk

Poultry

Egg

Vegetables



Selected Model Compounds

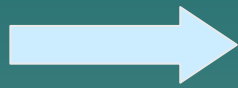
- ◆ 2,3,7,8-TCDD
- ◆ 1,2,3,6,7,8-HxCDD
- ◆ 1,2,3,4,6,7,8-HpCDD
- ◆ OCDD
- ◆ 2,3,4,7,8-PeCDF
- ◆ 1,2,3,4,6,7,8-HpCDF

Data used in model

- ◆ Temperature adjustment of partitioning coefficients
- ◆ Swedish climate data
- ◆ Food consumption data from SLVs food consumption survey of organic contaminants (Lind et al. 2002)
- ◆ The exposure factors handbook (USEPA, 1997)
- ◆ Swedish contaminated site investigations

Continuous air emissions were used to model background concentrations in all environmental media

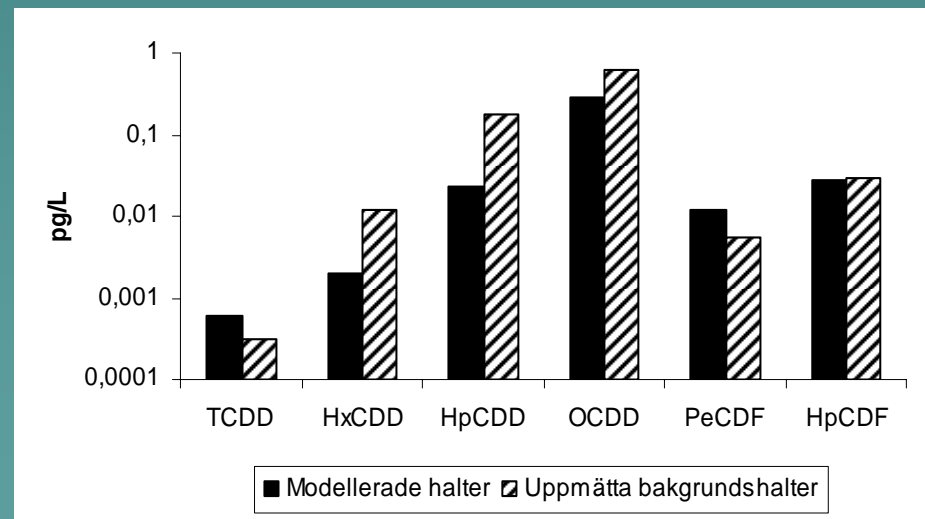
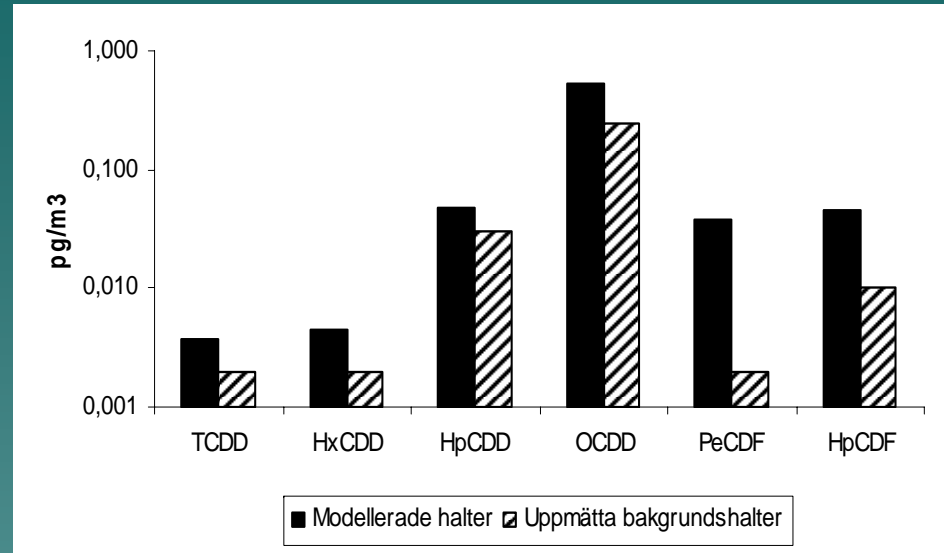
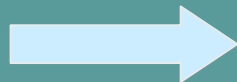
- **Air**: slightly overestimated



- **Soil**: slightly underestimated

- **Groundwater**: no measured data to compare with

- **Surface water**: slightly underestimated



Initial concentrations in soil were used to model contaminated site concentrations in all environmental media

- **Air**: up to 10 x background scenario
- **Soil**: up to 100 000 X background scenario
- **Groundwater**: up to 100 000 X background scenario
- **Surface water**: 100-1000 X background scenario



20-200 000 ng/kg
(TCDD-OCDD)



Totally 6 140 ng
WHO-TEQ₂₀₀₆/kg

Modelling results of background scenario exposure show that CalTOX overestimates uptake in biota!!

	Direct exposure (pg WHO-TEQ/kg bw/day)	Indirect exposure (pg WHO-TEQ/kg bw/day)	Total
High risk adult	2,8E-3	380	380
High risk child	3,0E-3	510	510
Low risk adult	1,6E-3	-	1,6E-3
Low risk child	2,7E-3	-	2,7E-3
Swedish food consumption survey^a	-	0.05-12.3	0.05-12.3

^A Lind et al., 2002

Modelling results of the contaminated site exposure show that direct exposure might exceed TDI (1-4 pg WHO-TEQ/kg bw/day).

	Direct exposure (pg WHO-TEQ/kg bw/day)	Indirect exposure (pg WHO-TEQ/kg bw/day)	Total
High risk adult	8,3 (2 900)	?	?
High risk child	180 (60 000)	?	?
Low risk adult	0,9 (540)	-	0,9
Low risk child	15 (5 500)	-	15

-However, the magnitude of exposure is very dependant on both population behaviour and age!

Some ongoing improvements of the model:

- ◆ Sediments normally defined as a sink, model modified sediments also as source
- ◆ Bioaccumulation in fish is more important than bioconcentration for hydrophobic compounds
- ◆ PCDD/Fs are found in the colloidal fraction in groundwater (Persson et al., submitted), model modified for colloidal transport in groundwater
- ◆ Improved sensitivity analysis

- ◆ The results of the project will be reported to S-EPA in November 2006
- ◆ A third phase of the project August 2006 – May 2007:
 - Site evaluation of the model including new field measurements from a sawmill site (Marieberg)

Thank you!

A decorative silhouette of a mountain range in shades of teal, located at the bottom right of the slide.