



PCB Human Biomonitoring in general and specific populations in France

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7th PCB workshop, 27-30 May 2012 – Arcachon, France



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1/ Context of PCBs in France

- Production of PCBs banned since 1987
However still in electrical transformers and contamination of rivers
- National plan on PCBs (2003, 2008) to eliminate transformers and to get a diagnostic of rivers contamination
- French public health priorities (2004) with national programmes
 - on health and nutrition
 - on environment and health
- Health thresholds for total PCBs in serum, set by Anses from a review of scientific literature
 - women of childbearing age: < 700 ng/g lipids
 - for the other adults: < 1800 ng/g lipids



2/ The different human biomonitoring (HBM) studies

A.1 Exposure to PCBs of the French population in 1986 (Dewailly E. et al., 1988)

Aim

to describe the exposure of the population to NDL-PCBs

Methods

- Cross sectional study in 20 health centers (questionnaires + blood samples (plasma))
- Population: n= 586
- Mean age: 38 years old (18-60 yrs)
- NDL-PCBs (20, 28, 52, 101, 138, 153, 180)

Results

- Sum of NDL-PCBs in plasma : GM= **4920** ng/L [4.730-5120]





A.2 ENNS study 2006/7 : Integrated approach

ENNS: A population based study

Nutrition and Health survey coupled with a HBM study: 1st time in France

Aim of environmental component of ENNS (HBM):

to describe the exposure of the population to some metals, NDL-PCBs and pesticides and their determinants

Methods





- Cross sectional study (one year in 2006 - 2007)
- Complex random sampling (stratified and multistage probability sample)
- Representative population (3-74 years old)
- 42 biomarkers of environmental exposure including **6 NDL-PCBs:**
28, 52, 101, 138, 153, 180

ENNS, 2006



A.2 ENNS methods

ENNS Study: information obtained, population studied and substances measured
(42 biomarkers of exposure: 11 metals, 6 PCBs and three families of pesticides)

Information obtained	Population (random sampling)	Matrices	Chemicals measured	Number of measurements
 Food survey	Adults (18-74 years)	Blood and urine	11 metals	2,000
 Questionnaires (face-to-face and self-administered) Sociodemographic characteristics Occupation Environment (domestic use of pesticides, etc.)		Blood and urine	Pesticides (organochlorines, organophosphorus compounds and pyrethroids)	400
 Clinical examination (anthropometric measurements, blood pressure)		Blood	PCB Non dioxin like	400
 Biological samples (blood, urine, hair)		Hair	Mercury	400
	Children (3-17 years)	Hair	Mercury	1,400

A.2 ENNS results: Geometric means of serum PCB levels

Distribution of biomarkers of NDL-PCBs in the studied population

Biomarkers	Matrix	Unit	n	Mean level*	
PCB 28	Serum	ng/g lip.	386	2.2	[1.9; 2.5]
PCB 52	Serum	ng/g lip.	386	1	[0.2; 3.1]
PCB 101	Serum	ng/g lip.	386	1.1	[0.9; 1.3]
PCB 138	Serum	ng/g lip.	386	70	[60; 80]
PCB 153	Serum	ng/g lip.	386	110	[100; 130]
PCB 180	Serum	ng/g lip.	386	90	[80; 110]
Sum of all PCBs	Serum	ng/g lip.	386	290	[260; 320]
Total PCBs**	Serum	ng/g lip.	386	480	[430; 530]

n: number of measurements performed in ENNS.

ng/g lip.: nanogram per gram of lipids.

* Mean level: geometric mean and its confidence interval to 95%.

** Sum of the 3 NDL-PDBs (138, 153, 180)x1.7.

A.2 ENNS results



- Serum PCB Levels in 2007:
 - **3 times lower** than those in 1986
 - **4920** ng/L in 1986 vs **1859** ng/L in ENNS (2007)
- > Health threshold (Anses)
 - **3.6%** of women of childbearing age (>700 ng/g lipids)
 - **0.4%** for the other adults (>1800 ng/g lipids)

A.2 ENNS results: Comparisons with international data


- French NDL-PCB levels :
 - generally superior to those of other European countries 
 - except for Czech Republic which were higher 
 - similar to those of Germans 10 years ago  and of Belgians 
 - 2-3 times higher than those observed in UK 
- 4-5 times higher than those of North American countries 
and New Zealand  



A.2 ENNS results: Factors influencing serum NDL-PCB levels

Groups of factors	Factors	p	Contribution
physiological	Age	<0.0001	44.3%
	Variation of weight in the last year	<0.001	
geographical	Region of residence	<0.0001	2.1%
socioeconomic	Diploma	<0.0001	1.4%
	Perception of financial difficulties	0.1	
food (animal origin)	Dairy products (g/day)	<0.01	1.8%
	Poultry	0.06	
	Pork-butchery	<0.0001	
food (sea food)	Fish	0.04	1.5%
	Shells	<0.001	
Variability explained by the model: 73 %			

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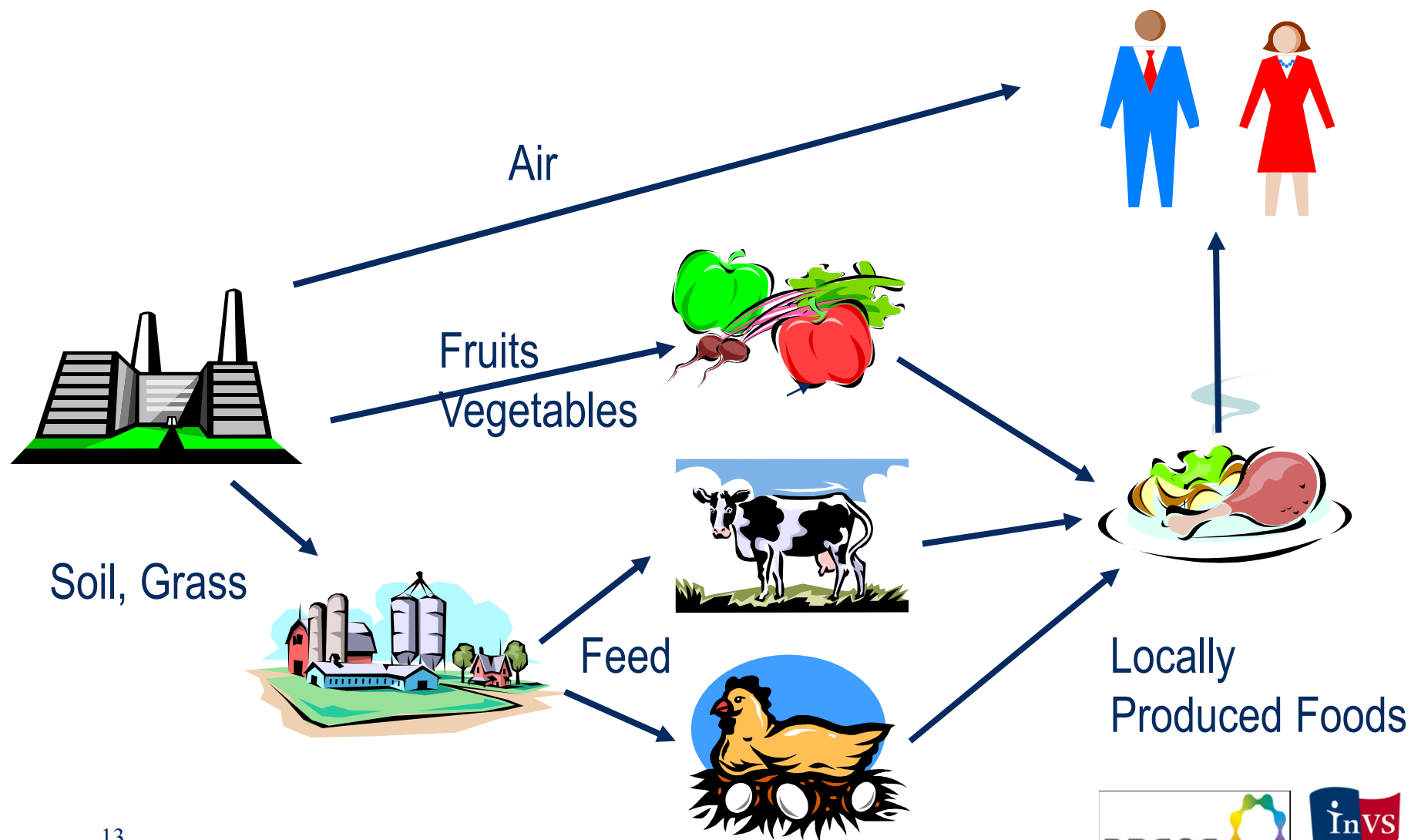
B1. Incinerators study 2005



- In France, lots of municipal solid waste incinerators (MSWI):
 - now, about 130
 - in 1998, about 300
- Past crises in agricultural areas surrounding MSWI:
 - Contamination of the environment
 - Contamination of food products
- Concern of the French population living in the vicinity of MSWI:
 - Do MSWI influence their serum dioxin level ?

⇒ **Measurement of dioxin and PCB levels in people living around MSWI**

Possible ways of contamination of people by the dioxin emissions of MSWI



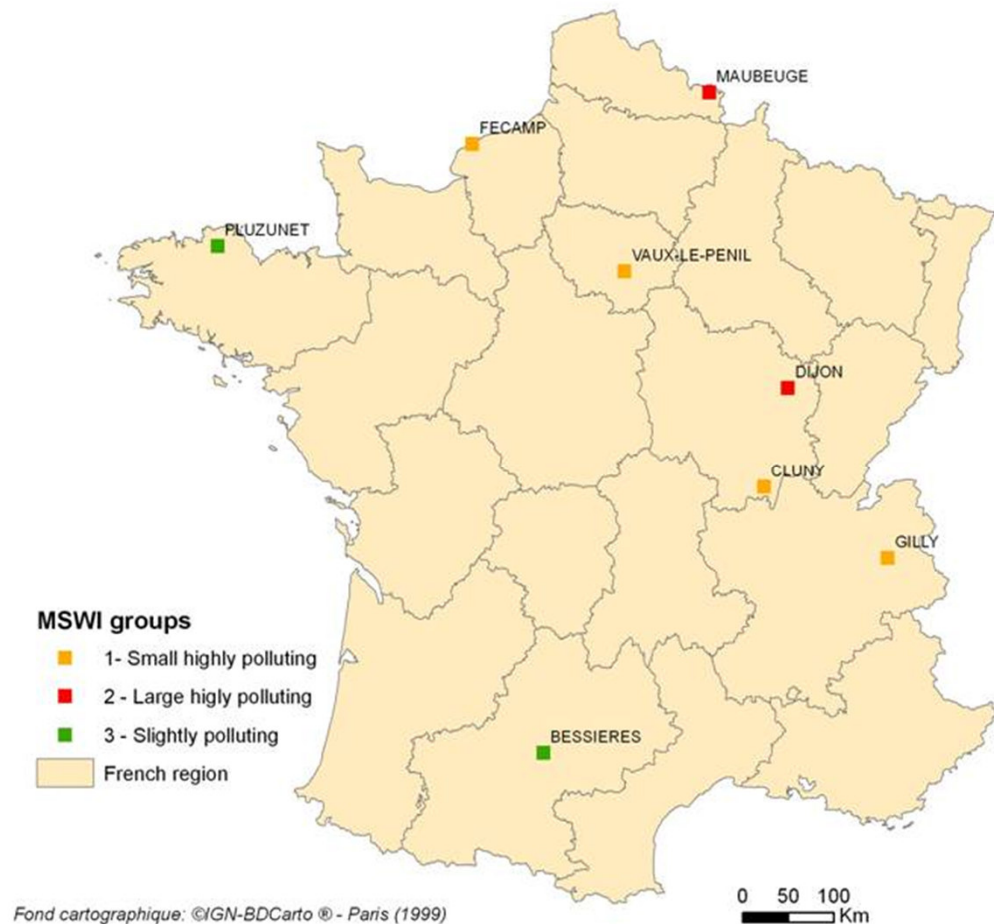


B1. Incinerators study - Methods

1030 adults 30-65 yrs old randomly selected living

- near 8 MSWI of different categories
 - Small highly polluting (old)
 - Large highly polluting (old)
 - Slightly polluting (recent)
- in control areas

→ Exposed and unexposed to the plume of the MSWI





➤ **1 030 serum samples** for dioxin and PCB measurements (17 PCDD/Fs, 12 DL-PCBs, 3 NDL-PCB (138, 153, 180))



➤ **Questionnaires:**

- socio-demographic
- food diet (general, local)
- occupation and environment



⇒ - mean age: 52 yrs old
- 55 % women





B1. Incinerators study - Results

	PCDD/Fs (pg TEQ _{WHO2005} /g lip.)	DL-PCBs (pg TEQ _{WHO2005} /g lip.)	PCDD/Fs + DL-PCBs (pg TEQ _{WHO2005} /g lip.)	Σ3NDL-PCBs (ng/g lipids)
Total	11.8	6.4	18.6	333.0
Exposed	11.8	6.5	18.7	334.8
Non exposed	11.8	6.0	18.1	326.3

⇒ Globally, living around an incinerator does not increase the mean concentration of the serum dioxin and PCBs

B1. Incinerators study – Results: Influencing factors for NDL-PCB

Groups of factors	Factors	p
physiological	Age	<0.0001
	Variation of weight in the last year	<0.001
	BMI	<0.001
	Serum lipids	0.03
socioeconomic	Occupational category	<0.0001
geographical	Area of residence	<0.0001
exposure	Exposure to MSWI	NS
general food	Lipids of meat	<0.014
local food	Lipids of meat	<0.0015
	Lipids of dairy products (g/day)	<0.0001

17 NS according to exposure groups and type of consumers

B2. PCBs Study in anglers (2009-2010)

Production of PCBs banned since 1987, but environmental contamination of some rivers

Aim

- Are the serum PCB levels higher in anglers who eat regularly contaminated river fishes than in the general population?



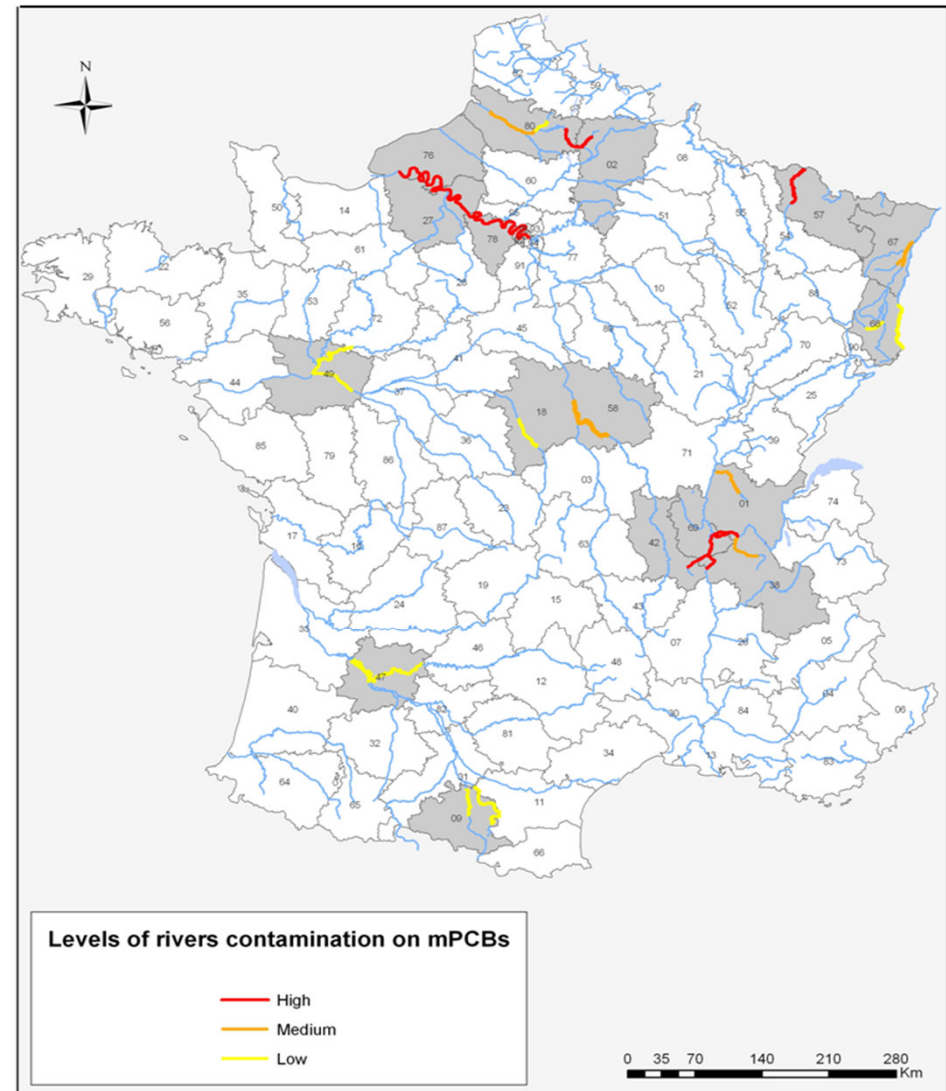
Method

- Cross sectional study (2009) conducted by Anses in collaboration with InVS
- 606 anglers from 6 zones in the French territory (identified through an environmental study)
- Questionnaire, fish consumption, blood samples ➔ measurement of serum PCBs



C2. PCBs Study in anglers - Methods

- ~ 21 200 angler households and 606 participants (18 to 75 yrs)
- from 6 fishing sites in France :
 - 6 sections of rivers
 - representing a total of 900 km
 - different PCB contamination levels in the sediments (high, medium, low)
- **FFQ** : - for specific freshwater fish
 - Bio+ (eel, barbell, bream, carp, sheatfish, roach)
 - Bio- (bleaks, gudgeon, pike, black-bass, perch, catfish, pike perch, tench, trout, dace, minnow)
- 19 - other dietary habits



Sources : BD Carthage, anses



C2. PCBs Study in anglers - Results

Sample of the population study	geometric mean for Total PCBs (ng/g lipids)
Whole population	492
Consumers of Bio+ fresh water fish (~ 10 times/year)	593
Non consumers of Bio+ fresh water fish	398

B2. PCBs Study in anglers - Results

- Consumption of freshwater fish in the studied population:
 - Low frequency: < 1 time/month
 - Few consumers of BIO+ freshwater fish :13%
- Excess of health blood threshold set by ANSES:
 - 0.3% for women of childbearing age (>700 ng/g lipids)
 - 2.2% for the rest of the population (>1800 ng/g lipids)

- 63% of the variability of the PCBs levels explained by the factors

Factors	Contribution to the variability
Age	61 %
BIO+ freshwater fish consumption	2%

- Highest serum PCB levels (> threshold) were generally associated with the highest consumption of BIO+ freshfish



B3. French studies on POPs in breastmilk (Elfe)



1/ In 1998-99:

the 1st national dioxin study on breastmilk
(a transversal study)

1998-2007: regulation and control on dioxins in France (MSWI, Industries, food)

Evolution of dioxin exposure in the population ?



2/ In 2007:

pilot of ELFE, a French Longitudinal Study since Childhood

- a multidisciplinary approach: Health, Social, Nutrition, Environment (Dioxins, PCBs incl.)
- nationally representative newborns in 2011 and their mothers



Comparison of the current French breastmilk data (ELFE) with:

- international data
- the previous French study conducted in 1998-99



B3. Breastmilk study (Elfe) - Methods

2007: Elfe pilot

- 5 counties: Ardèche, Isère, Loire, Savoie, Seine-Saint-Denis
- in maternity services (n=44)
- milk from mothers not all primiparous
- 17 PCDD/Fs,
12 DL-PCBs,
6 NDL-PCBs
(28, 52, 101, 138, 153, 180)
6th-8th w. after delivery

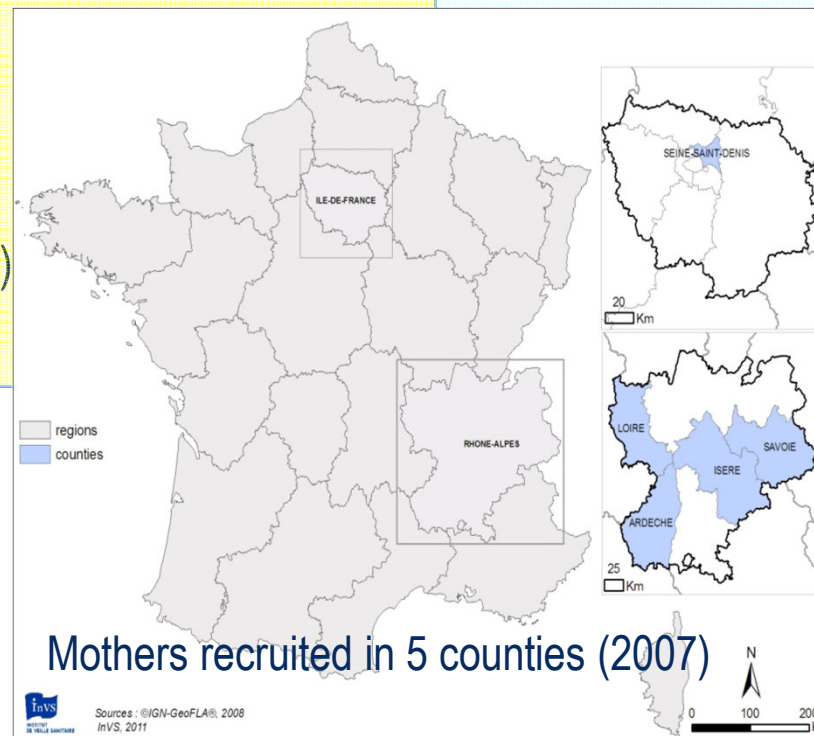


1998-99: 1st dioxin study

- throughout France
- in lactariums (centers where mothers give their breastmilk), (n=244)
- primiparous mothers



- 17 PCDD/Fs in individual samples of breastmilk collected 4th-8th weeks after delivery





B3. Breastmilk study (Elfe) - Results

French dioxin levels similar to those in Europe

Distribution of Dioxin and PCB levels – France 2007

Geometric means in pg WHO₂₀₀₅-TEQ/g lipids and ng/g lipids

PCDD/Fs (pg TEQ _{WHO2005} /g lip.)	DL-PCBs (pg TEQ _{WHO2005} /g lip.)	PCDD/Fs + DL-PCBs (pg TEQ _{WHO2005} /g lip.)	NDL-PCBs (ng/g lipids)
9.6	7.7	17.6	176.3

Decrease of 40 % of dioxins (1998/2007) but NDL-PCB?

Comparison with international data :

- similar of what has been observed in other countries in Europe, such as in Italy , Germany  or Czech Republic 
- lower than in Japan , but higher than in Australia 





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3. Summary of results of PCB studies

Study	Mean age	GM Σ NDL-PCBs (28,52,101,153,180)	GM total NDL-PCBs (Σ PCB138,153,180)x1.7
General population			
Study in 1986	38 yrs	4920 ng/L	
ENNS study 2007	45 yrs	290 ng/g lipids 1859 ng/L	480 ng/g lipids
Specific populations			
Incinerators study 2005	52 yrs	333* ng/g lipids	566 ng/g lipids
Exposed to MSWI		335* ng/g lipids	569 ng/g lipids
Non exposed		326* ng/g lipids	555 ng/g lipids
Anglers study 2009/10	45 yrs	235 ng/g lipids 289 ng/g lipids	399 ng/g lipids (population) 492 ng/g lipids (sample)
Fish Bio+ consumers		349 ng/g lipids	593 ng/g lipids
Non consumers Fish Bio+		234 ng/g lipids	398 ng/g lipids
Breastmilk study 2007	32 yrs	176 ng/g lipids	253 ng/g lipids

*: PCB138,153,180

4. Conclusion

In France, HBM on PCBs used as a powerful tool:

- for a better assessment of exposure and risk
- to support policy actions

Challenges:

- to translate risk assessment into risk management
- of an integrated approach: HBM, Health, Nutrition, Environment
- with different partners (ministries, national agencies, stakeholders) and multidisciplinary teams

- PCB levels in France divided by 3 in 20 years
- Globally no difference between the general population and people:
 - living around incinerators
 - anglers except for high consumers
- Influencing factors
 - Importance of individual characteristics
 - Food of animal origin, seafood





Thank you for



for your attention !

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