The French IAQ Observatory

Andrée Buchmann
President

contact@oqai.fr

French Observatory for indoor air quality (1)

Created in 2001

Objective: To coordinate and develop indoor air research activities on a national scale (get data on the building stocks)

- To provide support for public policies

- To publish recommendations for professionals and general public

Public funding: from ministries in charge of construction, environment and health + French Environment and Energy Management Agency (ADEME) + French Agency for Food, Occupational and Environmental Health and Safety (ANSES) + CSTB, operator and technical coordinator

French Observatory for indoor air quality (2)

6 research programmes:

– **Dwellings**

  o national survey in 567 dwellings (2003-2005)

– **Schools and day-care centres**

  o Case-studies: product emission for ex.

  o National survey in 300 schools (**on-going**)

– **Office buildings**

 o National survey in 300 buildings (**on-going**)

– **Low energy buildings**

  o Dissemination of protocols and data collection (**on-going**)

– **IAQ management tools**

– **Communication, training, education**

Photocatalytic air purification
Opportunity or threat for indoor air quality?
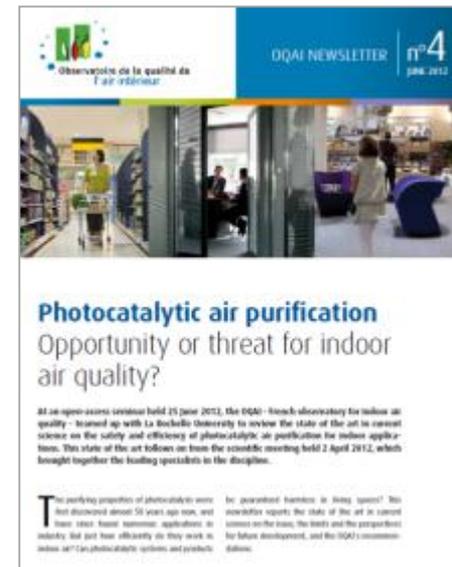
National survey in the housing stock: sampling
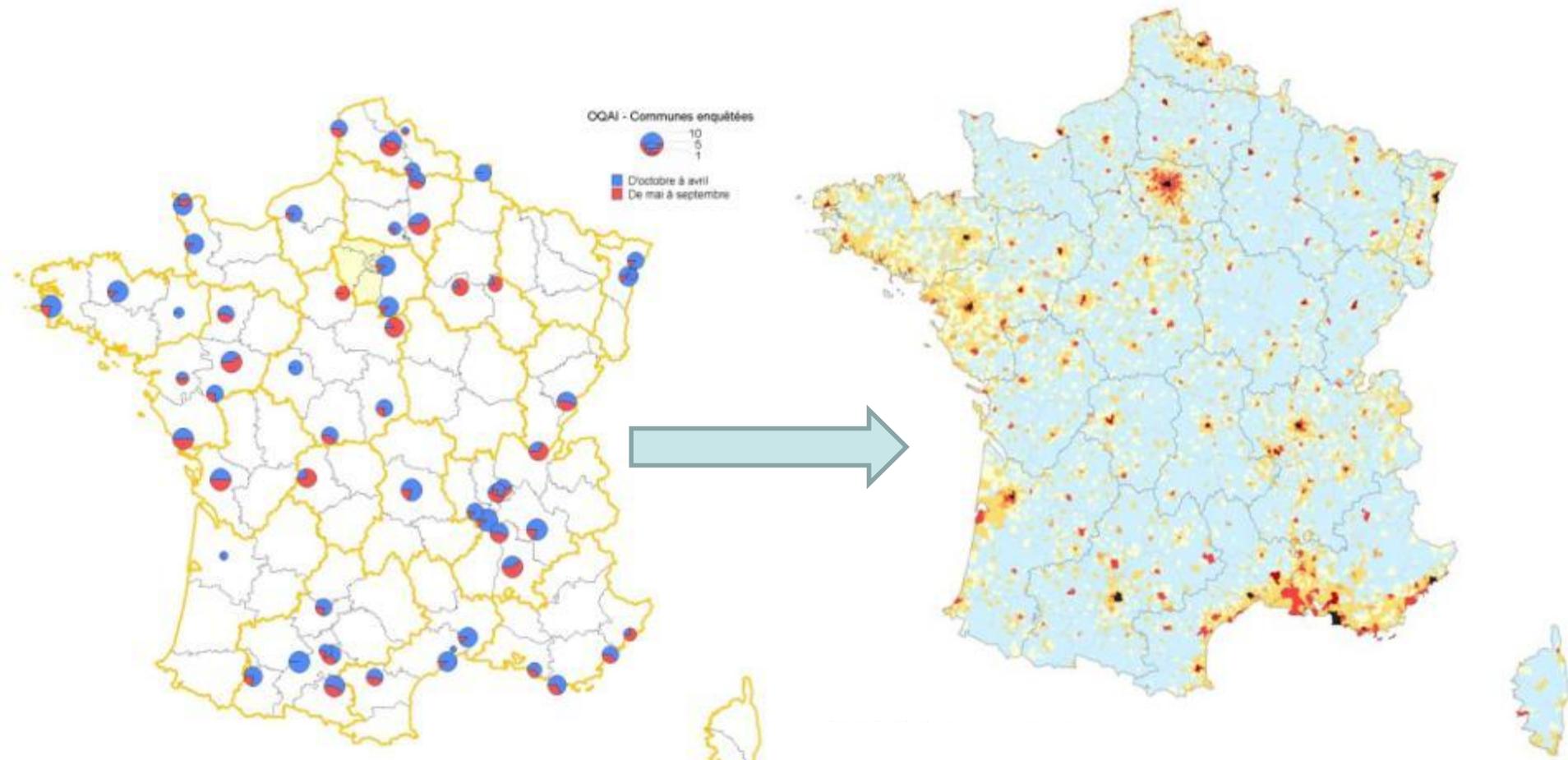
567 dwellings   **representing**   **24 672 135 main homes**
Each dwelling has a sampling weight

National survey in the housing stock: sampling

6 308 addresses drawn
811 participation agreements obtained
567 dwellings finally investigated

Measuring instruments

Exhaust air
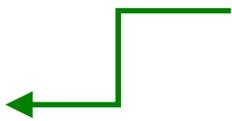
biological

Cat and dog allergens -1h

Dust mite allergens

physical

gamma ray (3h)

Radon (2 months)

PM_{10} and $PM_{2.5}$
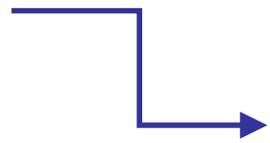
(1 week)

chemical

CO environmental monitoring

CO exhaled

T and RH monitoring

CO_2 monitoring

VOCs and aldehydes

Diffusive sampling 1 week

Results: global overview (VOCs & aldehydes)
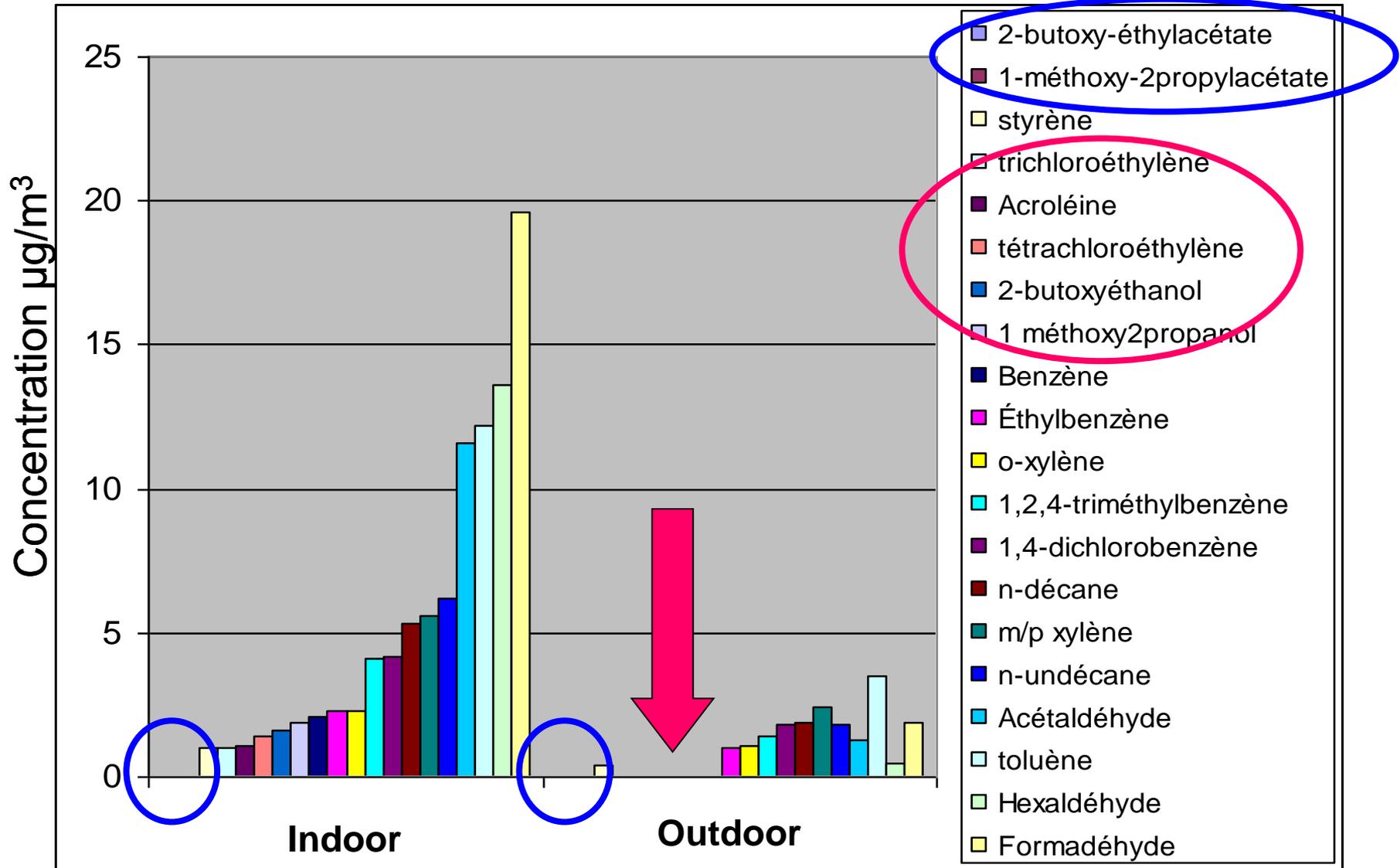
Chemical indoor pollution is not homogeneous

**40% of dwellings
(36-45%)**

(Duboudin, ERS 2010)

**26%
(23-31%)**
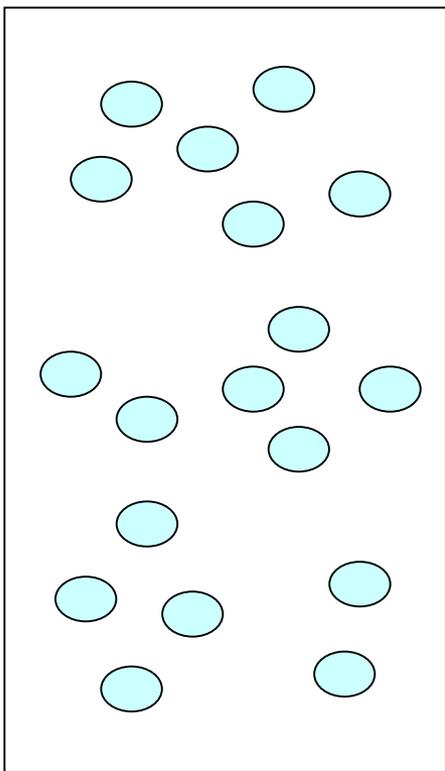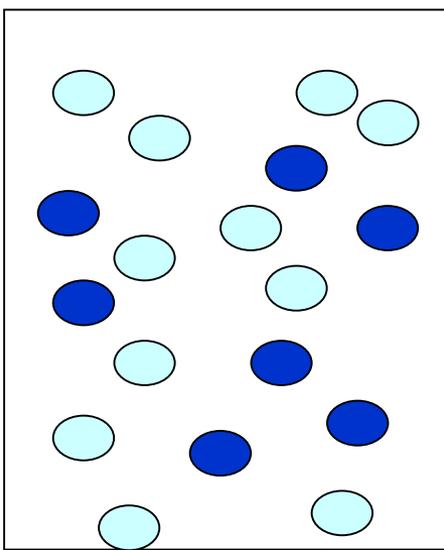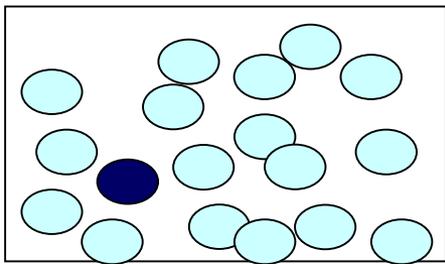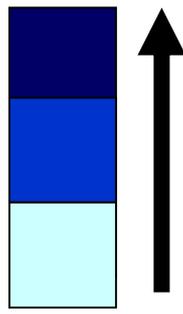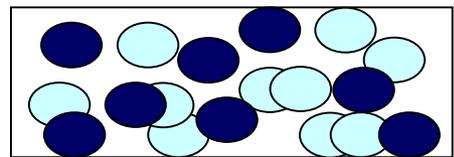
**Level of
concentrations**

**24%
(20-28%)**

**10%
(7-13%)**

VOC and aldehyde concentrations

Exposure profiles regarding housing features

- Same methods as for indoor pollution applied to identify homogeneous groups of dwellings regarding:

  - Building **characteristics** → 6 groups

  - **Household** profile → 7 groups

  - Daily **habits** → 9 groups

- Then: analysis of indoor pollution regarding building and household features

- The profile "Single-family houses, with an attached garage, DIY activities, use of incense and air fresheners" corresponds to more polluted dwellings

And now? Analysis of SVOCs in dust and PM_{10}

A group of semi-volatile organic compounds analysed:

- in settled dust: collection of vacuum cleaner bags (48 SVOCs; 145 bags)

- on airborne particles from the housing survey (66 SVOCs; 285 PM_{10} filters)

Phthalates (6/9)	PAHs (5/13)	PBDEs (8/9)	PCBs (10/11)	OC – OP Pest. (10/16)	Pyrethroid (1/4)	Musks (2)	BPA
DEHP	Anthracene	28	28	*Dichlorvos*	Permethrin	Galaxolide	
DiNP	*Acenaphthene*	47	31	Chlorpyrifos	*Cypermethrin*	Tonalide	
DiBP	BaP	85	52	Diazinon	*Deltamethrin*		
BBP	Fluorene	99	77	Dieldrin / Aldrin	*Permethrin*		**TBP**
DBP	Phenanthrene	100	101	Endrin	*Alkylphenols (3)*		
DEP	*Fluoranthene*	119	105	*Alpha-HCH*			
DMP	*Benzo[a]anthracene*	153	118	Lindane (γ-HCH)	4-tert-butylphenol		
DMEP	*Pyrene*	154	126	4,4'-DDE / *4,4'-DDT*	4-tert-octylphenol		*Triclosan*
DOP	*Chrysene*	*209*	138	Oxadiazon	4-n-nonylphenol		
	Benzo[b]fluoranthene		153	Endosulfan			
	Benzo[k]fluoranthene		*180*	*Cis-chlordane*			
	Dibenzo[a,h]anthracene			*Trans-chlordane*			
	Indeno[1,2,3-cd]pyrene			*Heptachlore*			
	Benzo[g,h,i]perylene			*Metolachlore*			
				Atrazine			

Only in settled dust; only in PM_{10}

OC – OP Pest.: organochlorine and organophosphorous pesticides

School survey: Objective and design

- **Objective: to describe indoor environment in a sample of schools representative of the French stock (≈ 55 000)**

- **School selection:**

  - 300 schools in metropolitan France, randomly selected

  - 2 classrooms per school, randomly selected

  - Stratified on:

    o Climatic zone

    o Urban *vs* rural

    o School level: 3-6 years old *vs* 7-10 years old
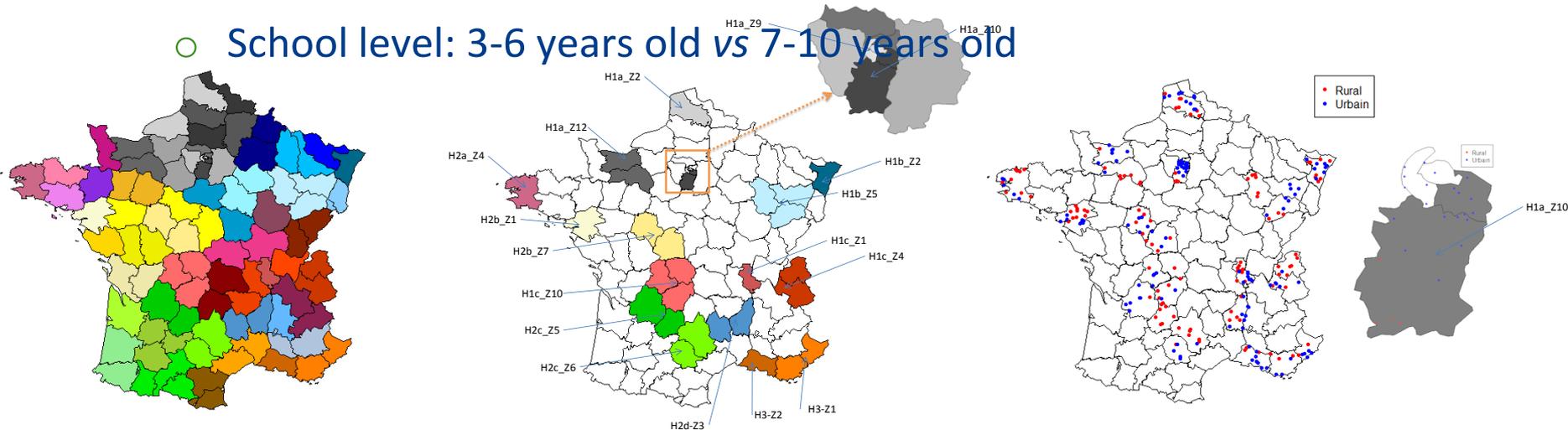
School survey: Monitored parameters (1)

- One week (MO-FR) monitoring

- **On-line: Temperature, relative humidity, CO_2**

- **VOCs, aldehydes and NO_2 (passive sampling)**

- **SVOCs** (phthalates, PBDE, PAH, PCB, pyrethroids; **active sampling; quartz filter + PUF**)

- **Particles: $PM_{2.5}$ (active sampling during occupation) + particle number (0.3 – 20 µm; optical particle counter)**

- **Mold: using contamination index based on mVOC**

- **Noise level, light level, electromagnetic fields**

School survey: Monitored parameters (2)

- **Lead in paints**

- **Settled dust sampling to measure:**

  - **SVOCs (vacuumed)**

  - **metals, including lead (vacuumed and wiped)**

  - **Dog, cat and dust mite allergens (only on mattresses of dormitories)**

- **All the results are sent to a central database**

- **Results in 2017**

Office building survey: Objective

- **To characterize indoor pollution in the office building stock in France and to describe installed systems**

- **To classify office buildings regarding:**

  - **indoor air quality**

  - **perceived comfort and health**

  - **energy performance**

- **To propose recommendations for a better indoor environment in offices**

300 office buildings investigated
**to provide estimates with an uncertainty of 10% for targeted aldehydes and VOCs**

Office building selection

- **Around 13,700 office buildings with more than 50 workers**

- **A two stage sampling**

1st = one or two primary sampling units (PSU) per climatic zone

2nd = in each PSU, selection of buildings proportionally
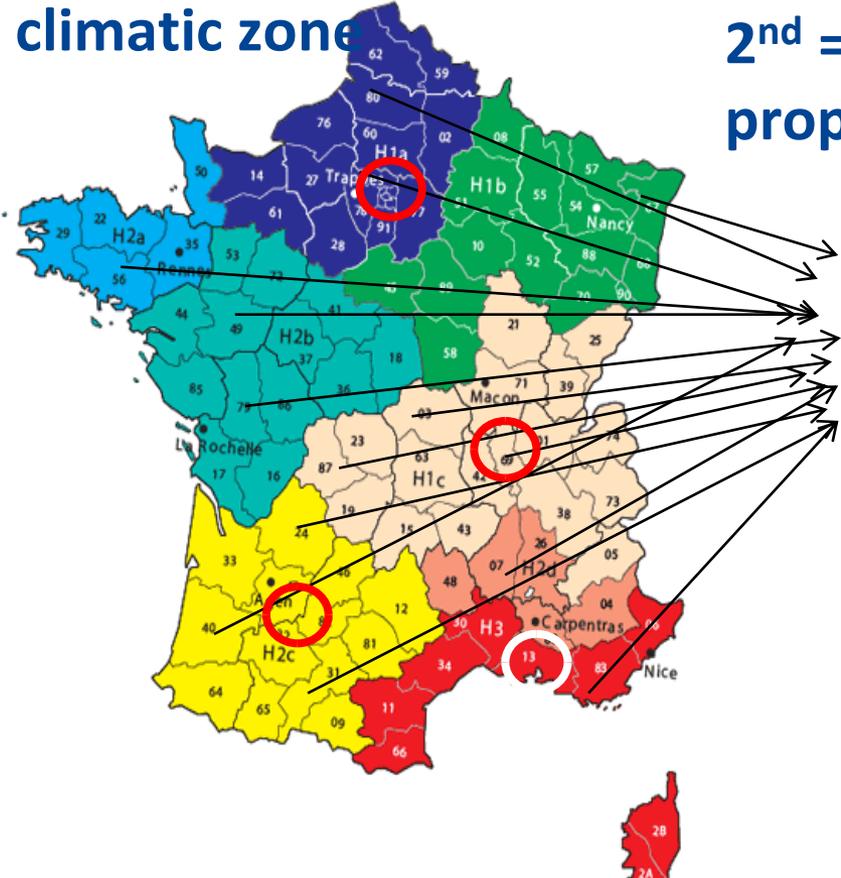
Climatic zones + 4 main cities	#
H1a {Paris excluded}	47
H1b	14
H1c {Lyon excluded}	19
H2a	11
H2b	12
H2c -{Toulouse excluded}	17
H2d	4
H3 {Marseille excluded}	18
LYON	6
MARSEILLE	5
PARIS	50
TOULOUSE	5

Office building survey: Design

2 successive stages

Phase 1 :	300 buildings

1 d

3 p

1. **Building audit**
2. **Perceived comfort and health**
3. **IAQ monitoring**
4. **Energy performance**

2013-2015

Phase 2 :	50 buildings

5 d

4 p

1. **IAQ and comfort monitoring**
   - **VOCs, aldehydes, O_3**
   - **Particles**
   - **Biocontaminants**
   - **Thermal comfort, light, noise**
   - **Ventilation (air flow rate)**
2. **Energy performance – detailed** **2016**

IAQ measurements in office buildings

| Representative Feasible	→	5 indoor + 1 outdoor

Sampling points **as diverse as possible** (floors, orientation, cellular offices *vs* open spaces, etc.)

Occupied offices

- **Active sampling (6h) for VOCs and aldehydes**

- **Ultrafine particles sampled 1h in each of the 5 offices (1')**

- **On-line monitoring (10') of T° , RH, and CO_2**
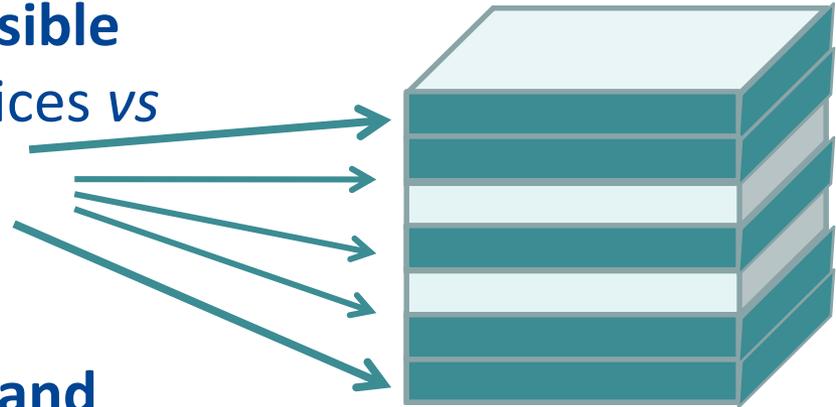
IAQ and comfort in energy efficient buildings

Offices

Schools

Dw...

Energy efficient buildings

Harmonized protocols

| IAQ | Ventilation | Comfort |

Data collection in buildings (agreement with private and public operators)

National database on IAQ and comfort In energy efficient buildings
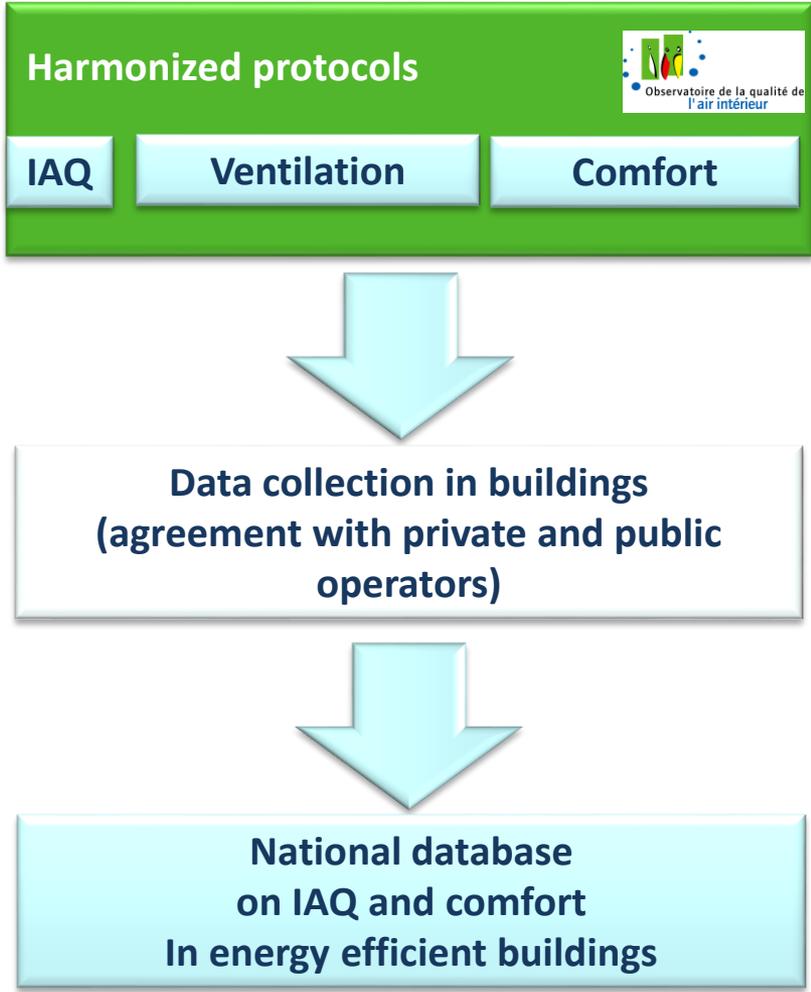
**First results on OQAI website (June 2015)**

Costs of indoor air pollution: first estimation for France

Selection of 6 target pollutants: CO, radon, ETS + benzene, TCE, PM$_{2,5}$

1. EXTERNAL COSTS	2. IMPACT ON PUBLIC FINANCES
1.1 Mortality cost (life year value = €115,000, Quinet, 2013) 1.2 Morbidity costs 1.3 Loss of productivity	2.1 Health care 2.2 Research 2.3 Pensions not paid ("benefits")

Annual costs in million euros for 6 target pollutants

Benzene	TCE	Radon	CO	Particles	ETS
883	39	2,694	308	14,331	1,279
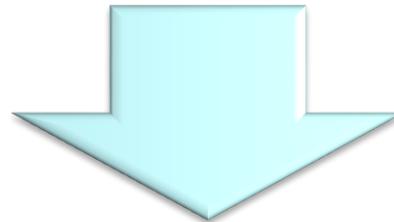
Total indoor pollution costs estimated at around €20 billions per year

Thank you for your attention!

http://www.oqai.fr