Comparison of a method of interpretation of pesticides public surface water monitoring data and a knowledge-based model of pesticides transfer at national scale

Irstea. Non point pollutions department. RiverLy. Irstea

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AGENCE FRANÇAISE POUR LA BIODIVERSITÉ

Établissement public du ministère de l'Environnement

anses

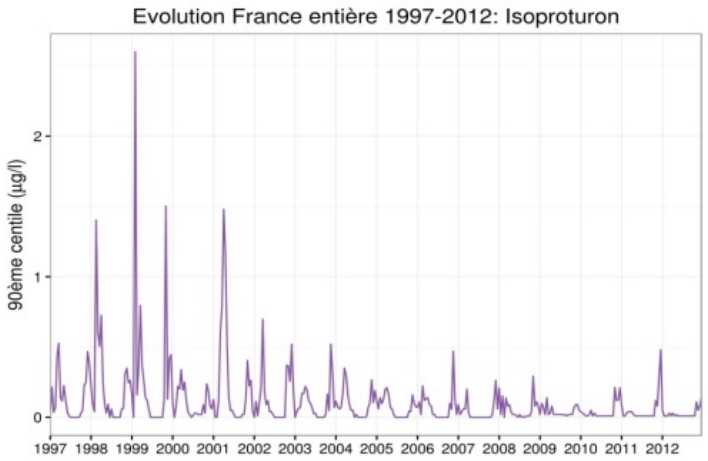
alimentation, environnement, travail

Context

- **WFD reporting:** assessment of the water quality and its evolution
- **Re-registration processes:** need of analysis methods as well
- Development of two methods by **Irstea** for **surface water bodies** monitoring data interpretation and contamination risk assessment

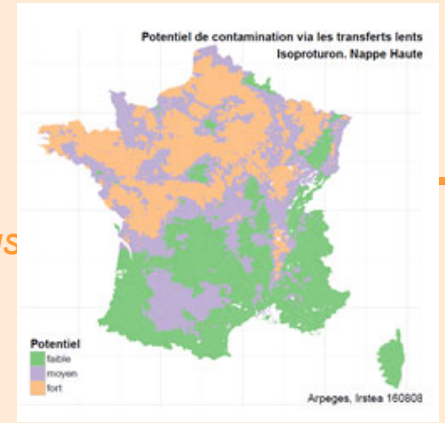
1 – Monitoring data interpretation

National temporal trends



2 – Surface water contamination risk assessment

Developped since 2012 for the 2013 and 2019 WFD Directive reportings

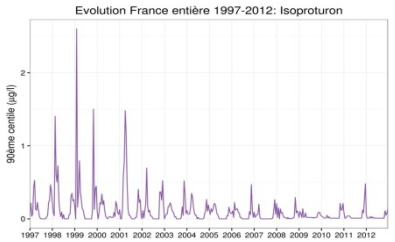


What are the benefits and limits of the two methods, and are they consistent ?

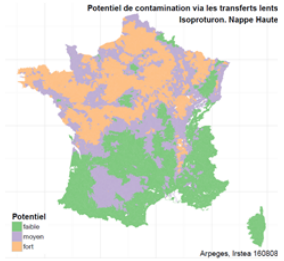
Outlines

Various studied pesticides

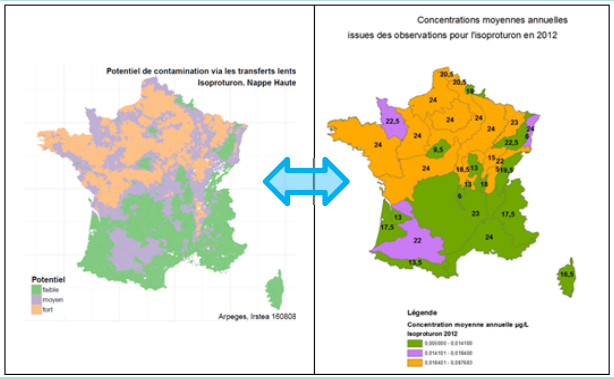
Monitoring data interpretation



Contamination risk assessment



Comparison of the two methods



Conclusions and prospects

Studied substances

For AFB - French Agency of Biodiversity (2017): Study of fifteen substances, in order to help French water agencies for the WFD reporting process

- 2,4-D
- 2,4-mcpa
- aminotriazole
- bentazone
- boscalid
- chlortoluron
- diflufnican
- glyphosate
- imidaclopride
- métaldéhyde
- metazachlore
- nicosulfuron
- oxadiazon
- pendimethaline
- S-métolachlore
- *isoproturon*
- *propyzamide*

Studied periods : **2013-2015** for monitoring data interpretation,
2015 for the contamination risk assessment.

Substances chosen because of their quantification frequency in surface water bodies

Surface water monitoring data interpretation

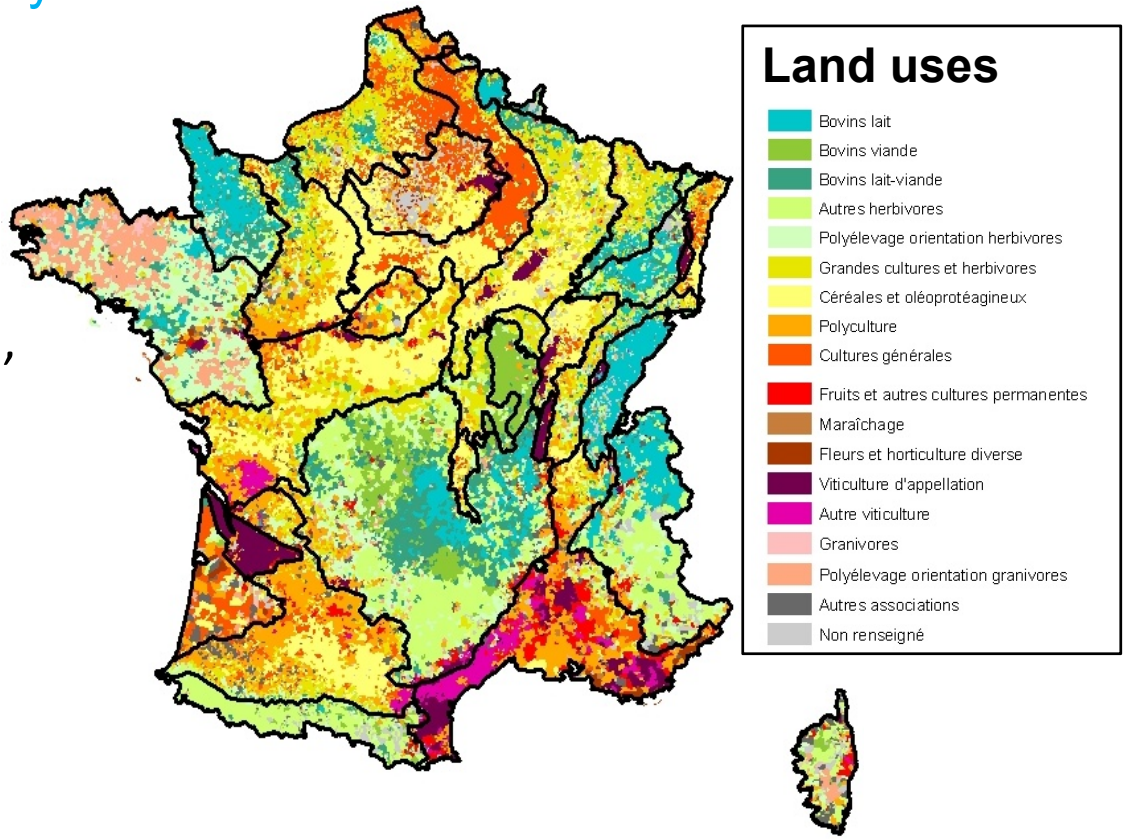
Monitoring data interpretation method

Hypothesis: temporal and spatial aggregation of monitoring data allows to by-pass their lack of representativeness at the station scale and to approach the contamination dynamics.

⇒ **Temporal aggregation:**
by 15 days

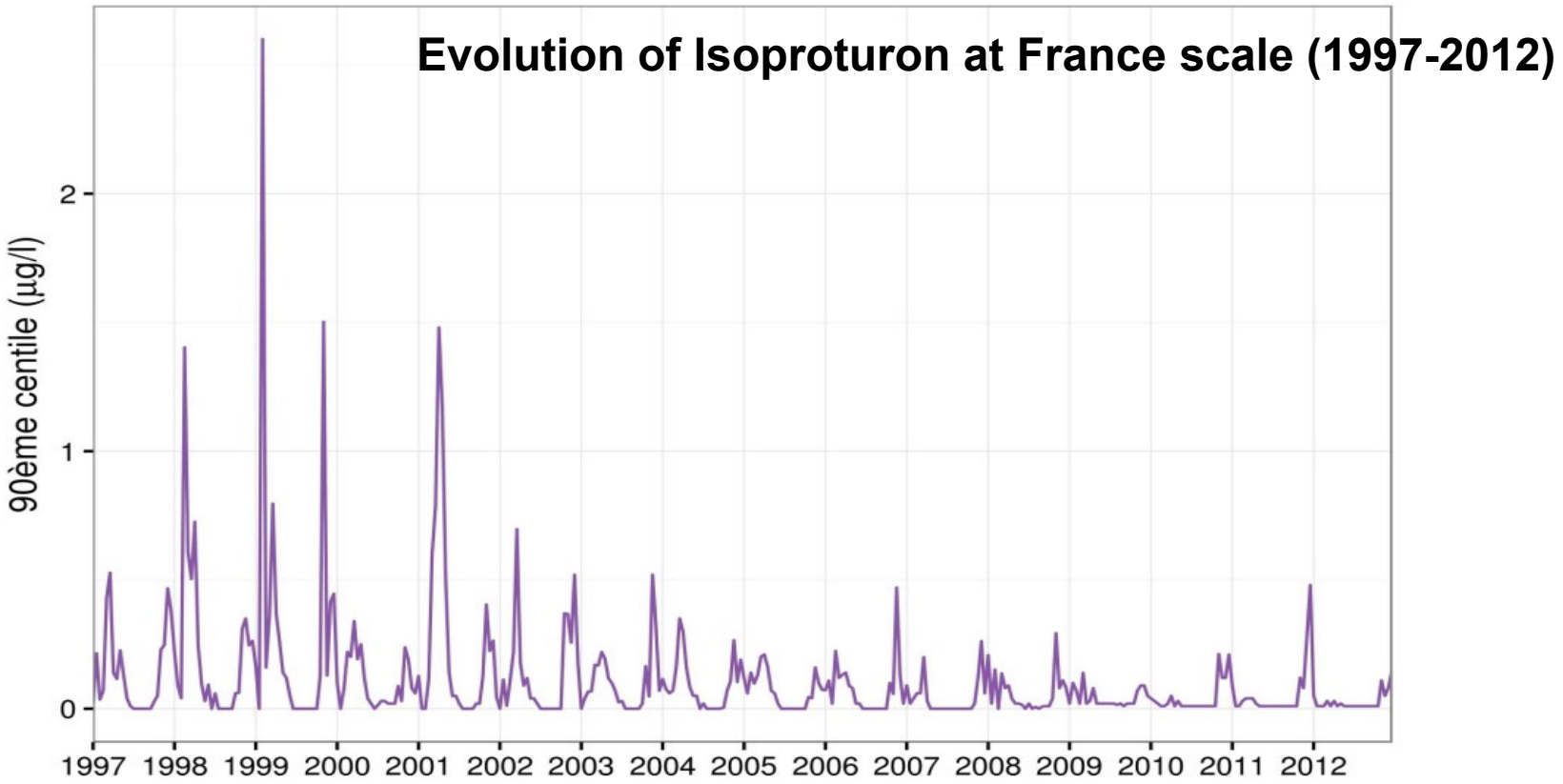
⇒ **Spatial aggregation:**
Hydro Eco Regions (HER) [1],
affined by land uses

⇒ **Descriptive value :**
centile 90 of data groups
⇨ envelop curve



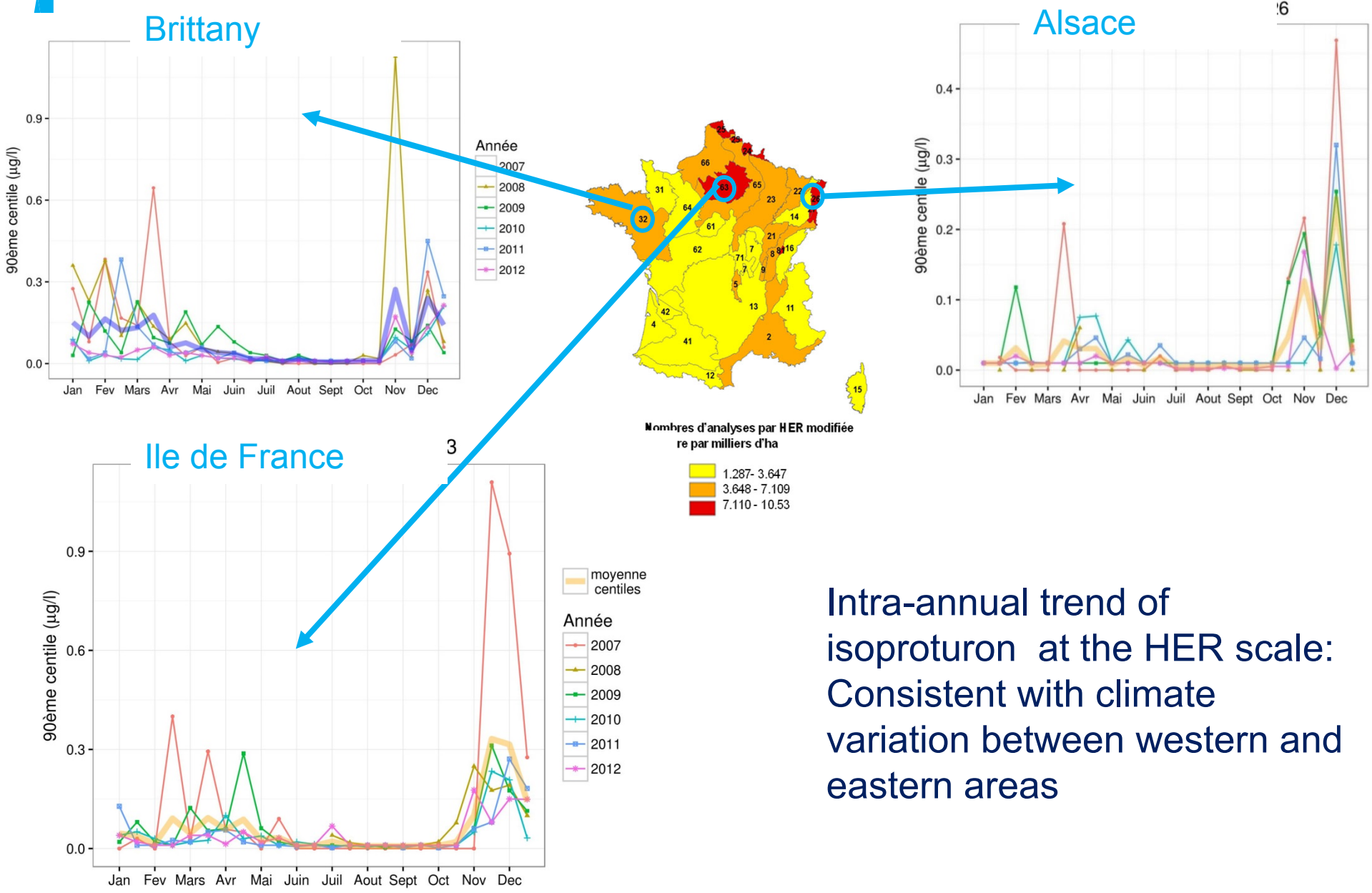
[1] Wasson J., et al. Les hydro-écorégions de France métropolitaine, approche régionale de la typologie des eaux courantes et éléments pour la définition des peuplements de référence d'invertébrés. Cemagref (2002).

Discrimination of temporal and spatial trends



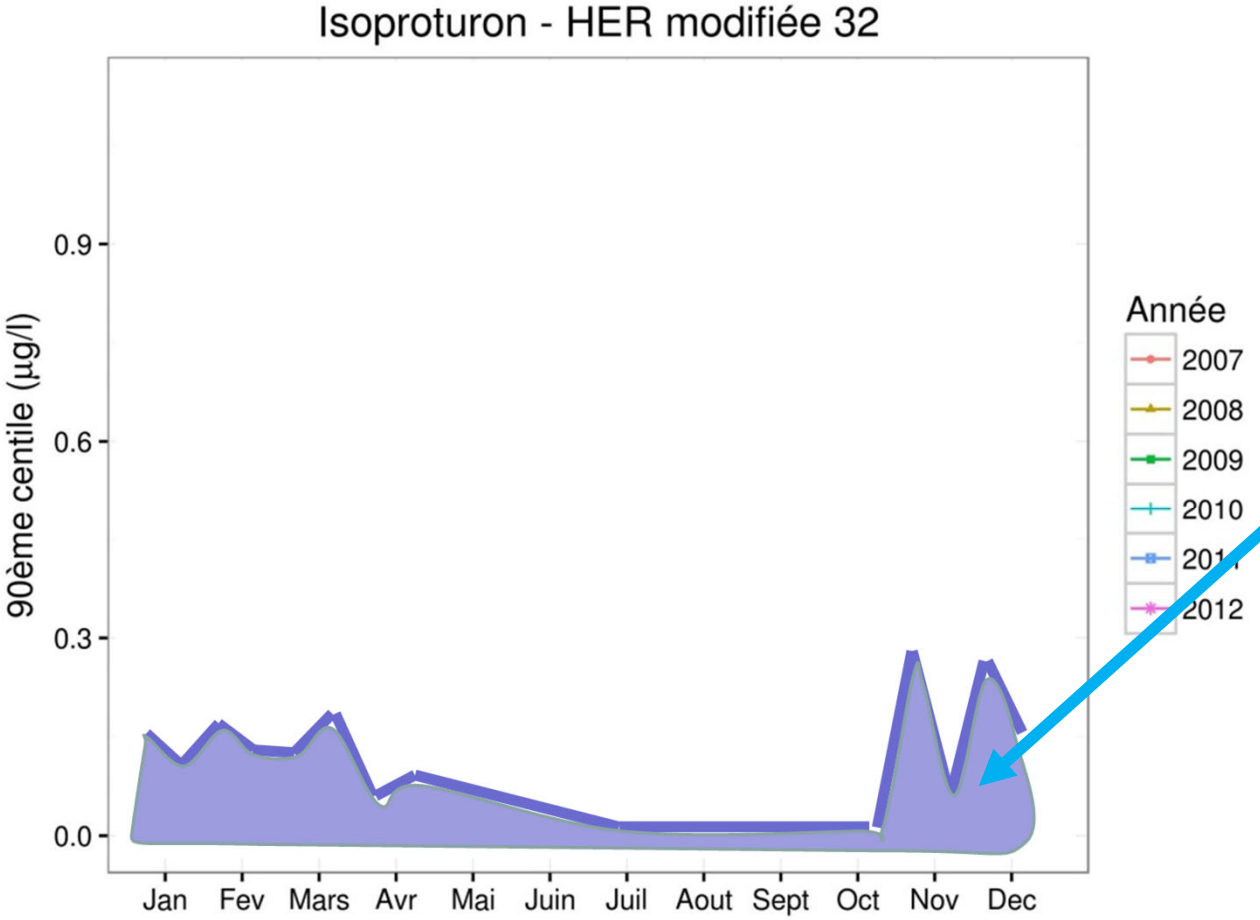
Inter-annual trend of isoproturon (national scale):
Consistent with weather inter-annual variability and dose reduction in 2004

Discrimination of temporal and spatial trends



Intra-annual trend of isoproturon at the HER scale: Consistent with climate variation between western and eastern areas

Ranking of spatial and temporal situations

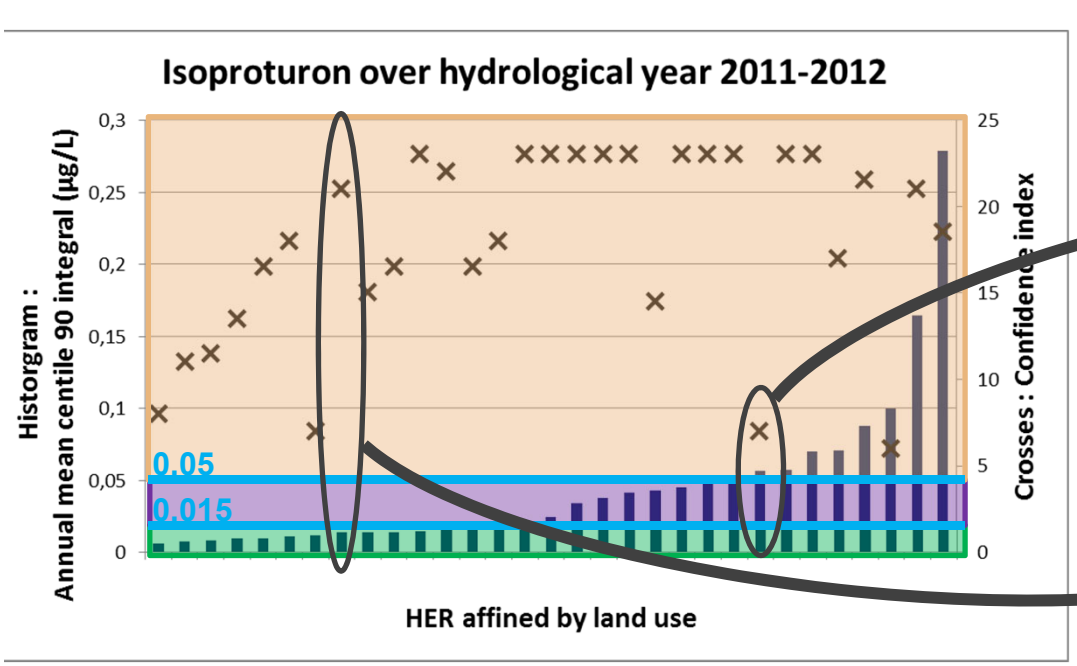


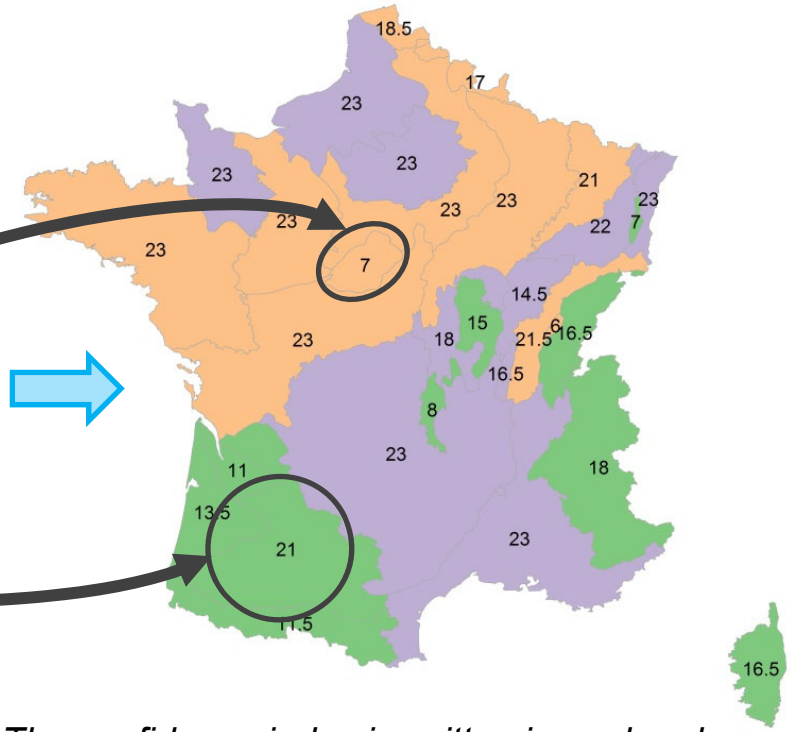
Integral for the indicator value of the 2007-2012 period

⇒ Envelop curves give trends but they don't provide a global view of each HER potential of contamination

⇒ Proposition of a simple indicator: mean of the envelop curve integral over the year, associated with a confidence index

Ranking of spatial and temporal situations: example of isoproturon





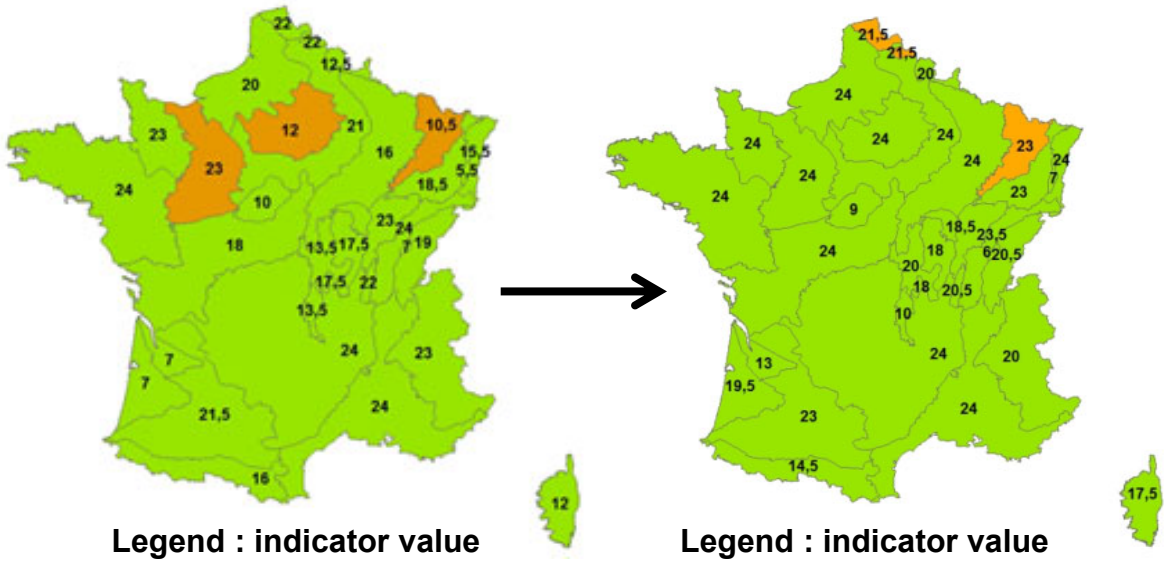
The confidence index is represented by the black crosses. *The confidence index is written in each polygon.*

Annual mean centile 90 integral (µg/L)

- 0,006 – 0,015
- 0,015 – 0,05
- 0,05 – 0,28

Ranking of spatial and temporal situations: example of Isoproturon

2007-2008 → 2011-2012



Drinkable water (0,1µg/L) and drinkable water treatment (2µg/L) thresholds

2011-2012

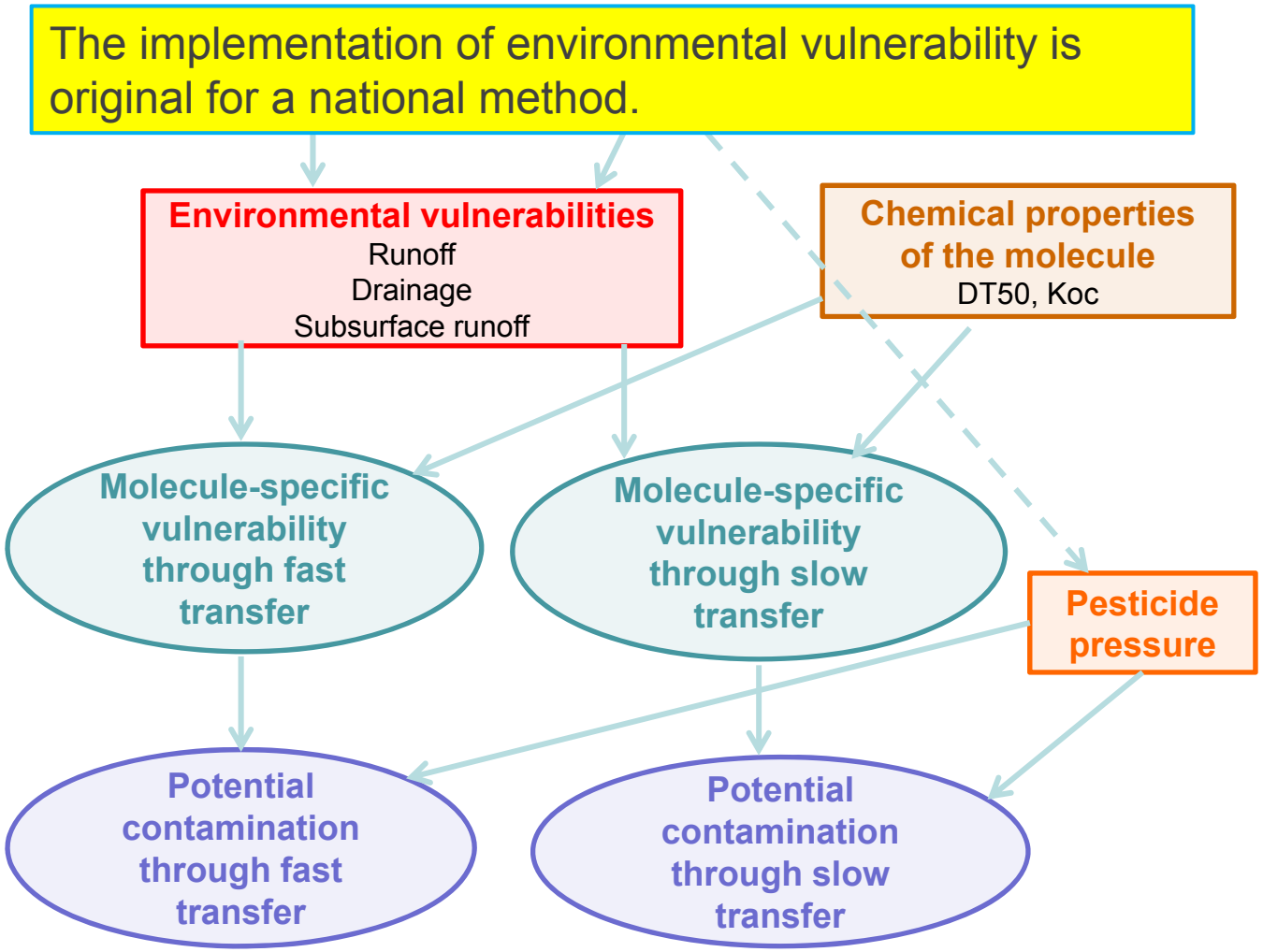
PNEC threshold (4,6 µg/L)

Cartographic representation of the ranking indicator:

Contamination risk assessment

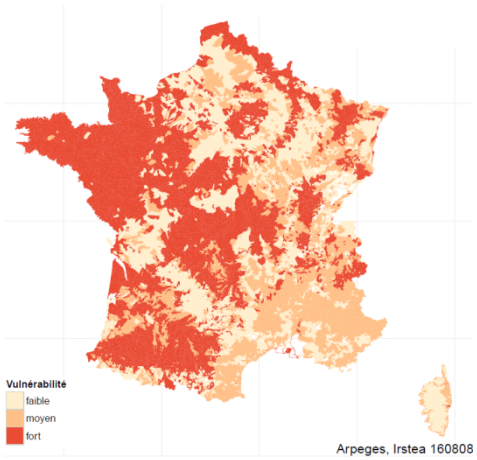
ARPEGES: a knowledge-based model of pesticide transfers to surface water bodies

- ✓ **One active ingredient** at a time
- ✓ **Geographical units:** water bodies catchments
- ✓ **Harmonised** at the national level
- ✓ **18 determinants** of pesticides surface waters contamination
- ✓ **3 or 5 classes** for each one (*very low* / low / medium / high / *very high*)
- ✓ Aggregation by a **bayesian network**



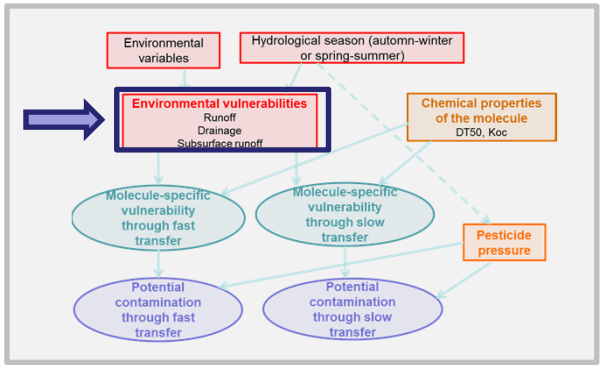
Environmental vulnerabilities: example of run-off

Autumn-winter



Variables used to calculate vulnerability to run-off:

- ✓ Run-off/Infiltration ratio
- ✓ Water content of soils
- ✓ Hydromorphy
- ✓ Crusting
- ✓ Grass strips
- ✓ Riparian areas



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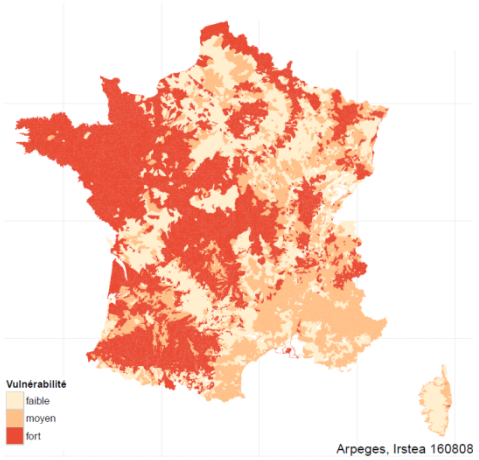
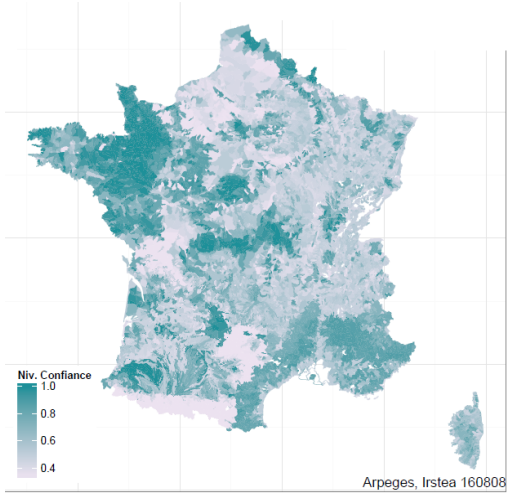
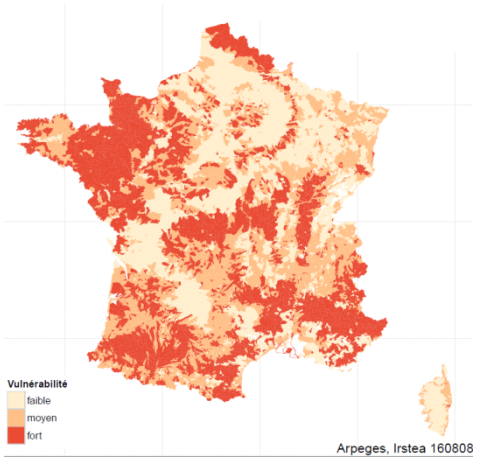




Result of vulnerability

Confidence index of vulnerability

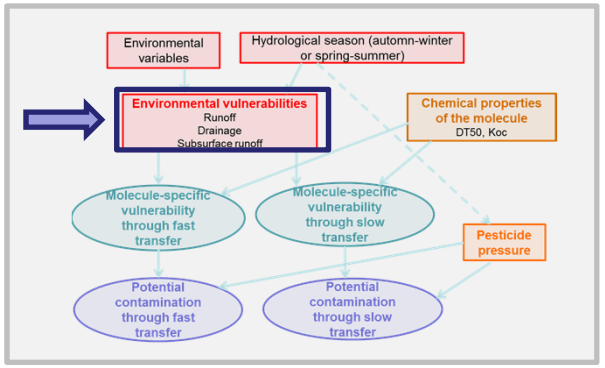
Spring-summer



Bayesian network

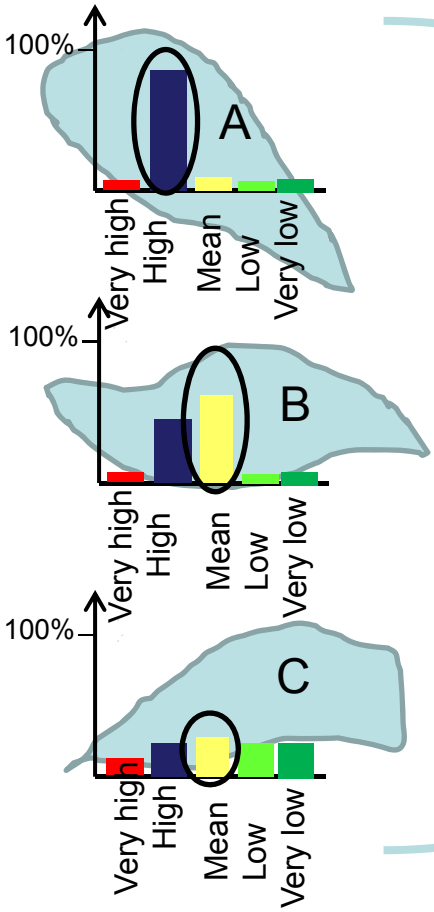
⇩

confidence index based on the probabilities

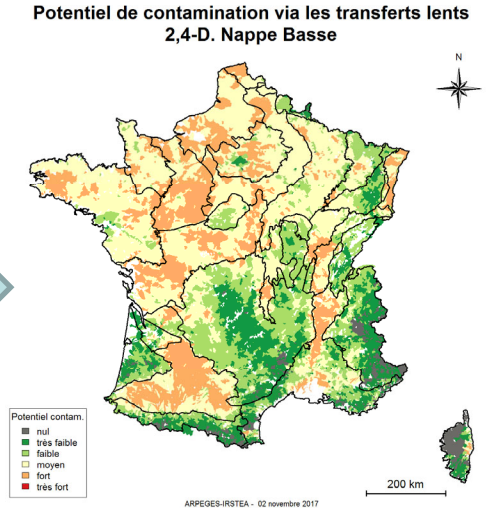


Determination of map of potential contamination and of confidence index

Gross result assessed by the bayesian network: triplet (intermediate result) or quintuplet (potential contam) of probabilities



Final decision



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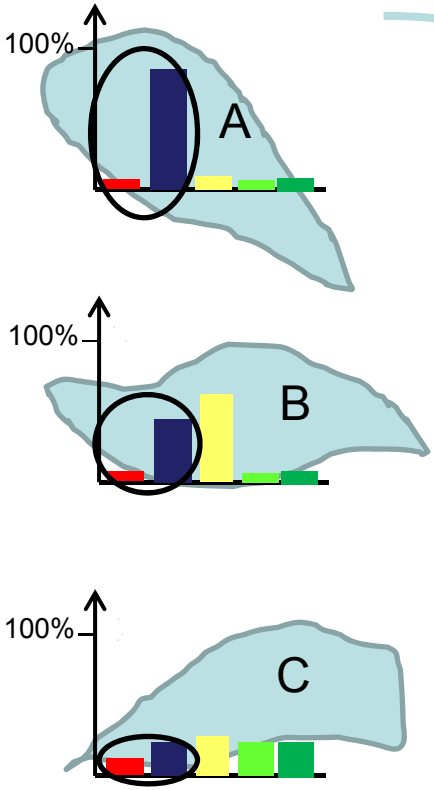
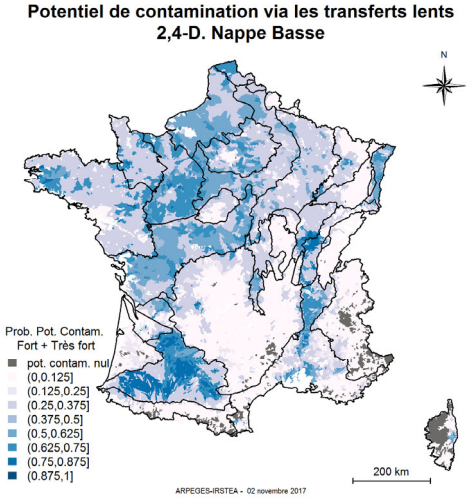


Proba risk
« high and very high »



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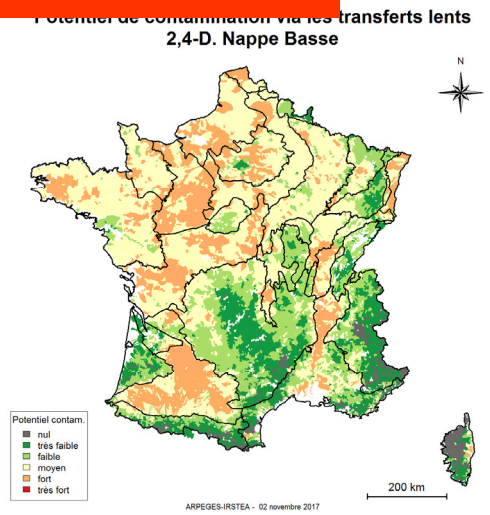

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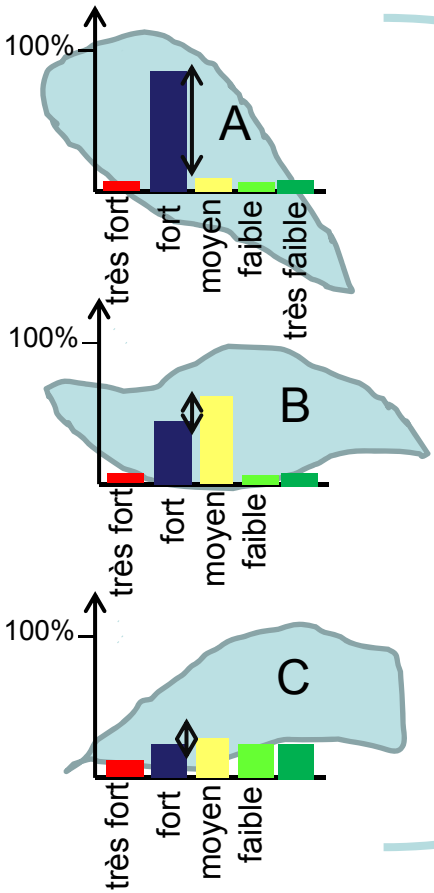
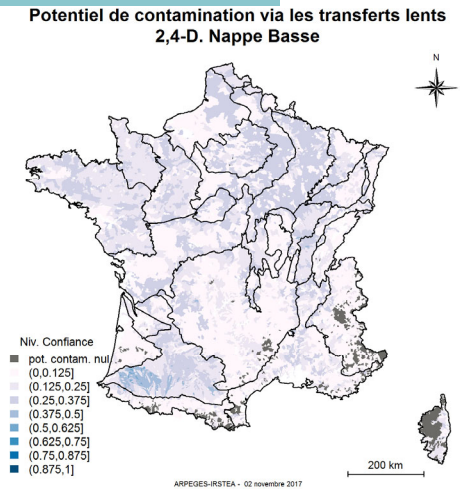


Confidence index



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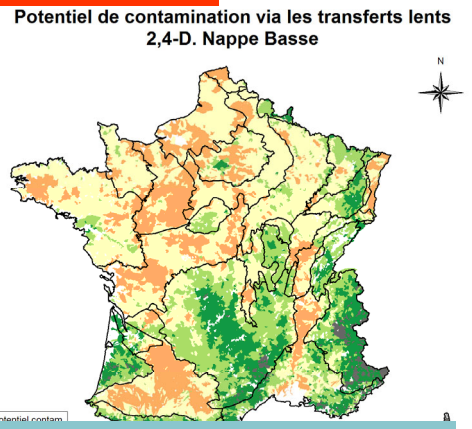

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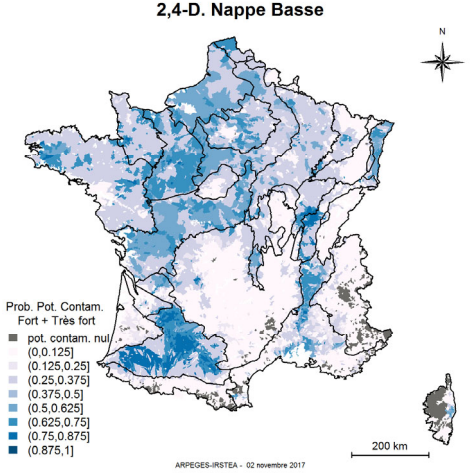
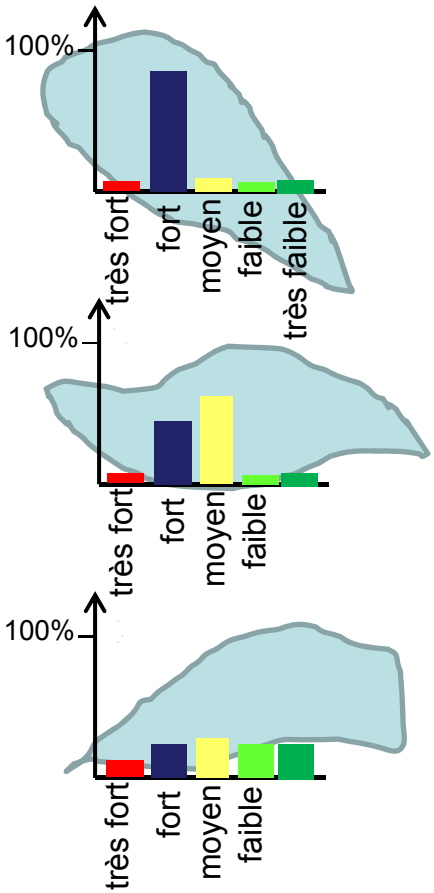


Obtention des cartes de risque et d'indice de confiance

Gross result assessed by the bayesian network: triplet (intermediate result) or quintuplet (potential contam) of probabilities



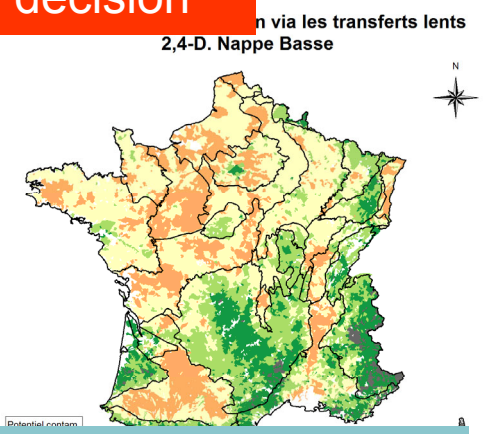
3 kinds of information for each output variable :

⇒ Potential contamination

⇒ Specific vulnerabilities

⇒ Intrinsic vulnerabilities

Final decision



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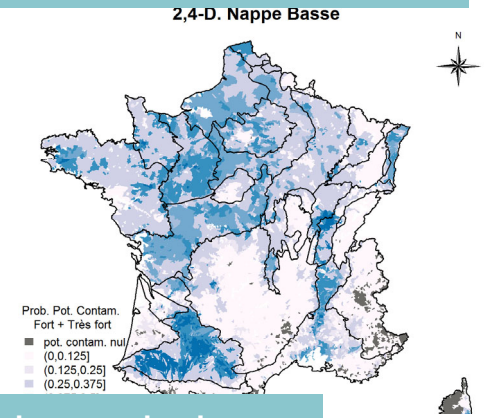
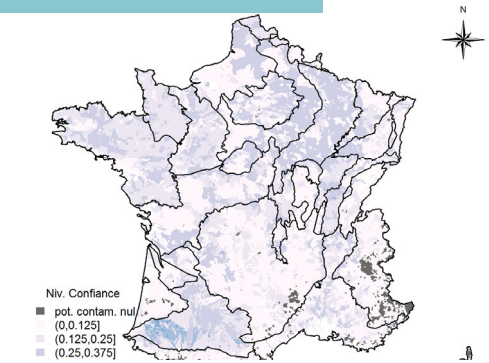
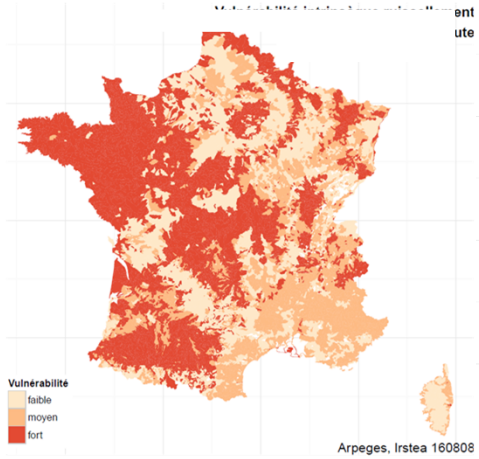


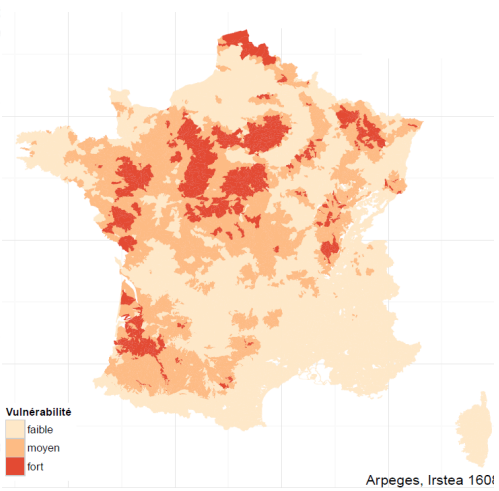
Confidence index

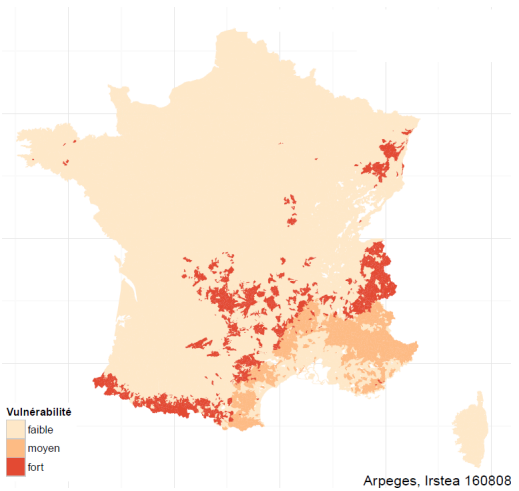


Environmental vulnerabilities

Autumn-winter

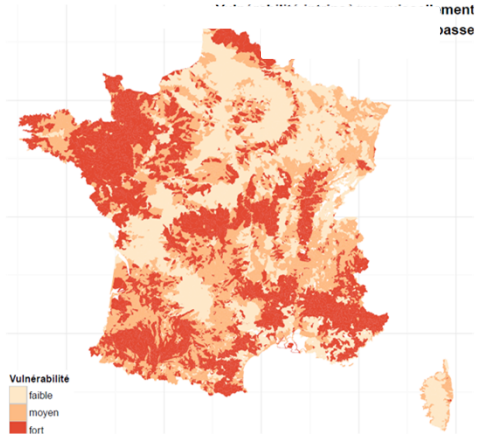


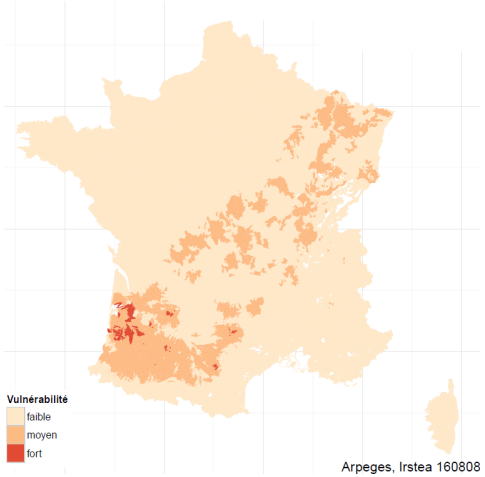


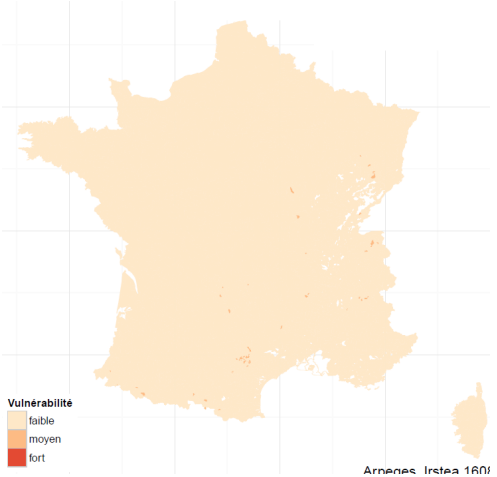


Run-off vulnerability | Drainage vulnerability | Subsurface vulnerability

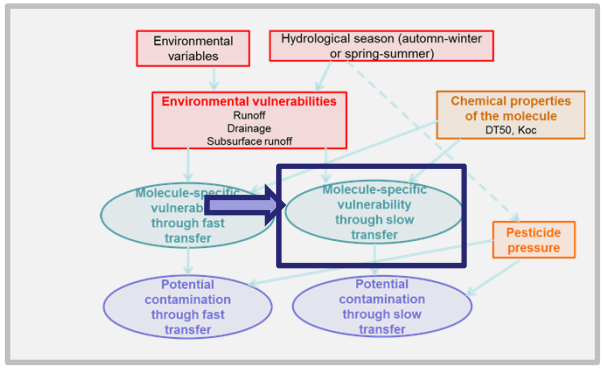
Spring-summer



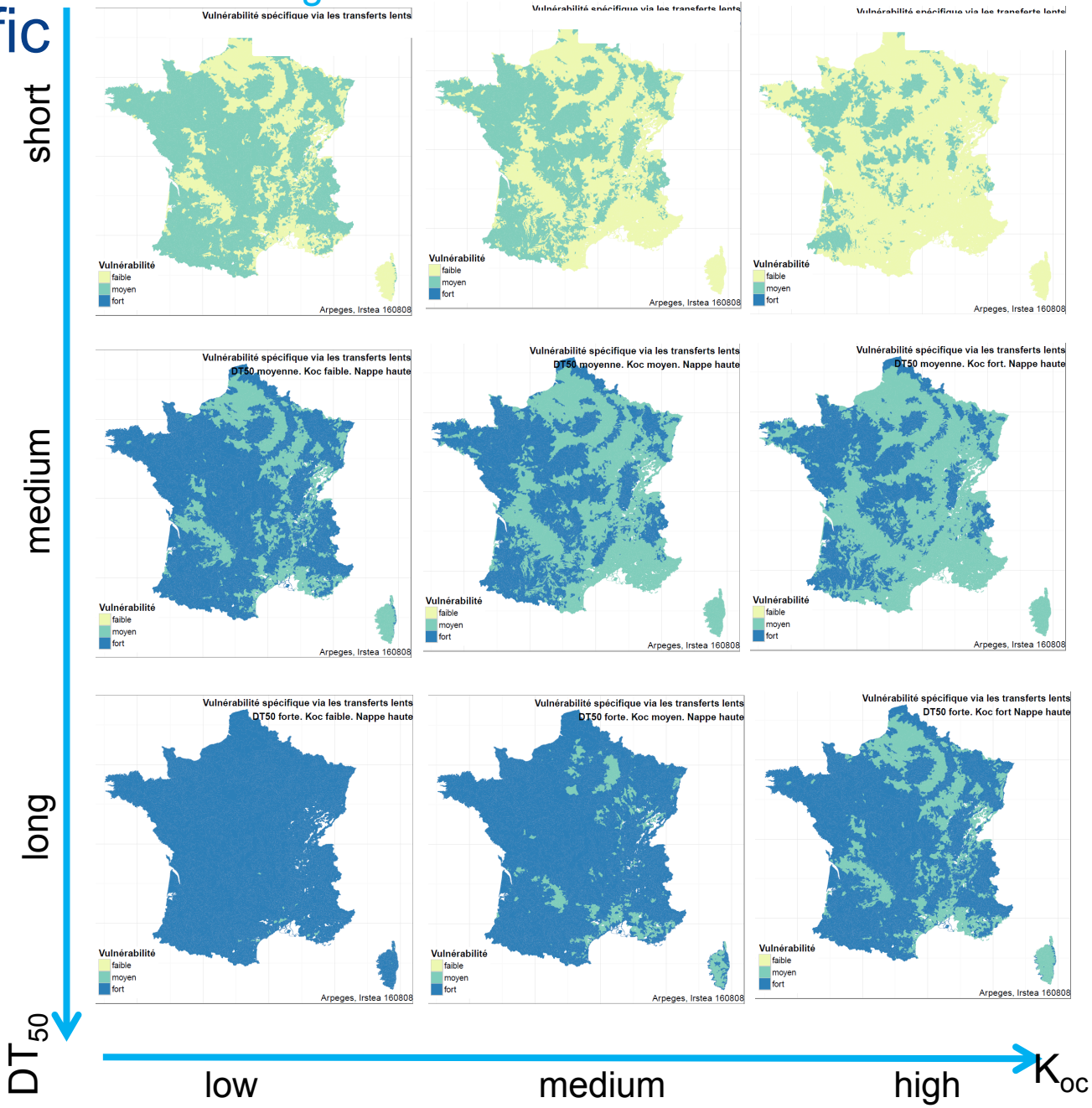




Molecule-specific vulnerability



Example for the vulnerability through slow transfers and autumn-winter

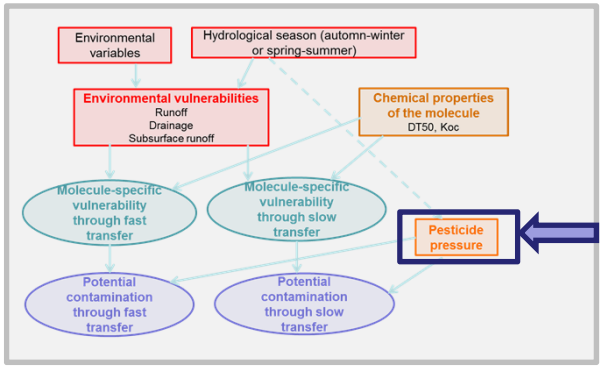


Active substances characteristics

DT_{50}	Short	Métaldéhyde		
	Mean	2,4-D 2,4-MCPA Aminotriazole Bentazone Nicosulfuron	Métazachlore S-métolachlore	
	Long		Boscalid Chlortoluron Imidaclopride	Diflufénicanil Glyphosate Oxadiazon Pendiméthaline
		Low	Mean	High
		K_{OC}		

Active substance	Default coefficients		Distinct coefficients for Seine Normandy Water Agency	
	% in « autumn-winter»	% in « spring-summer »	% in « autumn-winter»	% in « spring-summer »
2,4-D	50	50		
2,4-MCPA	0	100		
Aminotriazole	50	50		
Bentazone	0	100		
Boscalid	0	100		
Chlortoluron	100	0		
Diflufenican	80	20	90	10
Glyphosate	50	50		
Métazachlore	60	40	90	10
Nicosulfuron	0	100		
Pendimethaline	55	45		
S-metolachlore	0	100		

Pesticide pressure



Data : **BNV-D 2015**

⇨ the most recent and complete French database available at the time

Spatialization of the bought quantities (Method developed by INRA):

- Zip code of the buyer
- Soil occupation of the farm (RPG 2014)
- Registered rate for each crop

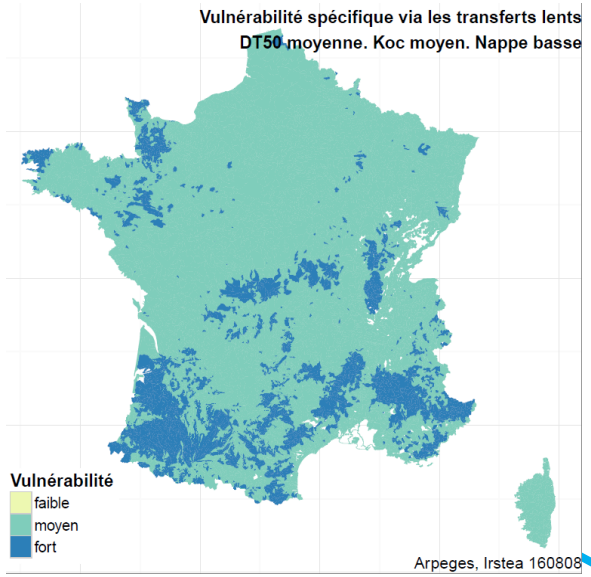
Five pressure classes :

Threshold level (g/ha)	Very low	Low	Medium	High
	0.1	1	5	10

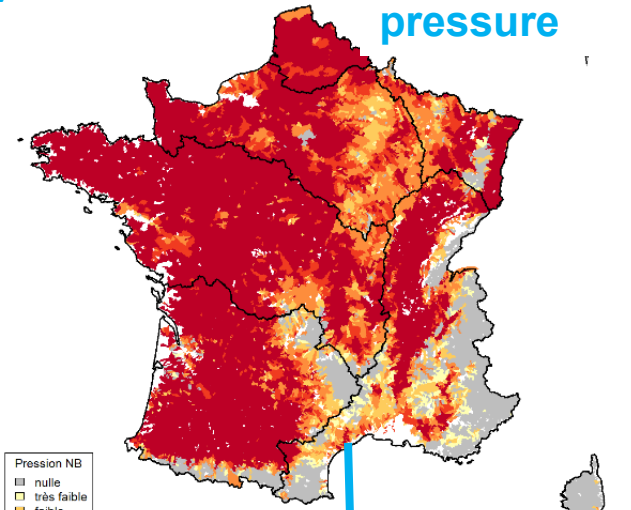
Determined considering pressure levels for the studied substances

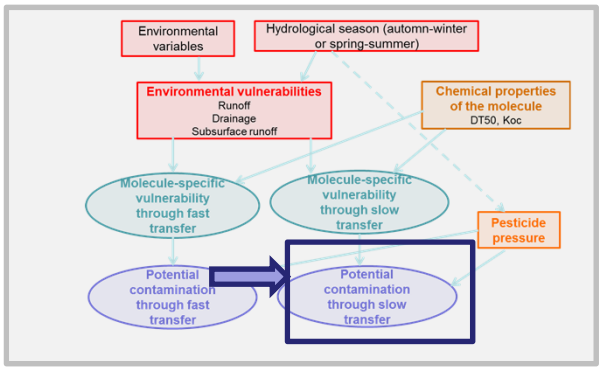
Potential contamination: example of slow transfers and spring-summer for S-Metolachlor

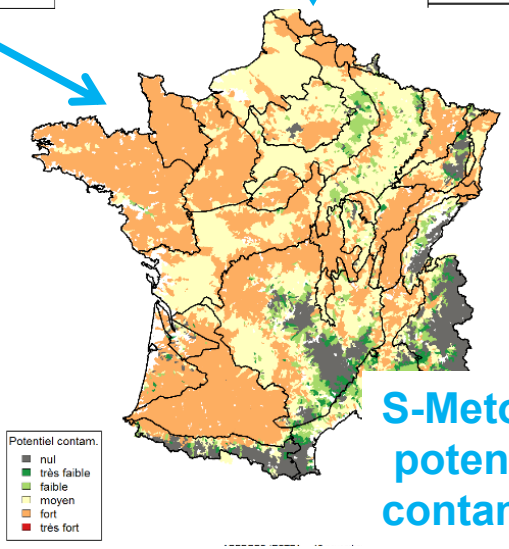
Molecule-specific vulnerability



S-Metolachlor pressure

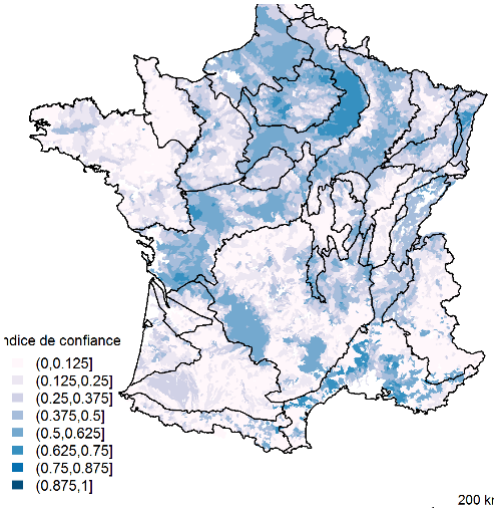


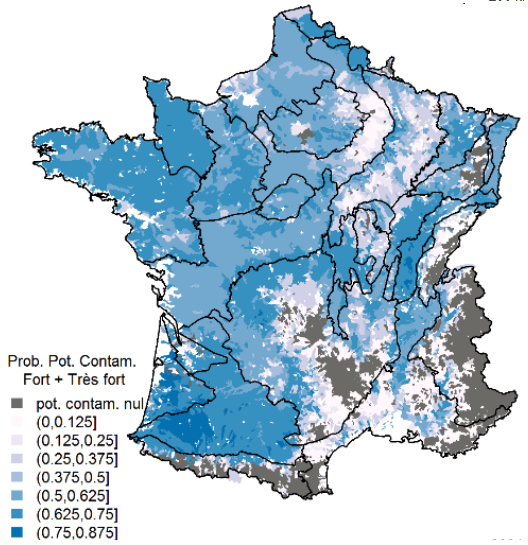




S-Metolachlor potential contamination

Confidence index

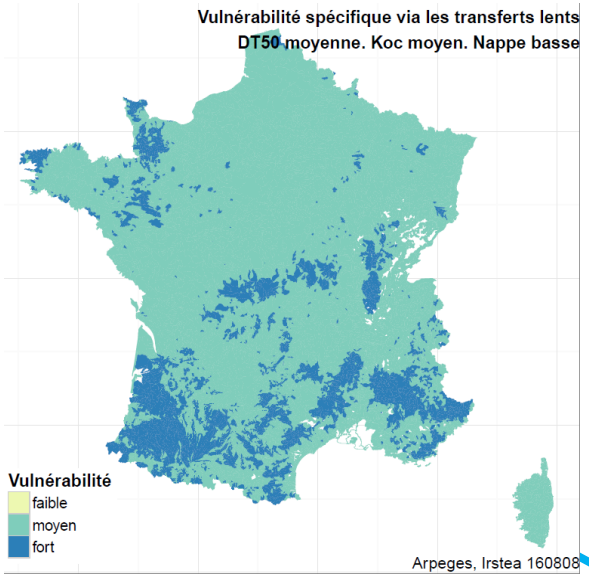




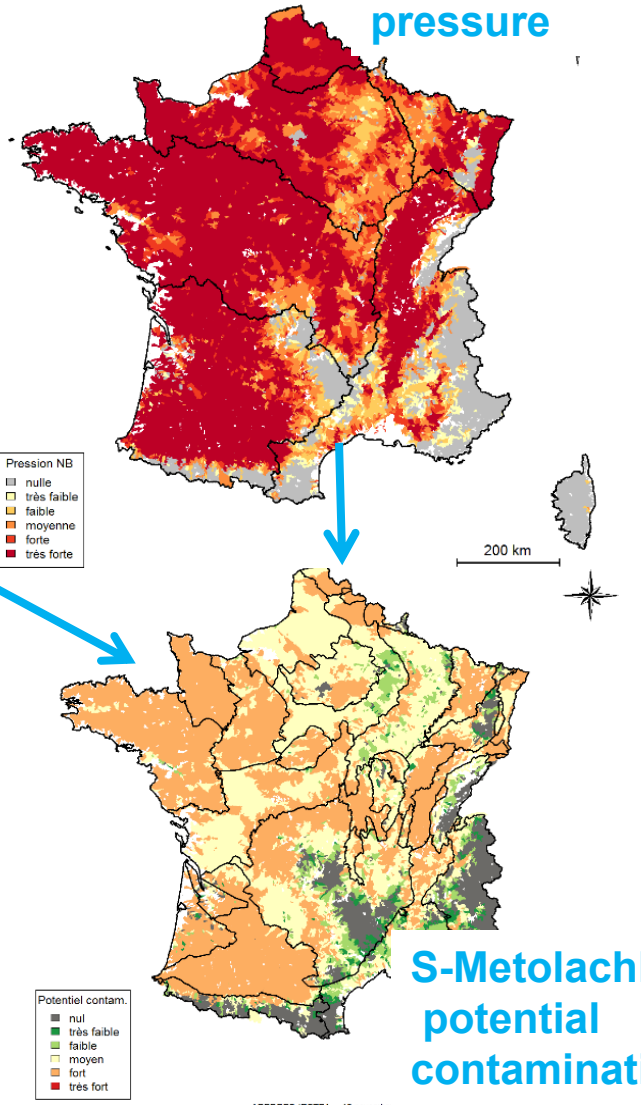
Probability of high or very high potential

Potential contamination: example of slow transfers and spring-summer for S-Metolachlor

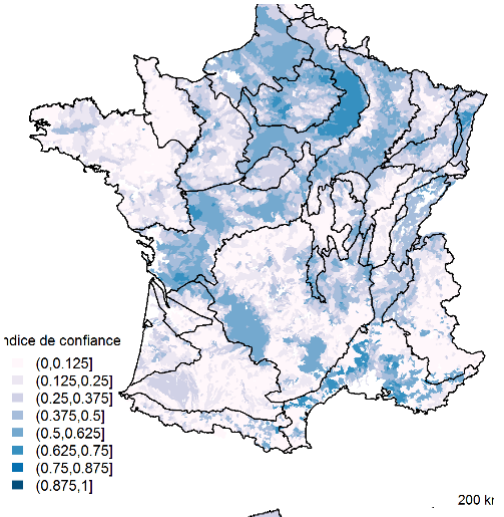
Molecule-specific vulnerability

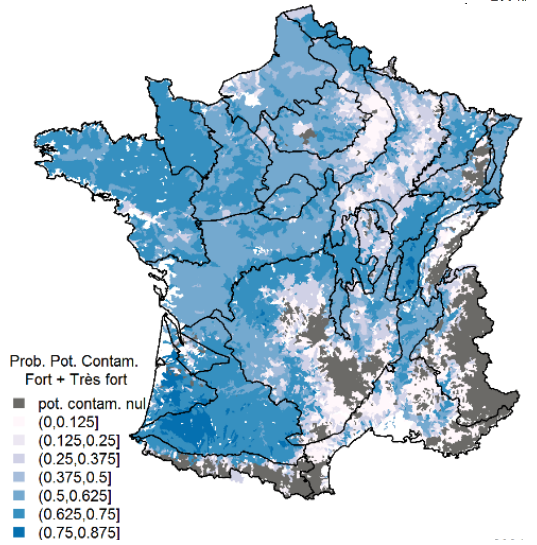


S-Metolachlor pressure



Confidence index





- ✓ Cartographic representation of potential contamination for each pesticide

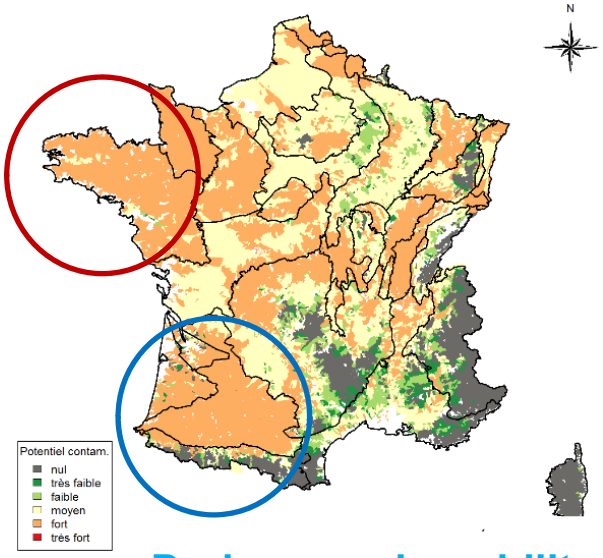
S-Metolachlor potential contamination

Probability of high or very high potential

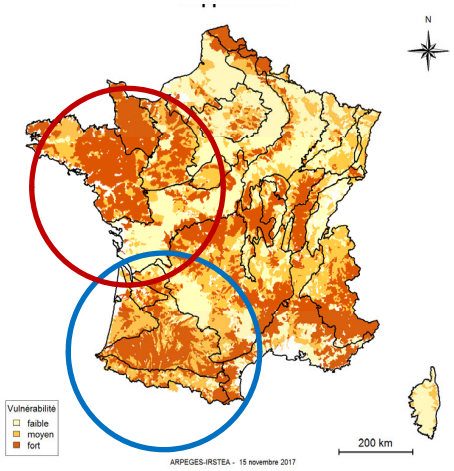
Potential contamination: example of slow transfers and spring-summer for S-Metolachlor

Possibility to identify the contribution of each transfer determinant

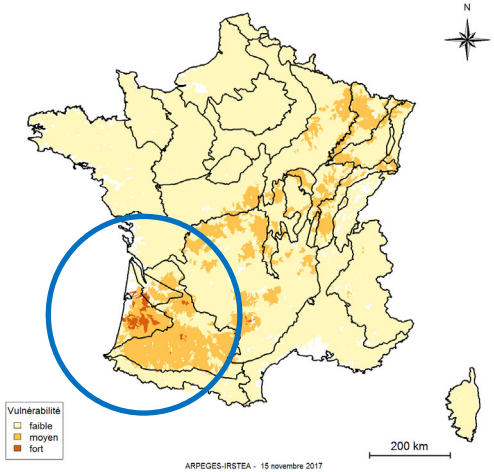
S-Metolachlor potential contamination



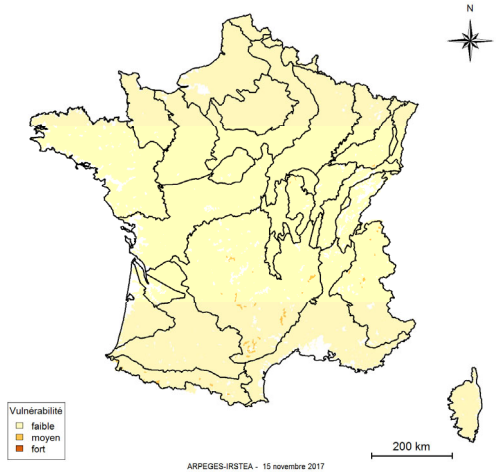
Run-off vulnerability



Drainage vulnerability



Subsurface vulnerability

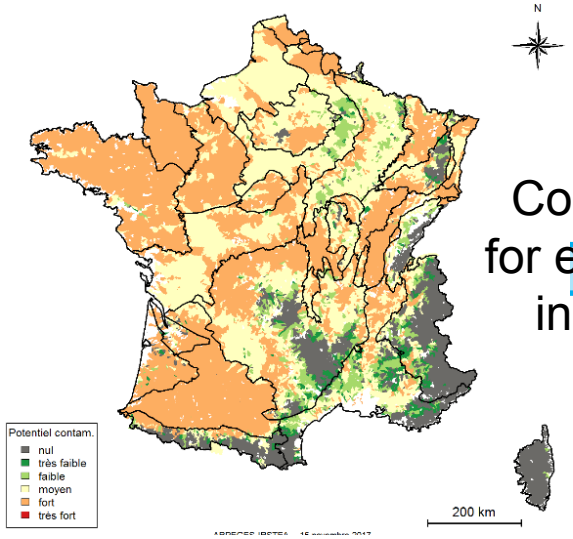


Comparison of the two methods

Cartographic comparison

ARPEGES

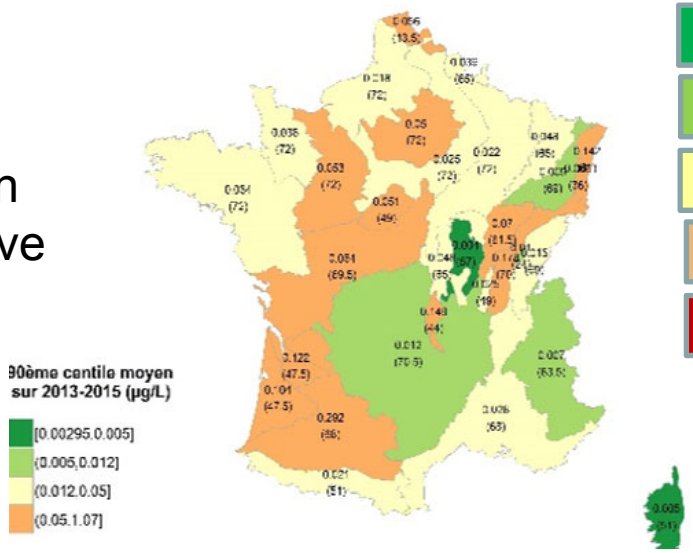
S-Metolachlore



Spring - summer

Comparison for each active ingredient

Monitoring data processed



[0 ; 0,005]

]0,005 ; 0,012]

]0,012 ; 0,05]

]0,05 ; 1,07]

]1,07 ; …[

Compared values :

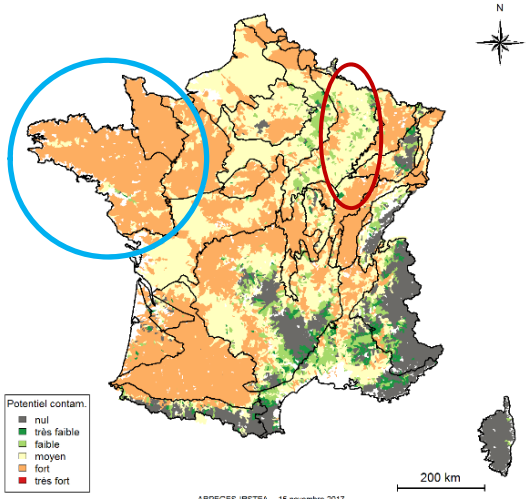
ARPEGES potential contamination through slow transfers and one season

VS monitoring data' centile 90 annual mean integral per HER for the 3 years 2013-2015

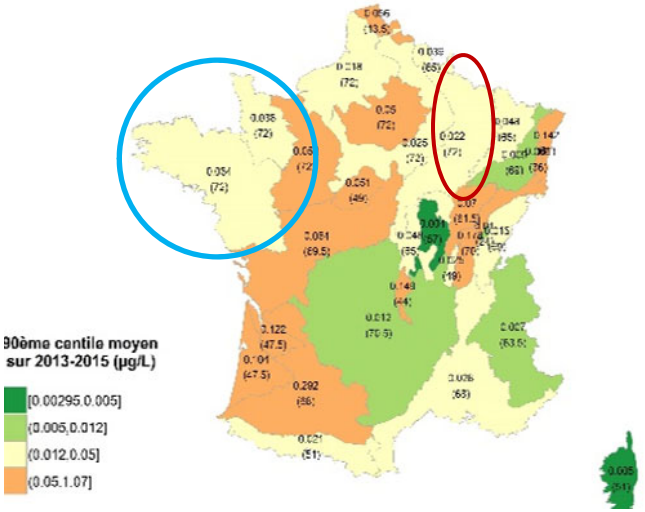
Cartographic comparison: example of S-Metolachlor

S-Metolachlor

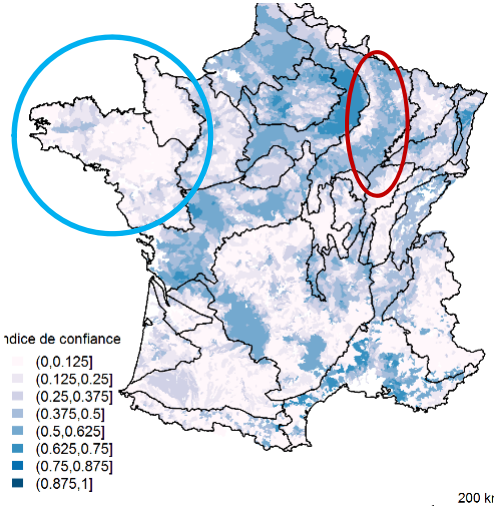
ARPEGES



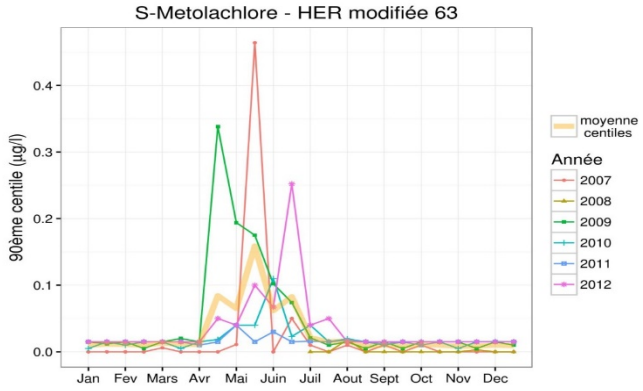
Monitoring data processed



Confidence index



- ✓ Global consistency of the results between the two methods
- ✓ At a closer look, local discrepancies, due to:
  - annual weather conditions
  - low confidence index of monitoring data
  - Resolution of each method

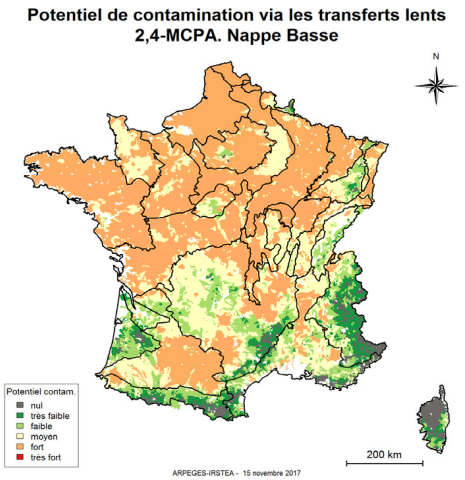


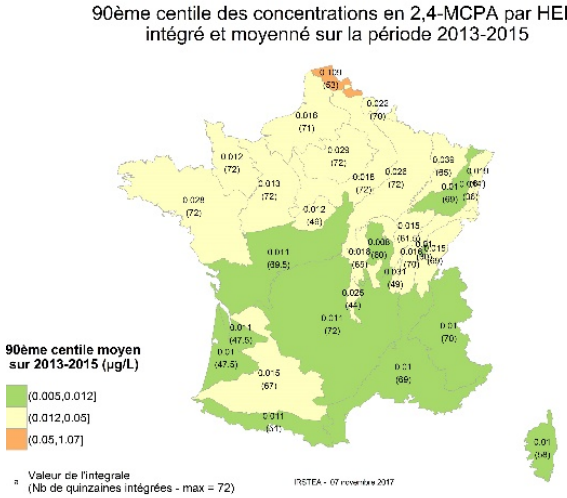
Cartographic comparison: examples of 2,4-MCPA and Nicosulfuron

ARPEGES

Monitoring data processed

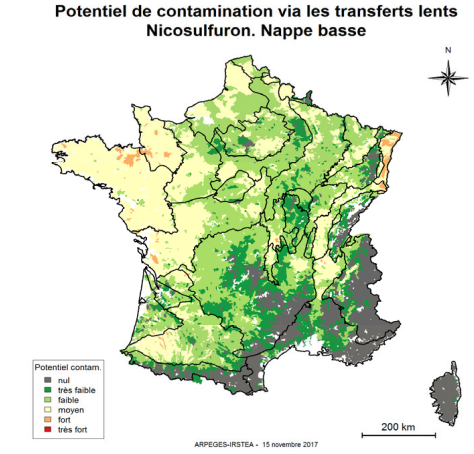
2,4-MCPA (spring-summer)

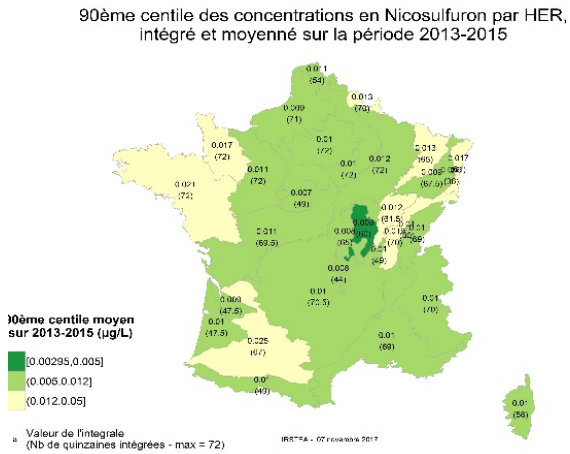




Global shift between the two maps, otherwise, consistency

Nicosulfuron (spring-summer)





Global consistency

Conclusions and prospects

Conclusions and prospects

- One method which allows to grasp the significance and the dynamics of contamination, for one substance, in a spatialized way, at the national scale;
- One method which allows to assess the potential contamination of water bodies by one substance at the national scale, taking into account both environmental vulnerability, physico-chemical characteristics of the substance, and its use pressure;
- Those methods could be applied in other European countries for re-registration process and WFD reporting as well - as long as there are enough available data:
  - Monitoring data
  - Environmental variables at national scale
  - Pesticide pressure at national scale

Acknowledgments

This work benefits from the technical and financial support of AFB (previously : Onema) and ANSES.

Thank you for your attention

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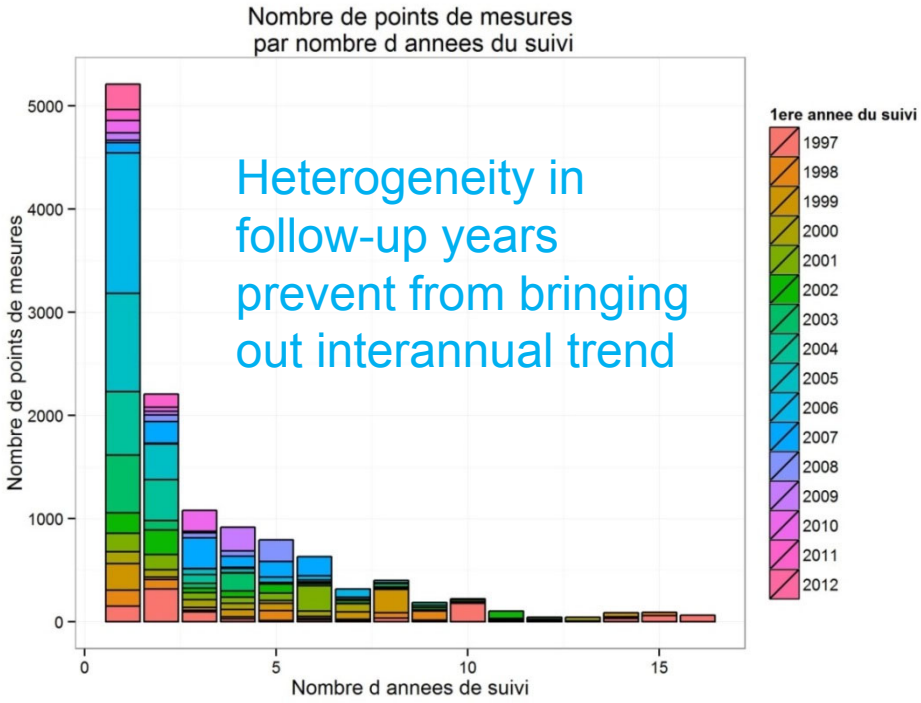
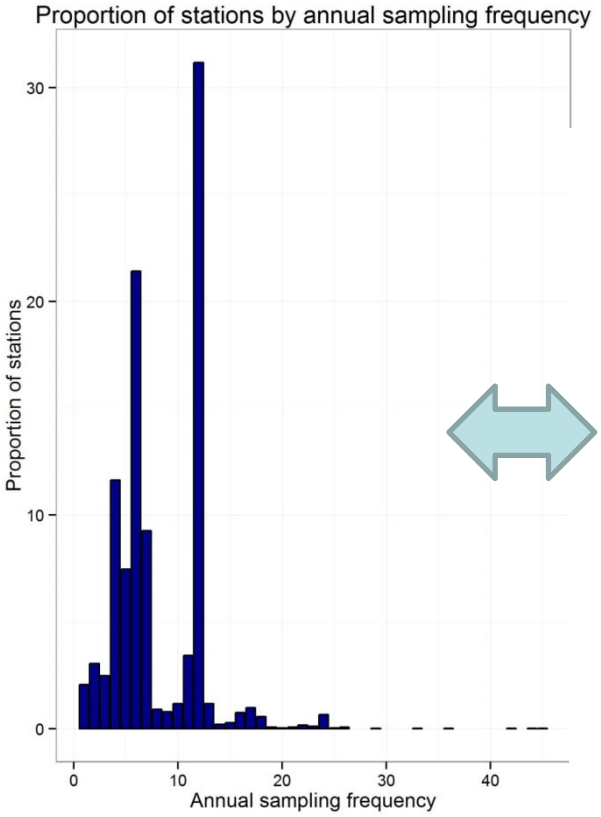
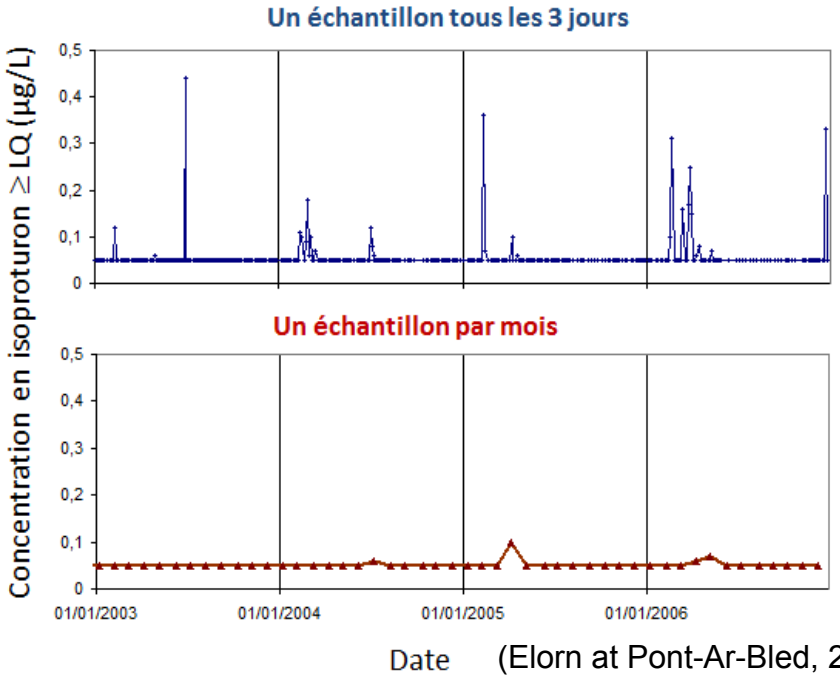
Monitoring data limits

Hypothesis : temporal and spatial aggregation allow to approach the contamination dynamics.



Heterogeneity in follow-up years prevent from bringing out interannual trend

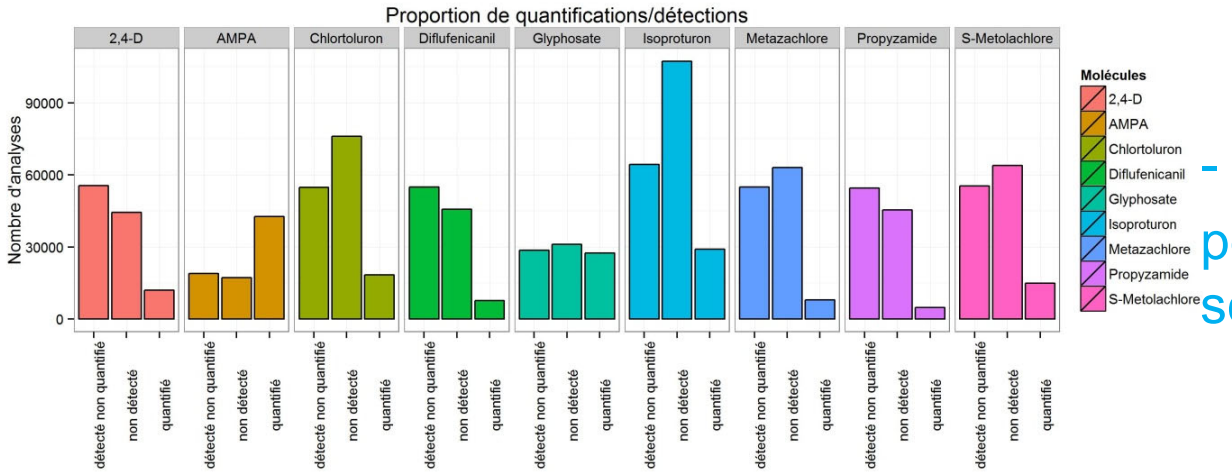


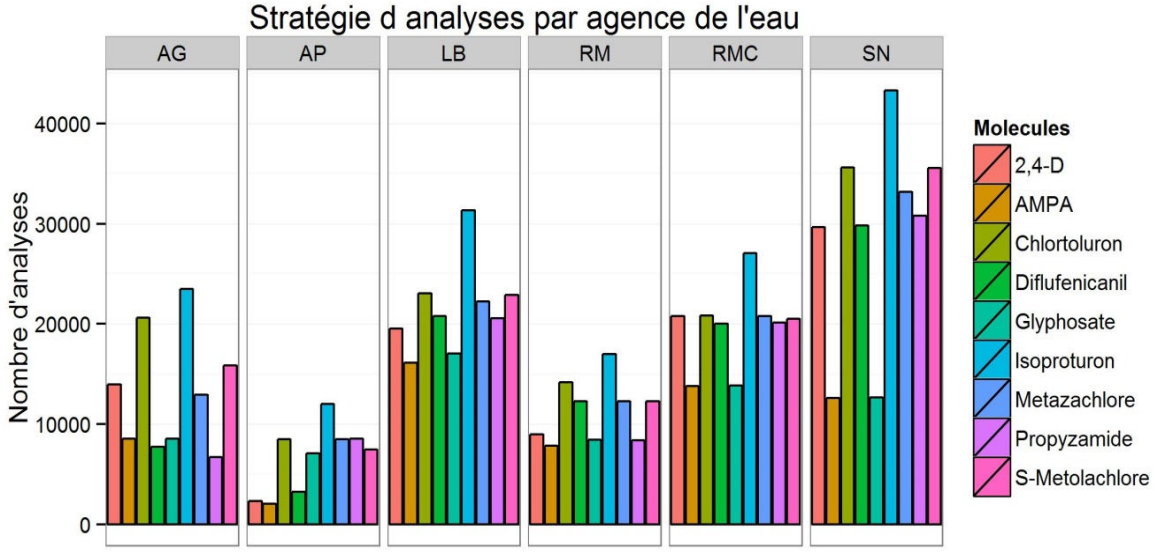


Low sampling frequency for some stations (compared to concentrations dynamics) prevents from bringing out intra-annual trend

(Elorn at Pont-Ar-Bled, 260 km²)

Monitoring data description





Data heterogeneity in :

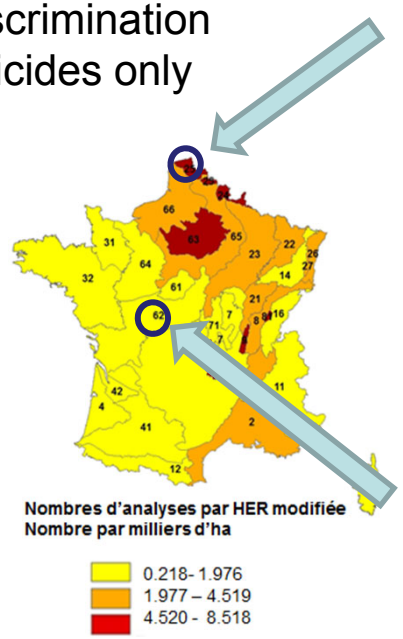
- The number of sampling per molecule at national scale

- The Water Agencies' strategies sampling

Special case of glyphosate (and AMPA) : pesticide sold in the largest quantities, but the least sampled and with the highest proportion of quantifications

Discrimination of spatial trends : example of Propyzamide

For intra-annual dynamics : discrimination for some pesticides only (isoproturon, metazachlore, propyzamide)

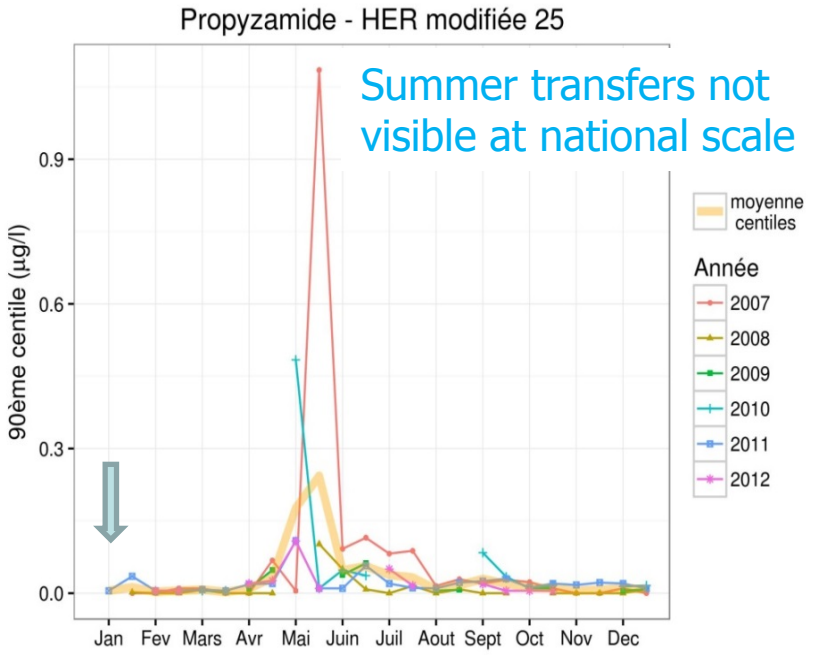


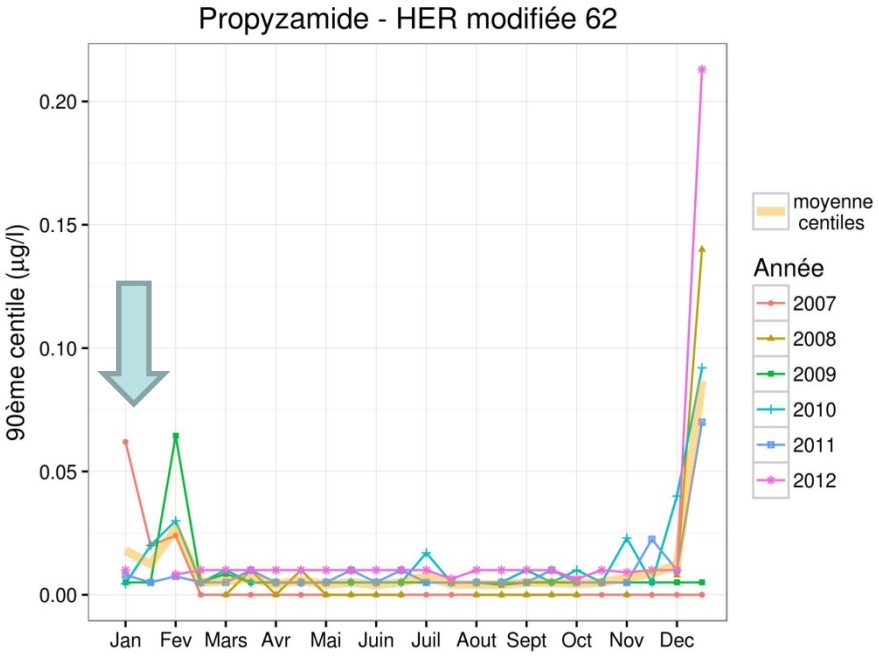
Flandre. Douai Condé

Spring uses on field vegetables

Tables calcaires Sud Loire et Charente-Poitou

Spreading on rapeseed in November

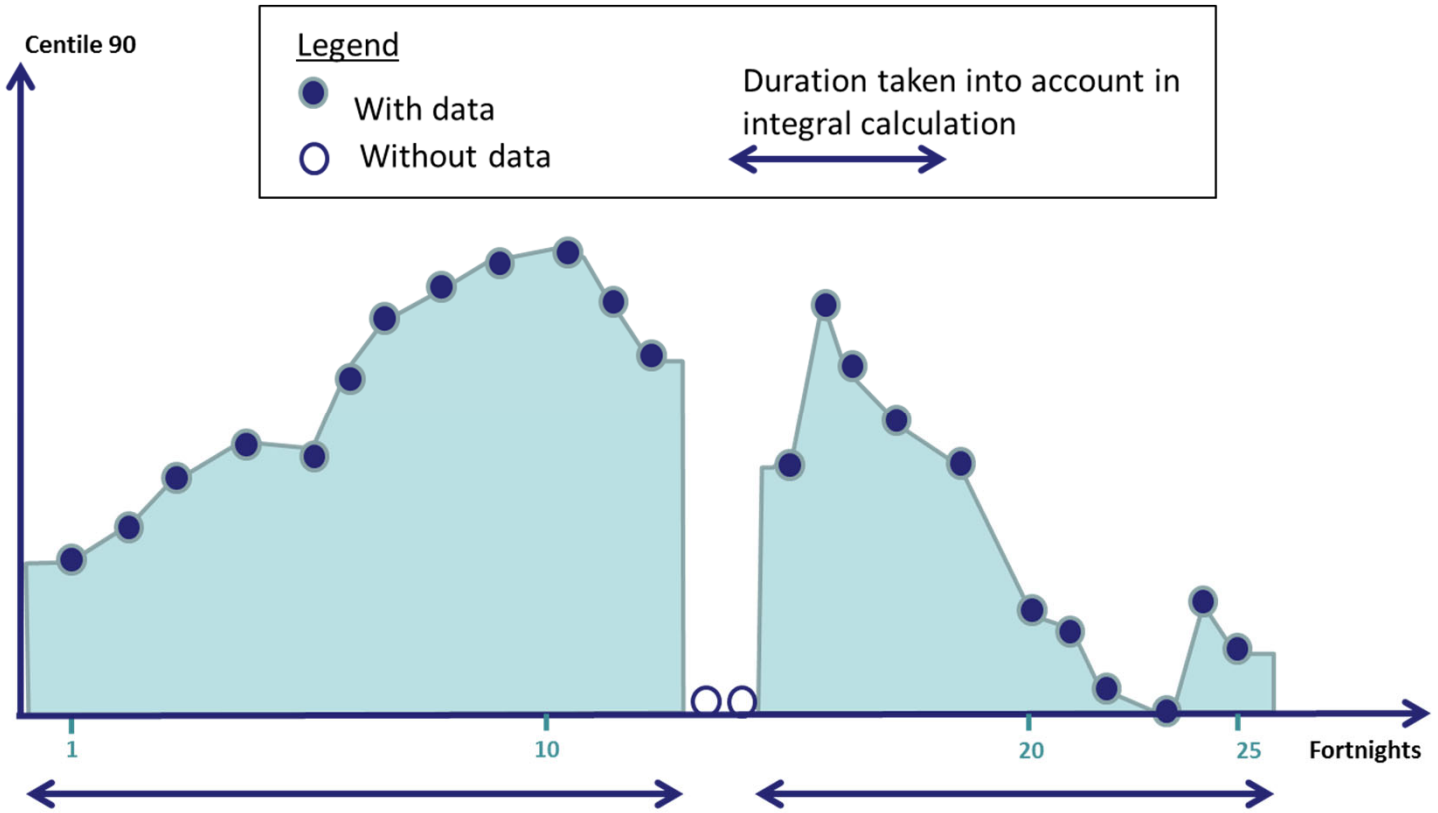




Ranking of spatial and temporal situations

- ⇒ Curve envelops give trends but are not easy to use to have a global view of each HER potential of contamination
- ⇒ Proposition of a simple indicator: mean of the envelop curve integral over the year

Situation 2 : some fortnights with no data



The number of fortnights used for calculating the mean (here : 22) is called « confidence index » and gives the representativeness of the indicator