Health risk assessment based on pesticide monitoring in Saïss plain (Morocco) groundwater

Imane BERNI, Aziza Menouni, Ibrahim El Ghazi, Lode Godderis,
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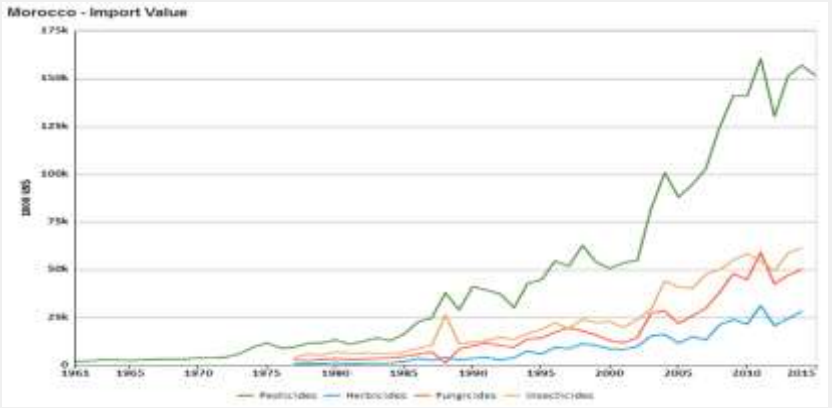
Why pesticides?

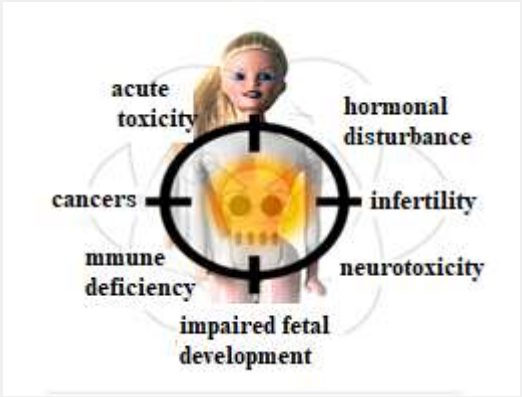
PESTICIDES

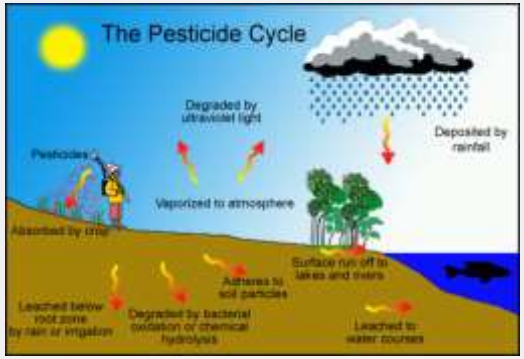
Increased import value growing at an average annual rate of 10.16 %



Pesticides trade in Morocco between 1961 and 2015 : (Source : FAO, 2017)

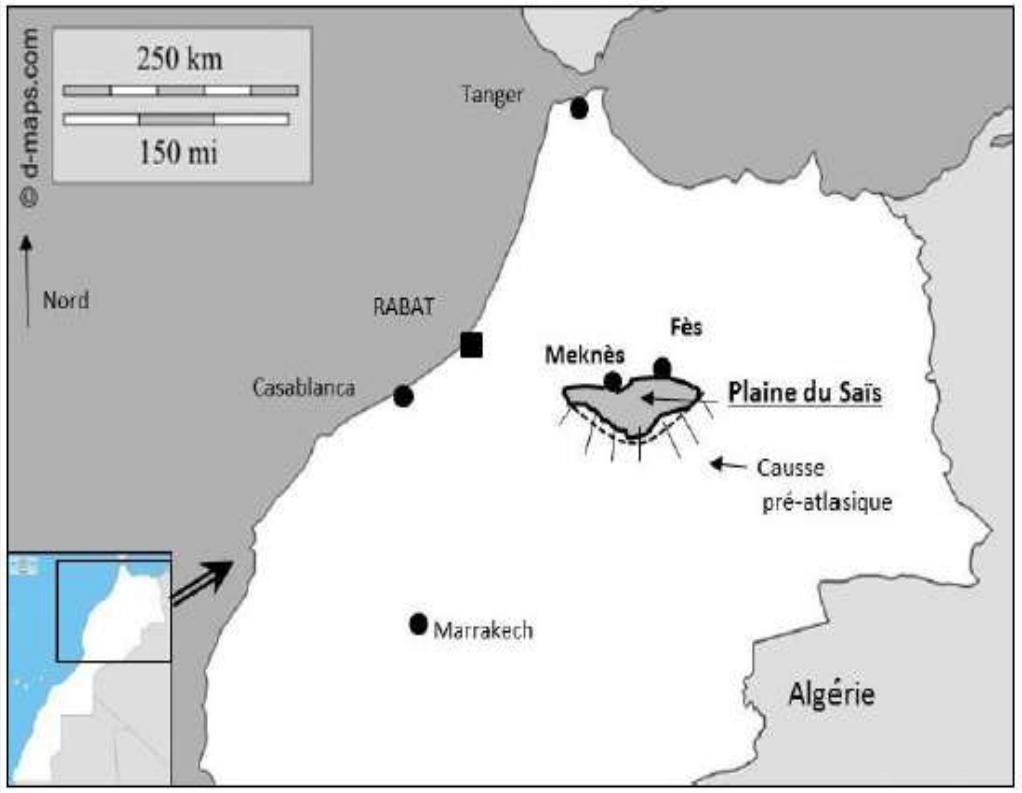
Environmental & health problems





Effect of pesticides on health and the environment

Study area



Saiss plain location

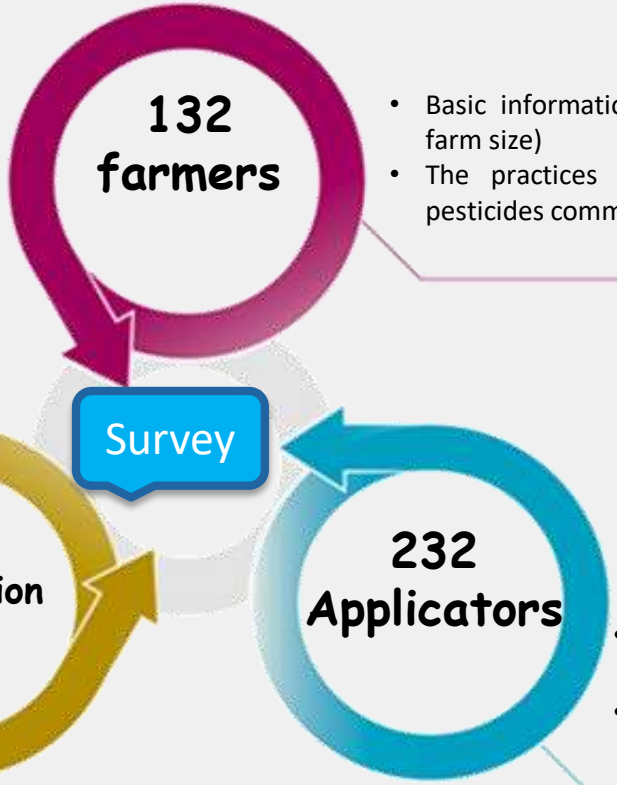
Saiss plain is an intensively agricultural region where **pesticides** are extensively used to boost agricultural productivity

Aim

Perform human health risk assessment based on the monitoring of pesticides in Saiss groundwater in Morocco using passive sampler devices

Saiss plain location

Pesticides practices



- Basic information (gender, age, educational level, farm size)
- The practices of pesticide application and the pesticides commonly used

- Observations during storage, mixture and application of pesticides in the field

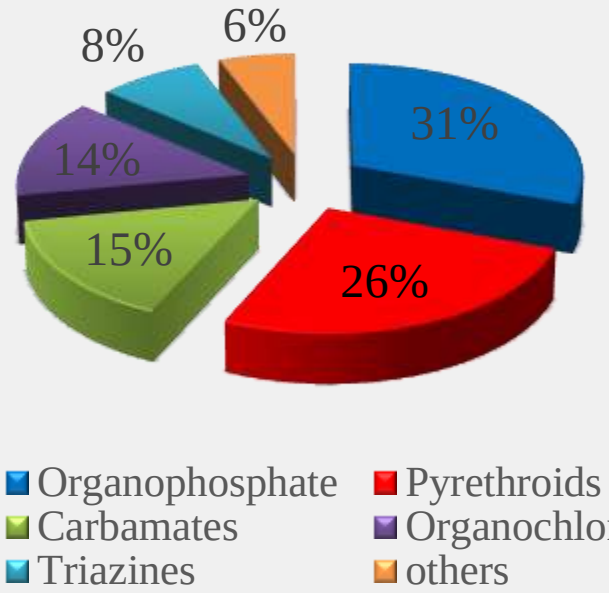
- The level of awareness of the dangers of pesticides
- Their strategy of phytosanitary practices

Method | Results

Pesticides practices

Socio-demographic characteristics of the interviewees

Parameter	Respondents			
	Farmers (N=132)	%	Applicators (N= 232)	%
Age				
<30	15	11,3	75	32,3
30-39	50	37,8	52	22,4
40-49	27	20,4	54	23,3
50-59	16	12,1	27	11,6
>60	24	18,1	24	10,3
Gender				
Male	130	98,4	216	93,1
Female	2	1,6	16	6,9
Education Levels				
Illiterate	28	21,2	74	31,9
Coranique	24	18,8	20	8,6
Primary	41	31,1	95	40,9
Secondary	32	42,2	42	18,1
College	1	0,75	1	0,4



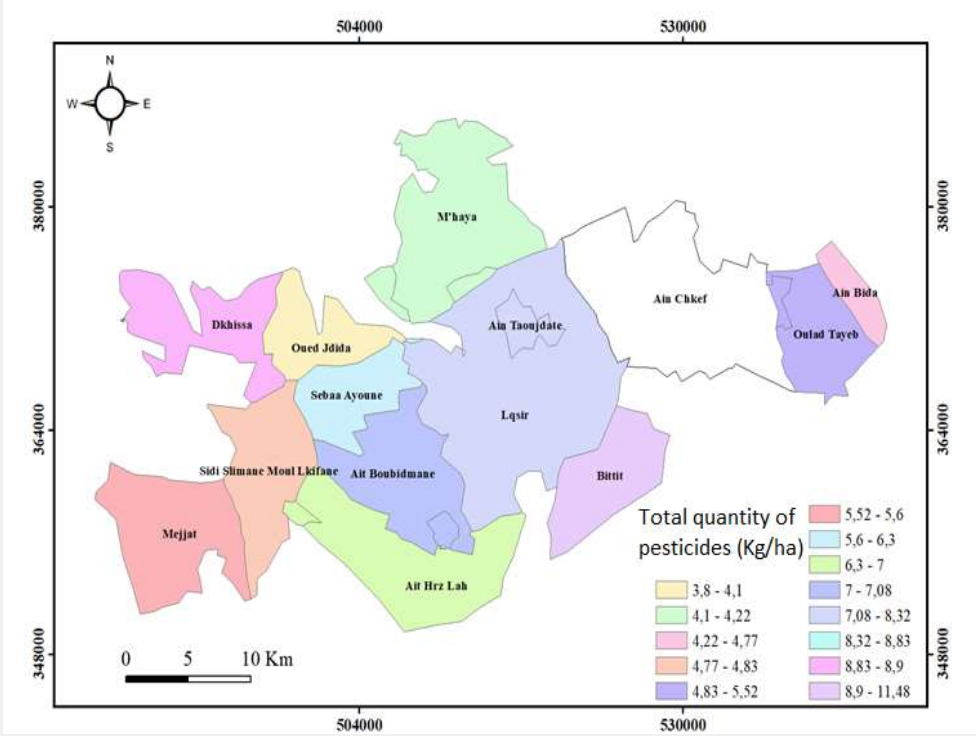
Distribution of active ingredients by chemical family in Saiss plain

Pesticides practices

List of common pesticides used in Saiss plain

Matière active	Classe de danger	Fréquence (n=132)	Pourcentage %
Deltaméthrine (pyr)	II	81	61,4
2,4 D (OC)		81	61,4
Carbendazime (Car)	U	75	56,8
Glyphosate (OP)	U	70	53,0
Zirame (Car)	III	68	51,5
Chlorpyrifos éthyl (OP)	II	64	48,5
Imidaclopride (Neo)	II	58	43,9
Manèbe (dithio)	U	54	40,9
Diméthoate (OP)	II	50	37,9
Malathion (OP)	III	35	26,5
Endosulfan (OC)	II	30	22,7
Parathion (OP)	Ia	29	22,0
Bifenthrine (Pyr)	II	26	19,7
Dicofol (OC)	O	23	17,4
Chlorothalonil	U	18	13,6
Chlorpyrifos méth		15	11,4

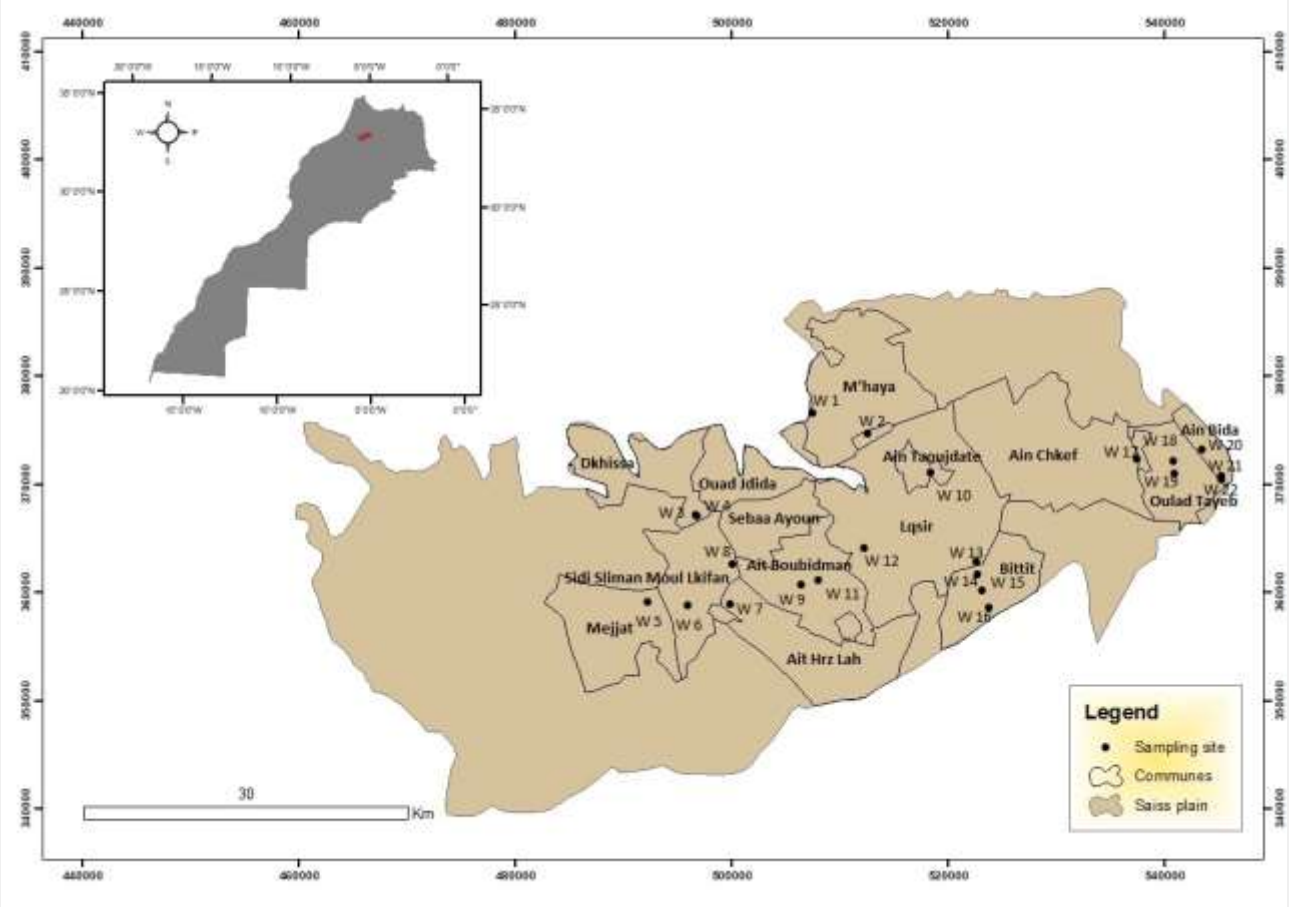
Total quantity of pesticides



Method

Results

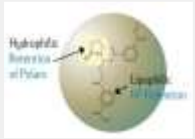
Environmental monitoring and Risk assessment



Maps location of 22 sampling sites where POCIS samplers were deployed

Method

Results



POCIS A & POCIS B

Field Deployment & Analysis Flowchart

Field Deployment

Sorbent Transfer to the Catridge

Sorbent Elution

Instrumental Analysis with UPLC-MS/MS & GC-MS

Data Quantification

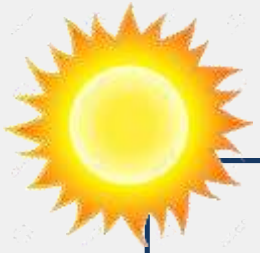
Human Health Risk Assessment

Carcinogenic risk of detected pesticides in groundwater used as drinking water for children, adults and infants were assessed using Hazard Quotient model (USEPA, 2010):

$$HQ = \frac{Cw \times IRw \times EF \times ED}{Bw \times AT \times RfD} \times SF$$

Cw *is the measured concentration (mg/L);* ***IRw*** *is the water ingestion rate;* ***EF*** *is the exposure frequency;* ***ED*** *is the exposure duration;* ***BW*** *is the body weight;* ***AT*** *is the average lifetime for non-carcinogens;* ***RfD*** *is the reference dose of the contaminant (mg/kg/day)*

28 compounds and their metabolites

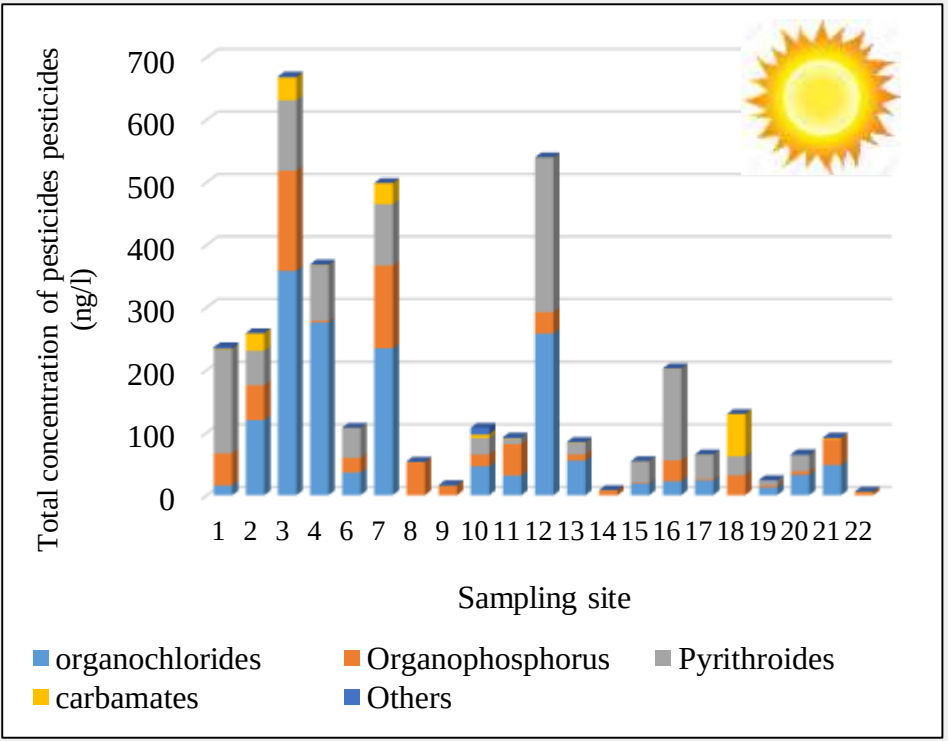


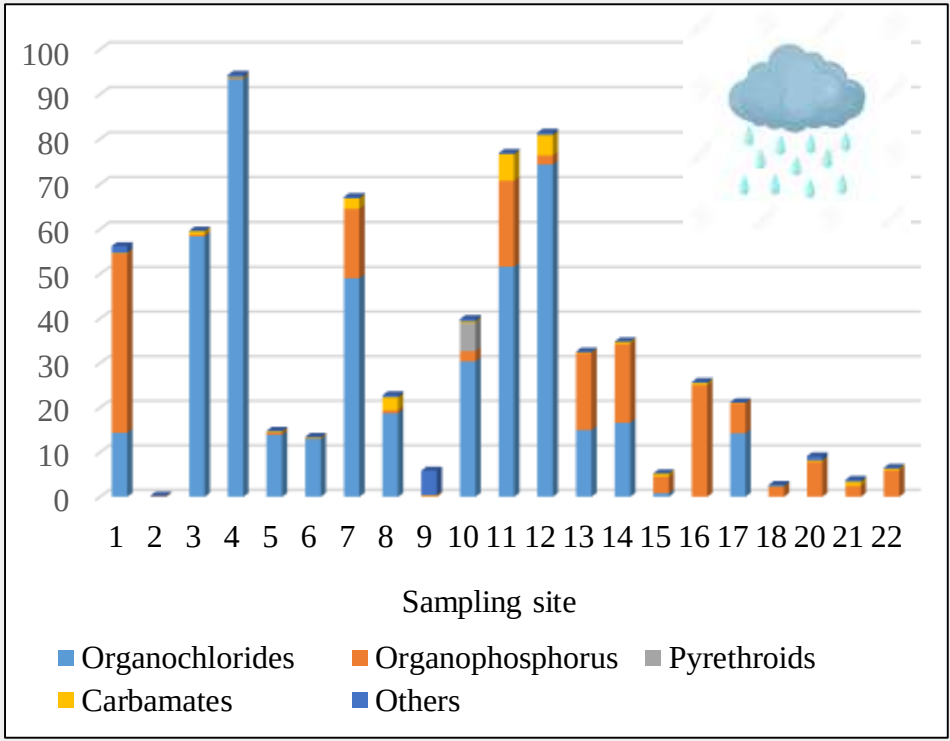
22 compounds

17 compounds

Environmental monitoring and Risk assessment

Total concentrations of pesticides identified at each sampling site in groundwater during summer and winter campaigns



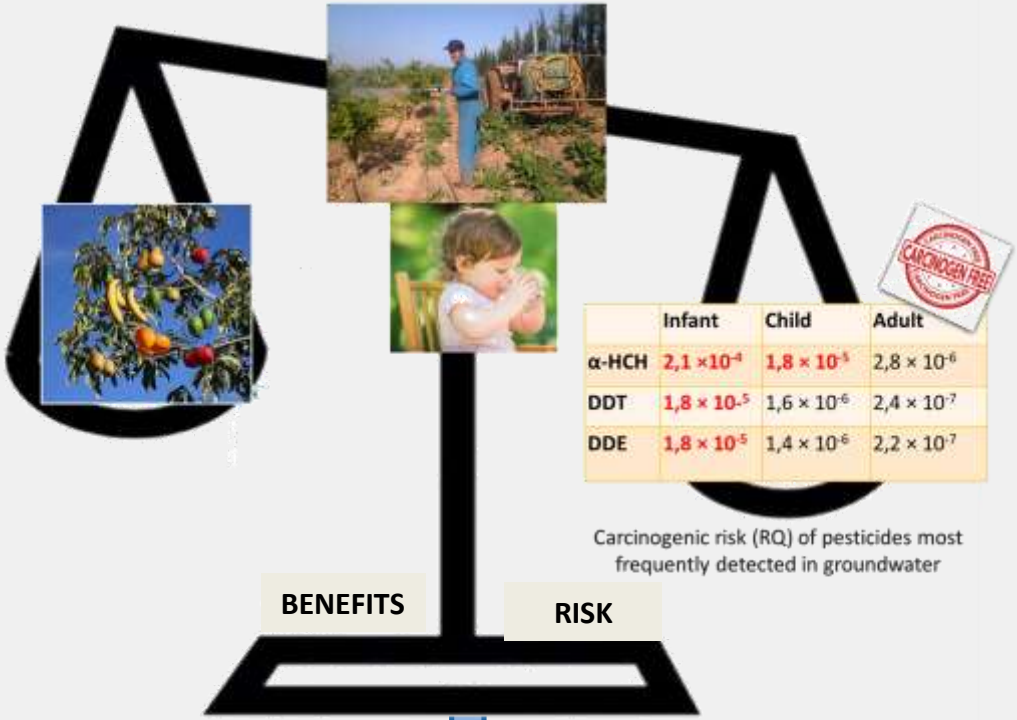


- Most of the identified pesticides showed important seasonal and spatial variation.
- Organochloride compounds contributed the most to the total pesticides burden in Saiss plain in Morocco

Method

Results

Human health: Carcinogenic Risk Assessment



	Infant	Child	Adult
α-HCH	$2,1 \times 10^{-4}$	$1,8 \times 10^{-5}$	$2,8 \times 10^{-6}$
DDT	$1,8 \times 10^{-5}$	$1,6 \times 10^{-6}$	$2,4 \times 10^{-7}$
DDE	$1,8 \times 10^{-5}$	$1,4 \times 10^{-6}$	$2,2 \times 10^{-7}$

Carcinogenic risk (RQ) of pesticides most frequently detected in groundwater

Exposure to pesticide through drinking groundwater pose risk to infant, children and adult

Method

Results

Environmental monitoring and Risk assessment

Use of Passive sampler as an analytical approach af pesticides monotoring

Human health risk assessment

Effective approach to suggest mitigation measures.

Conclusion

Contact us

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Health and ecological risk assessment based on pesticide monitoring in Saïss plain (Morocco) groundwater

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ABSTRACT

In many countries, including Morocco, groundwater contamination with pesticides such as globally banned organochlorides (e.g., dichlorodiphenyltrichloroethane (DDT)) and some accredited organophosphates and pyrethroids poses ecological and human health risks. To assess these risks, we herein monitored pesticides in Saïss plain groundwater (Morocco) during the summer of 2017 and the winter of 2018 using polar organic chemical integrative samplers. The two types of passive samplers were deployed in 22 traditional wells for 14–20 days and subjected to solid-phase extraction. The extracts were analyzed by gas chromatography-mass spectrometry and liquid chromatography-tandem mass spectrometry using a multiresidue method, and 27 pesticides were detected in total. In the summer campaign, 22 pesticides with individual concentrations ranging from <limit of quantitation (LOQ) to 243.1 ng L^{-1} were identified, whereas 17 compounds with concentrations ranging from <LOQ to 53.8 ng L^{-1} were detected in the winter campaign. In the summer period, the maximum individual concentrations of chlorothalonil, DDT, and γ-hexachlorocyclohexane (γ-HCH) equaled 111.7, 36.1, and 22.3 ng L^{-1}, respectively, with the respective values for the winter period equaling 18.14, 16.62, and 22.2 ng L^{-1}. Health risk assessment indicated that the carcinogenic α-HCH, β-HCH, DDT, and dichlorodiphenyldichloroethylene present in groundwater may also contaminate drinking water and thus pose a threat to human health, particularly to that of infants and children. Further analysis revealed that the Saïss aquifer presents a high ecological risk. Thus, the monitoring of pesticides in groundwater by passive sampling was effective and could be combined with human health and ecological risk assessment to

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