Pesticides

Exposure and impacts on wildlife

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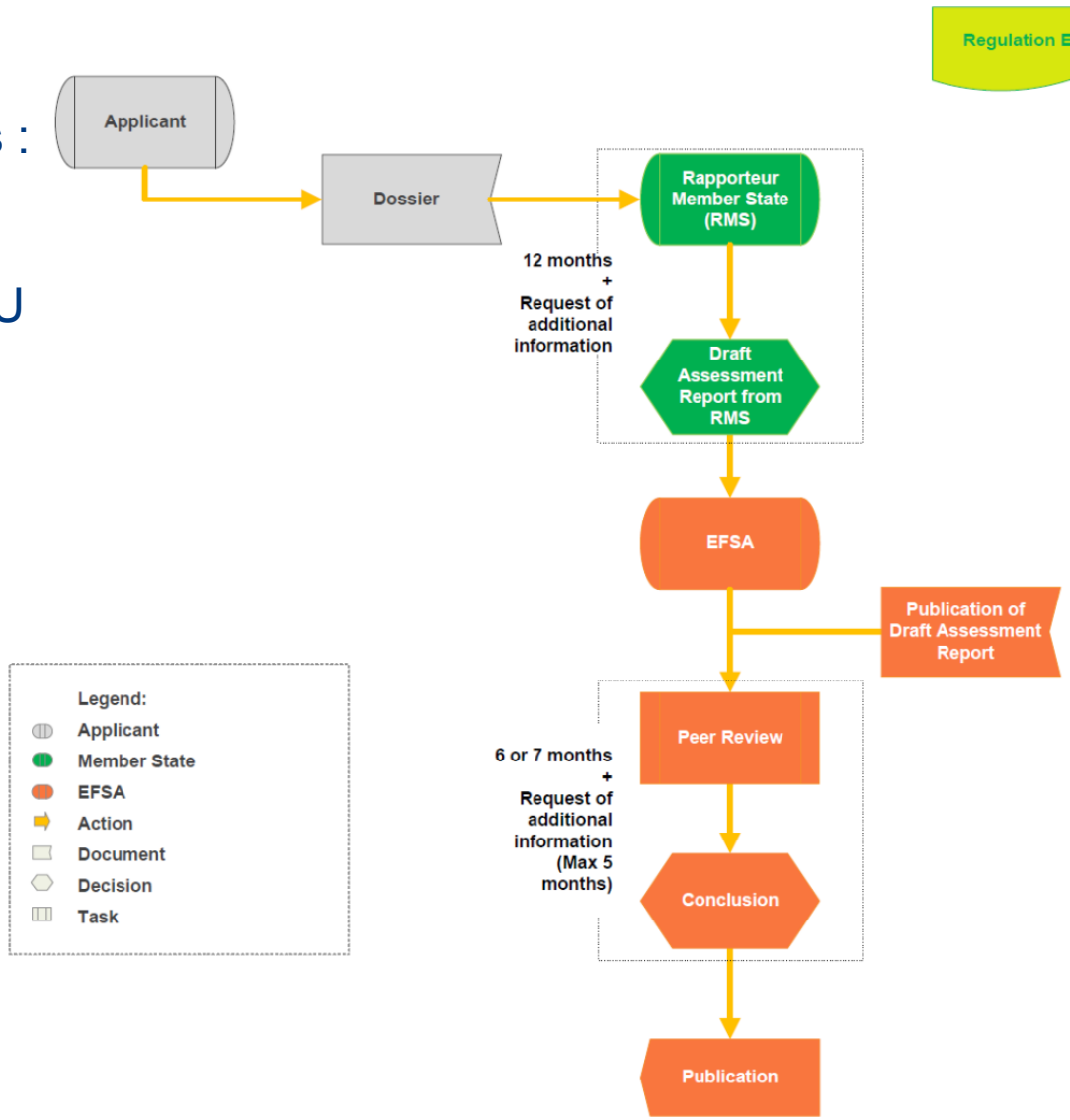
Forum Médecine et Environnement
Soleure 23 mai 2019
Jeanne Garric. Senior ecotoxicologist

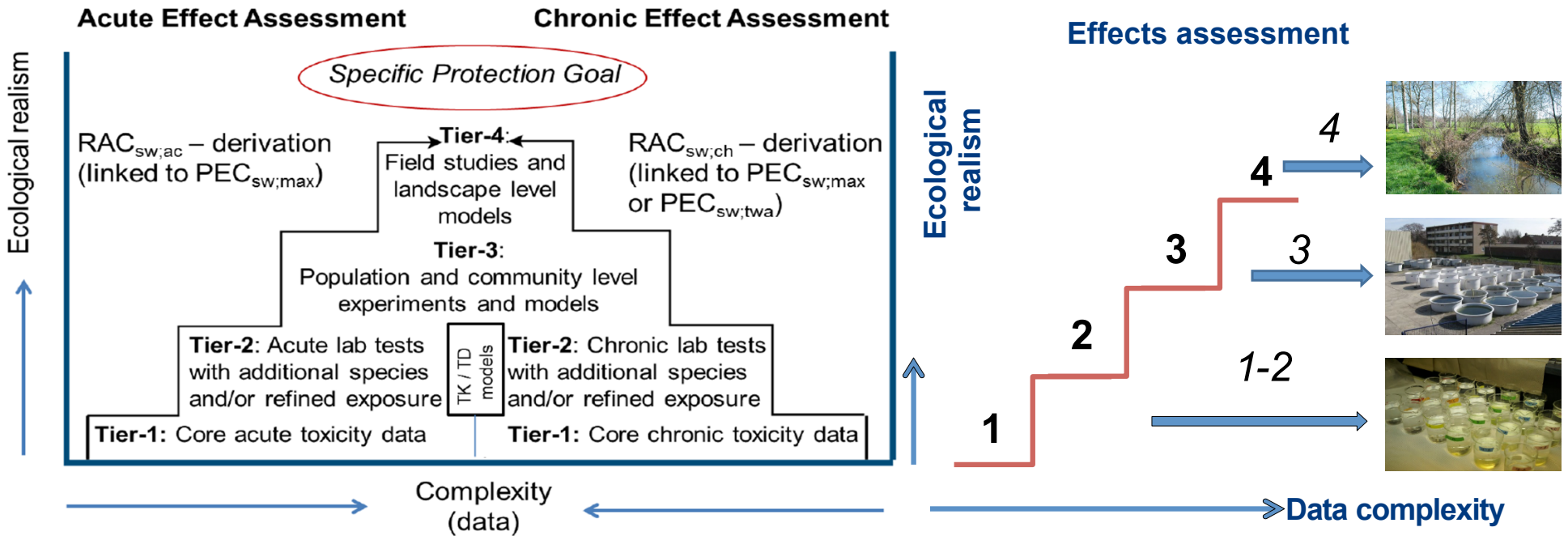
New active substances application workflow

Marketing and use of pesticides : Regulation EC 1107/2009
Specific data requirement : Regulation EU 283/2013 and EU 284/2013

The rules specify a comprehensive risk assessment and autorisation procedure for active substances and products containing these substances.
Applicants are obliged to provide data showing that a substance can be used safely wit respect to human health, animal health and the environment

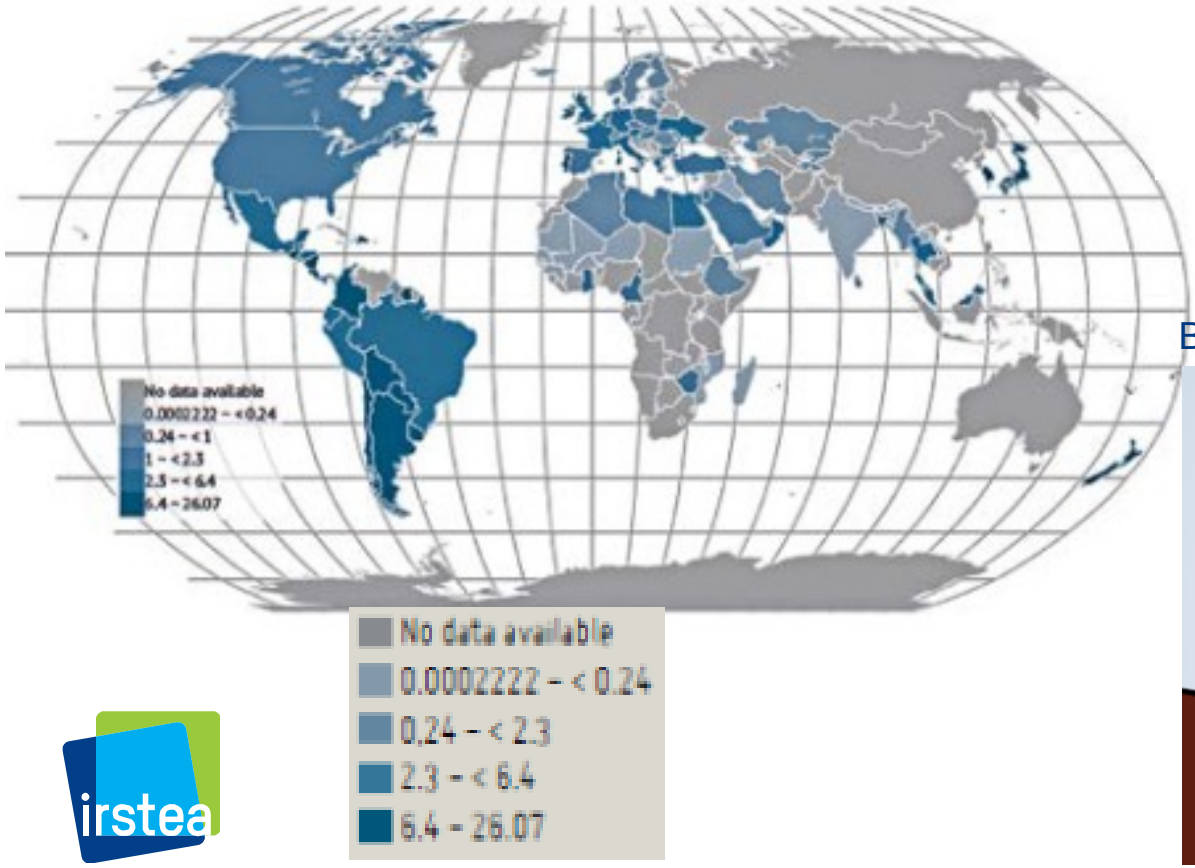


Guidance on tiered risk assessment EFSA 2013



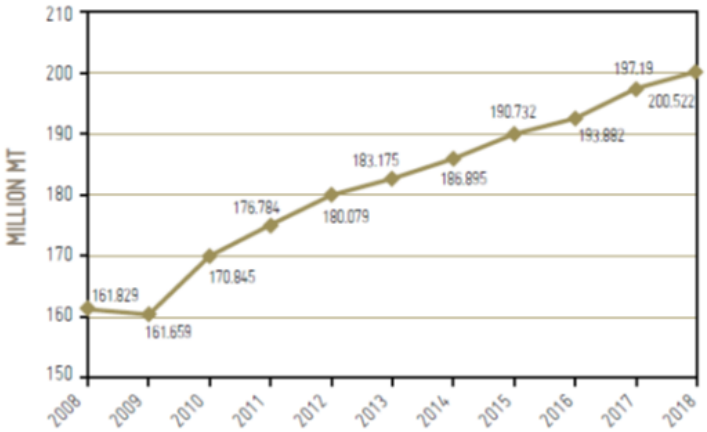
Wordlwide exposure

Use of pesticides per hectare of arable land, kg/ha, in the years 2007–2012. Source: FAO, 2015c

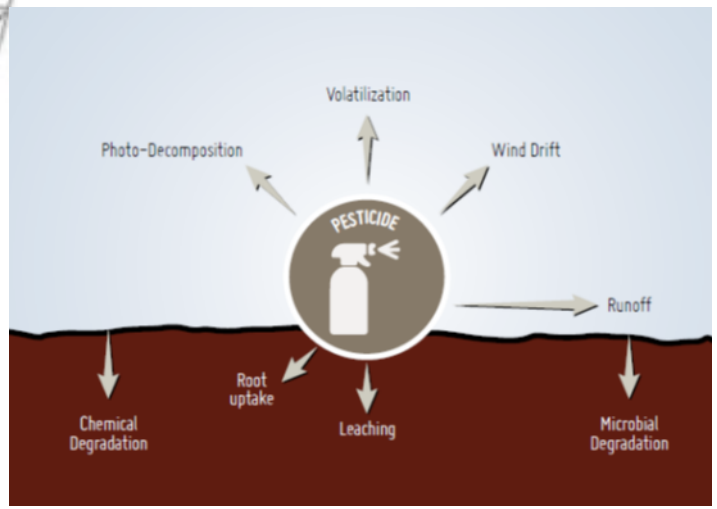


Rodríguez-Eugenio, N et al. 2018. Soil Pollution: a hidden reality. Rome, FAO. 142 pp.

Global synthetic fertilizers consumption.



Behaviour of pesticides in the environment

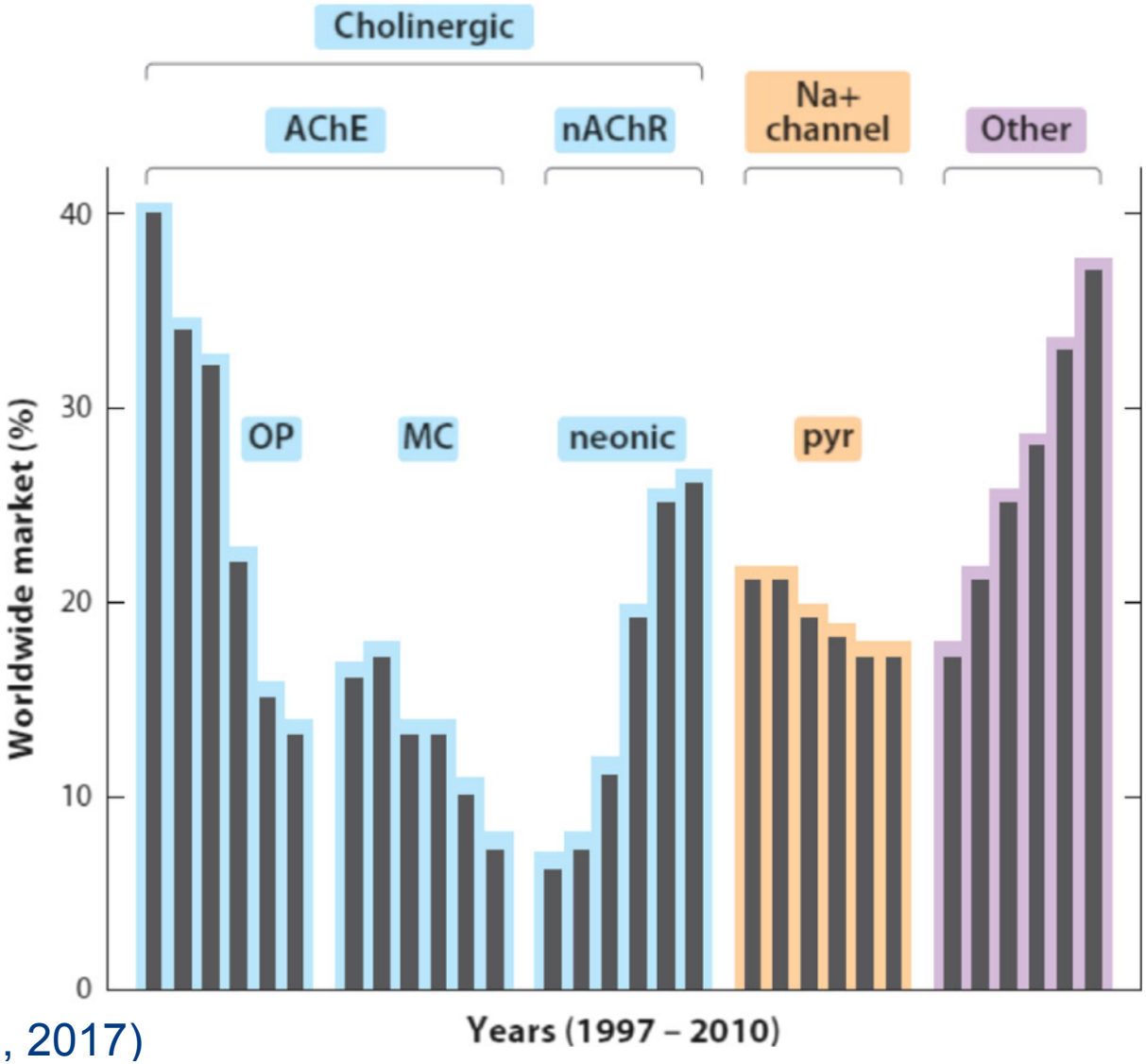


From Singh 2012

Pesticide market evolution: : increasing use of neocotinoids

Clothianidin, imidacloprid, thiamethoxam….

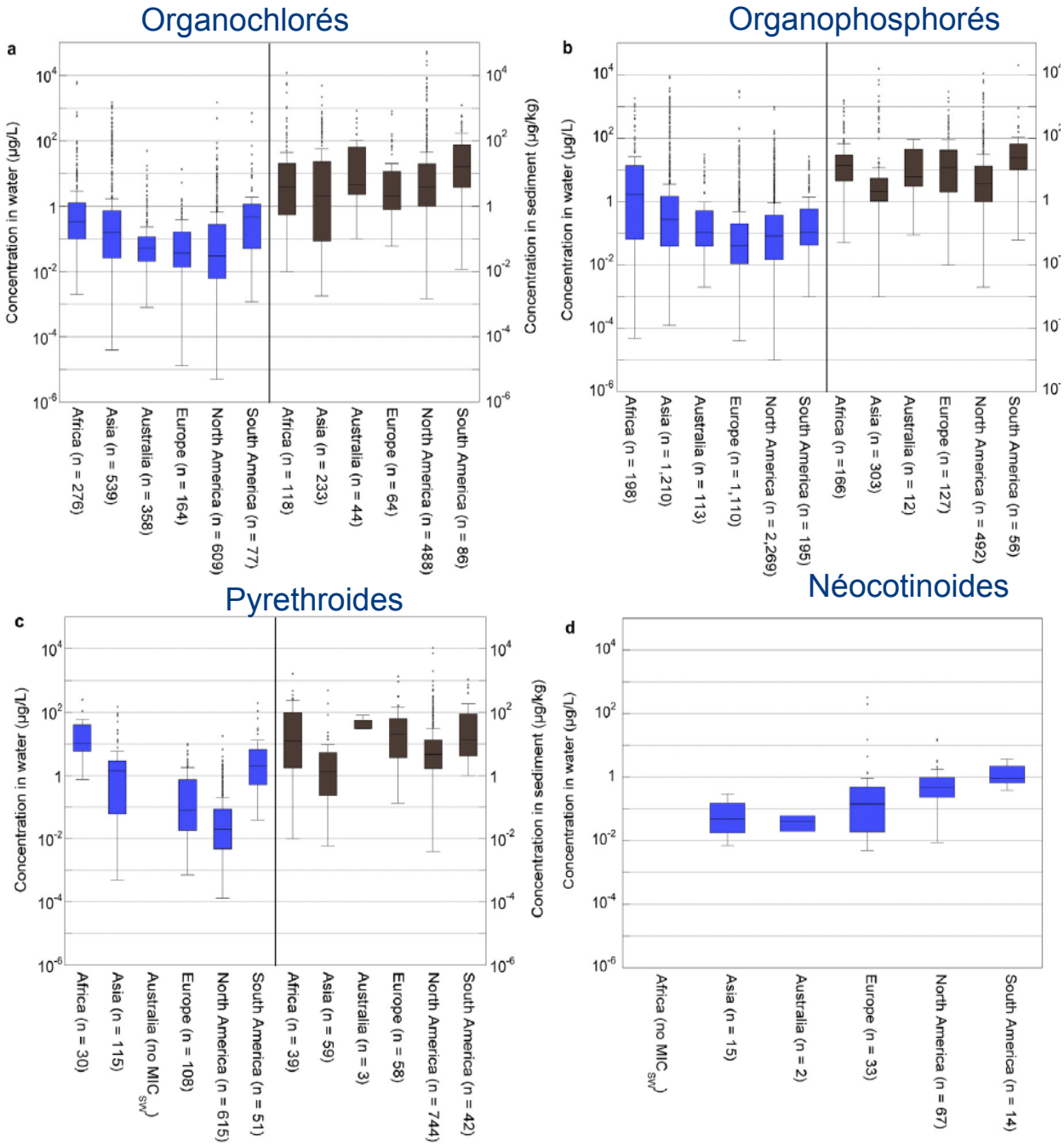
First introduction 1990s
The most widely used in the world, mainly as seed dressing
Persistence in soil (DT_{50} from 3 to 1000d)
Leaching with water



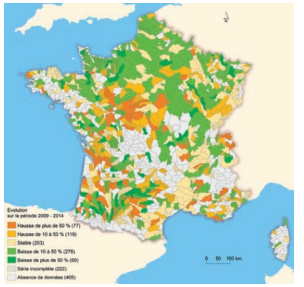
(Wood & Goulson, 2017)

Distribution of measured insecticide concentrations in water and sediment, at world wide scale

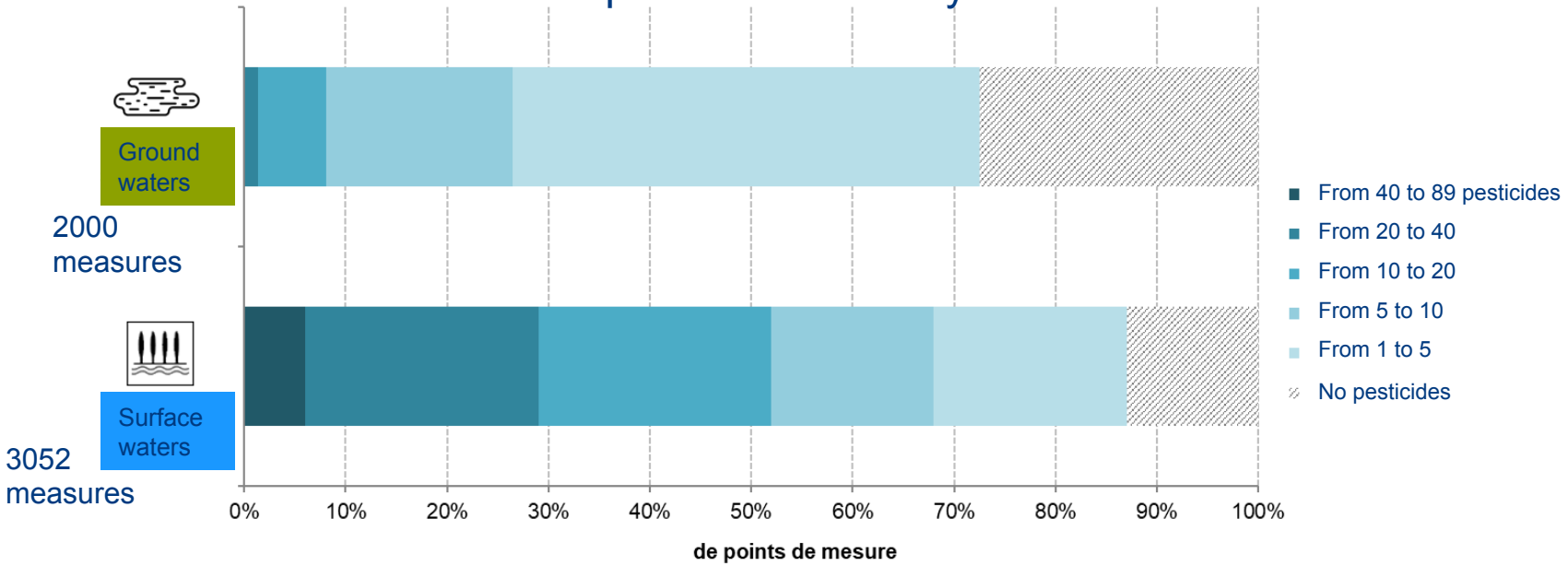
Stehle et al. 2018



Pesticides contamination ZOOM

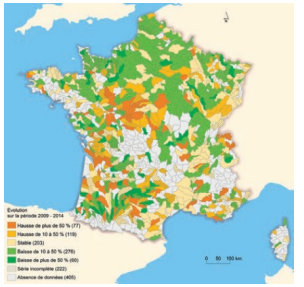


Number of measured pesticides in analysed areas in 2014

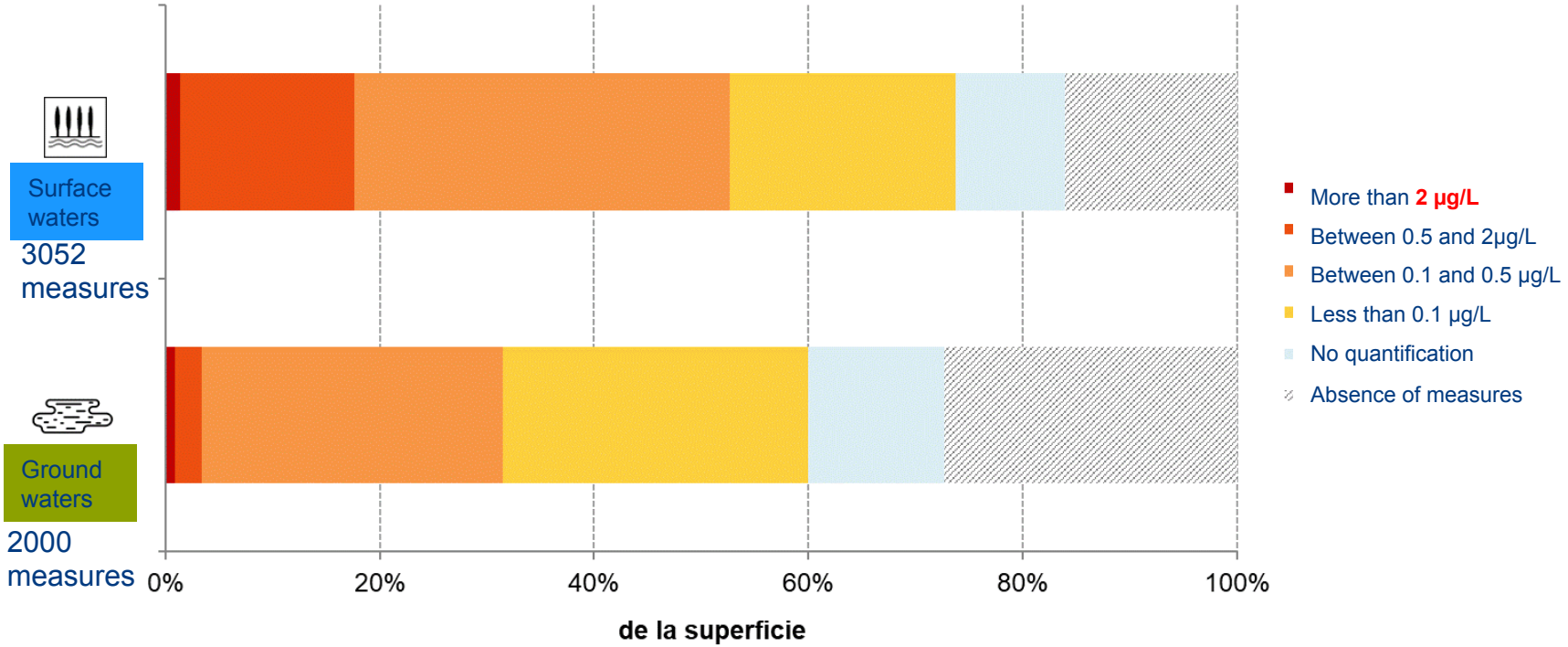


Pesticides are found in 87% of analysed areas.
40 pesticides are measured at least once in 6% of the areas

Pesticides contamination ZOOM



Distribution of the total pesticides concentration for hydrogeogical and hydrographical unit



Areas with concentrations exceeding **2 µg/L** represent 1.4% of total surface waters sectors and 0.9 % of hydrogeological units

Air contamination

Pesticides distribution in urban (6) and agricultural (2) areas (in Mediterranean regions (PACA , Corse)

726 samples analysed 2007-2012

ng/m3

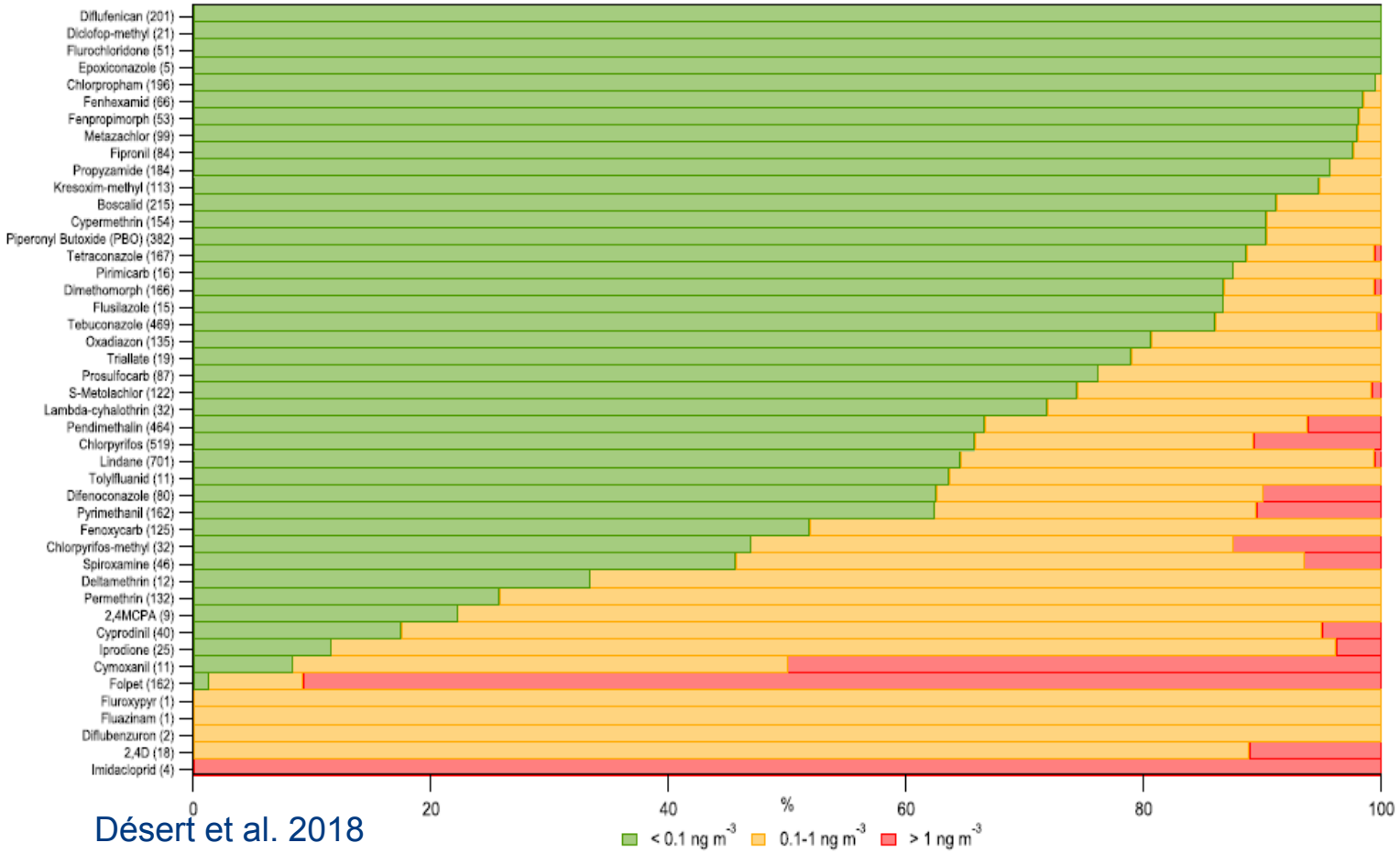
74,4%<0,1

0,1<20,5%<1

5,1%> 1

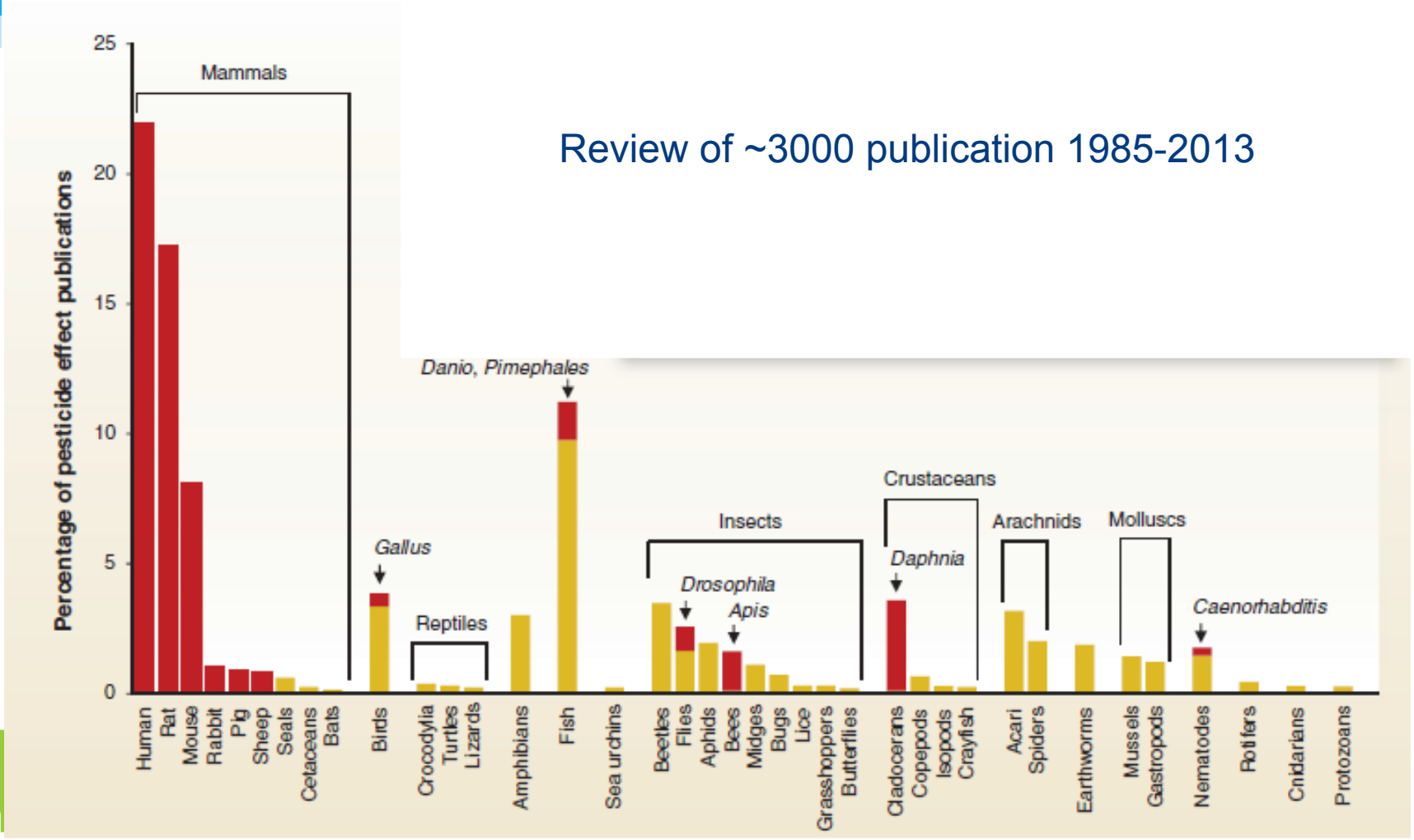
The most frequently detected :

- Pendimethalin (H)
- Tebuconazole (F)
- Chlorpyrifos (I)



Désert et al. 2018

Trends in research on pesticide effects

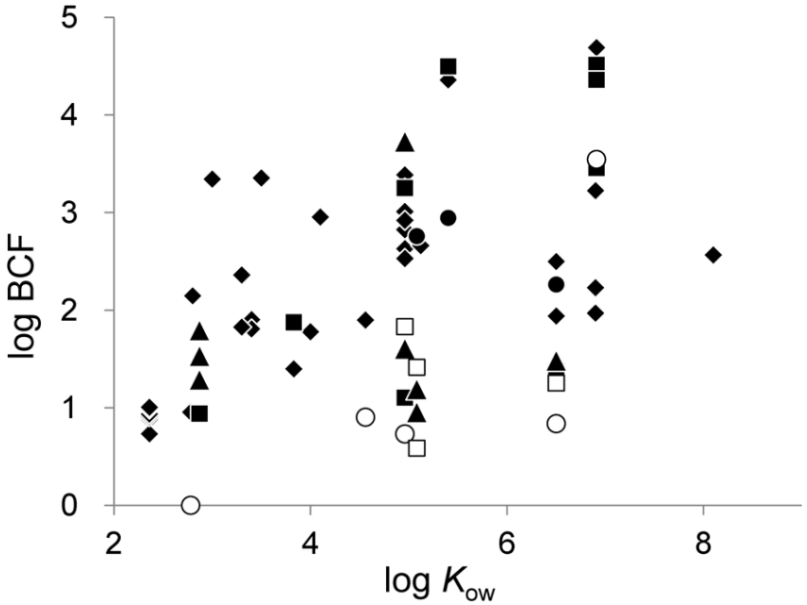


Review of ~3000 publication 1985-2013

Heinz-R Köhler and R. Triebskorn, Sciences 2013

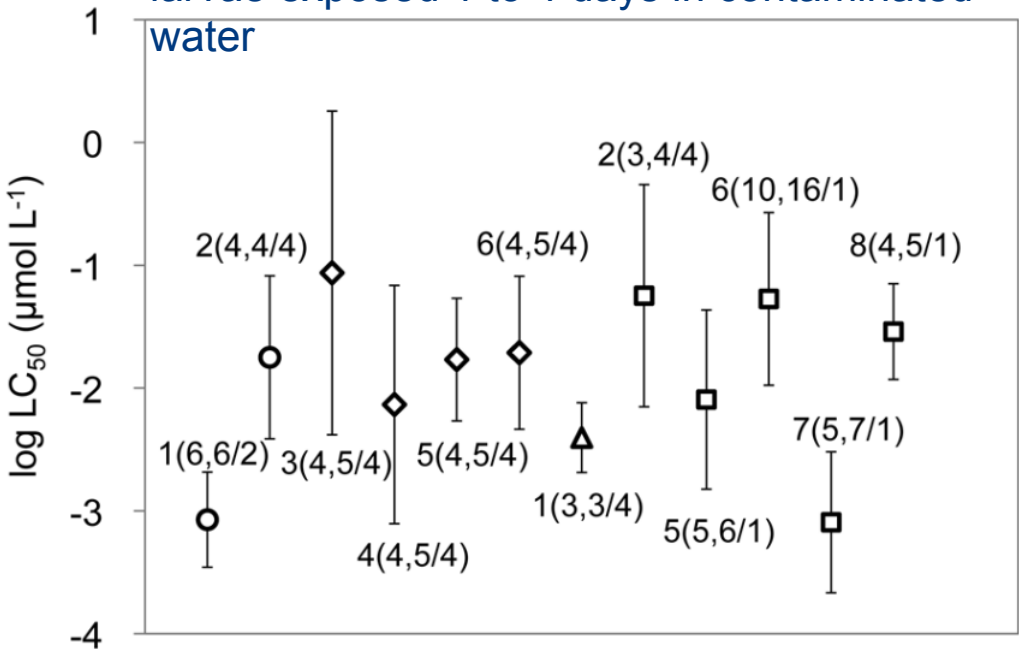
Some examples : accumulation and toxicity in insect larvae

Bioconcentration of pesticides in the aquatic insect larvae.



◆, midge; ■, mayfly; ▲, caddisfly; ●, stonefly; ○, damselfly; □, black fly.

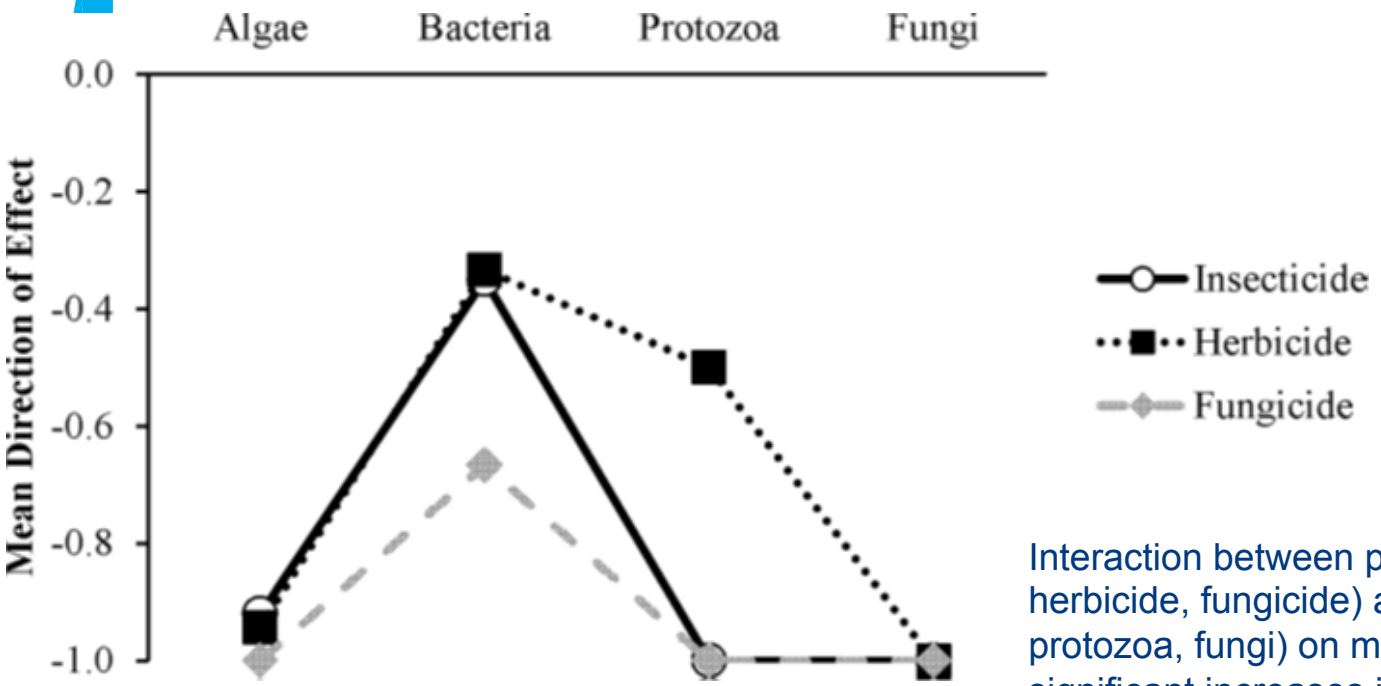
Acute toxicity of pesticides in aquatic insect larvae exposed 1 to 4 days in contaminated water



1, fipronil; 2, imidacloprid; 3, DDT; 4, dieldrin; 5, parathion; 6, malathion; 7, deltamethrin; 8, fenvalerate. Numbers of species and toxicity data / days of exposure are in the parentheses. ○, mayfly; ◇, stonefly; △, caddisfly; □, midge.

Katagi & Tanaka J. Pest. Sci., 2016

Some examples : pesticides and microorganisms



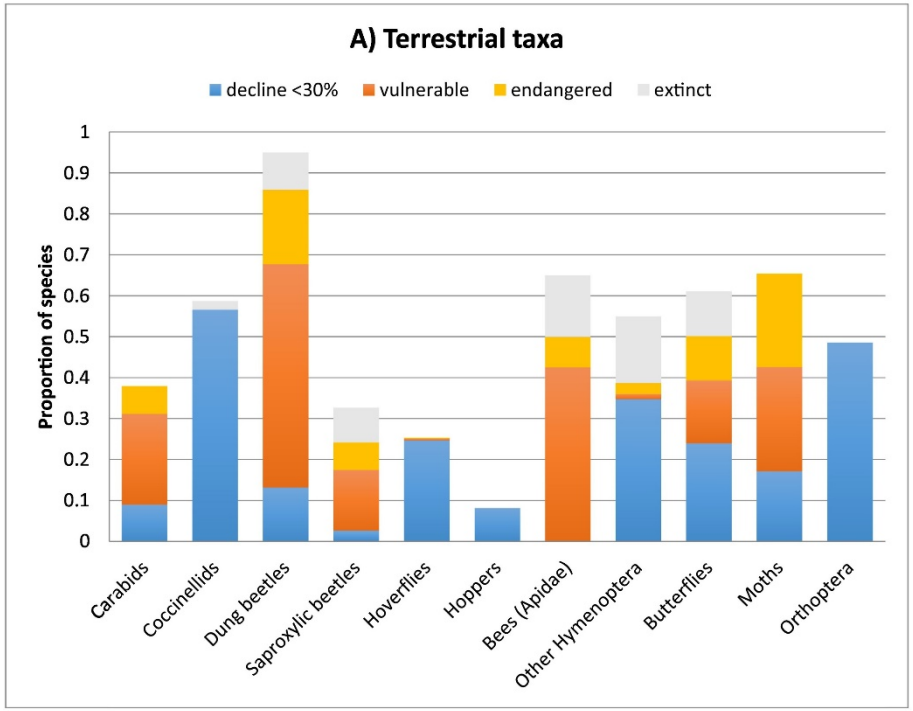
Interaction between pesticide type (insecticide, herbicide, fungicide) and taxon (algae, bacteria, protozoa, fungi) on microbial densities (+1 for significant increases in densities, 0 for null effects, −1 for significant decreases in densities).

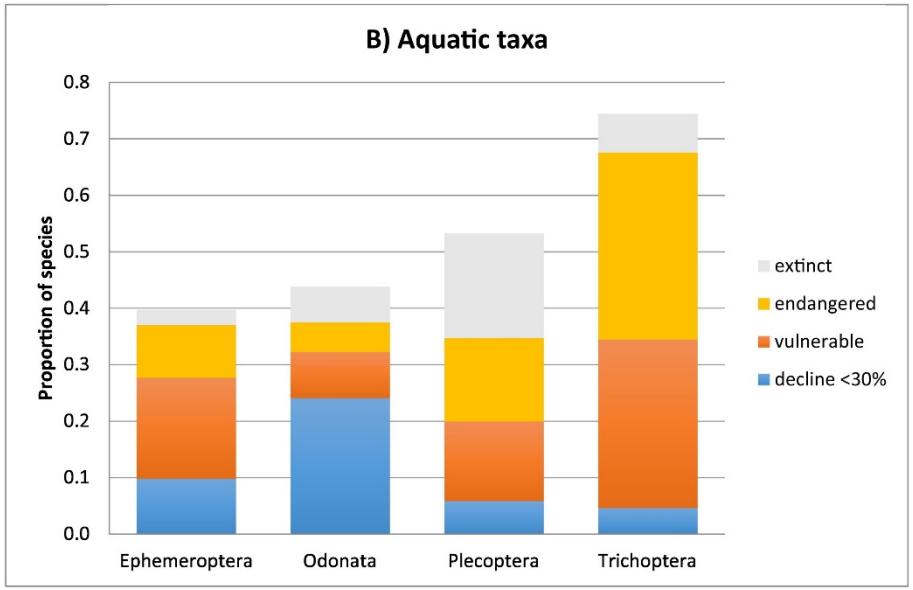
Negative effect of pesticides tends to be offset at community level . By example : both insecticides and fungicides reduce heterotrophic predators >> increase abundancy of lower trophic level, algal and bacteria.

Staley and al. Crit. Rev. Toxicol., 2015

Wordlwide decline of the entomofauna

- Dramatic rates of decline that may lead to the extinction of 40% of the world's insects species over the next few decades.
- All species are affected : specialist that occupy particular ecological niches and many common and generalist species.
- The abundance of small number of adaptable and generalist species is increasing.

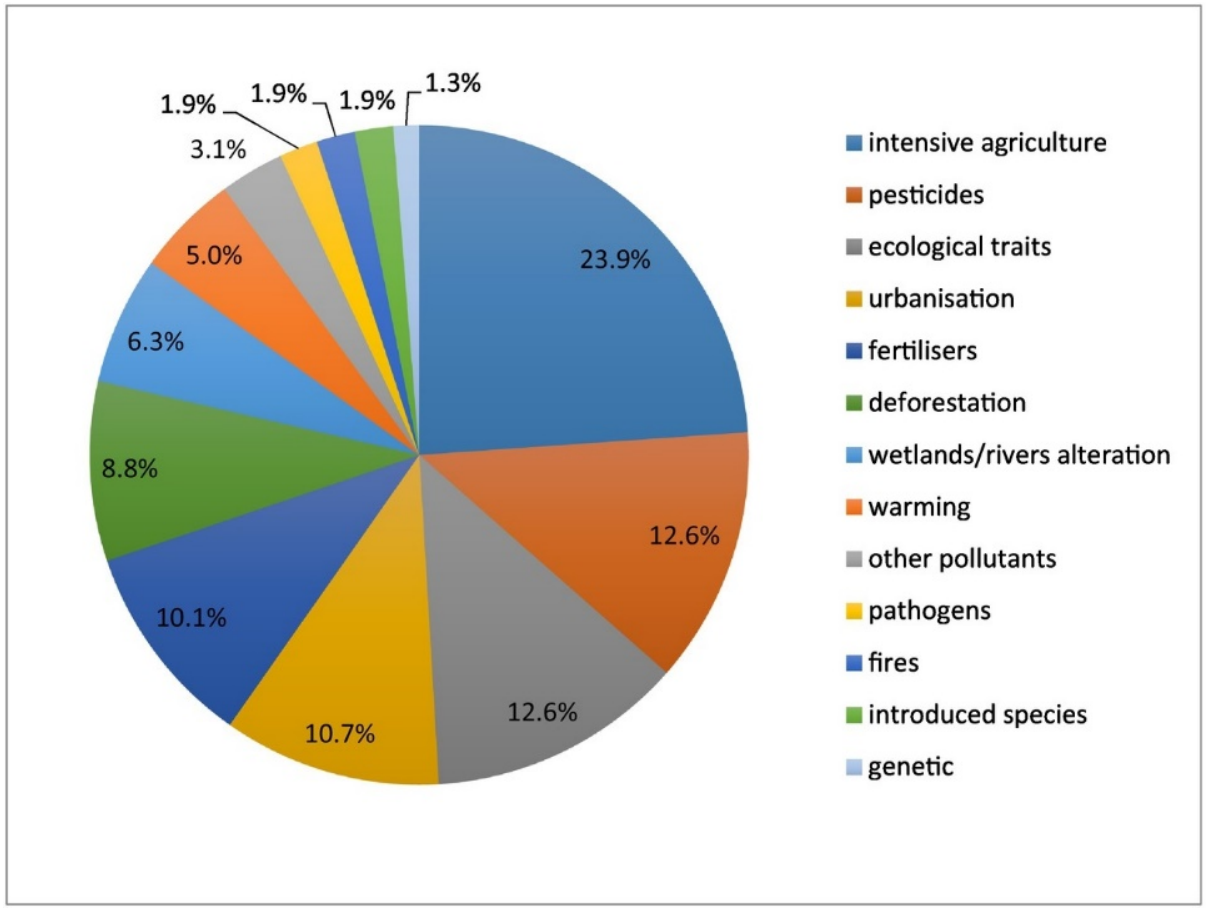




Sanchez-Bayo & Wyckhuys, Biological Conservation 2019

Wordlwide decline of the entomofauna : drivers

- 1) Habitat loss and conversion to intensive agriculture and urbanisation.
- 2) pollution: synthetic pesticides and fertilisers
- 3) biological factors : pathogens and invasive species
- 4) climate change important in tropical regions

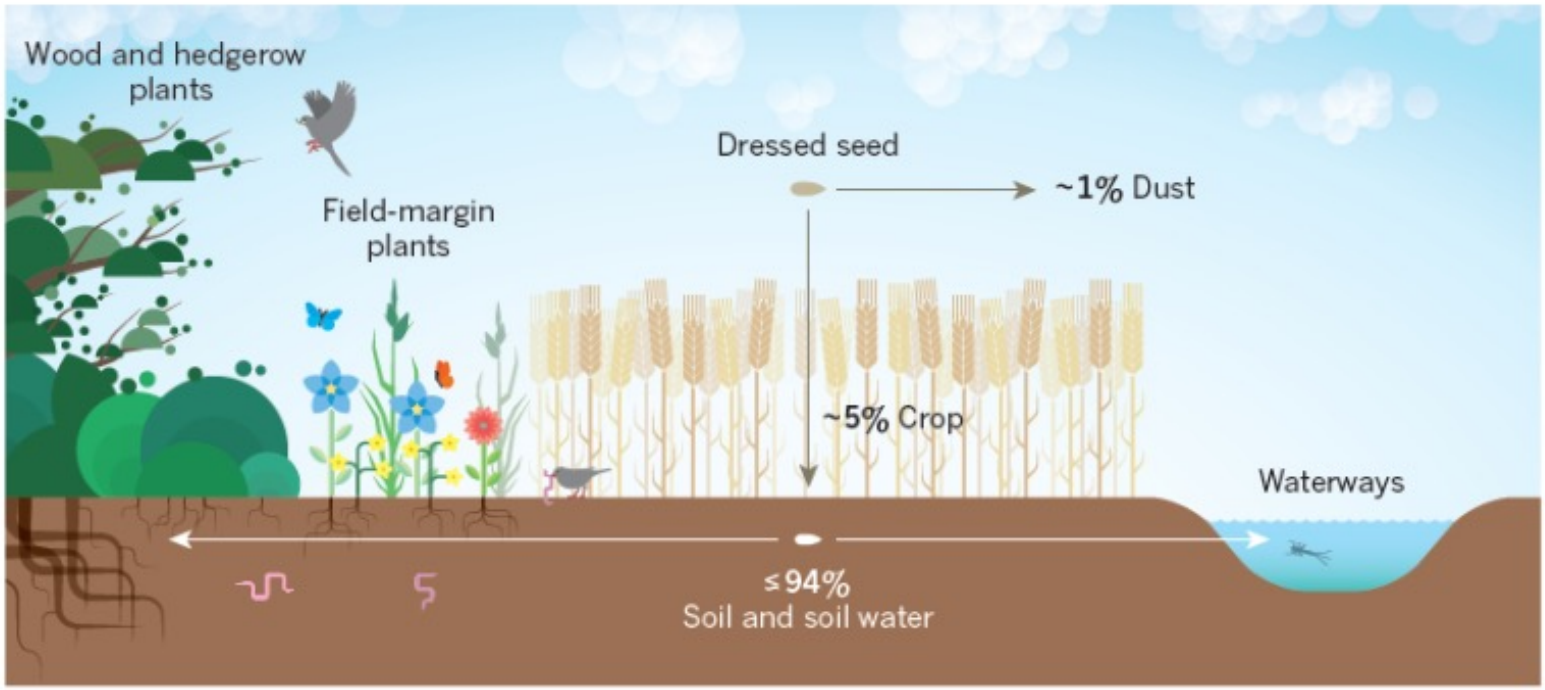


Sanchez-Bayo & Wyckhuys, Biological Conservation 2019

Pesticides and birds

Impacts on neonicotinoids in birds population

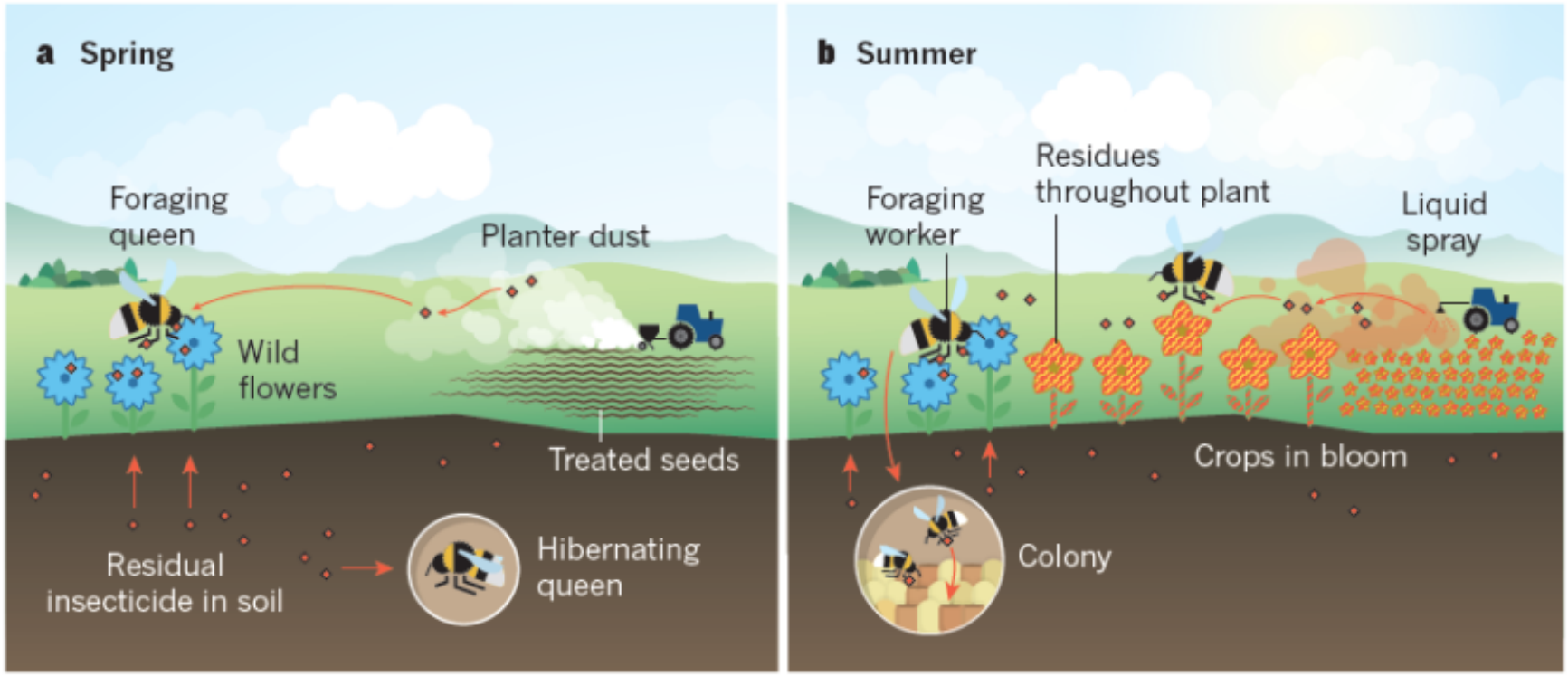
- From long term datasets analysis Hallman *et al.* (2014) show that regional patterns of population decline in insect-eating birds are nearly predicted by level of neonicotinoids detected in environmental samples.
- Effect are probably the results of depletion of the bird's food insects



Goulson, Nature 2014

Pesticides and pollinators insects

Bees, bumblebees are exposed to systemic pesticides (neonicotinoids, sulfoxamines) by multiple contamination routes

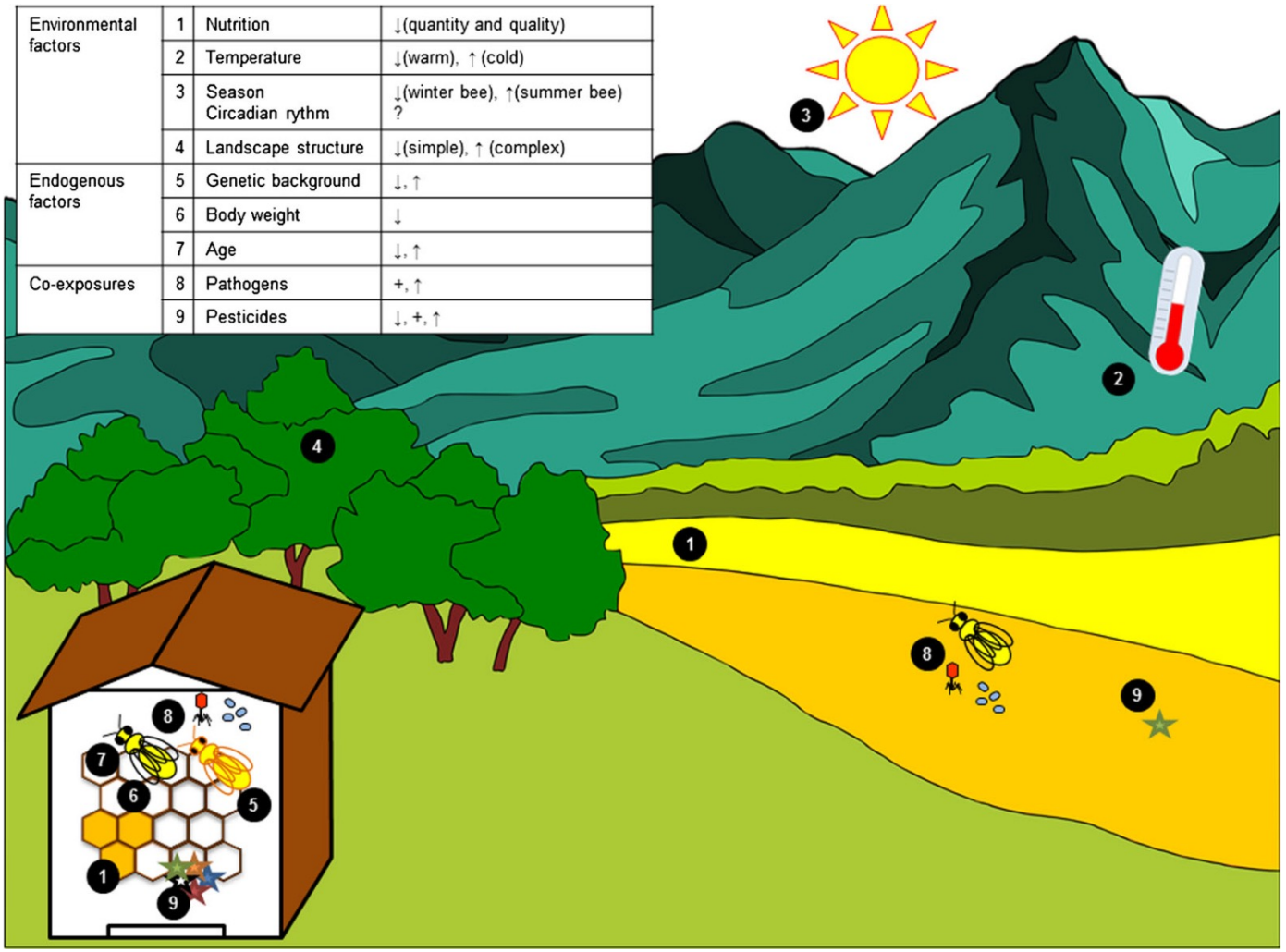


Raine N. Nature 2018

Pesticides and pollinator insects

Factors involved in the modulation of pesticide response

Environmental factors	1	Nutrition	↓(quantity and quality)
	2	Temperature	↓(warm), ↑(cold)
	3	Season Circadian rythm	↓(winter bee), ↑(summer bee) ?
	4	Landscape structure	↓(simple), ↑(complex)
Endogenous factors	5	Genetic background	↓, ↑
	6	Body weight	↓
	7	Age	↓, ↑
Co-exposures	8	Pathogens	+, ↑
	9	Pesticides	↓, +, ↑

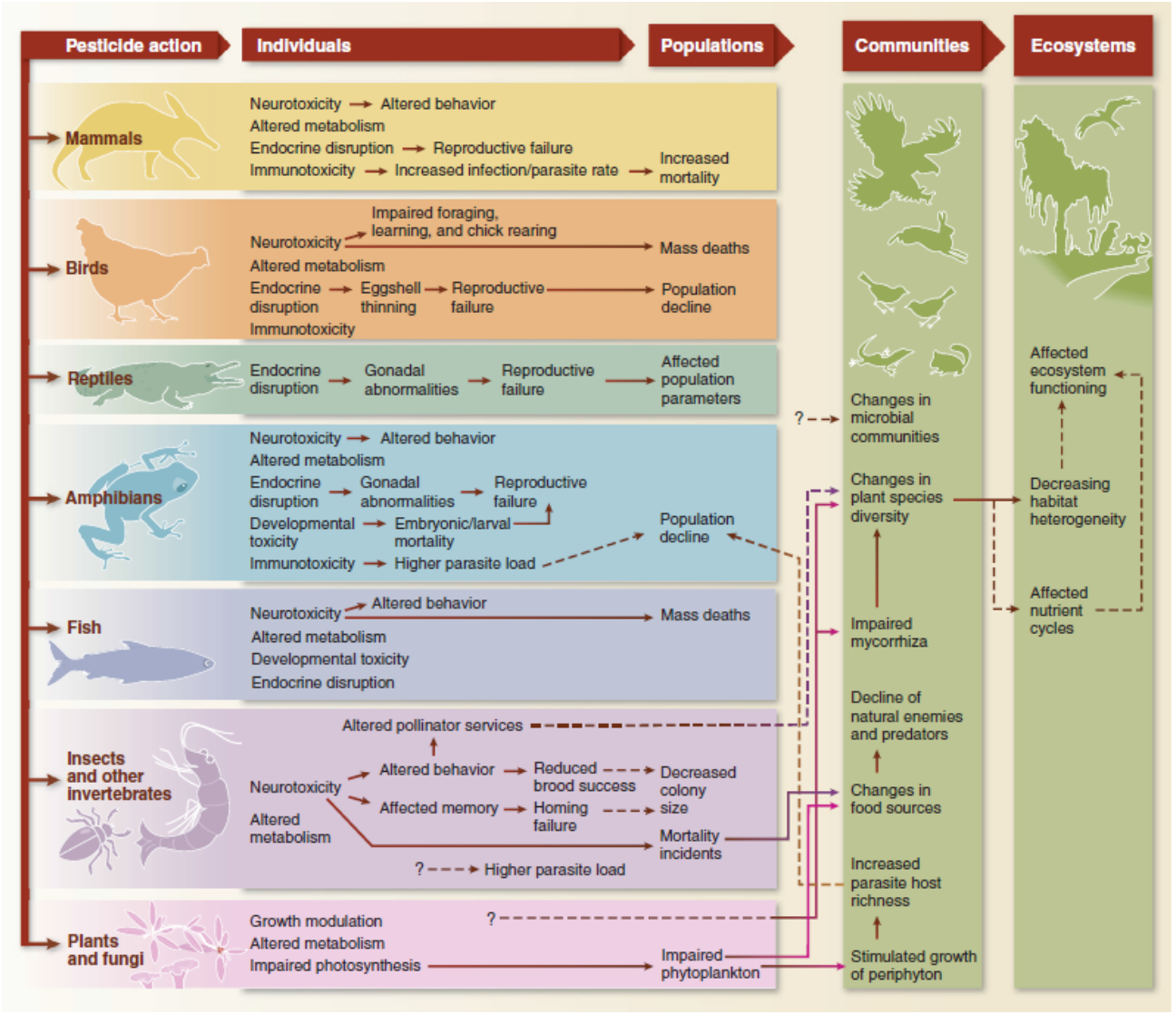


Downwards arrow and upwards arrow indicate a decrease and increase in pesticide toxicity, respectively, and plus sign denotes an additive effect. Question mark means that the effect on pesticide toxicity is unknown.

Poquet et al. Apid 2016

Pesticides long term risk : what do we know for wildlife ?

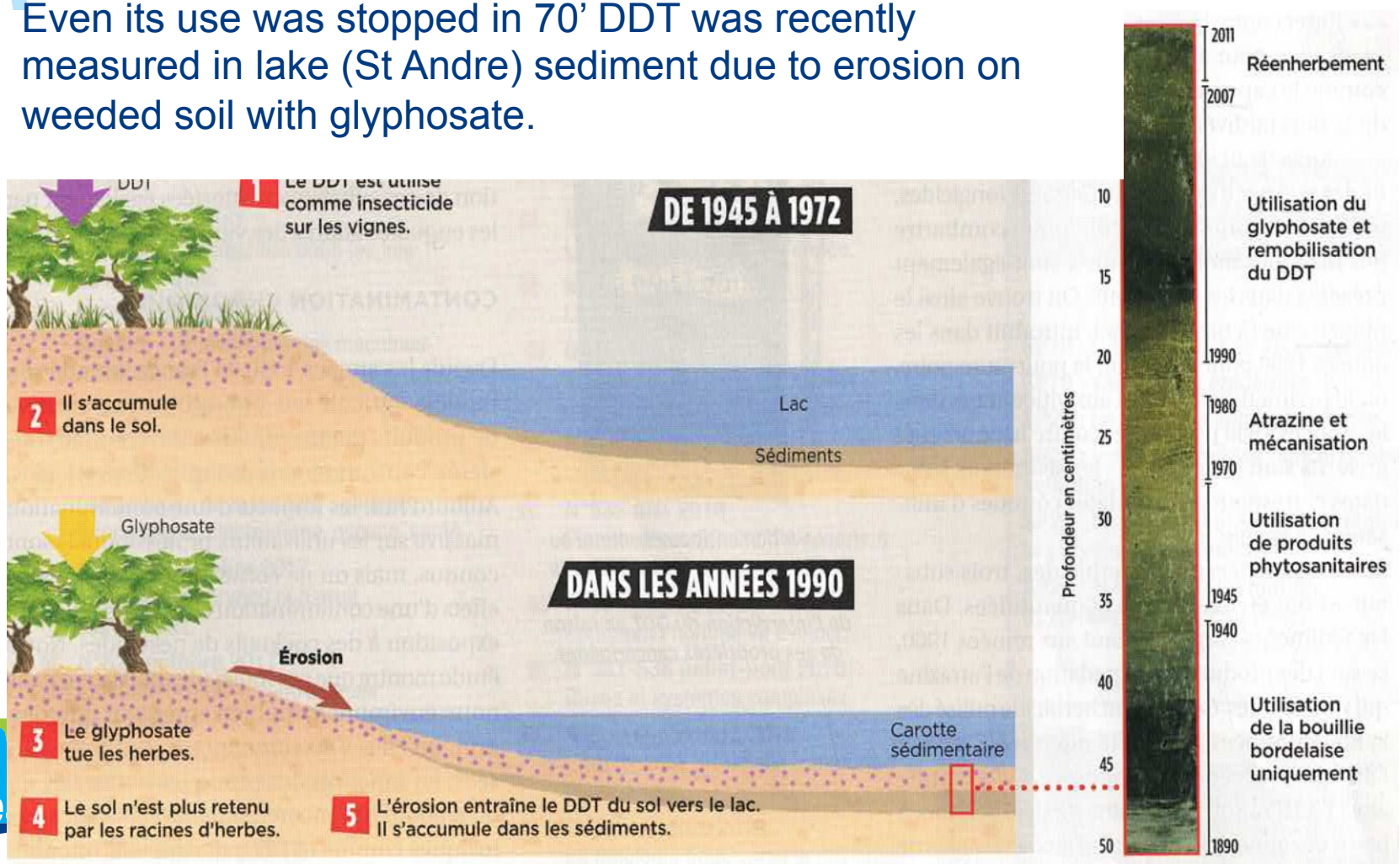
- Knowledge on direct impact on numerous taxa (individuals)
- Cause –effect relationships at population levels are often missing
- Low knowledge on indirects effects at community level



Heinz-R Köhler and R. Triebskorn, Sciences 2013

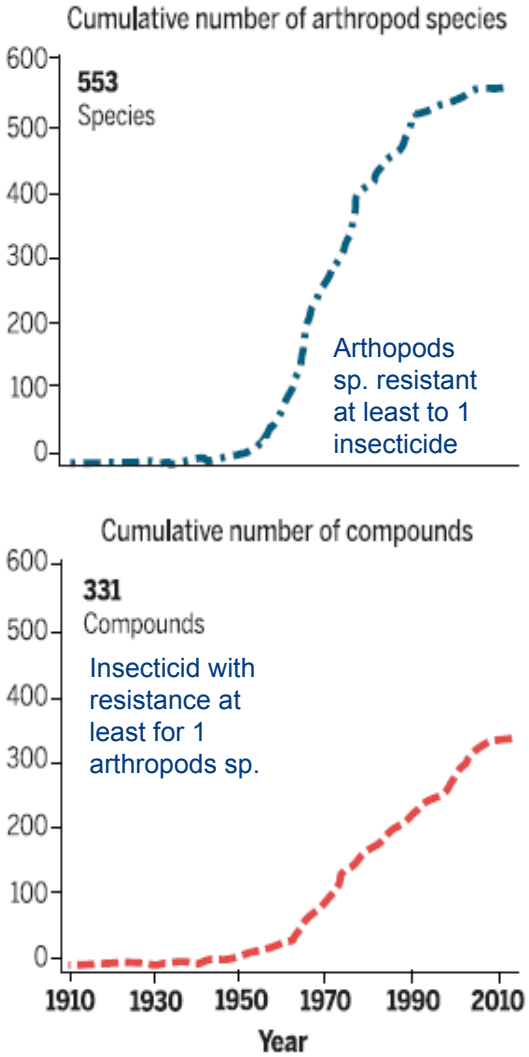
Pesticides long term risk : persistance in soil and delayed impact

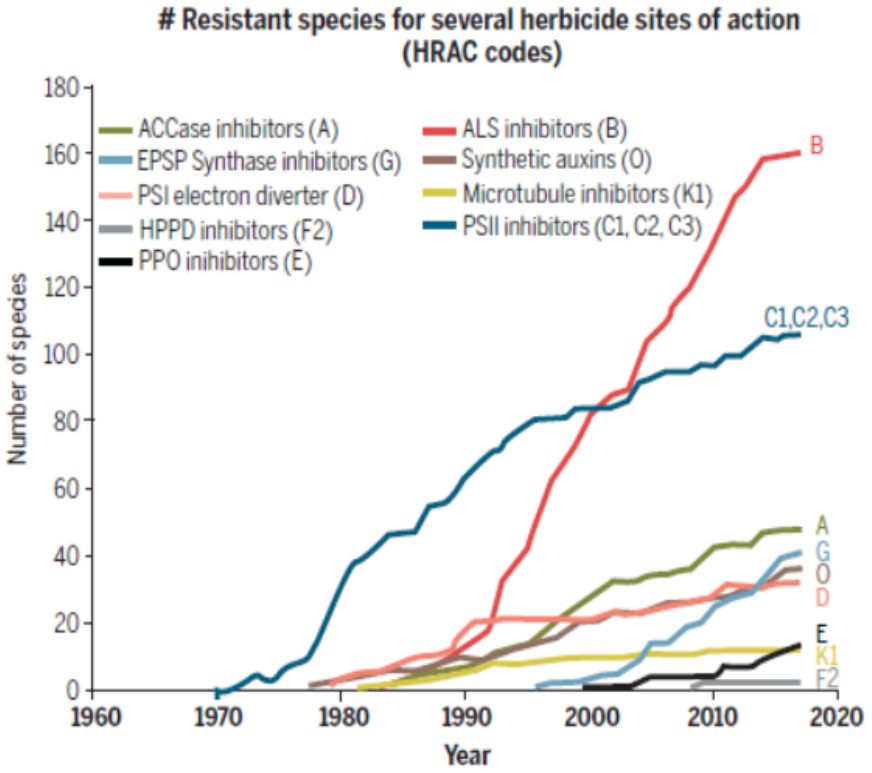
Even its use was stopped in 70' DDT was recently measured in lake (St Andre) sediment due to erosion on weeded soil with glyphosate.



Poulenard J. & Sabatier P. La recherche

Resistance : neglected consequence of chemicals





New pesticides : new issues ?

Environmental Science & Technology

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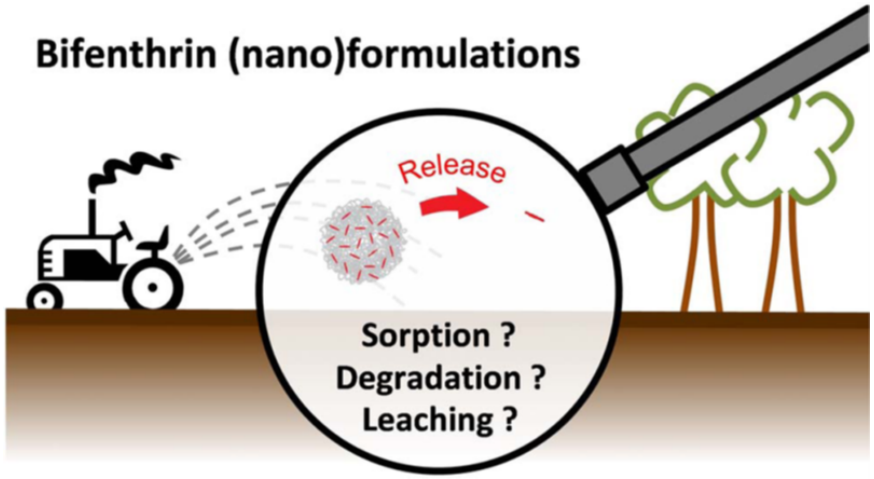
Article

pubs.acs.org/est

Impacts of (Nano)formulations on the Fate of an Insecticide in Soil and Consequences for Environmental Exposure Assessment

Melanie Kah,* Anne-Kathrin Weniger, and Thilo Hofmann*



Environ Sci Pollut Res (2018) 25:10184–10206
DOI 10.1007/s11356-017-9752-4

CrossMark

PLANT-BORNE COMPOUNDS AND NANOPARTICLES: CHALLENGES FOR MEDICINE, PARASITOLOGY AND ENTOMOLOGY

Mosquito control with green nanopesticides: towards the One Health approach? A review of non-target effects

Giovanni Benelli[1] · Filippo Maggi[2] · Roman Pavela[3] · Kadarkarai Murugan[4] · Marimuthu Govindarajan[5] · Baskaralingam Vaseeharan[6] · Riccardo Petrelli[2] · Loredana Cappellacci[2] · Suresh Kumar[7] · Anders Hofer[8] · Mohammad Reza Youssefi[9] · Abdullah A. Alarfaj[10] · Jiang-Shiou Hwang[11] · Akon Higuchi[12]

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New pesticides : new issues ?

frontiers in Plant Science

REVIEW
published: 27 July 2015
doi: 10.3389/fpls.2015.00566

Is the efficacy of biological control against plant diseases likely to be more durable than that of chemical pesticides?

Marc Bardin [1], Sakhr Ajouz [1], Morgane Comby [1], Miguel Lopez-Ferber [2], Benoit Graillot [2,3], Myriam Siegwart [4] and Philippe C. Nicot [1]*

frontiers in Plant Science

REVIEW
published: 19 June 2015
doi: 10.3389/fpls.2015.00381

Resistance to bio-insecticides or how to enhance their sustainability: a review

[2,3], Christine Blachere Lopez [4], Samantha Besse [3], and Miguel Lopez-Ferber [2]

Environmental Science and Pollution Research (2018) 25:33895–33900
https://doi.org/10.1007/s11356-018-3356-5

ECOTOX, NEW QUESTIONS FOR TERRESTRIAL AND AQUATIC ECOTOXICOLOGY

CrossMark

Biocontrol, new questions for Ecotoxicology?

Marcel Amichot [1] · Pierre Joly [2] · Fabrice Martin-Laurent [3] · David Siaussat [4] · Anne-Violette Lavoir [1]

Received: 30 April 2018 / Accepted: 26 September 2018 / Published online: 10 October 2018
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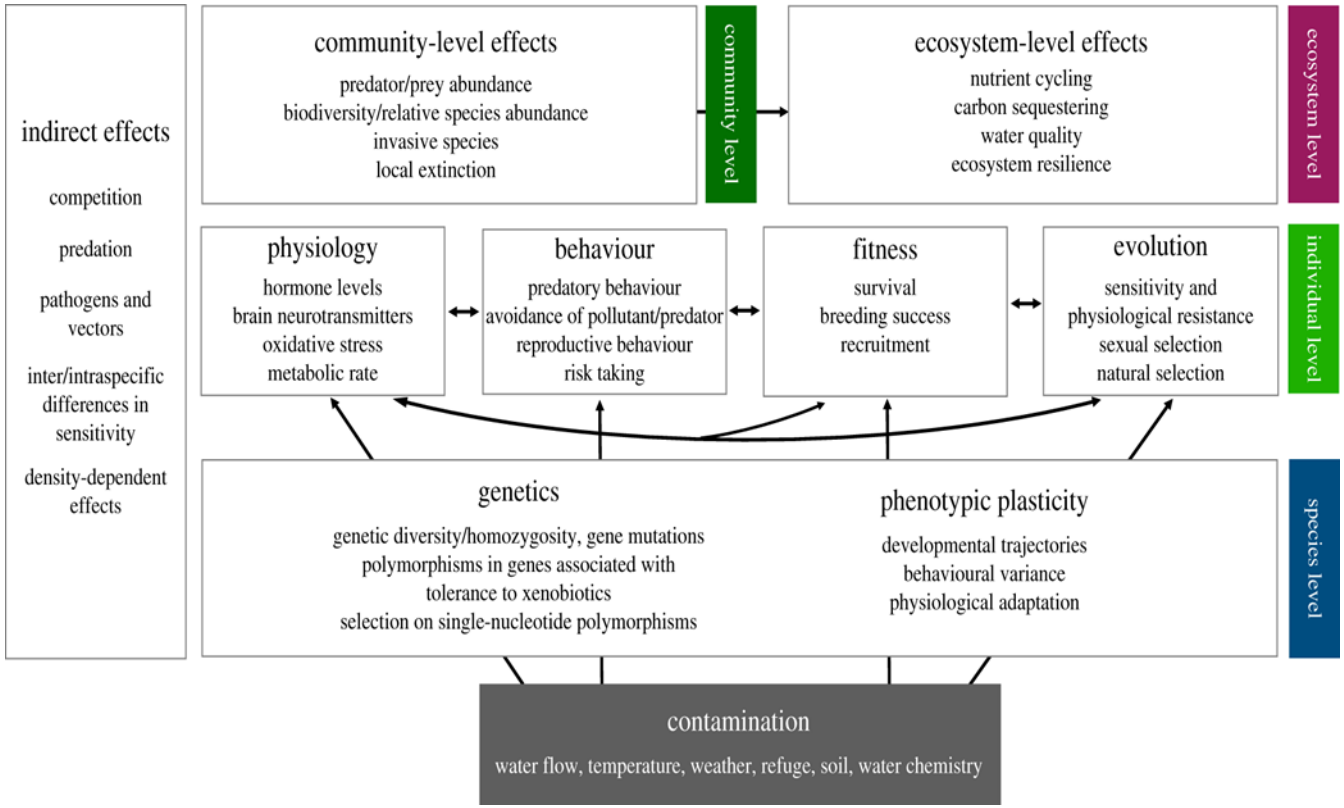
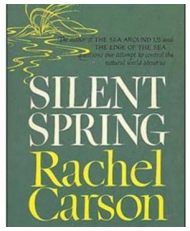
Conclusions : Ecological and evolutionary impacts of chemicals

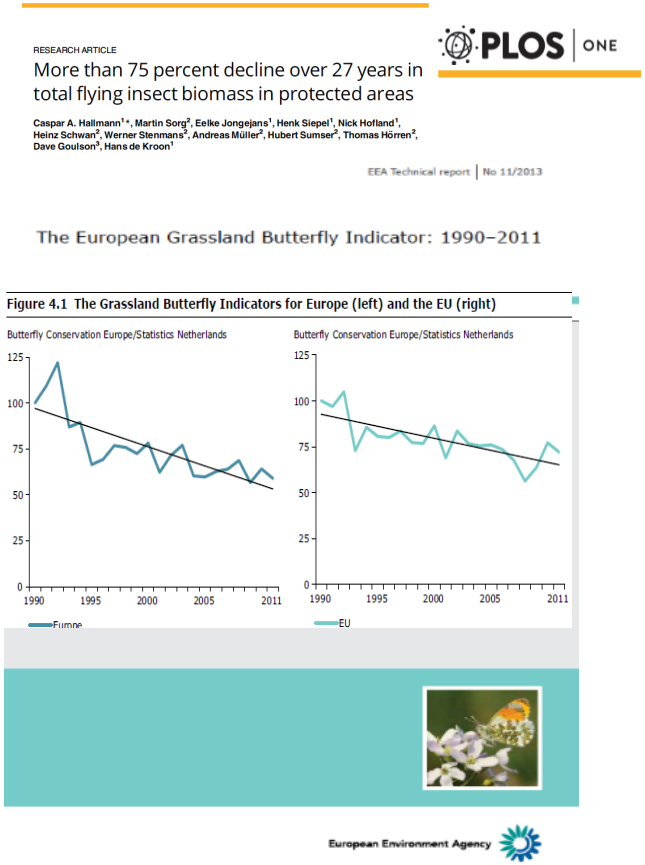
Need of an holistic research approach to understand the effect and to manage chemicals (pesticide) risks.



Saaristo et al. Proc. R. Soc. 2018



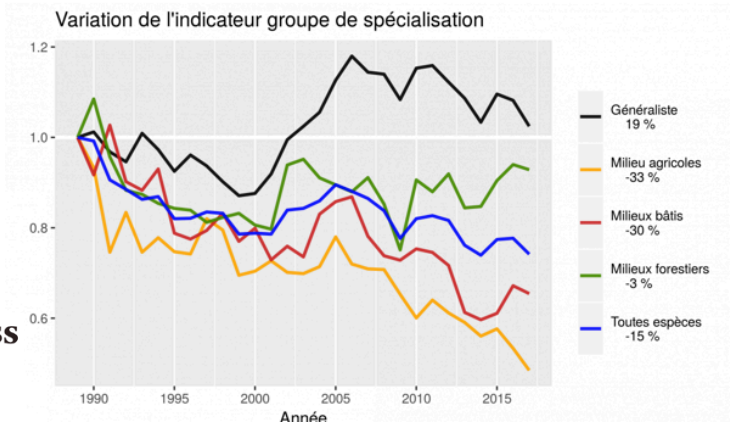
And yet …since the 60' ….



'Shocking' decline in birds across Europe due to pesticide use, say scientists

New figures reveal decline in farmland birds at a 'level approaching an ecological catastrophe'

https://www.birdlife.org/sites/default/files/attachments/BL_ReportENG_V11_spreads.pdf



http://vigienature.mnhn.fr/page/produire-des-indicateurs-partir-des-indices-des-especes-habitat

Chemicals : one of causes of worldwide biodiversity decrease

Merci pour votre attention