Impacts of climate change on chemical environmental fate processes

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Background

- **Worldwide megatrends** including urbanisation, competition for resources, environmental pollution and **climate change** ultimately affect how humans and the environment are exposed to chemicals[1,2].
- Increases in mean **Global temperatures** are expected in the future, and relative concentration pathway 8.5 (RCP8.5) forecasts a mean **increase of between 2.6-4.8°C by 2081-2100**[3] if societal practices continue as "business as usual".
- In the **European Union** (**EU**), the extent of these **temperature shifts will vary regionally and seasonally** across countries located at Northern, Central and Southern latitudes of the EU[4].
- Therefore, it is important to consider how **future temperature changes** could impact specific chemical environmental fate processes among **different climatic regions**, as temperature is an important modulator of physical and environmental processes[5], and could **drive changes in exposure patterns**[6].

Overall Goal

To investigate the overall effects and trends of predicted changes in temperature on chemical fate and exposure in freshwater systems leading up to years 2081-2100.

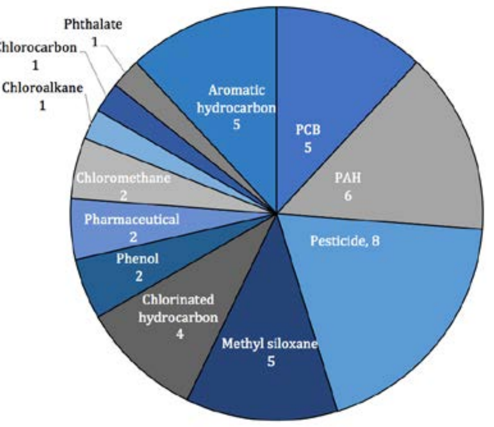
Objectives

1. Review literature to determine the impacts of temperature changes on key environmental fate processes (i.e. sorption, volatilisation, and degradation).
2. Gain an improved understanding of how temperature-corrections are considered and implemented into environmental risk assessment of chemicals.

Methods

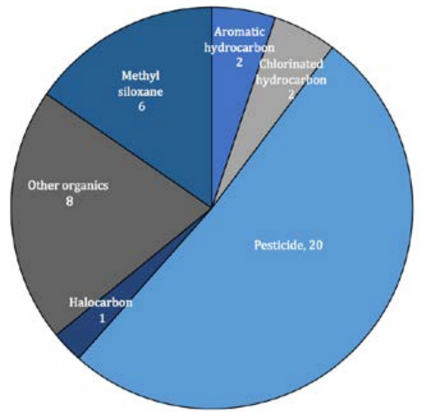
Summary of literature review

Number of total chemicals



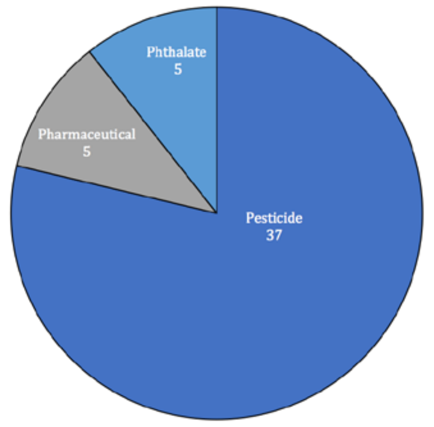
Sorption

- 17 studies which determined sorption coefficients (K_d) for 42 total chemicals across a temperature range of 2.3-40°C.



Volatilisation

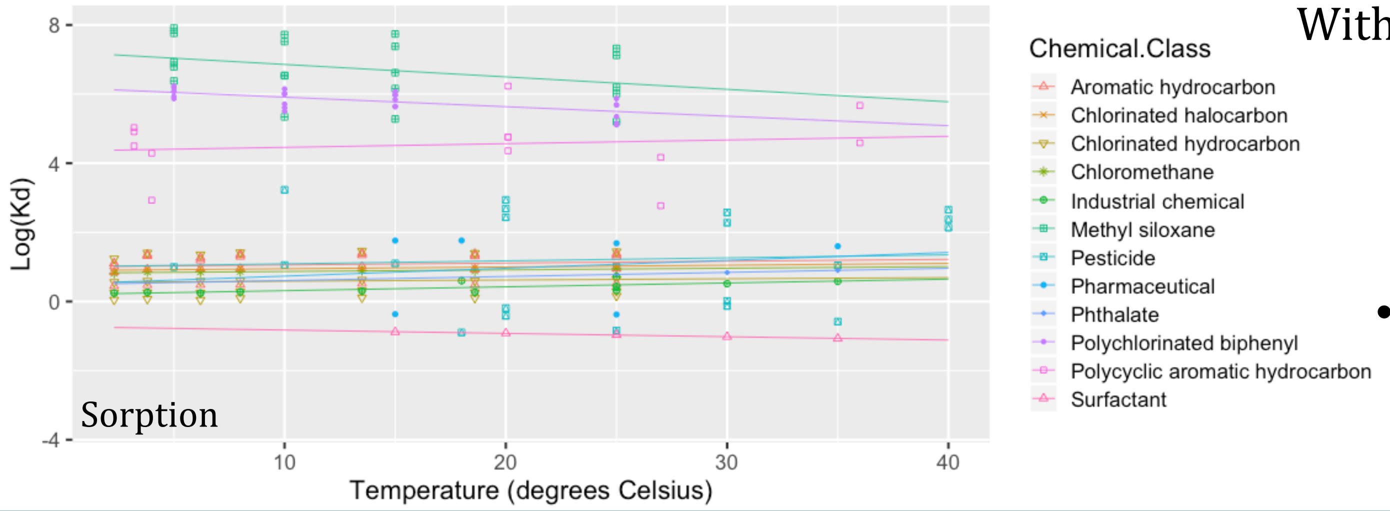
- 7 studies which determined Henry's Law constant coefficients (K_H) for 41 total chemicals across a temperature range of 4.2-40°C.



Degradation

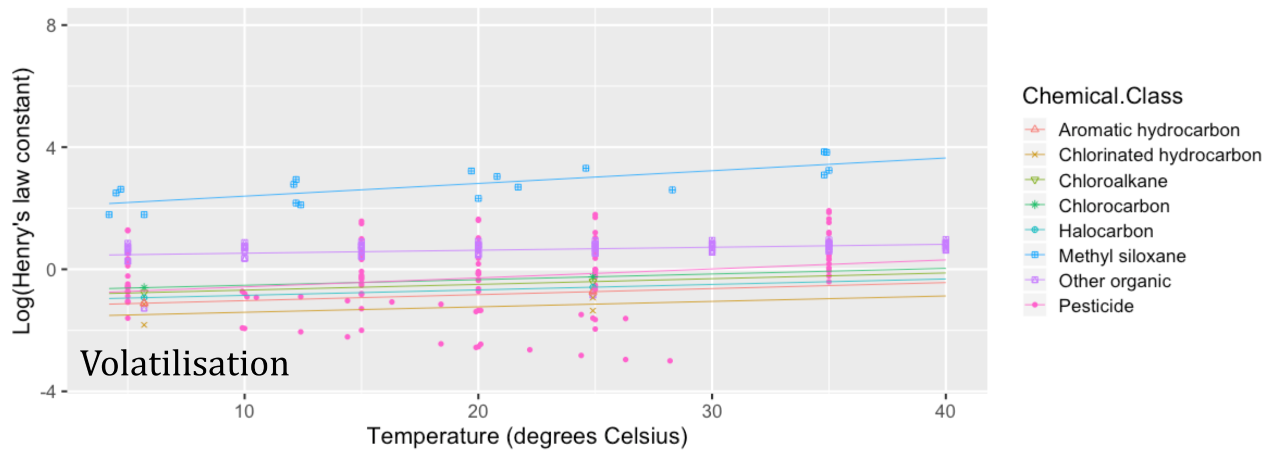
- 25 studies which determined chemical half-lives for 47 total chemicals across a temperature range of 4-37°C.

Results

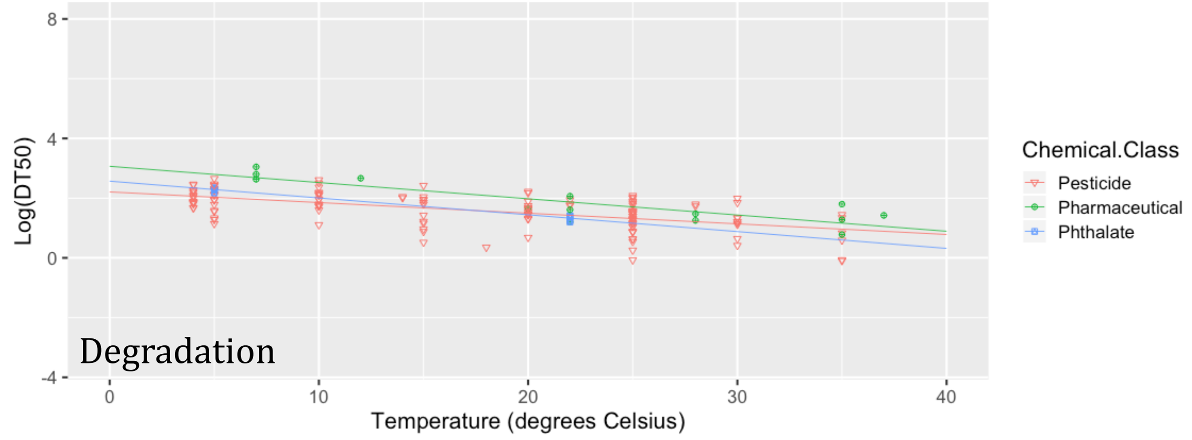


Within the study temperature range:

- Increased K_d: 17 compounds
- Decreased K_d: 25 compounds
- Greatest increase, carbofuran, (106%)
- Greatest decrease, PCB28, (89.3%)



- Increased K_H: 39 compounds
- Decreased K_H: 2 compounds
- Greatest increase, chlorpyrifos, (17731%)
- Greatest decrease, diazinon, (91%)



- Increased DT50: 47 compounds
- Decreased DT50: None
- Greatest increase, chlortetracycline, (98.6%)
- Smallest increase, chlorpyrifos, (20.7%)

Discussion

- Biodegradation and volatilisation data was predominantly pesticides, and often lacked tests conducted at more than three temperatures.
- For chemical sorption, compounds with higher K_d tended to show decreased sorption as temperature increases, whereas compounds with lower K_d showed increases in sorption as temperature increases.
- Arrhenius-based temperature corrections in REACH guidance might not appropriately predict the effects of temperature on biodegradation[7,8].

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