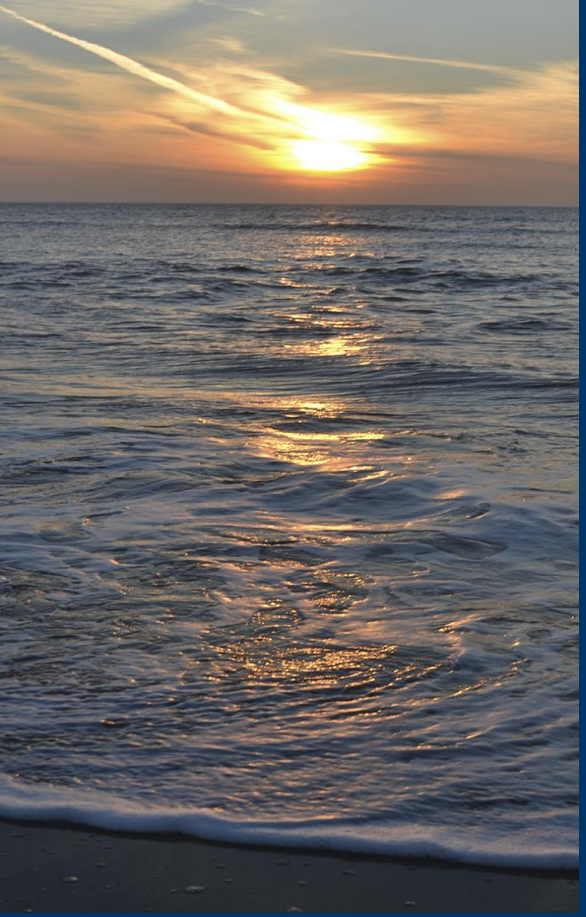

Characterization of Natural Organic Matter and processes during drinking water treatments

Junias Adusei-Gyamfi

Supervisors:

University of Lille: ***Justine Criquet, Baghdad Ouddane***

TU Delft: ***Bas Heijman, Luuk Rietveld***

Second DOC2C's workshop

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Summary

- Introduction
- Problem context
- Methodology
- Results
- Conclusions and Perspectives

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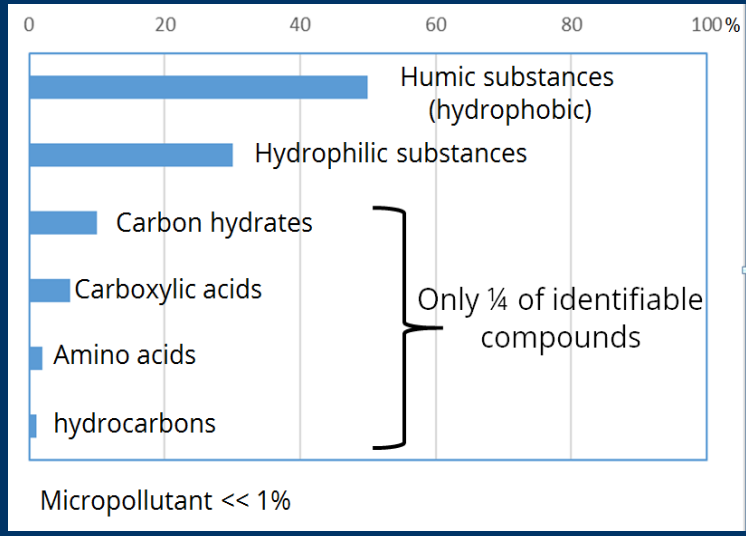
Introduction

Natural organic matter (NOM) refers to a complex mixture of different organic compounds that are present in fresh water

- Increase in quantity and a change in quality
- Threat to drinking water treatment processes
- Source – Great influence on its properties



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Problem Context

Effects of NOM in water;

- Aesthetic effects (colour, taste and odour)
- Biological growth in distributing network channels
- Complexation with other pollutants present *e.g.* trace metals
- Increase in the dosage of treatment chemicals
- Production of disinfection by-products (DPB)
- Competition with target pollutants

Characterization Parameters

Parameters	Analytical tools
Colour , Aromaticity	UV-visible spectrometry
TOC, DOC, BDOC	DOC analyser
Assimilable organic Carbon (AOC), Bacterial regrowth	Bacterial regrowth potential
Functional groups	GC-MS, Infra red spectrometry (FTIR), NMR
Hydrophobicity/Hydrophilicity	Rapid refraction
****Molecular weight distribution**	**High performance Size Exclusion Chromatography (HPSEC)**

Objectives

- **Focus on NOM-Metal complexation**
  - Historical research theme in our lab
  - Innovative apparatus
- **Study of the complexation of various NOM fractions with metal**
- **Impacts on drinking water processes**
  - Coagulation, membrane filtration, disinfection by-product formation, trace metal leaching, ion exchanges (MIEX),…
- **The effect of treatment processes on each fraction**

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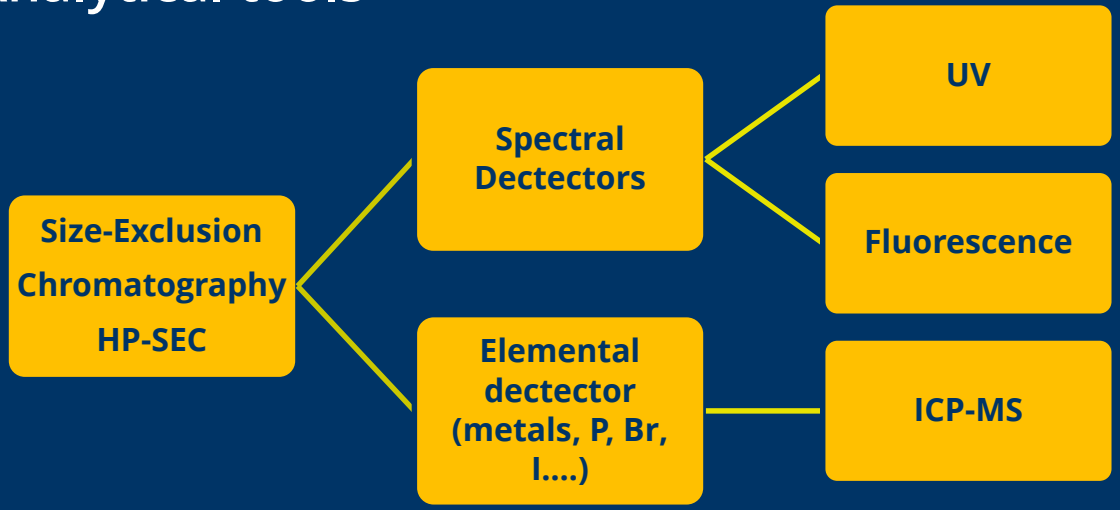
Methodology

Analytical tools



Column: Bio SEC-5 Column – Spherical, porous silica with hydrophilic polymeric coating

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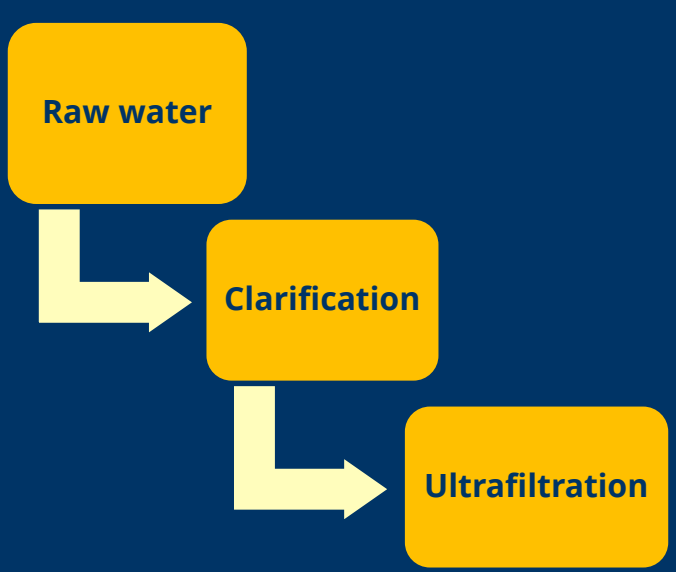
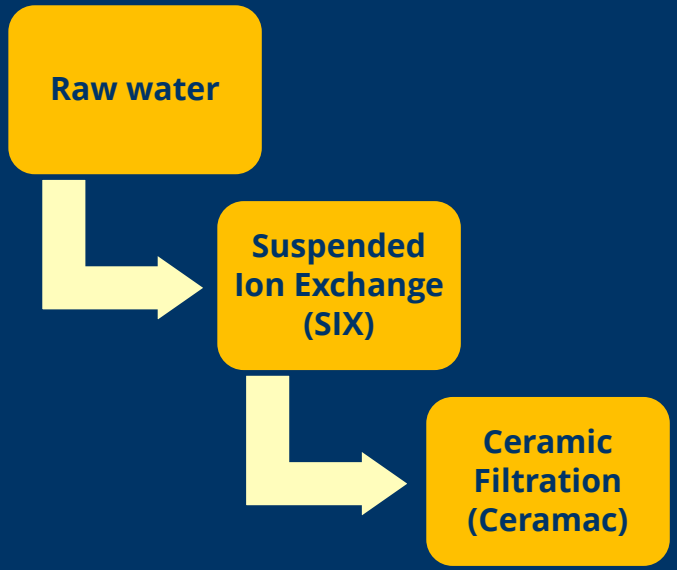
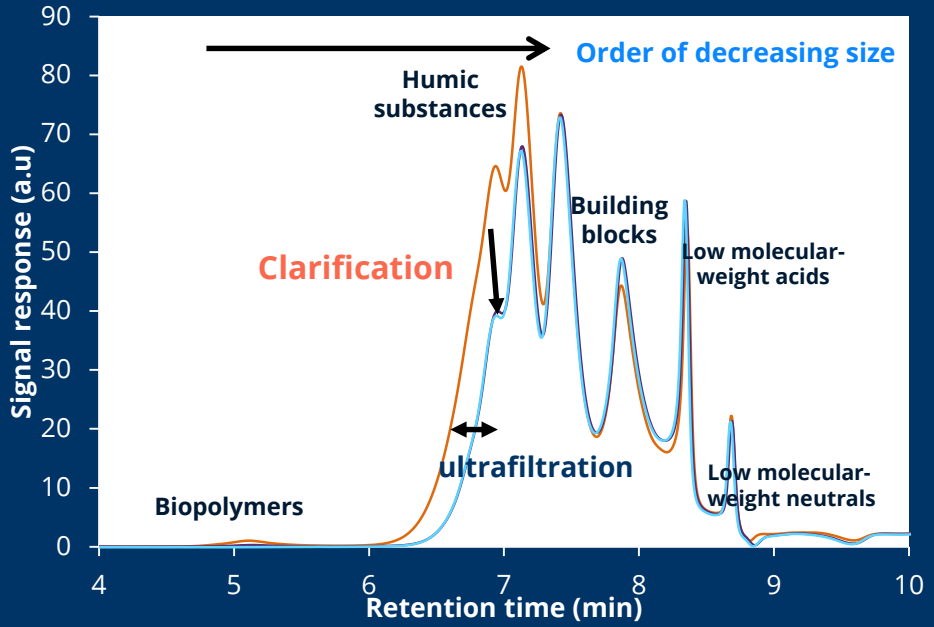
PWN pilot water samples (Andijk)– Two separate treatment lines

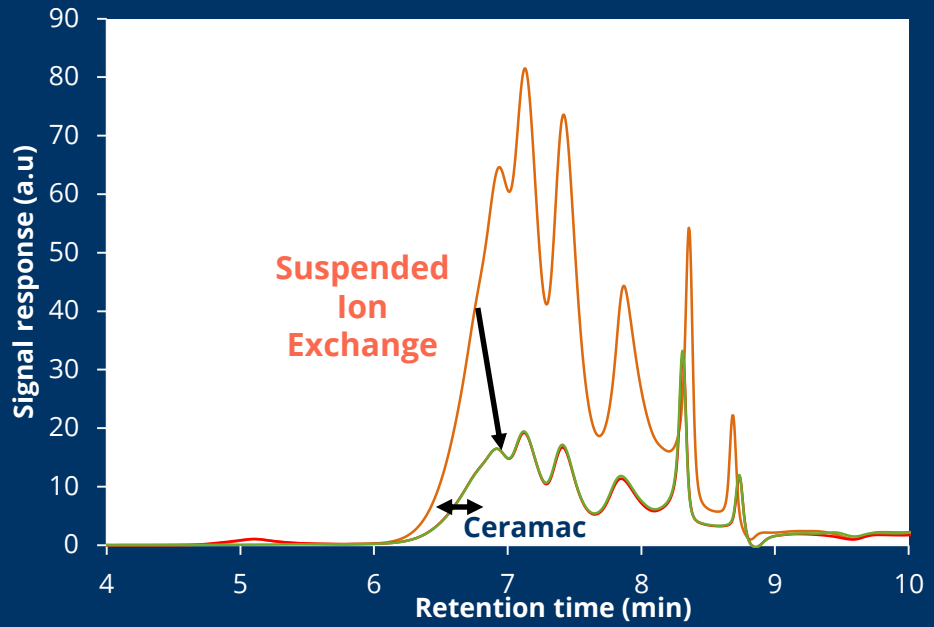




Results

Chromatograph for the two separate lines





Ceramic microfiltration removes the biopolymers (hardely seen with UV detector)

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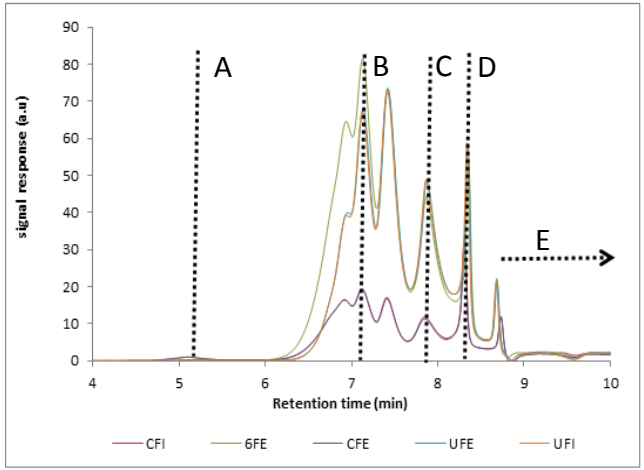

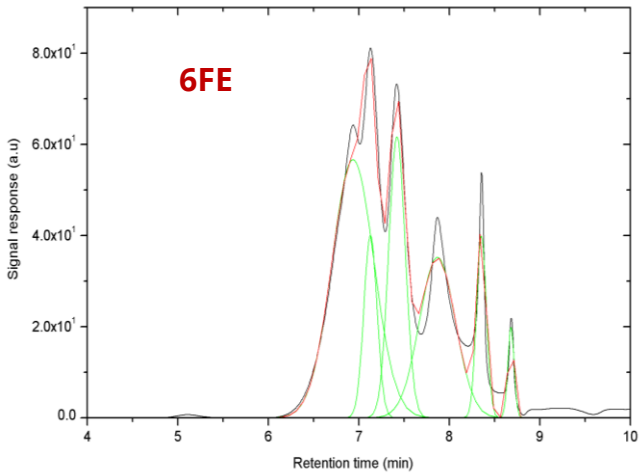

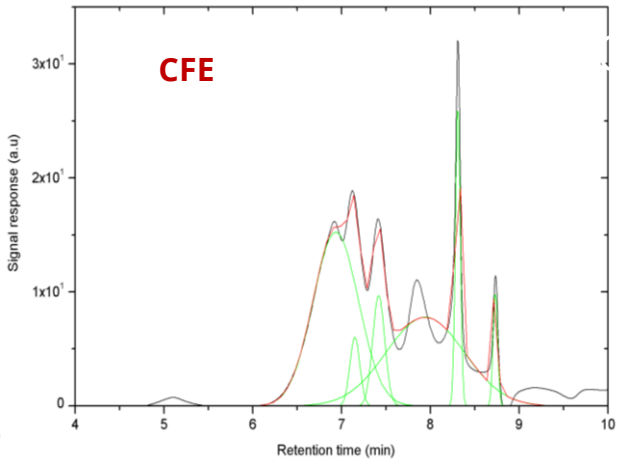

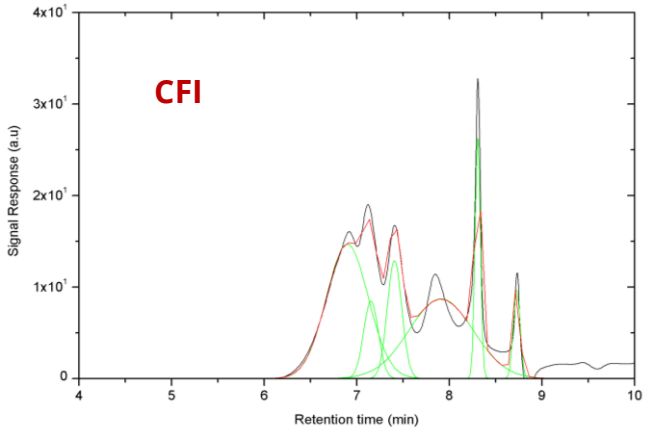

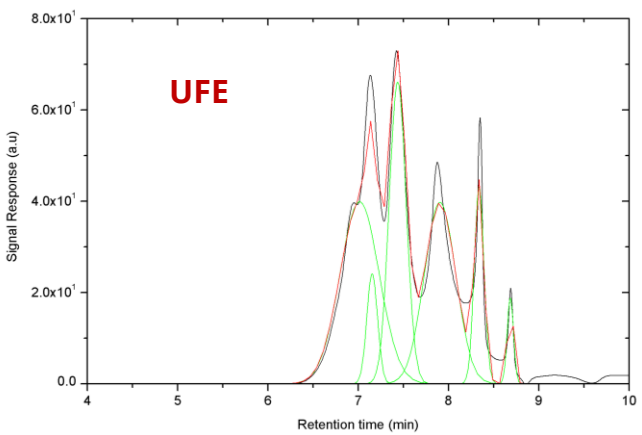

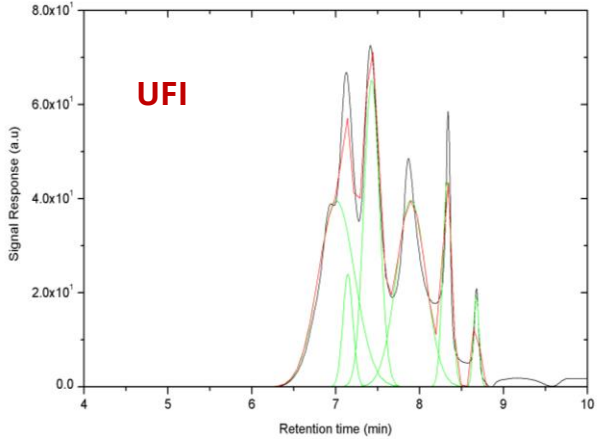

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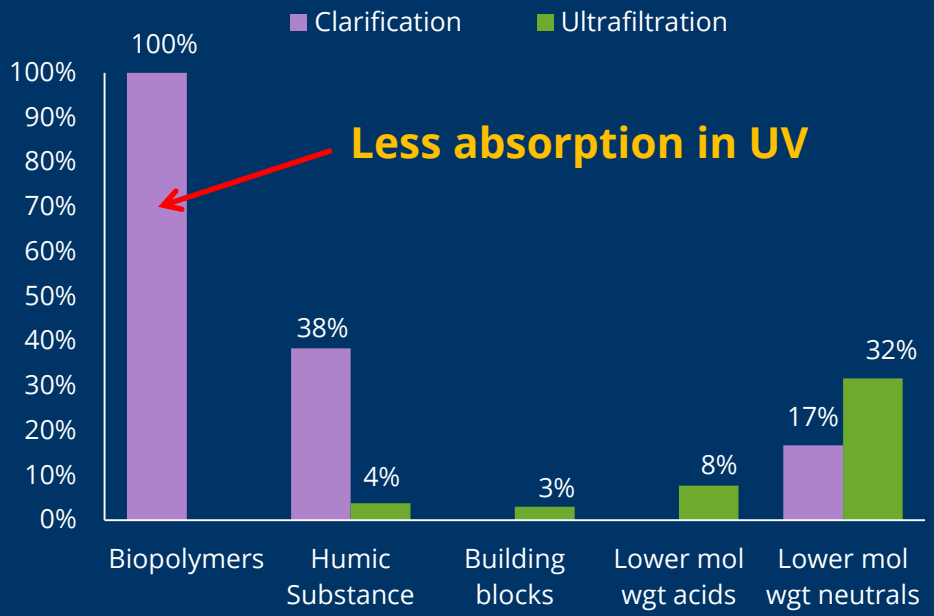
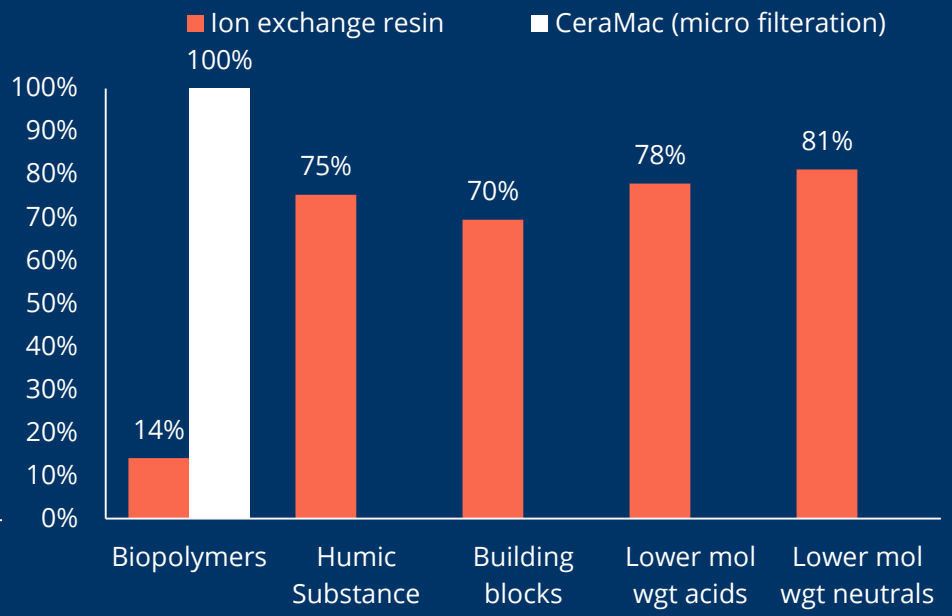
Removal efficiency of UV absorbing components at 254 nm (aromatic & unsaturated structures)





UV absorbance measurement not purely quantitative

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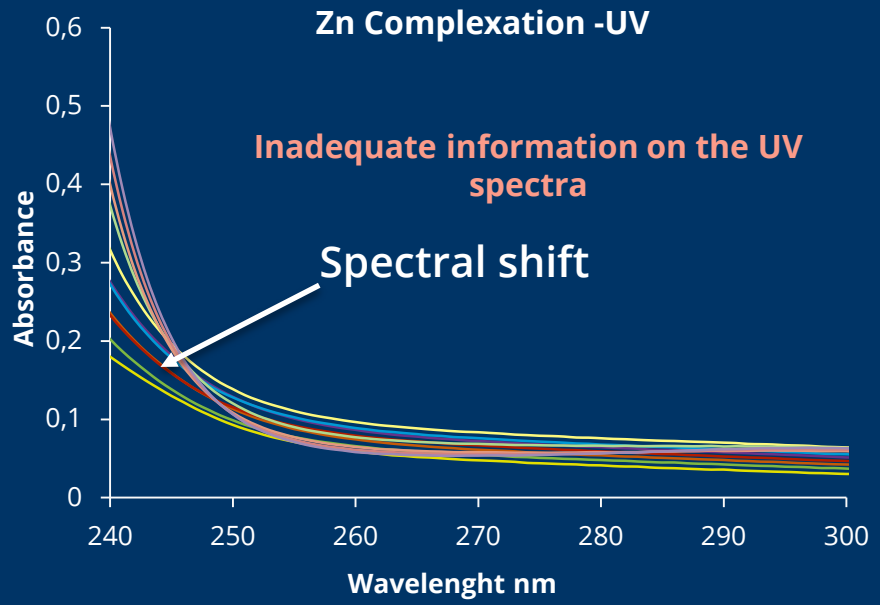
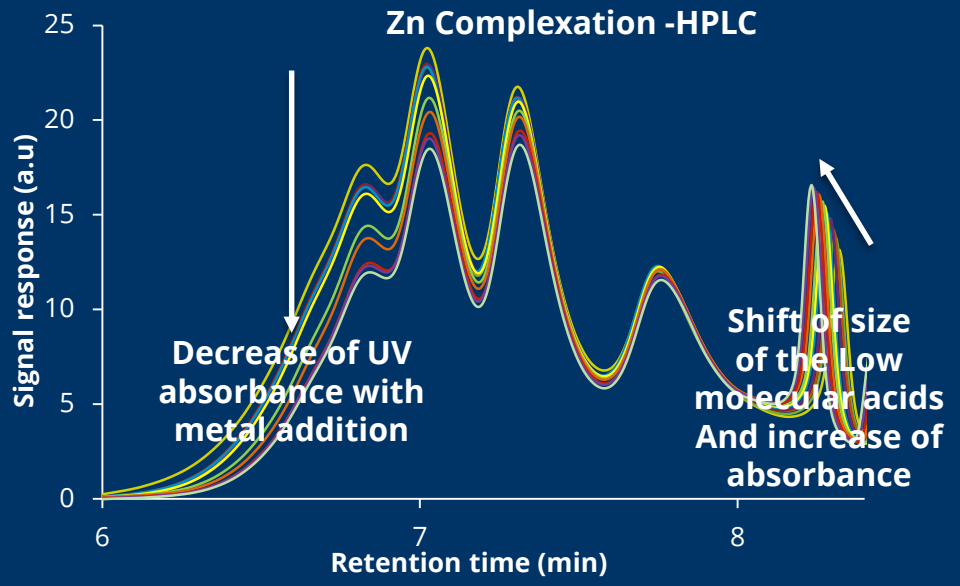
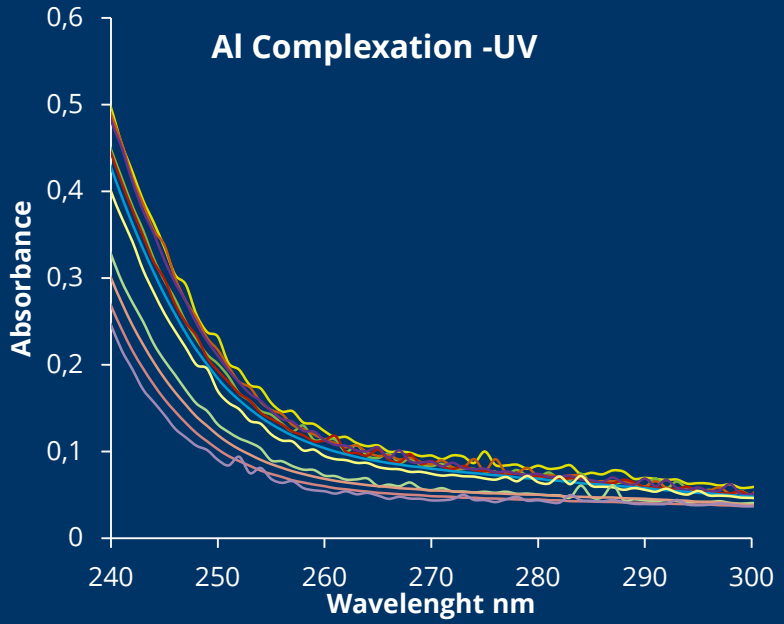
Changes in spectral properties with NOM-metal complexation

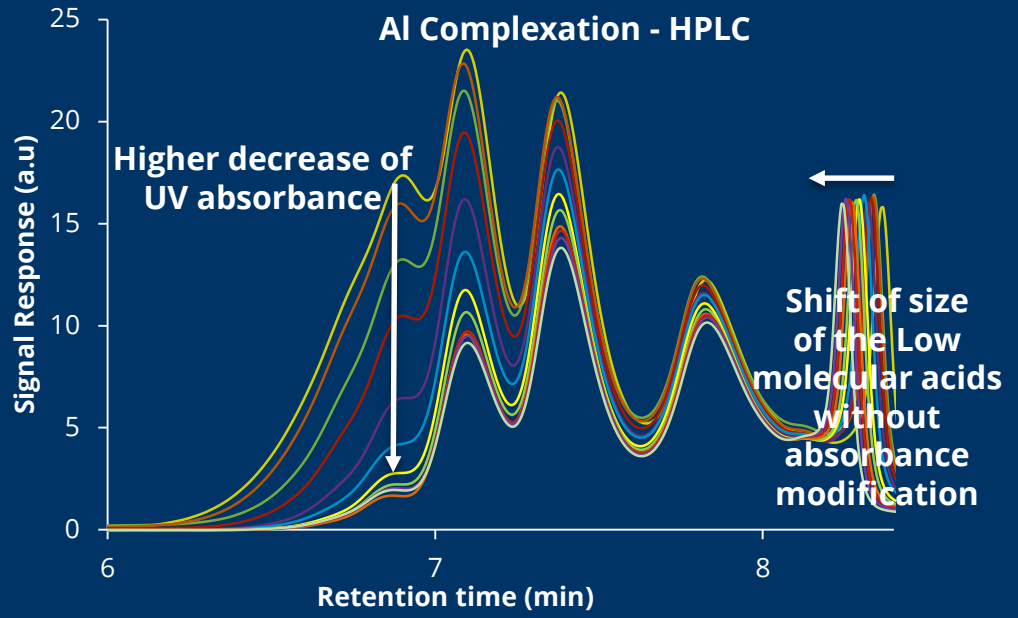
- Cu, Al, Zn, Mn from ~ 0 up to 150 µmol/L (11 samples)





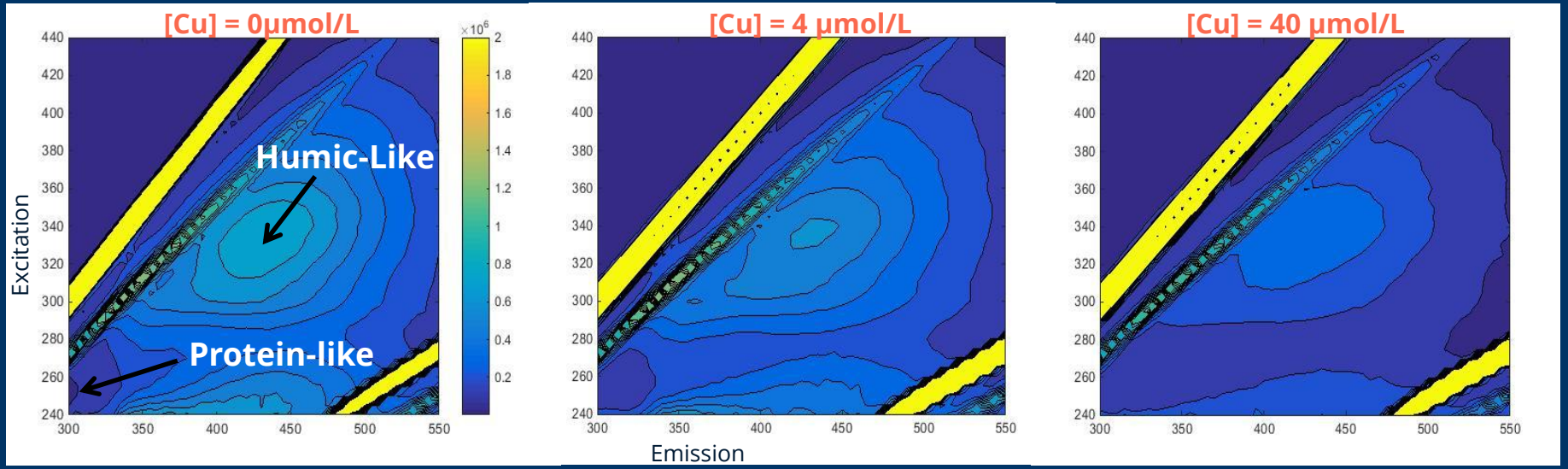
- The quenching of UV absorbance is well documented – not the shift of size





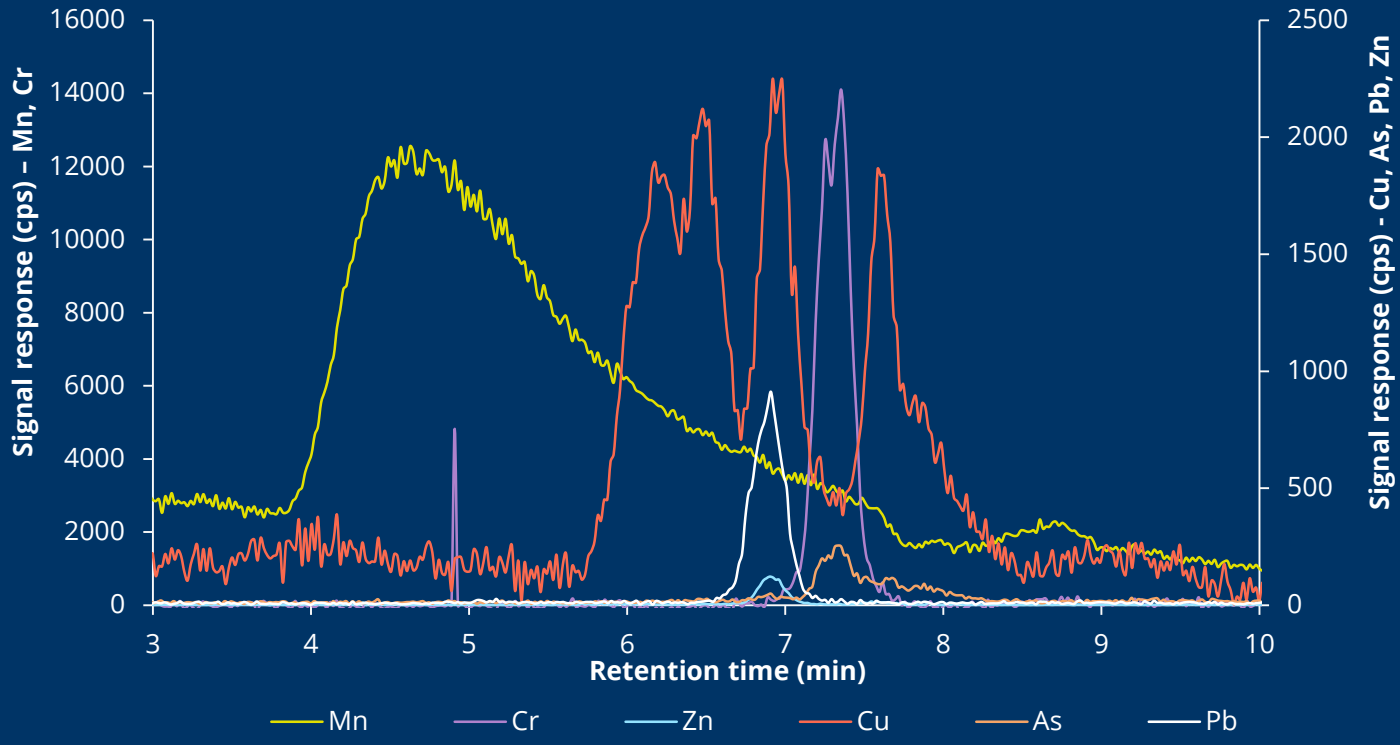
- Different behaviour : Al better complexant than Zn
- The quenching depends on the humic substance molecular weight

Cu complexation - Excitation emission matrix (EEM) fluorescence



- **A decrease in fluoresence intensity with increase in metal concentration**
- **Matrix to be fully treated**

SEC-ICP-MS chromatograph - Andijk raw water, natural metal concentration



Element	Concentration (µg/L)
Mn	23.6
Cr	3.14
Cu	4.25
As	0.70
Pb	0.52
Zn	50.9

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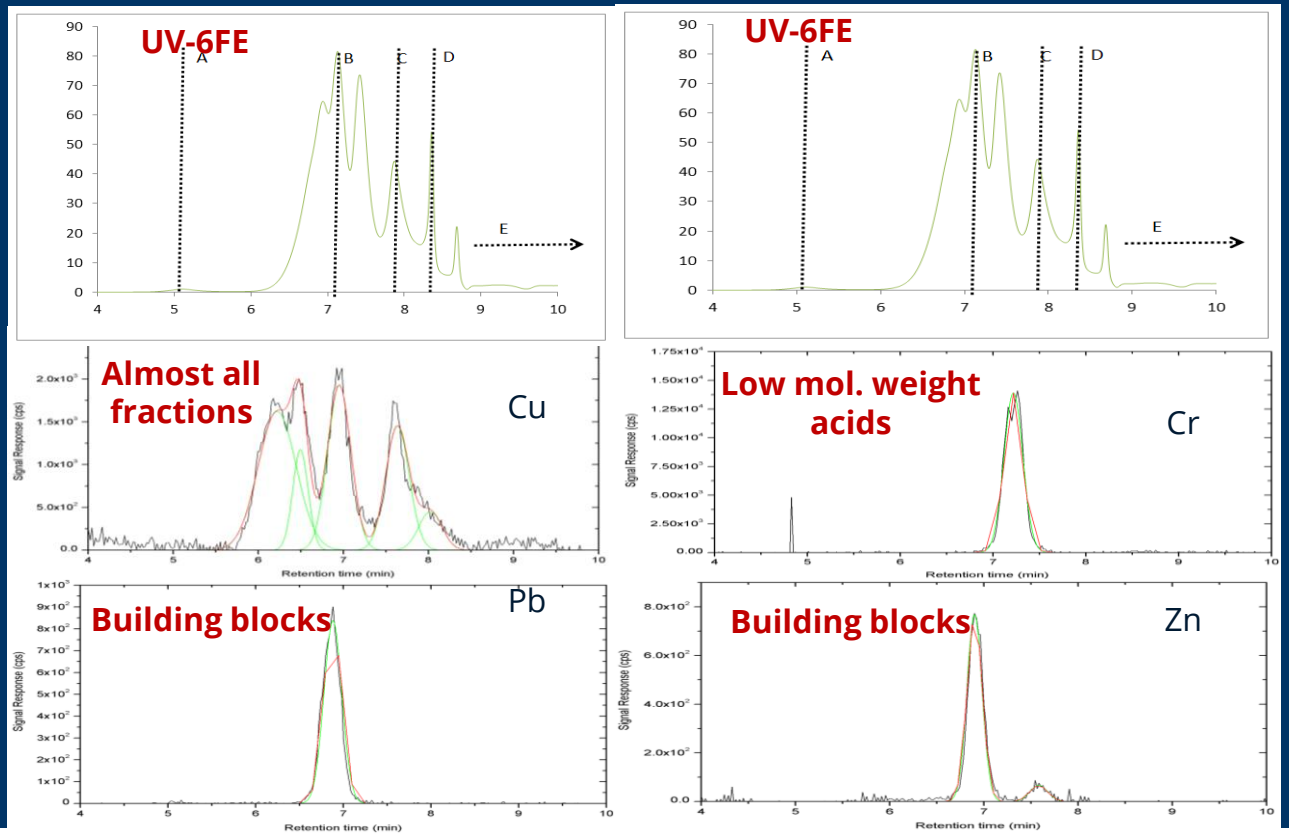
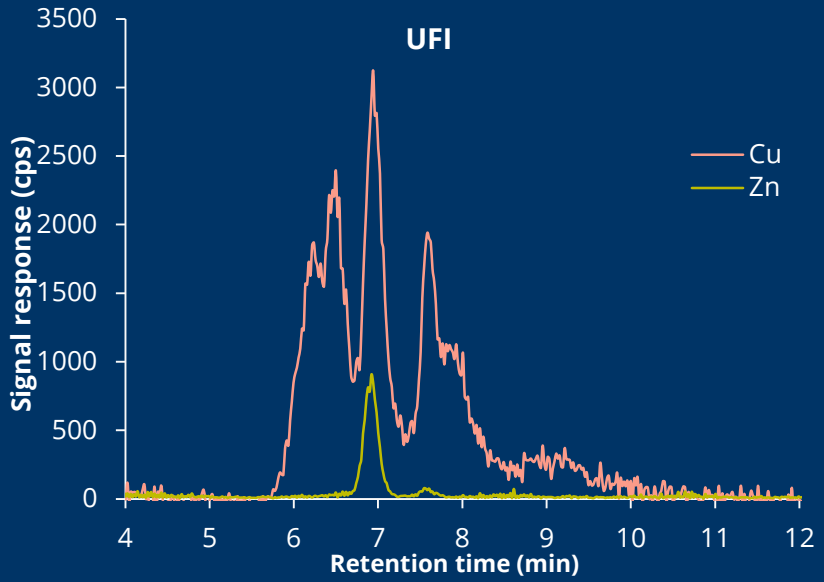
Comparing UV and ICP-MS Chromatographs



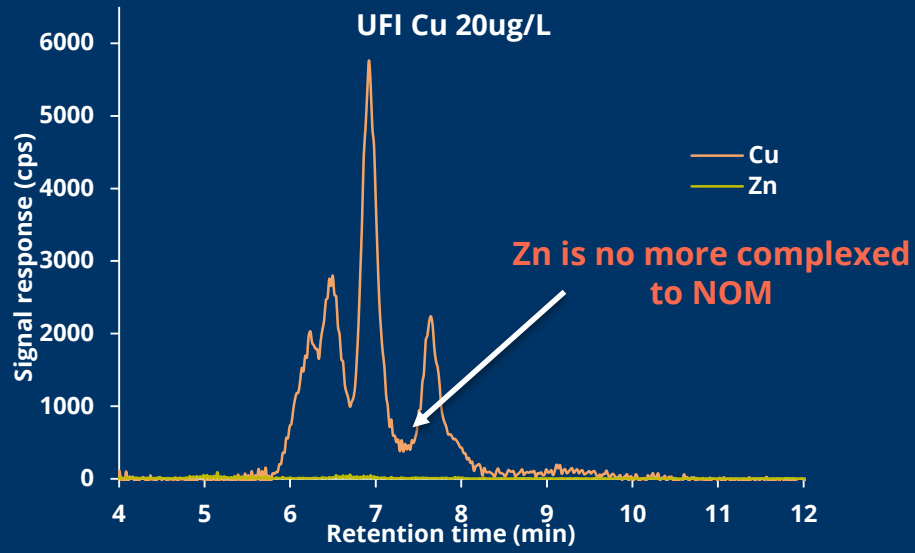
Each metal deplays a peak corresponding to its complexed fraction

Cation competition for binding sites

[Cu] = 4.25 µg/L , [Zn] = 50.9µg/L



Addition of 20 µg/L of Cu



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Conclusions & Perspectives

HPSEC-UV-Fluorescence-ICP-MS → **Effective technique** for **understanding** the **characteristics** of **NOM**, **NOM-metal complexation** & **effect** of **treatment** on each **fraction**

- Quantitative measurement of complexed metals- SEC-ICP-MS
- Well classify the various broad functional groups of my samples; SEC-ICP-MS
- Detailed explanation to the possible quenchings and shifts

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Conclusions & Perspectives

- **Applicability; Impact on drinking water processes**
  - Coagulation
  - Membrane filtration,
  - Lime-soda softening
  - Disinfection by-product formation,
  - Trace metal leaching
  - Ion exchanges (MIEX)
  - Activated Carbon
  - …

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Thank you

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