Method development for on-site freshwater analysis with pre-concentration of nickel via ion-exchange resins embedded in a cafetière system and paper-based analytical devices for readout

Mila Sari[1], Samantha Richardson[2], Will Mayes[3], Mark Lorch[1], Nicole Pamme[1,4]

[1]*Department of Chemistry and Biochemistry, University of Hull, UK*
[2]*Department of Biological and Marine Science, University of Hull, UK*
[3]*Department of Geography, Geology, and Environment, University of Hull, UK*
[4]*Department of Materials and Environmental Chemistry, Stockholm University, Sweden*

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Heavy metals in water environments

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The mean concentration of **heavy metals** in global rivers and lakes has been increasing since 1970

→ **Monitoring required**

Limitations of current monitoring methods:

- Not on-site
- No real-time result
- Require trained personnel and laboratory environment

Citizen Science advantages:

- Potential for wider spatio-temporal monitoring
- Potential to produce more data → better mapping
- Reduce cost (travel, *etc.*)

Paper-based analytical devices for water analysis

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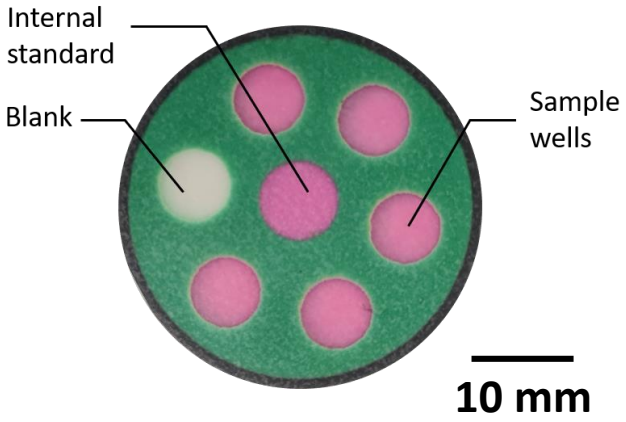
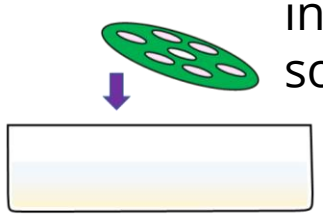
What is microfluidic paper-based analytical device (μPAD)?



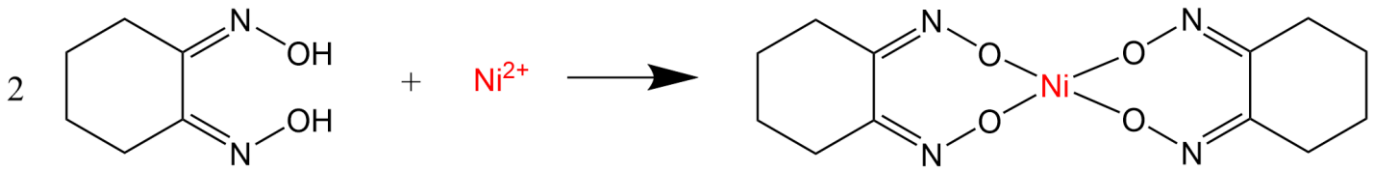
Method



μPAD dipped into sample solution

Picture taken for further analysis

Chemical reaction for Ni^{2+} detection



Advantages of μPADs in water analysis:

✓Simple
✓Affordable
✓Potential for Citizen Science

Challenge: for heavy metal analysis, preconcentration is needed

M Almeida et al., Talanta, **2018**, *177*, 176. | A Lace, J Cleary, Chemosensors, **2021**, *9*, 60. | W Alahmad, *et.al.*, Biosens Bioelectron, **2021**, *194*, 113574.

Cafetière-based pre-concentration with IE resin

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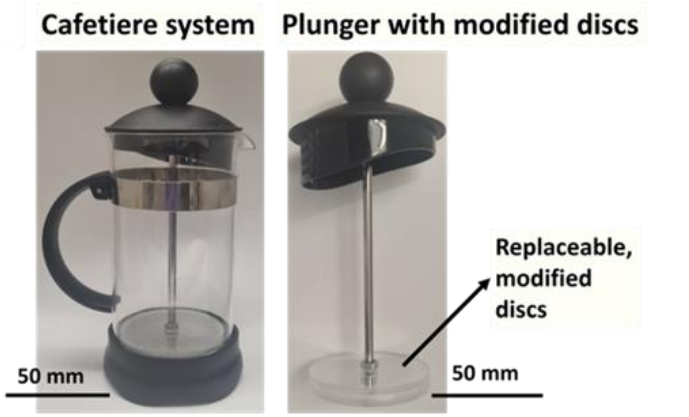
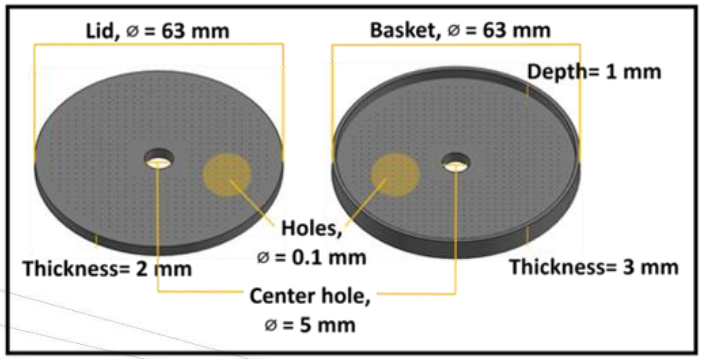
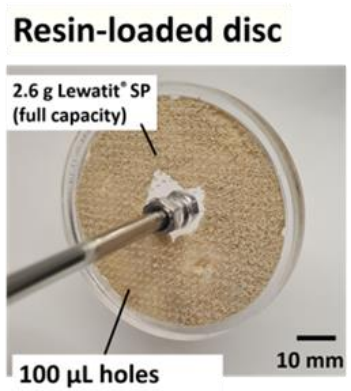
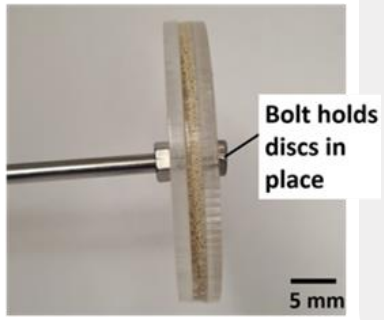
We aim to develop a pre-concentration workflow with ion exchange (IE) resin to be coupled with µPADs for heavy metal analysis to enable citizen led monitoring

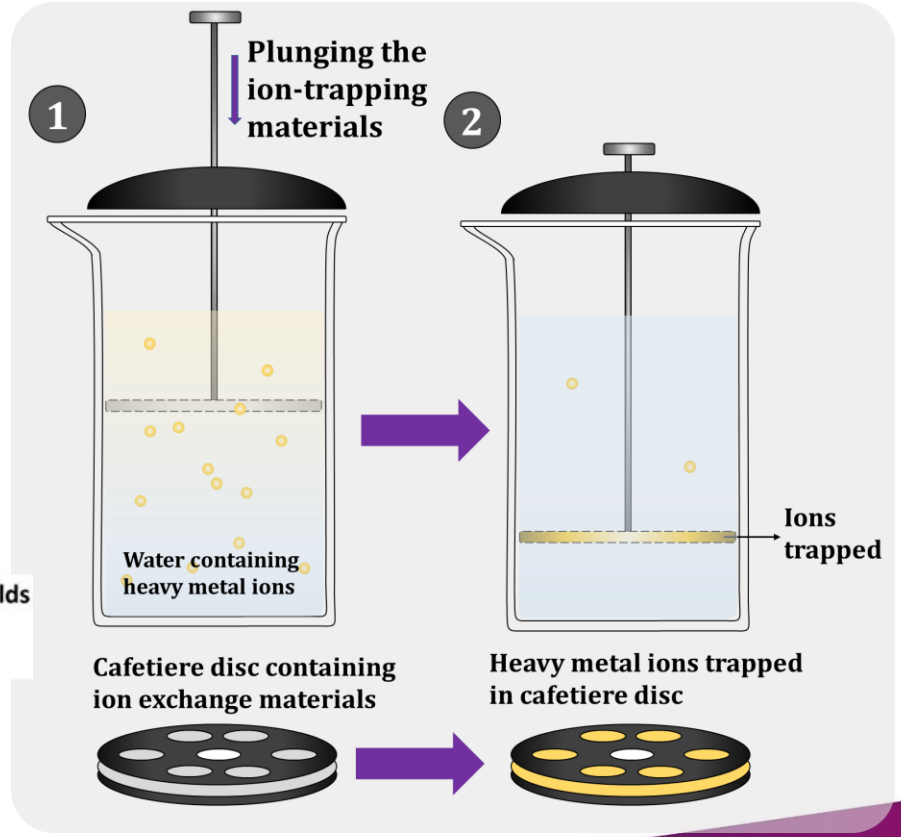


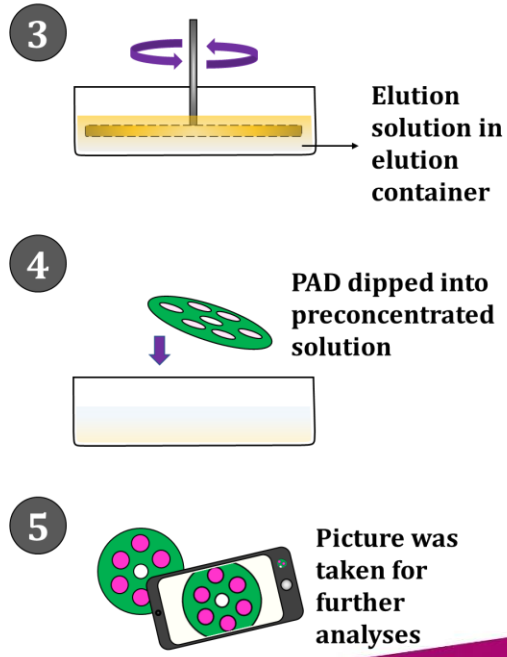




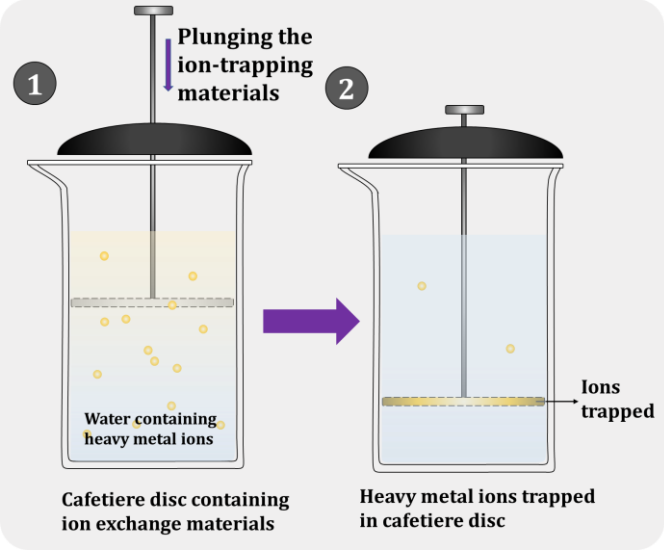


Method:





Key results – Ni^{2+} adsorption and elution



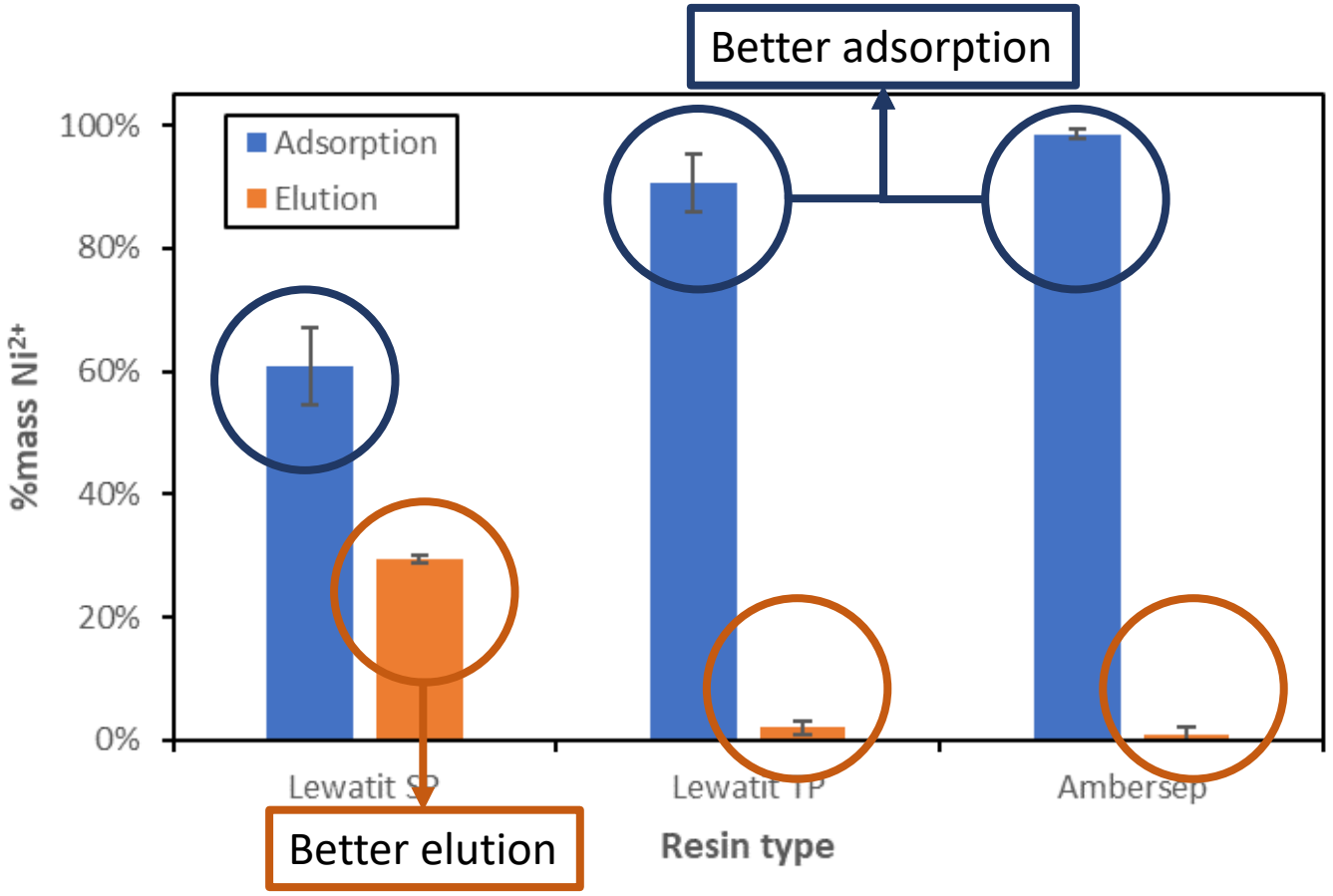
Experimental conditions

Adsorption

Sample volume: 300 mL
Initial Ni^{2+} conc.: 0.8 mg L^{-1}
Resin mass: 2.60 ± 0.02 g
Mixing time: 5 min

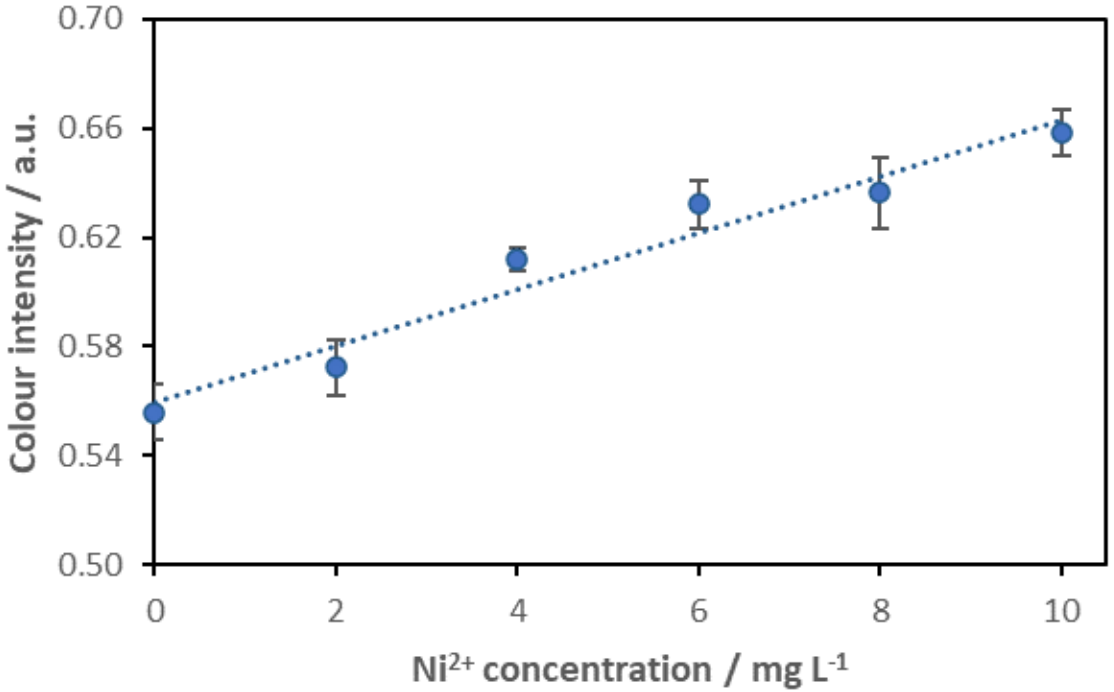
Elution

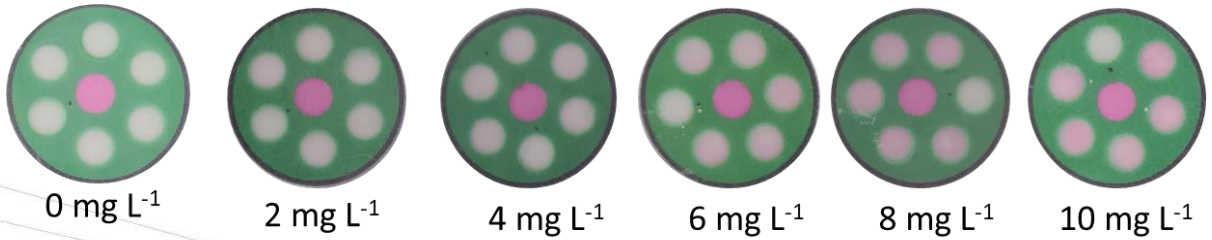
NaCl concentration: 5 M
NaCl volume: 30 mL
Time: 1 min



- Lewatit® TP 207 and Ambersep® M4195 showed better Ni^{2+} adsorption performance
- Lewatit® SP showed better elution performance

Key results – Ni^{2+} pre-concentration



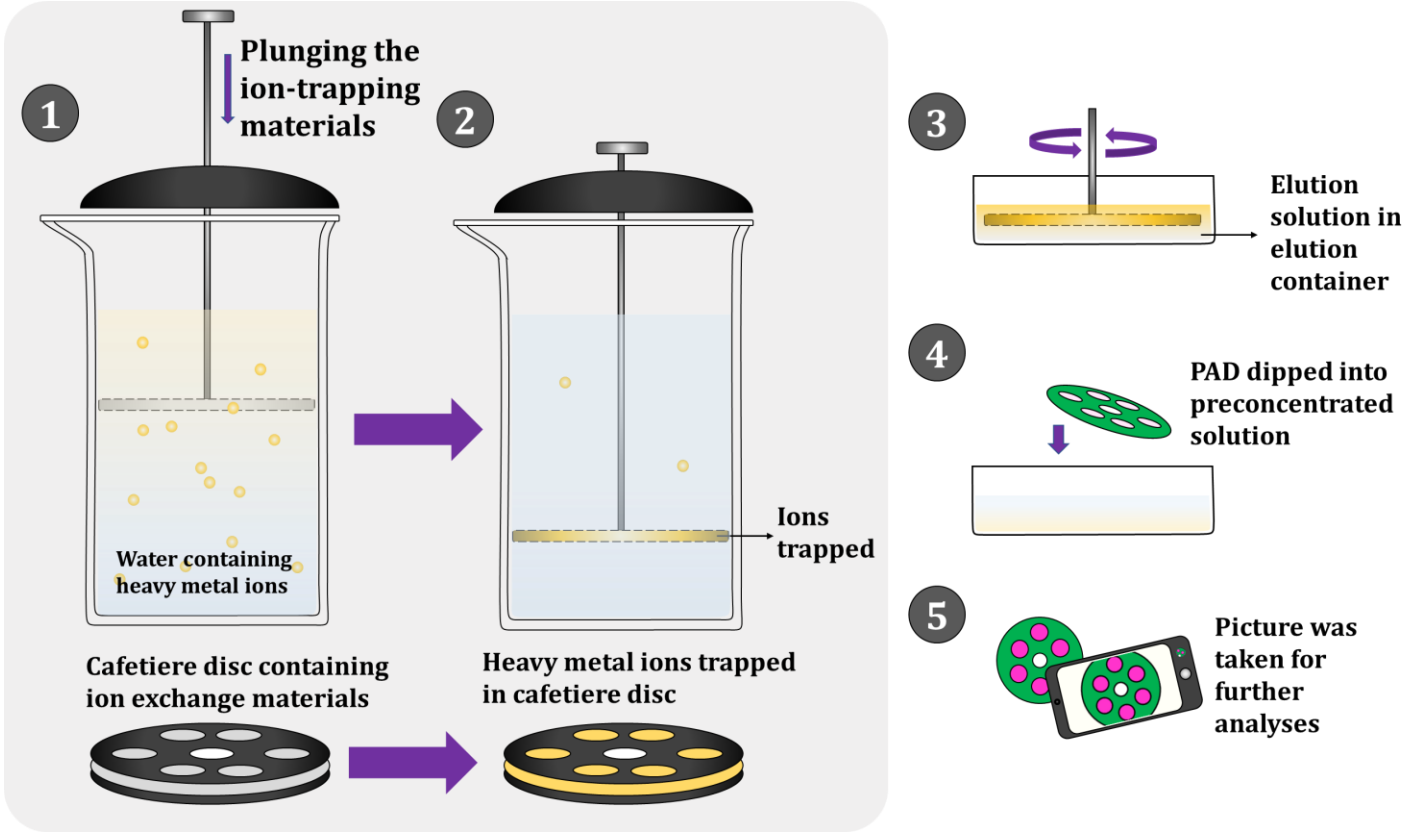


Initial conc. / mg L^{-1}	Final conc. / mg L^{-1}	Pre-concentration factor
0 ± 0.1	0 ± 0.1	0
2 ± 0.3	6 ± 0.3	3
4 ± 0.3	9 ± 0.2	2
6 ± 0.2	12 ± 0.1	2
8 ± 0.2	13 ± 0.1	2
10 ± 0.1	18 ± 0.1	2

→ developed workflow increased Ni^{2+} concentration by up to 3 times

Conclusion

- developed **rapid** (<10 min) pre-concentration method
- pre-concentration with **non-hazardous** chemicals → suitable for **citizen science**
- pre-concentration can be **integrated** with detection workflow with **µPAD**
- **further study** on optimisation to detect environmentally-relevant levels of Ni^{2+}



Thank you for your attention

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