Ecological Flow Conditions as Drivers of Seasonal and Vertical–Horizontal Distribution of Reservoir Microplastics

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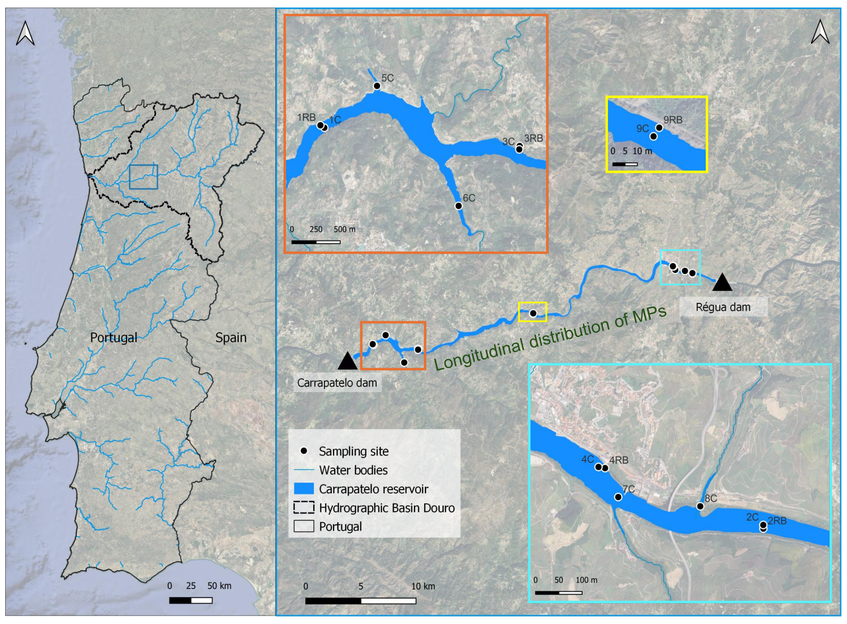
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Introduction

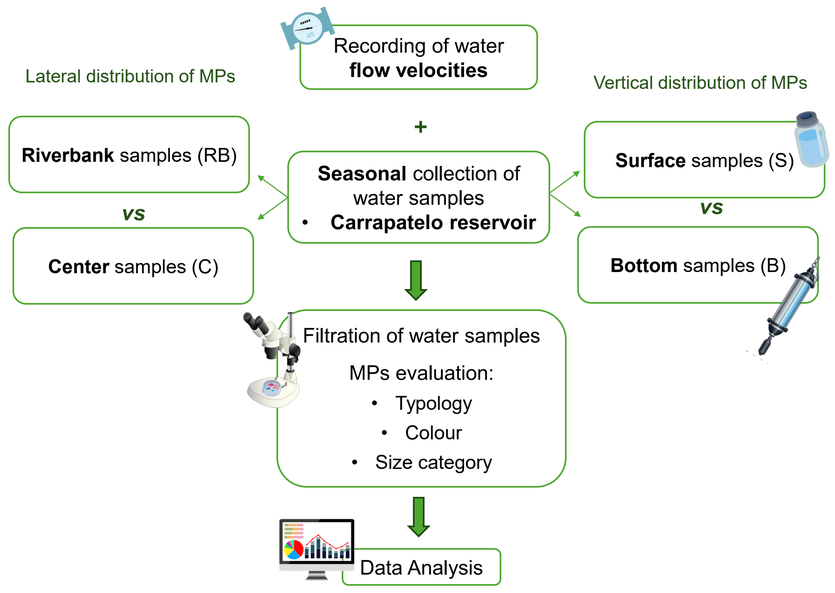
- **Reservoirs** are vital freshwater lentic ecosystems, that provide water for human consumption;
- **Microplastics** (MPs) are **emerging contaminants** with ecological and potential human health impacts that have been found in Portuguese and worldwide reservoirs[1,2];
- **Seasonality** and **flow conditions** can influence **spatial-temporal** distribution of MPs[3,4].

Aim

Assess the occurrence and **spatial-temporal distribution** of **MPs** in a Portuguese reservoir subject to different ecological **flow regimes**



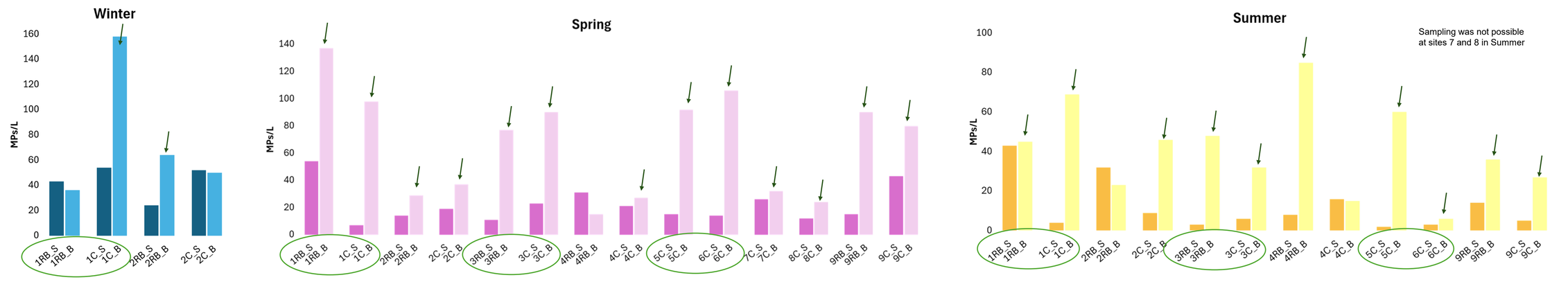
Material and methods



Results and Discussion

MP abundance:

- Except for Summer, sampling site **1** consistently recorded the **highest concentration** of MPs: at 1RB_B in Spring (137 MPs/L) and Autumn (126 MPs/L), and at 1C_B in Winter (158 MPs/L – highest abundance observed).



In all season, the Dark bars = Surface (S) and the Light bars = Bottom (B)

Longitudinal analysis revealed:

- **Higher abundance** of MPs in the **downstream** section (sampling sites 1, 3, 5, and 6; consistent with other studies[1,5]), **near the Carrapatelo dam**, compared to the section immediately downstream of the Régua dam (sampling sites 2, 4, 7, and 8);
- Intermediate concentrations of MPs at sampling site 9.

MPs from upstream sections of Douro River **retained** by Régua dam ⇔ Inputs of MPs from other pollution sources between the two dams

Vertical analysis:

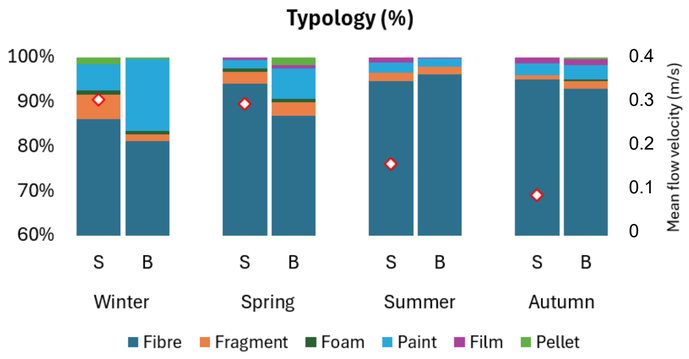
- **B** samples consistently exhibited **higher MP abundance** than S samples across all seasons;
- **Autumn** exhibited **more homogeneity** between S and B concentrations of MPs, associated with the lowest mean flow velocities recorded (0.09 m/s).

Lateral analysis:

- **No consistent pattern** was observed between C and Rb samples in response to variations in flow velocities.

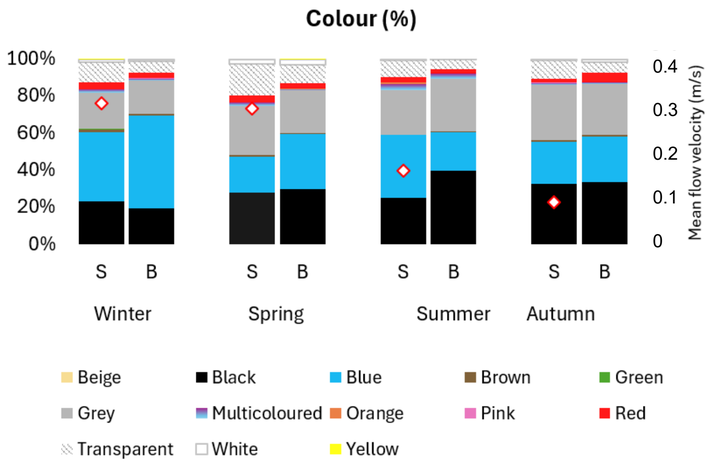
MP characteristics:

- It varied little between sampling sites and sampling periods;
- However, **Winter and Spring** revealed **greater variation between S and B** samples. These sampling periods were characterized by **higher mean flow velocities** (0.31 m/s and 0.29 m/s, respectively), while Autumn presented the lowest mean flow velocity value (0.09 m/s);
- Patterns were similar to those found by other studies in reservoirs[1,5,6].



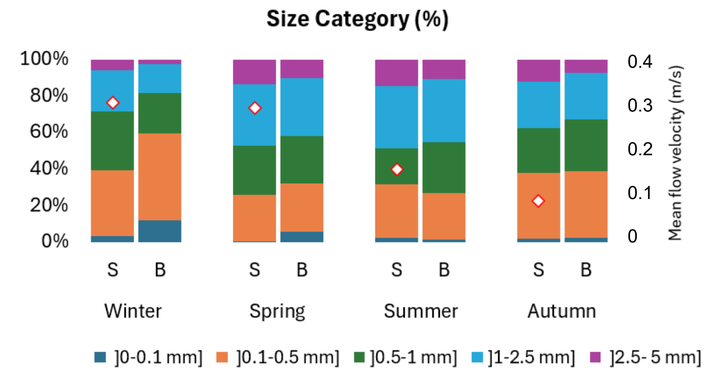
Typology:

- **Fibres dominated** across all sampling sites and periods regardless of depth (> 81 %);
- However, in comparison to other seasons, Winter and Spring exhibited higher concentrations of paint particles, especially in B samples (16 % and 7 %, respectively) (particularly at site 1C_B).



Colour:

- **Blue**, **black**, and grey were the **dominant colours** at all sampling sites and periods (together accounting for > 74 %);
- Transparent particles were also commonly found, especially in S samples in Spring (17 %).



Size category:

- The majority of MPs sampled were within the **]0.1-0.5 mm]** and **]1-2.5 mm]** size ranges (> 26 % and > 22 %, respectively);
- MPs of **larger** and **smaller** sizes were the **least abundant** across all sampling sites;
- The highest occurrence of smaller particles]0-0.1 mm] was recorded at 1C_B in Winter and Spring, corresponding to a greater abundance of paint particles.

Conclusion

Expected scenario

Higher flow conditions ⇩ Vertical mixing and homogenous distribution of MPs

But... **Influence of other factors**

- Increased runoff during rainy seasons
- Sediment resuspension (especially during high-flow periods)
- Variability in polymer densities

Barrier effect of Régua dam (upstream) ⇒

Inputs from anthropogenic activities (e.g. nautical activities, urban and industrial discharges, agriculture, etc) ⇒

- Greater heterogeneous distribution of MPs in Winter and Spring (high flow conditions)
- Greater homogeneous distribution in Autumn (low flow conditions)
- Higher abundance of MPs in bottom samples
- Accumulation of MPs near Carrapatelo Dam (site 1)

⇒ **Key knowledge** for implementing **monitoring frameworks** and **source-based mitigation strategies**

References

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