Spatial distribution of dissolved oxygen at rapid hydraulic structures as an indicator of local-scale processes

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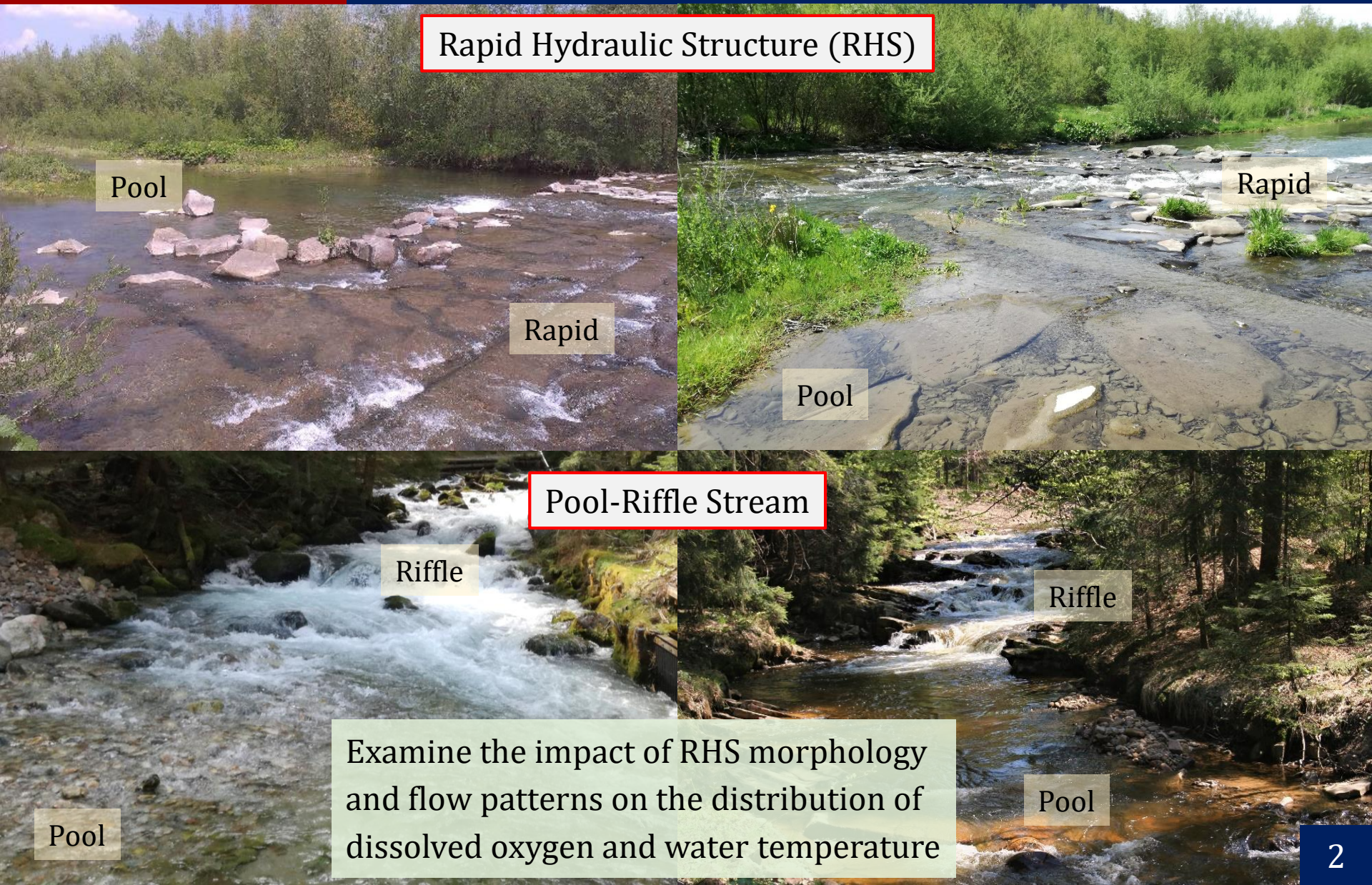

Examine the impact of RHS morphology and flow patterns on the distribution of dissolved oxygen and water temperature

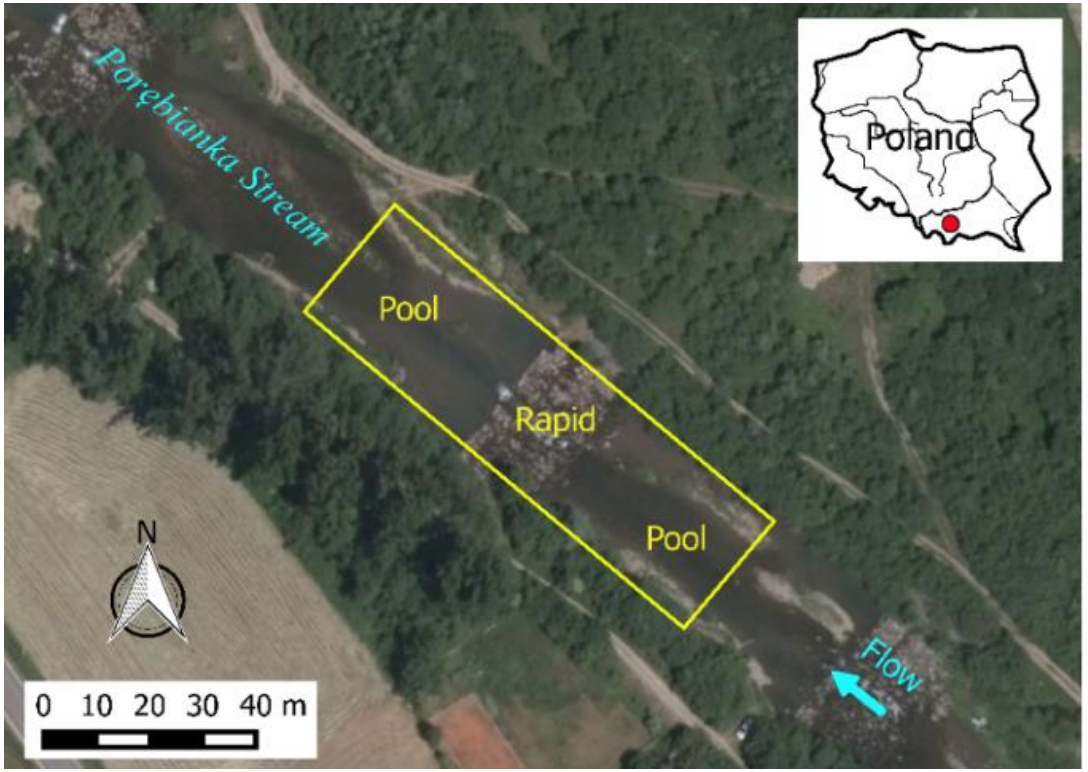

Fig. 1 Study site – Porębianka Stream

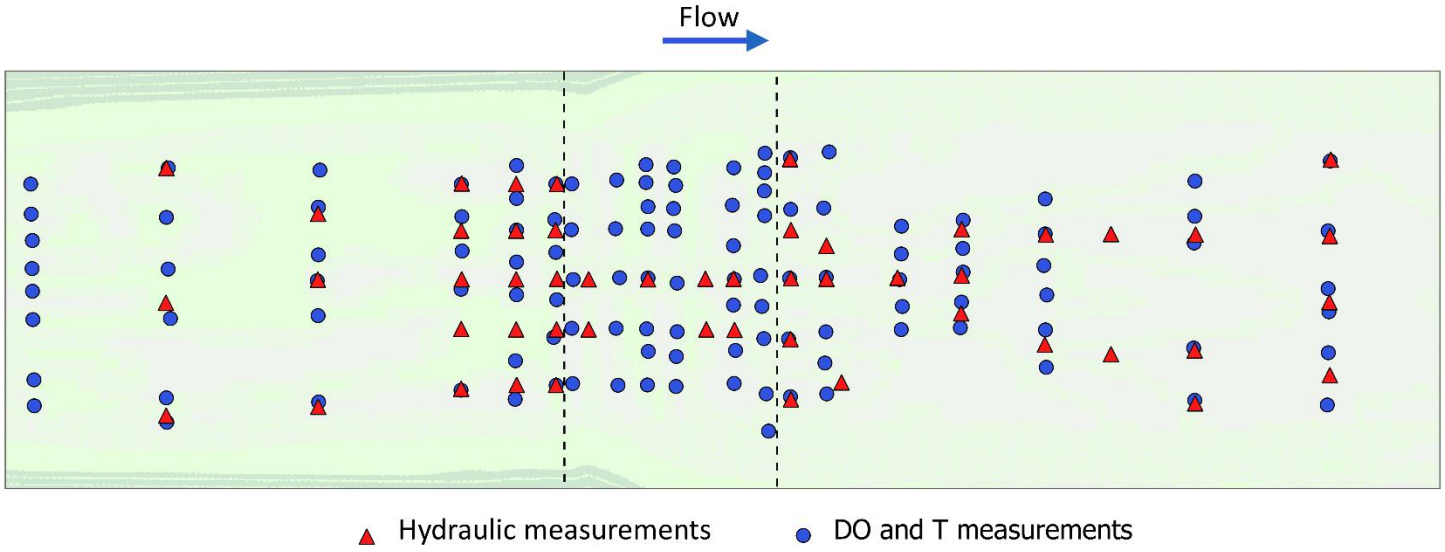

Fig. 2 Study reach with the distribution of measurement points.

Shear velocity

$$U^* = \frac{a}{5.75}(m \cdot s^{-1})$$

Shear stress

$$\tau = \rho \cdot (U^*)^2 \ (N \cdot m^{-2})$$

Reynolds number

$$Re = \frac{V_{av} \cdot \mathrm{h}}{\upsilon}$$

Froude number

$$Fr = \frac{V_{av}}{\sqrt{\mathrm{gh}}}$$

a – slope of a straight line ($y = a\mathrm{h} + b$)
h – height above the river bed where the velocity measurement was performed
b – equation free term
ρ – water density (1000 kg·m^{-3})
V_{av} – depth averaged velocity (m·s^{-1})
υ – kinematic viscosity (m^2·s^{-1})
h – water depth (m)
g – gravitational acceleration (m·s^{-2})

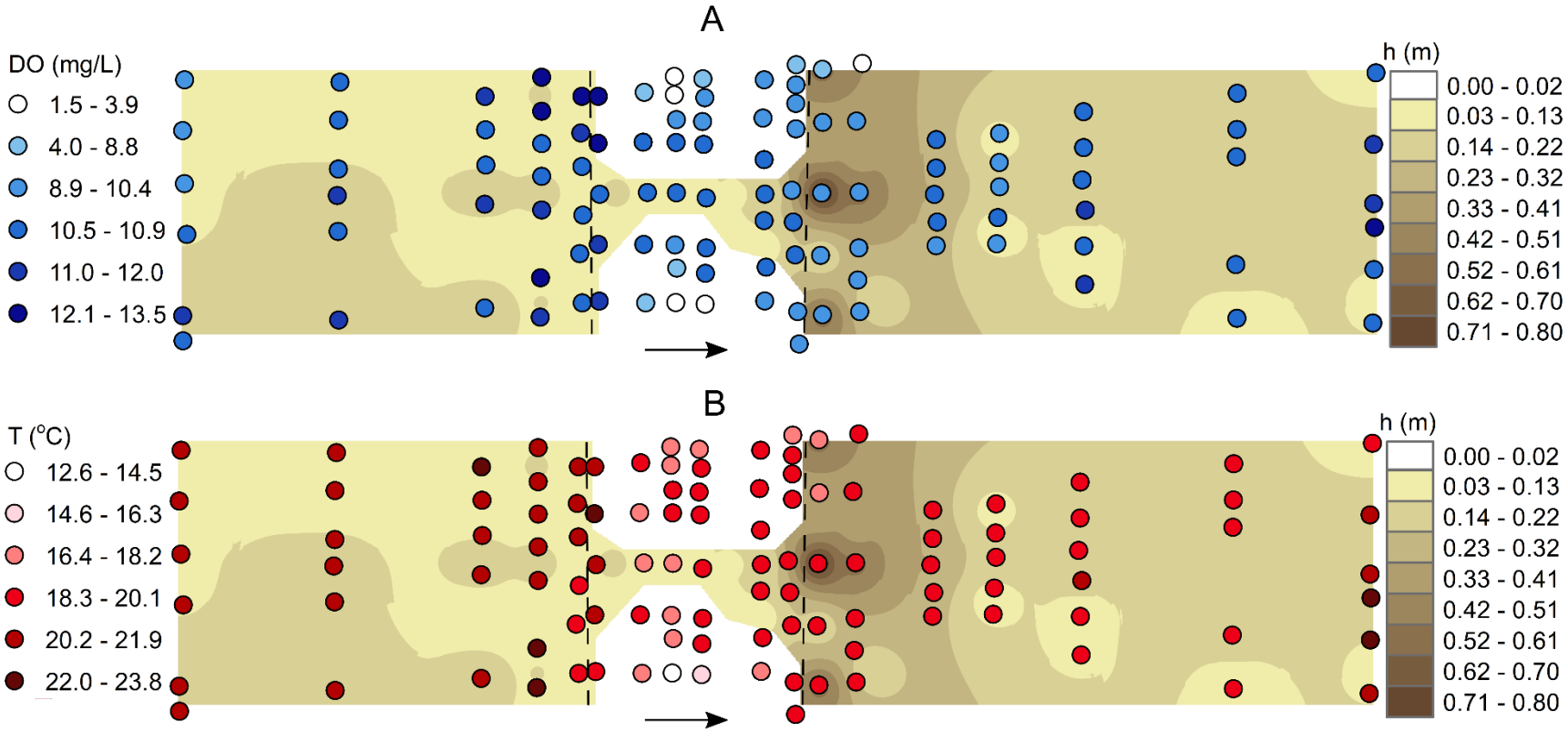

Fig. 3 The bathymetry of hydraulic structure (Q=1.6 $m^3 \cdot s^{-1}$) with DO concentrations data (A) and water temperature data (B).

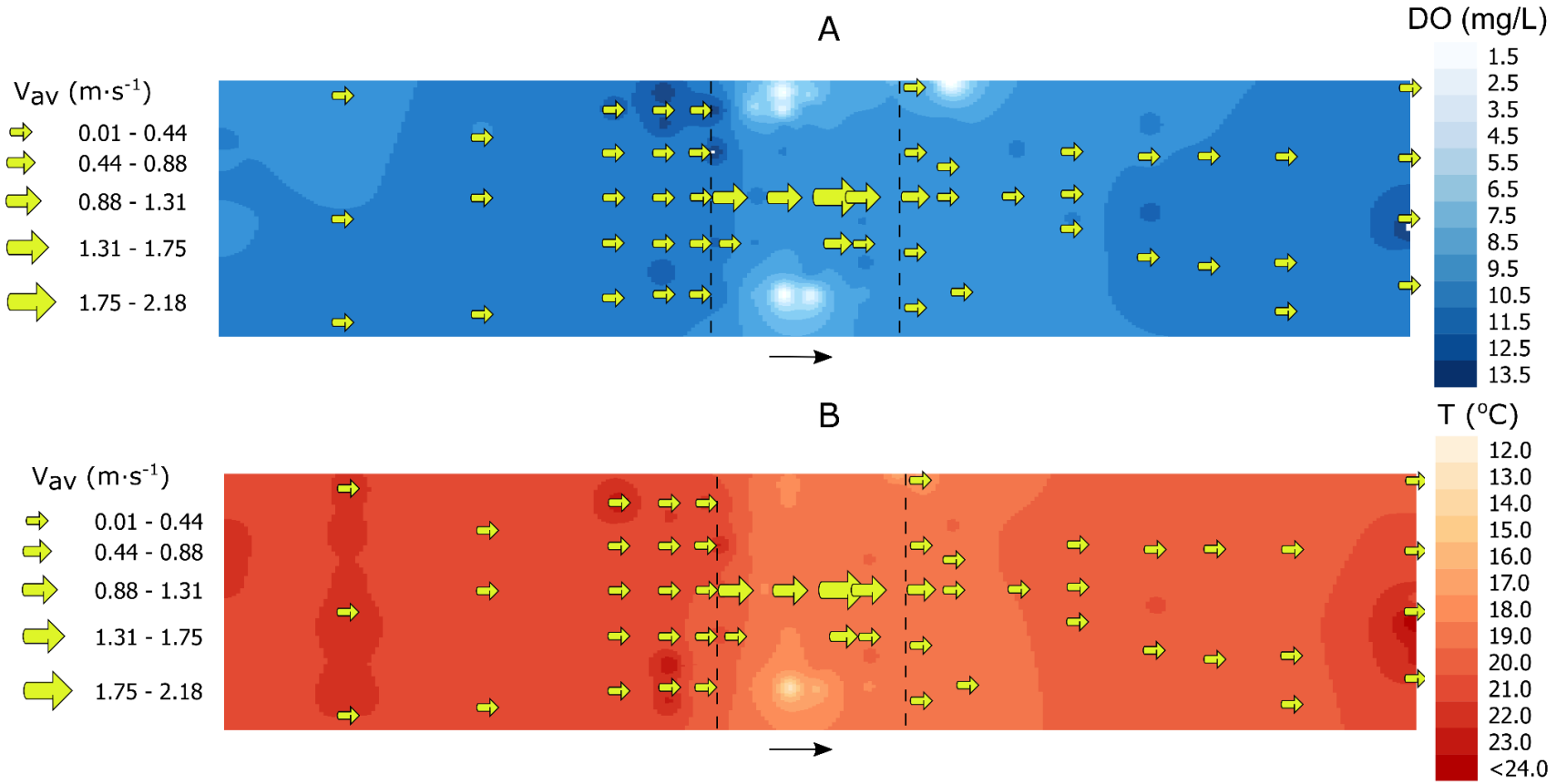

Fig. 4 Contour maps of dissolved oxygen concentration (A) and water temperature (B). Arrows represent the depth averaged velocity at individual measurement points.

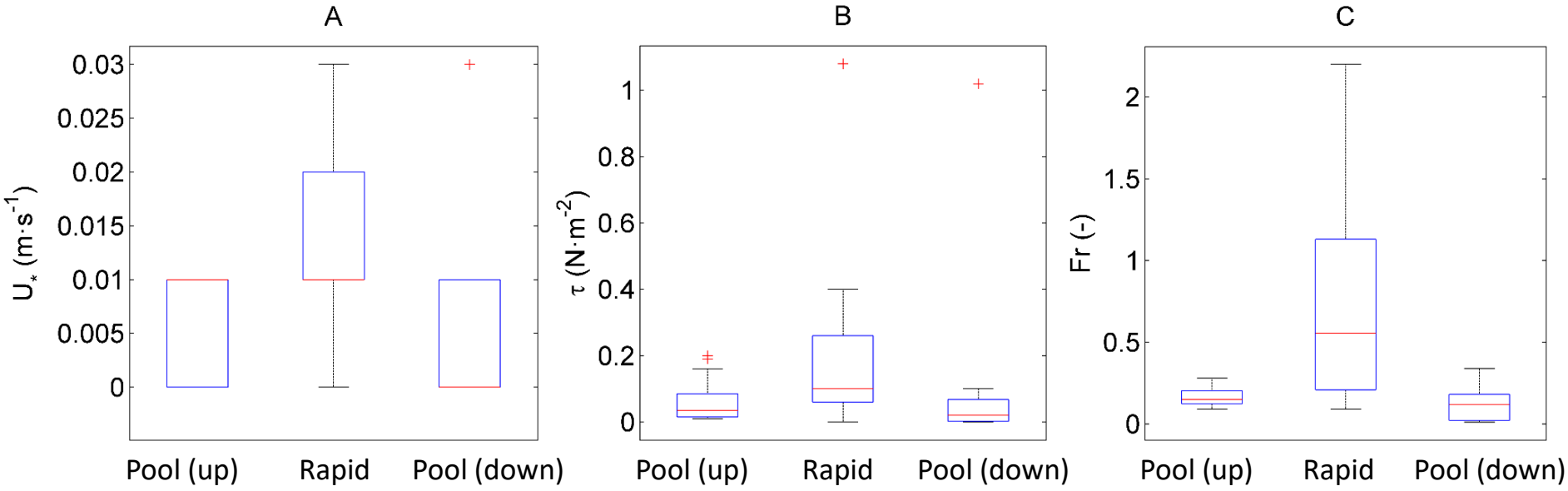

Fig. 5 Hydraulic characteristics along the structure: (A) shear velocity, (B) shear stress, (C) local Froude number.

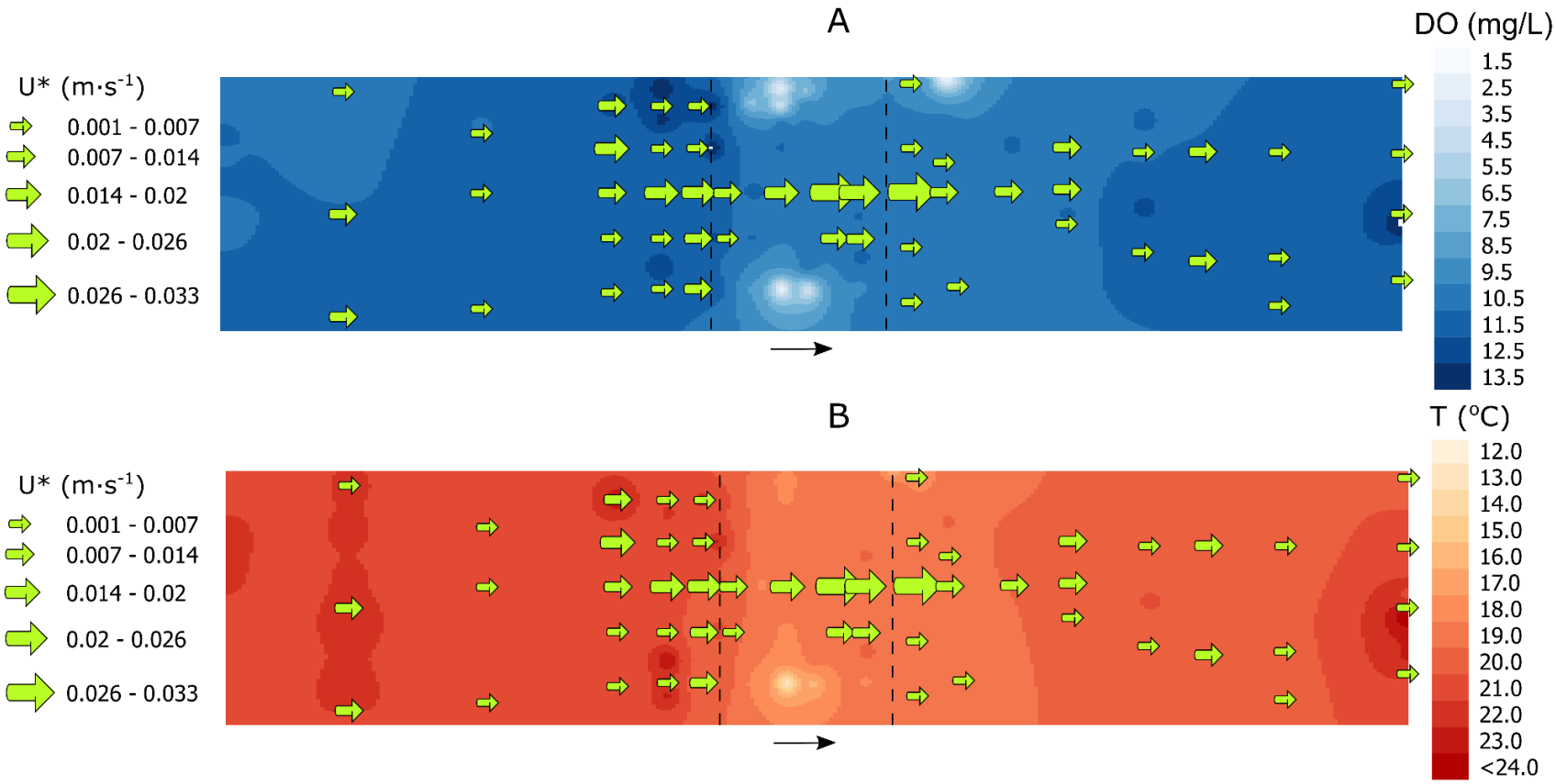

Fig. 6 Contour maps of dissolved oxygen concentration (A) and water temperature (B). Arrows represent the shear velocity at individual measurement points.

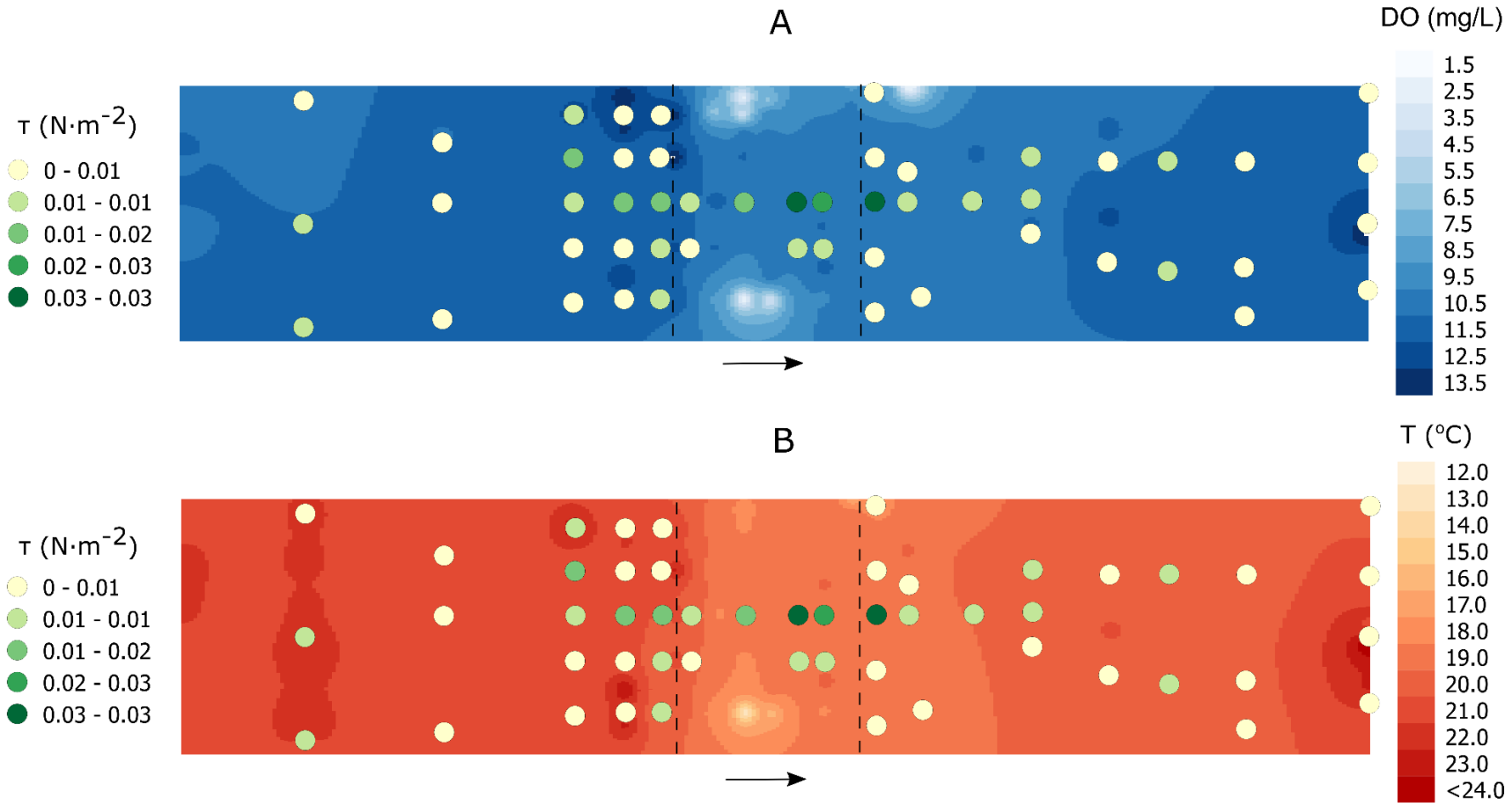

Fig. 7 Contour maps of dissolved oxygen concentration (A) and water temperature (B). Dots represent the shear stress at individual measurement points.

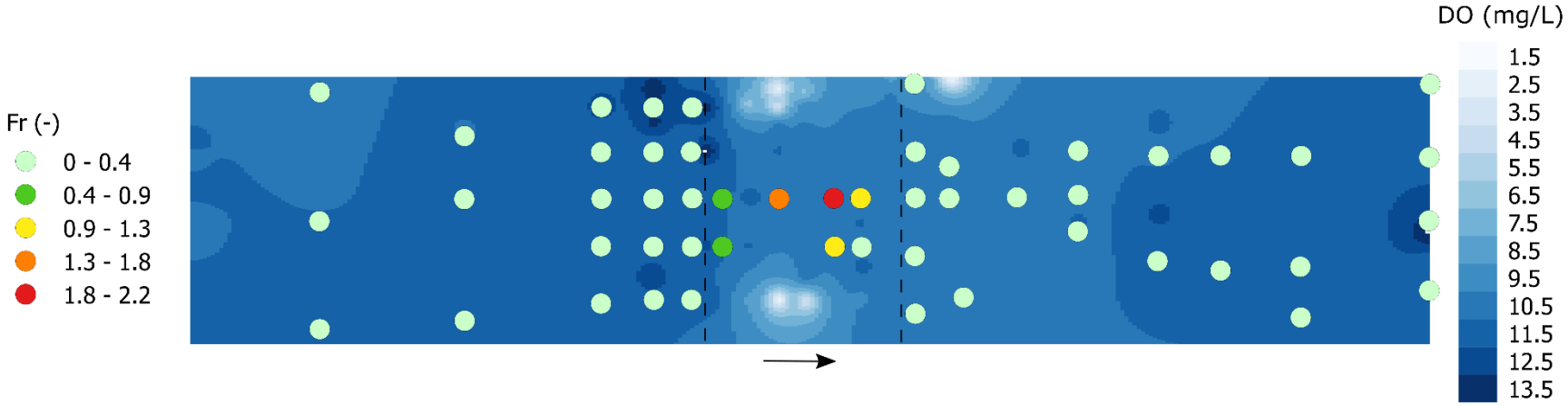

Fig. 8 Contour map of dissolved oxygen concentration. Dots represent Froude number at individual measurement points.

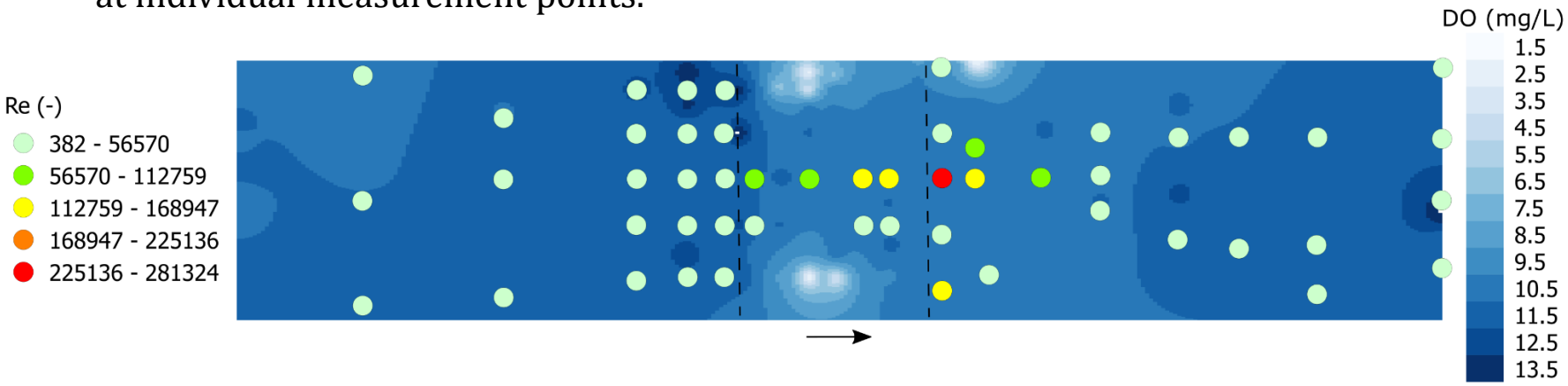

Fig. 8 Contour map of dissolved oxygen concentration. Dots represent Reynolds number at individual measurement points.

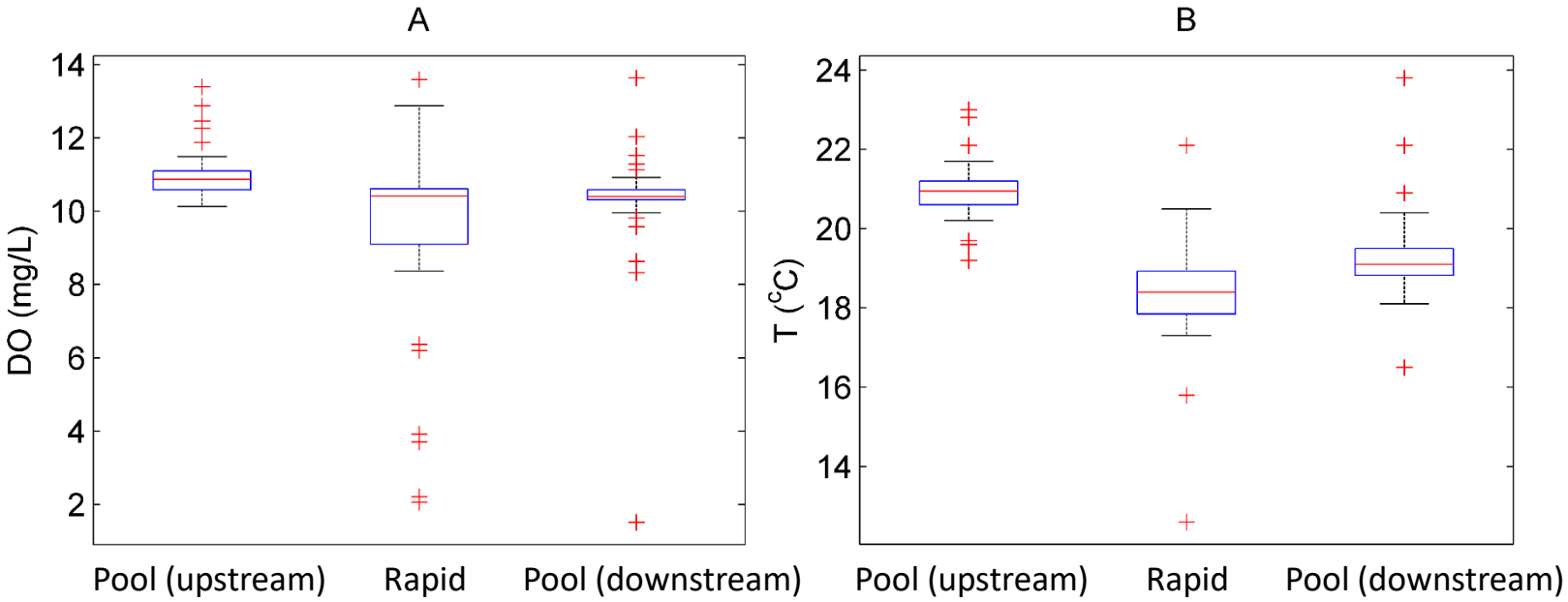

Fig. 9 Boxplots: (A) dissolved oxygen concentration, (B) water temperature.

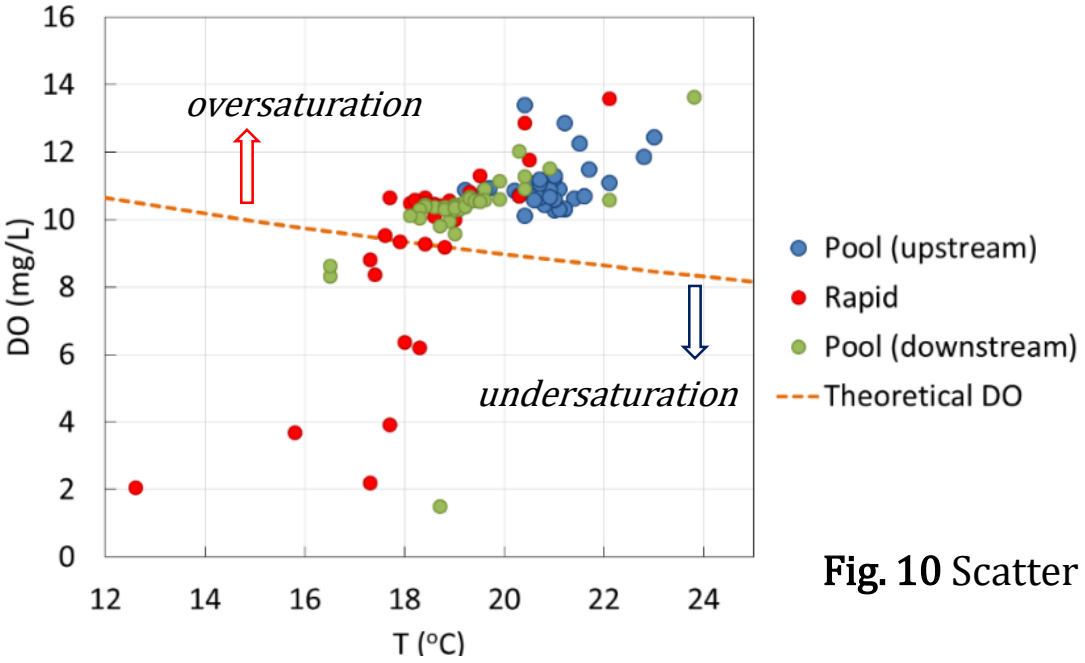

Fig. 10 Scatter plot of DO and water temperature.

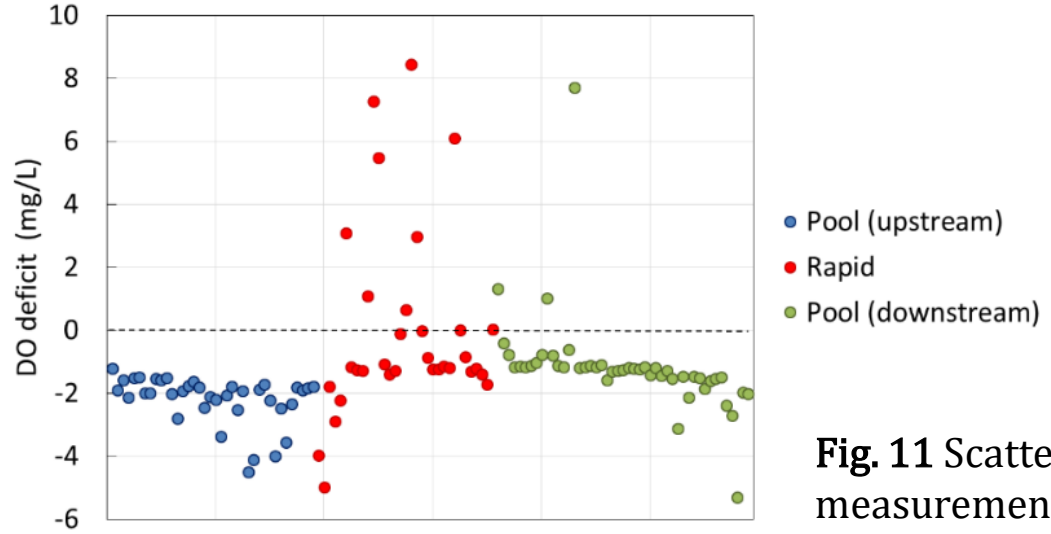

Fig. 11 Scatter plot of DO deficit at individual measurement points.

- RHS are characterised by great spatial heterogeneity of oxygen and thermal conditions;

- Distribution of dissolved oxygen and water temperature is strongly associated with flow paths and morphological features of the structure:
  - the highest concentrations of oxygen occur in pools,
  - the lowest DO concentrations occur in pore spaces at the rapid ramp;

- The study of site-specific characteristics might help to understand multi-scale processes in rivers and improve restoration practices in mountain streams.

Thank you for your attention